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**Human and Ecosystem Well-being**



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## Introduction

On September 21-22, 2015, 6th International Scientific Conference “Quality of Life 2015. Human and Ecosystems Well-being” was held in Wrocław.

The conference was a part of the cycle of the conferences on the topic of quality of life that have been organized by the Department of Statistics (Wrocław University of Economics) since 1999. The aim of the cycle is to participate in the still rising all over the world wave of scientific studies on quality of life: ethical background and definitions of quality of life, investigating (how to measure it), presenting the results of differences of quality of life over time and space, its interdependences with natural environment, mathematical methods useful for the methodology of measuring quality of life and finally – possible methods of improving it. The conferences are meant to integrate the Polish scientific community doing research on these topics as well as to make contacts with foreign scientists.

This year our honorary guest was Professor Filomena Maggino, past President of International Society for Quality-of-Life Studies (ISQOLS), who presented a plenary lecture.

We hosted about 30 participants, among them scientists from Spain, Romania, Italy and Japan. We had 24 lectures on such a variety of topics as carbon footprint and mathematical properties of some estimators. The common background of all of them was to better comprehend, measure and possibly to improve the quality of humans' life.

The present volume contains the extended versions of some selected lectures presented during the conference. We wish to thank all of the participants of the conference for co-creating very inspiring character of this meeting, stimulating productive discussions and resulting in some potentially fruitful cooperation over new research problems. We wish also to thank the authors for their prolonged cooperation in preparing this volume, the reviewers for their hard work and for many valuable, although anonymous, suggestions that helped some of us to improve their works.

Finally, we wish to thank the members of the Editorial Office of Wrocław University of Economics for their hard work while preparing the edition of this volume, continuous kindness and helpfulness exceeding their duties of the job.

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**SUBJECTIVE PERCEPTION OF QUALITY OF LIFE –  
MULTIDIMENSIONAL ANALYSIS  
BASED ON THE FUZZY SETS APPROACH**

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**SUBIEKTYWNE POSTRZEGANIE JAKOŚCI ŻYCIA –  
WIELOWYMIAROWA ANALIZA  
NA PODSTAWIE PODEJŚCIA WYKORZYSTUJĄCEGO  
ZBIORY ROZMYTE**

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**Summary:** The study presents a multidimensional approach to an analysis of subjective assessment of the quality of life using the fuzzy set theory. The analysis uses the survey data from “Social Diagnosis” research conducted in 2013. It includes 16 items relating to the evaluation of satisfaction with particular aspects of life. Each of these items, measured on a 7-grade scale, is converted into a  $[0, 1]$  interval by using a membership function. To aggregate items into synthetic indicators the study employs Betti and Verma weighting procedure taking into account differentiation of items and the correlation among them. To assess the analyzed phenomenon in the whole population and selected sub-populations some summary indices are computed. For this purpose the counterparts of incidence, depth and inequality measures applied in poverty analysis are proposed. Such an approach enables the evaluation of life satisfaction in the whole sample of individuals. It is found that Poles were best satisfied with social aspects and worst – with environmental aspects. Moreover women were slightly worse-off than men and a better education corresponded to a more positive quality of life perception.

**Keywords:** quality of life, fuzzy set approach, multidimensional data analysis.

**Streszczenie:** W pracy podjęto temat wielowymiarowej analizy subiektywnego postrzegania jakości życia z zastosowaniem teorii zbiorów rozmytych. W analizie wykorzystano dane z badania „Diagnoza Społeczna” przeprowadzonego w 2013 r. Uwzględniono 16 cech mierzonych na skali porządkowej odnoszących się do oceny własnego zadowolenia z różnych dziedzin i aspektów życia. Cechy te przekształcono za pomocą funkcji przynależności w cechy o wartościach z przedziału  $[0, 1]$ . Za pomocą wag wyznaczonych metodą Bettiego i Vermy skonstruowano syntetyczne wskaźniki subiektywnej percepcji życia. W celu oceny analizowanego zjawiska w całej populacji i w wybranych subpopulacjach obliczono średnie wartości tych wskaźników oraz wartości miar będących odpowiednikami indeksów zasięgu, głębokości i nierównomierności stosowanych w analizie ubóstwa. Stwierdzono, że najlepiej oceniano aspekty społeczne jakości życia, najgorzej zaś – aspekty środowiskowe. Ponadto

oszacowano, że kobiety nieco gorzej postrzegały swoją sytuację niż mężczyźni oraz lepsza edukacja odpowiadała bardziej pozytywnej percepcji jakości życia.

