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Identification of Factors Influencing the Quality of Life in European Union Countries Evaluated by Principal Component Analysis

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Abstract

In the paper we evaluate the quality of life in European Union countries. The introductory database is made up of 19 variables which, in our view, appropriately capture numerous spheres of human life. The reference date for this data, taken from the Eurostat database is April 10, 2021. The Principal Component Analysis that we have used in this paper is not rare in the conditions of multivariate statistics, however, when evaluating the quality of life, it is not much used. Many authors dealing with the topic take advantage of the traditional questionnaire survey and the points-based approach when analysing data. Our objective was to demonstrate that the Principal Component Analysis can be used in evaluating quality of life, especially if it is necessary to evaluate a significant number of variables and select factors with the highest impact. Apart from the main objective - the identification of factors most impacting the quality of life in European Union countries, we also focused on the comparison of countries as per particular main factors and searched for what caused differences between them. Quality of life is also reflected in the subjective perception of responders' happiness. We were concerned to know whether the evaluated data would indicate that the feeling of happiness increases along with prosperity, or does not depend on growing prosperity at a certain stage.

Keywords: Eurostat; European Union countries; quality of life; Principal Component Analysis

Introduction

While many European countries and their societies underwent significant economic, political and social changes in the 1950s, the countries of the former Eastern Bloc accelerated and fundamentally transformed only at the beginning of the 1990s. These cardinal changes resulted in the growth of social prosperity and general economic prosperity on the one hand, however, on the other, did not always result in the growth of people´s satisfaction with their own life.

From this point of view it is not possible to explain the overall level of (un-) satisfaction in a population by material good only, but it is necessary to see the problem in a wider context. The imaginary mathematical equation then comprises also other important spheres using variables such as health, environment, psychological, social, relational sphere etc. The approach that absorbs all these important elements is the concept of quality of life which, according to Macků and Voženílek (2019), represents an extensive field closely

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connected with human existence. It is a focus of many scientific disciplines, social, medical and natural and nowadays attracts numerous researchers. The term is being developed in several academic disciplines, such as economics, psychology, sociology and geography. (Madziková et al., 2015).

Our article concentrates on the quality of life in European Union (EU) countries and we attempt to identify the factors that influence their quality of life the most based on a set of selected indicators from the Eurostat database using Principal Component Analysis (PCA) – one of the methods of Factor Analysis. At the same time we concentrate on comparison of countries or groups of countries according to their similarities or differences from the main factors' point of view and endeavour to establish the causes of these differences.

Theoretical Background

The inconsistency between objective growth and prosperity on the one hand and not always satisfied people on the other, mentioned above, can be explained by the following fact: Progress and prosperity has often been and still is looked at only through the optics of economic growth usually expressed by the complex indicator of gross domestic product (GDP). It is, according to Nohlen and Nuscheler (1992, in Maier & Tödtling, 1998), just one of five elements of development. GDP is very often that factor which is considered the most important and determinant indicator of prosperity and perceived by the lay public as something that needs to consistently "grow". However, in recent years more and more attention has been drawn to its shortcomings and limitations (e.g. Cummins et al., 2003; Matlovič & Matlovičová, 2005, 2011; Sloboda, 2006; Žúdel et al., 2007; Buček et al., 2010; Giannetti et al., 2015; Prasad & Castro, 2018; Figueres & Rivett-Carnac, 2020; etc.). Adler (2009) mentions the following problems when using it: GDP monitors economic progress, but not the progress of people´s prosperity within a society; progress and prosperity of a society as complex quantities cannot be monitored by only one number represented by GDP; GDP does not retain partial components of prosperity of a country; GDP fails in the distribution of income and wealth in a country; although GDP grows, the number of happier and more satisfied people might decrease. D´Agostino et al. (2021) point out that in addition to economic indicators (especially GDP), new innovative indicators are needed to assess social progress which would better reflect various aspects of individual quality of life.

According to several researchers, the policy of each country should focus more on people´s satisfaction with their life and their happiness rather than on the economic growth of the country itself (Sachs, 2012 in Helliwell et al., 2012). Life satisfaction, subjective well-being and happiness in evaluation of quality of life are all emphasized in the works of Glaser et al. (2016), Novianti et al. (2020) and Đerčan et al. (2017). It is confirmed that the level of satisfaction with life does not grow automatically with the growth of prosperity. Mlčoch (2005) states that economists name the relationship between growing material prosperity and stagnating even decreasing subjective happiness as the "Easterlin Happiness-Income Paradox". Similarly, Pacione (2003) warns that quality of life is not necessarily a simple function of material wealth. He calls it the "Prosperity Paradox".