**Słowa kluczowe:** jakość życia, zbiory rozmyte, wielowymiarowa analiza danych.

## 1. Introduction

In recent years, in the analyzes of the quality of life, a growing interest of subjective indicators can be observed. Such analyzes are conducted by the public statistics, as well as international organizations and research centers. Indicators of satisfaction with various aspects of personal and social life are regarded as an important part of monitoring the social situation. They allow for a comparison of subjective feelings of people with objective data on living conditions. Thus they are an indispensable and crucial element in the multidimensional measurement and the analysis of the quality of life.

The measurement of the subjective quality of life in Poland is carried out, among others, in the “Social Diagnosis” research. Due to the complexity and multidimensionality of the subject matter, in the questionnaires of this survey a lot of questions about satisfaction of respondents are included. They relate to various dimensions referring to the social, material, environmental, health spheres and others. In our study we use this data collected in the frame of the this research and we consider subjective perception of the quality of life to be a “fuzzy” concept. This approach uses a membership function to capture each individual’s degree of inclusion to the satisfied set, yielding scores that have values from  $[0, 1]$  interval. In order to assess a multidimensional phenomenon of satisfaction with life, the scores are aggregated into synthetic indicators. Averaging these indicators leads to obtaining summary indices for the whole sample population or for the suitable subpopulations. To get a deeper insight into the analyzed phenomenon a measurement of incidence, depth and inequality of satisfaction with life can be undertaken. To evaluate these issues we propose our own indices.

In the literature there is a small number of studies examining life satisfaction in Poland from the multidimensional perspective<sup>1</sup>. We hope that our paper fills in this gap to some extent by creating a picture of a subjective perception of the quality of life for Poland by adopting a fuzzy set approach.

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<sup>1</sup> To papers in this field one can include research [Struzik, Struzik, Szwarz 2015] on children’s subjective well-being.

## 2. Data

The analysis uses the survey data from “Social Diagnosis” research conducted in 2013. The main objective of this survey is to provide an assessment of the living conditions and the subjective perception of quality of life of the Polish population. Two separate questionnaires are used in “Social Diagnosis” project. The first is a source of information about a household composition and living conditions completed by the interviewer during a meeting with one best-informed household representative. The second questionnaire is completed by all available members of a given household aged 16 or more and contributes information about individual persons’ quality of life [Czapiński, Panek 2014]. In 2013 the survey involved 12,355 households and 26,307 household members over 16 years of age. Since we are interested in a subjective assessment of the quality of life we use the database including information from individual persons.

According to Czapiński [2014] the most realistic in the evaluation of the level of well-being is a study of satisfaction with particular areas and aspects of life. “Social Diagnosis” research takes into account 16 different items exhausting nearly the entire scope of interests and activities of an average person. In a report of the research these items are assigned into five dimensions regarding to:

- social aspects (satisfaction with relationships with close family members, friends, spouses and children),
- material aspects (satisfaction with the financial situation of the family and with the housing conditions),
- environmental aspects (satisfaction with the situation in the country, the place of residence, the level of safety in the place of residence),
- health-related aspects (satisfaction with one’s health condition, with their sex-life and the way of spending their free time),
- aspects related to a self-assessment (satisfaction with one’s own achievements, prospects for the future, educational level, work).

Respondents were asked to assess all 16 areas of their life and indicate the extent of satisfaction with them. They have a choice of replies: 1) very satisfied, 2) satisfied, 3) rather satisfied, 4) rather not satisfied, 5) not satisfied, 6) very dissatisfied, 7) not applicable. In our study we assign value 3.5 to those individuals who indicated answer “7” and to those who did not give any answers, thus we attribute them a neutral position.

## 3. Methods

The application of the fuzzy set approach requires three steps:

- 1) identification of the relevant items and grouping them into dimensions,
- 2) definition of a functional form for the membership function,
- 3) choice of a weighting method to aggregate items into a single indicator.

Concerning the first point, we analyze 16 items grouped into 5 dimension<sup>2</sup>. In the second step we construct a membership function for each item. Several methods have been proposed in the literature<sup>3</sup> (see for example [Cerioli, Zani, 1990; Betti, Verma 2008]) for it. We opt for a method using the empirical distribution function of each item. Such an approach takes into account a relative position in the society in a given field. We use the formula proposed in [Cheli, Lemmi 1995]:

$$d_{k,j,i} = \frac{1 - F(c_{k,j,i})}{1 - F(1)}, \quad (1)$$

where:  $c_{k,j,i}$  – category of the  $j$ -th item in  $k$ -th dimension for the  $i$ -th individual,  $1 \leq c_{k,j,i} \leq 6$ ;  $F$  – corresponding cumulative distribution functions.

According to formula (1) the item's categories are converted into a  $[0, 1]$  interval. In this context, the score  $d$  can be interpreted as the membership level in the virtual set of satisfied people, in particular value 0 refers to complete dissatisfaction ( $c = 6$ ) and value 1 to complete satisfaction ( $c = 1$ ).

As in the case of the selection of membership function, there are several approaches to choose weights for aggregating different items in each dimension (see for example [Desai, Shah 1988; Cheli, Lemmi 1995; Filippone, Cheli, D'Agostino 2001; Lazim, Osman 2009]). In the study we use the method proposed by Betti and Verma [1999]. Our choice may be supported by the following arguments: this method gives less importance to poorly differentiated items and it takes into account the problem of data redundancy. According to these properties the weights can be defined as follows [Betti, Verma 1999]:

$$W_{k,j} = W_{k,j}^a \cdot W_{k,j}^b, \quad (2)$$

where:

$$W_{k,j}^a = V_{k,j}, \quad (3)$$

$V_{k,j}$  – the coefficient of variation for  $j$ -th score  $d$  in the  $k$ -th dimension.

Betti and Verma [1999] suggest that the coefficient of variation of each score  $d$  can be used as the first factor, and the second factor can be obtained by applying the following formula:

<sup>2</sup> To identify dimensions one can use statistical methods (for example factor analysis) [Betti, Verma 2008], but in this study we use a classification applied in "Social Diagnosis" Report. According to it we have 5 dimensions encompassing 16 items.

<sup>3</sup> Fuzzy set theory has been applied in various socio-economic areas such as measurement of poverty [Cheli, Lemmi 1995; Betti, Verma 2008; Panek 2010], job satisfaction [De Battisti, Marasini, Nicolini 2015], quality of life [Lazim, Osman 2009; Betti et al. 2015].



$$W_{k,j}^b = \left( \frac{1}{1 + \sum_{j'=1}^{m_k} r_{k,jj'} \mid r_{k,jj'} < r_k^*} \right) \cdot \left( \frac{1}{\sum_{j'=1}^{m_k} r_{k,jj'} \mid r_{k,jj'} \geq r_k^*} \right), \quad (4)$$

where:  $r_{k,jj'}$  is the correlation coefficient between two different scores  $d_{k,j}$  and  $d_{k,j'}$ ;  $r_k^*$  is a predetermined cut-off correlation level in the  $k$ -th dimension;  $m_k$  is the total number of items in the  $k$ -th dimension.

Thresholds  $r_k^*$  can be determined in many ways, e.g. Betti and Verma [2008] suggest to use the point of the largest gap between the ordered set of correlation values encountered, while Panek [2011] proposes to apply the following formula:

$$r_k^* = \min_j \max_{j' \neq j} |r_{k,jj'}|. \quad (5)$$

The weights are determined within each dimension separately. They reflect the relative importance of items in contributing to an individual level of satisfaction in a given aspect of life. Scaling them to sum 1 within each dimension is convenient:

$$w_{k,j} = \frac{W_{k,j}}{\sum_{j=1}^{m_k} W_{k,j}}. \quad (6)$$

The application of the membership function to each item produces a number of standardized variables (scores  $d$ ) that range between zero and one. Therefore such variables are expressed in the same unit of measurement and can be aggregated. The indicators derived according to this may be considered as indicators of a subjective perception of the quality of life. For  $i$ -th individual, aggregation over a set of items in a  $k$ -th dimension ( $k = 1, 2, \dots, 5$ ) is given by formula [Betti et al. 2015]:

$$S_{k,i} = \sum_{j=1}^{m_k} w_{k,j} d_{k,j,i}, \quad (7)$$

and an overall composite indicator for the  $i$ -th individual is calculated as:

$$S_i = \frac{1}{K} \sum_{k=1}^K S_{k,i}, \quad (8)$$

where  $K$  – number of dimensions.