That is why, when assessing countries and regions, it is important to take into consideration the widely understood concept of quality of life and the existence of its two essential dimensions, namely, an objective dimension (public, social, environmental), and a subjective one (individual, personal and private). Quality of life can be understood as a result of the mutual impact of these two dimensions or of the mutual interaction between the external impacts and the internal "environment" of a person (Andráško, 2005; Ira & Andráško, 2007; Ira & Murgaš, 2008; Ira, 2010; Rišová, 2016; Klamár & Gavaľová, 2018). Similarly, Dissart and Deller (2000) wrote that quality of human life depends on exogenous (objective) life factors and their endogenous (subjective) perception. For the first dimension of quality of life, the psychological one, Massam (2002, in Ira & Andráško, 2007) uses alternative names such as individual/personal quality of life, subjective welfare and satisfaction with life. The second dimension, the environmental one, is known variously as urban quality of life, residential quality of life, community quality of life or quality of location.

Based on the above, it is evident that, when assessing quality of life, it is misguided to take into consideration only a one-dimensional economic indicator like GDP, however complex it is. In this context Andráško (2008a) mentions that, to a certain extent, it is a paradox that indicators of economic prosperity and welfare were the ones that stood at the beginning of the growth of "society-wide" interest in quality of life.

Quality of life as such cannot be measured or expressed directly but can be done only indirectly via elements also known as indicators, components, criteria, agents, domains etc. (Murgaš, 2009; Ira & Šuška, 2006; Godor & Horňák, 2010).

Fahrenberg et al. (2000, in Džuka, 2004) defined ten elements of life and individual satisfaction with

them: health, work, financial situation, free time, marriage and partnership, relations with children, satisfaction with oneself, sexuality, friends and relatives, and housing. Within a WHO (World Health Organization) project entitled "Measuring Quality of Life" six domains were defined: physical health, mental health, level of independence, social relations, environment, spirituality (religion) and personal persuasion (Ištok & Angelovič, 2012). When evaluating the quality of life in Standard Metropolitan Statistical Areas in the United States Liu (1976, in Dissart & Deller, 2000) used 123 factors and variables that were measured through five different quality-of-life components: economic, political, environmental, health and education, and social. Similarly, Amin et al. (2021) used 4 sub-indexes to assess quality of life in the United States: physical and social environment subindex, economics subindex, health subindex and natural environment subindex.

Several papers have assessed the quality of life in European countries. In the case of 28 EU Member States supplemented by other selected European countries, Macků and Voženílek (2019) evaluated five aspects (economic power and material security, health, social environment, education and environment) and defined 13 indicators. Lagas et al. (2015) used nine indicators to assess regional quality of life in Europe: public services, purchasing power and employment, housing, social environment, natural environment, recreation, health, education, governance. Liargovas and Kratimenou (2020) used a set of the following indicators to monitor the quality of life convergence in the EU: population density, GDP per capita, long-term unemployment, household consumption expenditure per capita and electric power consumption, services, health, education, natural and urban environment, infrastructure. Sanchez-Sellero et al. (2021) classified within the subject matter five dimensions of quality of life: subjective component of governance, public services, environment, general satisfaction with life, and socioeconomic issues. When assessing the quality of life in Slovakia and its regions Ira (2005) grouped the monitored indicators into six dimensions: demographic, material comfort and social securities, household equipment, environment, security, and educational-informational; Ira and Šuška (2006) used a set of 26 indicators in five domains: location and accessibility, housing and household equipment, environment, demographic, and economic; and Murgaš (2009) in three domains: prosperity, deprivation, and human capital.

From the overview above it is evident that when assessing quality of life it is important to couple objective indicators with subjective ones. This has to be done while bearing in mind their character and statistical source.

Methodology

The objective of this article is to identify the factors that most significantly influence the quality of life of people in EU countries.