For sub-indicators (7) and overall indicator (8) aggregated indices can be typically derived on the basis of sample data:

$$S_k = \frac{1}{n} \sum_{i=1}^n S_{k,i}, \quad k = 1, 2, \dots, K, \quad (9)$$

$$S = \frac{1}{n} \sum_{i=1}^n S_i, \quad (10)$$

where  $n$  – number of individuals in the whole population;  $K$  – number of dimensions.

This approach to construct indices is the simplest and the most common strategy in the literature on multidimensional analysis [Deutsch, Silber 2005]. Such summary indices enable to assess the average life satisfaction in the whole population.

In the next step of analysis, to get a deeper insight into the undertaken subject matter, we measure incidence, depth and inequality of life satisfaction. We propose to apply counterparts of appropriate summary indices used in classical poverty analyses. In one-dimensional analyses the most popular indices are FGT indices named after Foster, Greer and Thorbecke<sup>4</sup>:

$$P_\alpha = \frac{1}{n} \sum_{i=1}^n g_i^\alpha, \quad (11)$$

where:  $g_i = \max \left\{ \frac{y^* - y_i}{y^*}, 0 \right\}$ ,  $y_i$  – income of  $i$ -th individual,  $y^*$  – poverty threshold (poverty line),  $\alpha$  – parameter,  $\alpha = 0, 1, 2$ .

- With  $\alpha = 0$ , the formula (11) reduces to the poverty incidence (headcount ratio), i.e. the fraction of the population living below the certain threshold named the poverty line:  $P_0 = \frac{n_u}{n}$ , where  $n_u$  – number of poor individuals (i.e. the number of those whose income does not exceed  $y^*$ ),  $n$  – number of individuals in the whole population.
- With  $\alpha = 1$ , the formula (11) yields depth of poverty index (poverty gap index):  $P_1 = \frac{1}{n} \sum_{i=1}^{n_u} \left( \frac{y^* - y_i}{y^*} \right)$ .  $P_1$  takes into account the extent to which individuals fall below the poverty line as a proportion of the poverty line.
- With  $\alpha = 2$ , the formula (11) gives to the average of square relative poverty gap in the population  $P_2 = \frac{1}{n} \sum_{i=1}^{n_u} \left( \frac{y^* - y_i}{y^*} \right)^2$ .  $P_2$  is called severity of poverty index, it captures differences in income levels among the poor.

In the multidimensional approach to poverty there are some extensions of FGT indices [Alkire et al. 2015; Bourguignon, Chakravarty 2003; Foster et al. 2010; Panek

<sup>4</sup> This class of decomposable poverty indices was proposed in a famous paper [Foster, Greer, Thorbecke 1984].

2010]. In our study we focus on Bourguignon and Chakravarty method because we think it can be adopted to the measurement of life satisfaction.

Bourguignon and Chakravarty [2003] build a class of multidimensional poverty measures that extends the FGT indices to many dimensions. They take as a fundamental starting point shortfalls from thresholds on each dimension of an individual's well-being:

$$MP_{\alpha} = \frac{1}{n} \sum_{k=1}^K \sum_{i=1}^n w_k g_{ki}^{\alpha}, \quad (12)$$

where:  $g_{ki} = \max \left\{ \frac{y_k^* - y_{ki}}{y_k^*}, 0 \right\}$ ;  $y_{ki}$  – attribute of poverty of  $i$ -th individual in  $k$ -th

dimension,  $i=1, \dots, n$ ,  $k=1, \dots, K$ ;  $y_k^*$  – poverty threshold in  $k$ -th dimension;  $w_k$  – weight for  $k$ -th dimension,  $k=1, \dots, K$ ;  $K$  – number of dimensions in poverty analysis;  $n$  – number of individuals in the whole population;  $\alpha$  – parameter,  $\alpha = 0, 1, 2$ .

We adopt formula (12) in the measurement of life satisfaction. In our study we have 2 obvious thresholds for answer “3” meaning “rather satisfied” and to answer “4” – “rather not satisfied”. For each of these thresholds for  $j$ -th item in  $k$ -th dimension we can compute corresponding “critical values”  $d^s$  (for 3 – rather satisfied) and  $d^{ns}$  (for 4 – rather not satisfied). More formally, for score  $d_{k^j i}$  obtained by formula (1),

we define:  $g_{k,j,i} = \max \left\{ \frac{d_{k,j,i} - d_{k,j}^s}{d_{k,j}^s}, 0 \right\}$  and  $h_{k,j,i} = \max \left\{ \frac{d_{k,j}^{ns} - d_{k,j,i}}{d_{k,j}^{ns}}, 0 \right\}$ . Value  $g_{k^j i}$

means a relative gap for  $i$ -th individual which is satisfied (relative distance of value  $d_{k^j i}$  from threshold  $d^s$ ) and  $h_{k^j i}$  denotes a relative gap for  $i$ -th individual which is unsatisfied (relative distance of value  $d_{k^j i}$  from threshold  $d^{ns}$ ). We construct life satisfaction indices as:

$$LS_{\alpha} = \frac{1}{nK} \sum_{n=1}^n \sum_{k=1}^K \sum_{j=1}^{m_k} w_{k,j} g_{k,j,i}^{\alpha} \quad (13)$$

and similarly life dissatisfaction indices can be defined as:

$$LDS_{\alpha} = \frac{1}{nK} \sum_{n=1}^n \sum_{k=1}^K \sum_{j=1}^{m_k} w_{k,j} h_{k,j,i}^{\alpha}, \quad (14)$$

where:  $w_{k,j}$  – the weight assigned to  $j$ -th item in the  $k$ -th dimension;  $m_k$  – the total number of items in the  $k$ -th dimension;  $K$  – number of dimensions;  $n$  – number of individuals in population;  $\alpha$  – parameter,  $\alpha=0, 1, 2$ .

In particular,

- for  $\alpha = 0$  we have  $LS_0$  and  $LDS_0$  – incidence of satisfaction and incidence of dissatisfaction, denoting, respectively, percentage share in population of satisfied individuals and unsatisfied individuals;
- for  $\alpha = 1$  we obtain  $LS_1$  and  $LDS_1$  – depth of satisfaction and depth of dissatisfaction;
- for  $\alpha = 2$  – inequality of satisfaction and inequality of dissatisfaction.

In our opinion such indices are useful in the quality of life measurement.

#### 4. Results

In our analysis we investigate 5 dimensions encompassing 16 items. All items are converted by membership function (1) into scores. In order to calculate weights for them we applied the Stata procedure *mdepriv*<sup>5</sup> [Pi Alperin, Van Kerm 2014]. These weights are used to obtain synthetic indicators of a subjective perception of the quality of life. Next, to assess the analyzed phenomenon in a given population, some summary indices are computed.

The empirical results of the study are reported in tables 1-3. All tables present the diversity of satisfaction with life due to the gender and educational status. Two groups regarding educational status are examined: the first refers to those who attained secondary, post-secondary or higher level of education and the second concerns poorly educated people involving persons with basic, lower secondary, vocational level or without educational attainment.

Table 1 reports the overall aggregate index  $S$  and the indices  $S_1, S_2, S_3, S_4, S_5$  corresponding to the five dimensions (computed accordingly by (10) and (9) formulas). Moreover it provides information about incidence of satisfaction and dissatisfaction.

As shown in table 1 Poles were best satisfied in relationships with other people (social aspects) and the worst – with environmental aspects. Our results indicate that near 60% of the population exhibited positive assessment of life and only 3% of the sample population – a negative perception of life. The remaining part, containing 37%, relates to neutral attitudes<sup>6</sup>. What is interesting, only less than 1% of the people had a bad opinion about their own relationships with other people and more than 70% – positively valued these social aspects. The incidence of satisfaction is especially low in the dimension referring to the aspects related to a self-assessment – less than 40% of individuals evaluated well their own achievements, prospects for the future, their educational level and work. On the other hand, headcount ratios, placed in the

<sup>5</sup> We found among all pairs of scores in given dimension weak or moderately strong positive correlations. For all dimensions threshold  $r^* = 0.3$  is used.

<sup>6</sup> Neutral attitudes concern such cases for which  $LS_0$  was less than “critical value” corresponding to answer “3 – rather satisfied” and  $LDS_0$  was greater than “critical value” corresponding to answer “4 – rather not satisfied”.  $LS_0$  and  $LDS_0$  are defined respectively by formulas (13) and (14).

**Tables 1.** Basic summary statistics for composite indicators of life satisfaction

Index	Overall	1 Social	2 Material	3 Environmental	4 Health-related	5 Self-assessment
Aggregate index of life satisfaction	0.4012	0.4357	0.4040	0.3740	0.4112	0.3811
– women	0.3963	0.4438	0.4030	0.3715	0.3939	0.3690
– men	0.4062	0.4212	0.4053	0.3770	0.4323	0.3952
– at least secondary level of education	0.4318	0.4570	0.4358	0.3800	0.4469	0.4391
– poor educational level	0.3719	0.4154	0.3735	0.3682	0.3770	0.3254
Incidence of satisfaction	58.91%	72.84%	69.95%	43.17%	63.12%	35.93%
– women	58.01%	74.60%	69.89%	42.87%	59.84%	33.24%
– men	60.04%	70.63%	70.03%	43.53%	67.22%	39.30%
– at least secondary level of education	67.08%	75.35%	75.69%	45.61%	70.40%	47.11%
– poor educational level	51.08%	70.44%	64.44%	40.83%	56.13%	25.21%
Incidence of dissatisfaction	3.09%	0.72%	17.55%	24.11%	7.20%	11.87%
– women	2.97%	0.62%	17.75%	24.41%	7.54%	12.21%
– men	3.25%	0.85%	17.31%	23.74%	6.76%	11.55%
– at least secondary level of education	1.64%	0.44%	13.09%	23.61%	4.68%	6.72%
– poor educational level	4.49%	0.98%	21.84%	24.60%	9.61%	16.80%

Source: own calculation.

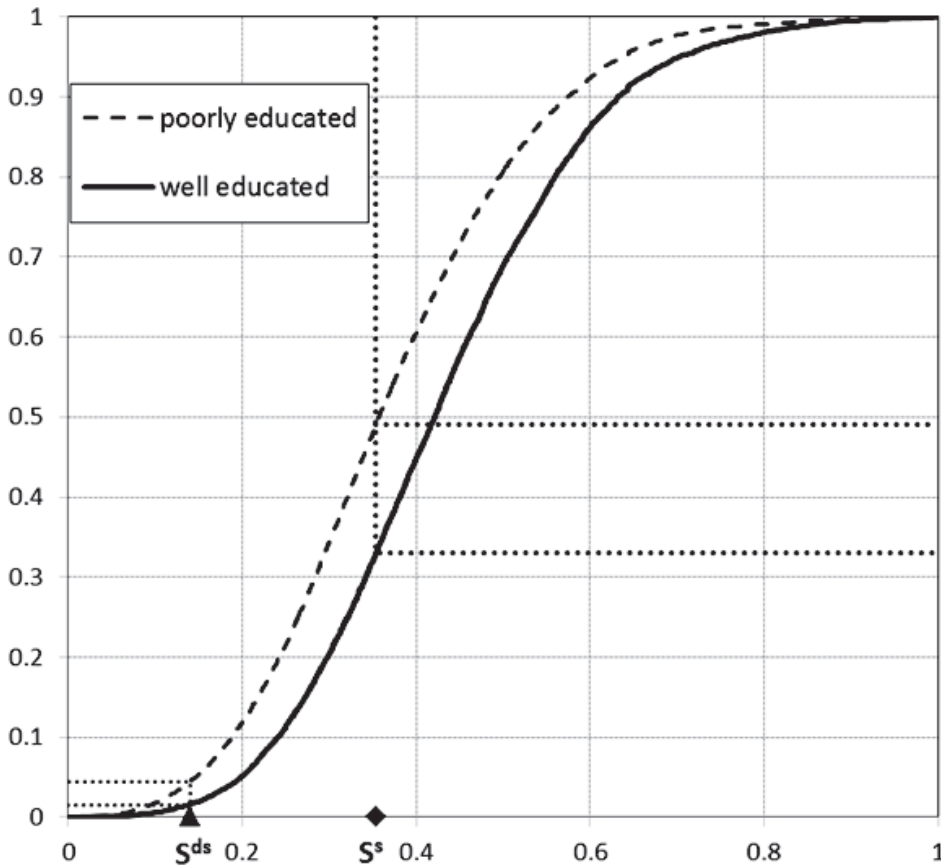
bottom of the table 1, indicate that a fraction of dissatisfied individuals with these aspects was about 12%. It means that about 50% of individuals expressed decidedly neither a positive nor a negative opinion on this matter. It should also be noted that almost a quarter of the sample population was dissatisfied with environmental aspects taking into account the situation in the country, the place of residence and the level of safety in the place of residence.

Dividing the population into sub-groups according to gender, it can be observed that women are slightly worse-off than men. One notable exception is the social aspect. Taking into account educational status one can state that well-educated people definitely better perceived their quality of life than poorly educated people. The biggest differences between these two groups refer to aspects related to a self-assessment and the smallest – to environmental aspects.

Figure 1 presents cumulative distribution functions of overall composite indicators  $S$  for well-educated and poorly educated people. It highlights a few salient facts. First, one can find that incidence of dissatisfaction for well-educated people equals about 1% and for poorly educated people – about 4% (see values on vertical axis corresponding to threshold  $S^{d^s} = 0.14^7$ ), secondly, these headcount ratios

<sup>7</sup> Weighted thresholds  $d^{is}$  corresponding to answer “4” – “rather not satisfied” yield thresholds  $S^{is}$  and weighted thresholds  $d^s$  for answer “3” – “rather satisfied” yield  $S^s$ .

for satisfaction are about 67% and 51% respectively (see values on vertical axis corresponding to threshold  $S^s = 0.35$  and subtract them from 1). Moreover it can be seen that median of overall composite indicator  $S$  for the first group is about 0.43 and for the second – 0.37. Generally, a worse subjective assessment of the quality of life among poorly educated people than well-educated people is visible.



**Figure 1.** Comparison of overall composite indicators  $S$  for well-educated and poorly educated people

Source: own computation.

Next, in order to assess the depth of satisfaction and dissatisfaction with life values of  $LS_1$  and  $LUS_1$ , defined respectively by formulas (13) and (14), are computed and reported in table 2.

**Tables 2.** Depth of satisfaction and dissatisfaction

Indicator	Overall	1 Social	2 Material	3 Environmental	4 Health-related	5 Self-assessment
Depth of life satisfaction	24.76%	63.92%	48.29%	17.38%	38.50%	12.12%
– women	23.65%	65.80%	48.07%	17.08%	34.52%	11.03%
– men	26.14%	61.57%	48.57%	17.75%	43.48%	13.50%
– at least secondary level of education	30.17%	69.96%	55.28%	18.37%	45.52%	17.17%
– poor educational level	19.56%	58.13%	41.59%	16.43%	31.76%	7.28%
Depth of life dissatisfaction	0.84%	0.28%	7.32%	11.16%	2.62%	4.03%
– women	0.77%	0.25%	7.41%	11.29%	2.64%	3.98%
– men	0.91%	0.30%	7.21%	11.00%	2.61%	4.10%
– at least secondary level of education	0.42%	0.19%	5.06%	11.01%	1.69%	2.21%
– poor educational level	1.23%	0.36%	9.49%	11.30%	3.52%	5.78%

Source: own calculation.

In general, it is found the depth of life satisfaction exceeds the depth of life dissatisfaction. It means that at least good assessments of own life (which corresponds to the answer 1 or 2) were observed more frequently than bad evaluation of life (which corresponds to the answer 5 and 6). In other words, on the average, the extent of satisfaction was greater than the extent of dissatisfaction<sup>8</sup>. This result relates to all dimensions, but particularly it is evident for social aspects.

It is worth noticing that a poor assessment of the fifth dimension was accompanied by low values of depths (see last columns in tables 1 and 2). It means that satisfaction and dissatisfaction were “shallow” here, which one can interpret that most of people had moderate (neither very good nor very bad) opinions in the field of their own achievements, prospects for the future, educational level, work. Taking into account gender, one can observe that men more frequently than women exhibited extreme judgments on this matter.

Turning to comparison groups with different educational status it was found that in all aspects satisfaction of well-educated people was deeper than satisfaction of poorly educated people and opposite relationship held in regards to the depth of dissatisfaction.

The next table provides information about diversities among satisfied and dissatisfied people.

<sup>8</sup> Among satisfied people distances from threshold relating to answer “3 – rather satisfied” were greater, on average, than distances from threshold relating to answer “4 – rather not satisfied” among unsatisfied people.

**Tables 3.** Inequality of satisfaction and dissatisfaction

Indicator	Overall	1 Social	2 Material	3 Environmental	4 Health-related	5 Self-assessment
Inequality of life satisfaction	3.1694	8.7776	1.5817	4.0885	0.9346	0.4644
– women	3.2283	9.1673	1.6075	4.0244	0.8796	0.4629
– men	3.0956	8.2898	1.5494	4.1688	1.0033	0.4664
– at least secondary level of education	3.4148	9.5541	1.7848	4.0991	1.0399	0.5963
– poor educational level	2.9331	8.0306	1.3862	4.0777	0.8332	0.3378
Inequality of life dissatisfaction	0.0830	0.0168	0.0963	0.1485	0.0724	0.0810
– women	0.0833	0.0163	0.0968	0.1481	0.0749	0.0804
– men	0.0827	0.0175	0.0956	0.1491	0.0692	0.0819
– at least secondary level of education	0.0684	0.0131	0.0702	0.1402	0.0555	0.0630
– poor educational level	0.0970	0.0204	0.1213	0.1566	0.0885	0.0984

Source: own calculation.

Table 3 shows greater inequalities in a positive assessment than in a negative evaluation of all aspects of life. The greatest diversities among the satisfied refer to social aspects, the lowest – to self-assessment aspects. As indicated in table 3 inequalities in a group of the dissatisfied are very small. This is due to the fact that answer “4 – rather not satisfied” dominated among the negative opinions.

Taking into account gender, one can observe that, with the exception of social aspects, inequalities for women were less than for men. Dividing the population into sub-groups according to educational level it can be seen that in a well-educated group inequalities of satisfaction were greater than in a poorly educated group and the opposite relationship held for inequalities of dissatisfaction.

Finally, it is important to underline that the application of multidimensional analysis in a subjective perception of the quality of life is relatively new. In order to present the use of a fuzzy set approach to the undertaken issue, this paper shows introductory results for the data from one year and includes a comparison of satisfaction in the selected groups regarding gender and educational status.

## 5. Concluding remarks

The increasing interest in a well-being analysis has caused growth of different measurement approaches. This study presents a methodological framework for the assessment of subjective perception of life by using the methods of fuzzy set theory applied in a multidimensional poverty analysis. The data used for the analysis come from the “Social Diagnosis” research conducted in 2013. In this research a lot of



questionnaires' items are devoted to aspects of personal life that can be meaningfully described in ordinal terms. In our framework the ordered data relating to subjective assessments are converted by a membership function into a  $[0, 1]$  interval. In the next step, in order to obtain a synthetic indicator encompassing a lot of areas and aspects of life, weights reflecting the relative importance of partial satisfaction scores are used. The main way to a synthesis in the evaluation of life satisfaction in the whole sample population is the computation of composite indices. The paper explores how to measure the incidence, depth and inequality in multivariate analysis of satisfaction with life.

It was found that the best satisfaction referred to social aspect, the worst – to environmental and self-assessment aspects. Incidence of life satisfaction equals about 60% for overall life satisfaction, 70% for satisfaction in social and material aspects, 60% – in health-related, 40% – in environmental and self-assessment aspects. The overall depth and inequality of life satisfaction was greater than overall depth and inequality of dissatisfaction.

The use of micro-level data is useful and has the potential to yield important insight into disparities regarding gender and educational status. It was found that, except for social aspects, subjective quality of life was slightly better and deeper among men than among women. Moreover well-educated people definitely better perceived their quality of life than poorly educated people.

The application of fuzzy sets to issues of satisfaction with life is relatively new. We plan various extensions of our study. Among other things, the future directions of the research should include an analysis of the data from several years and comparing the obtained results, an application of panel data models for controlling unobserved heterogeneity of individuals, an analysis of the influence of various socio-demographic characteristics on a subjective perception of the quality of life.

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