The object of the assessment was selected indicators (further referred to as features or variables) that were divided into the following groups in keeping with Eurostat methodology (in the thematic part Quality of Life):

- **factors of material living conditions** – net income in PPS (Purchasing Power Standards) (**A**), main GDP aggregated per capita in PPS (**B**), households making ends meet with great difficulty (**C**),
- **productive and other main activities** – persons reporting a work-related health problem (**D**), persons reporting an accident at work (**E**), long term unemployment (**F**), employment rate (**G**),
- **economical safety** – inability to face unexpected financial expenses (**H**), arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards - EU-SILC (European Union Statistics on Income and Living Conditions) survey (**I**),
- **health** – healthy life years (**J**), frequency of heavy episodic drinking at least once a week (**K**), time spent on health-enhancing (non-work-related) aerobic physical activity-300 minutes or over (**L**),
- **education** – education (**M**),
- **social interactions** – frequency of contact with family and relatives several times a month (**N**), frequency of getting together with friends several times a month (**O**),
- **living environment and physical safety** – pollution, grime or other environmental problems (**P**), noise from neighbours or from the street (**Q**), crime, violence or vandalism in the area (**R**),
- **life satisfaction** – percentage of population rating their satisfaction as high (**S**).

In the case of monitored indicators we used available input data from the Eurostat database mainly covering the situation in 2018, as some of the data were not available for 2019 (or newer). In some of the cases it was necessary to use even earlier data. Therefore, the reference year is given in Table 1 after the name of the variable.

Principal Component Analysis (PCA) was used to identify the factors influencing quality of life in the

EU. Although it is a quite frequently used method of multi-dimensional analysis, it has not been used very much when assessing quality of life so far (applied e.g. in papers by Andráško, 2008b; Macků & Voženílek, 2019). The main advantage of this method is in its analysis of a small number of uncorrelated **principal components** representing the linear combination of original features instead of examining a high number of original features (variables) with complex internal bonds (Bartholomew, 2010). The largest part of information about variability of original features is hidden in the first principal component and the smallest in the last one. The components are arranged in order of decreasing variance (Bartholomew, 2010).

The standard process in Principal Component Analysis is the decrease of dimensionality of the space or the reduction of features so that information does not get lost. The model of principal components is as follows

$$X=TP^T+E= \textit{data structure} + \textit{noise},$$

where X is the source data matrix, T is the component score matrix, P^T is the transpose matrix of component weights and E is the matrix of residues (see Meloun et al., 2012). The role of PCA is to analyse the product TP^T presenting the data structure instead of the matrix X itself. Matrix E is the noise matrix or the matrix of residues that is not classified by the PCA model.

The principal components have a common beginning that corresponds to the centre of cluster of objects (in this case the states of EU). In order to calculate a suitable number of principal components we employed a table of eigenvalues supplemented by a graphic representation via the **Cattel Index Graph of the Base of Eigenvalues** where the principal components are separated from the unimportant ones (representing the bottom of the graph) by an evident drop. In this practice, the Kaiser criterion is used as well, according to which the factors (principal components) corresponding to eigenvalues higher than 1 are considered to be statistically significant. In order to identify the suitable number of factors, a percent variance criterion is used too. In natural sciences it usually achieves about 95% of covered variance; in human sciences it is about 60% (Meloun et al., 2012).

In our case the PCA has been provided by the help of software Statistica 13.0. After reducing the number of variables, we calculated the component weights and component score.

The Graph of Component Weights (loads) can be viewed as a bridging of the original features and principal components and demonstrates the intensity of dependence between variables and their importance. The graph shows how the original features contribute to the principal components. The features placed close to the beginning are of small importance whereas features with a high level of variability in objects have more significant component weights. In the 2D graph of the first two principal components they are placed far from the beginning of the coordinate system. In cases where the difference in the clarification of the original features between the first and the second principal component is significant, the original features of the high weight in the first principal component will be more important than the features with a high weight in the second. The features placed close to each other on one side towards the beginning with a small angle between the respective position vectors of features have high positive correlation. The features with a 0° angle between position vectors show strong positive correlation, the features of a 90° angle are uncorrelated and those of a 180° angle are negatively correlated (Bartholomew, 2010).

The Graph of Component Score shows clusters of objects (EU countries) of similar qualities from the view of monitored characteristics. The objects located far from the beginning of the coordinate system represent the extremes. From the graph it is possible to identify isolated objects, as well, which can be distant. Normally, the component score is expressed for the first two principal components (Bartholomew, 2010).

The comparison of the graph of component weights and that of component score refers to the coupling between factors and respective objects (EU countries). It helps to understand connections between the closeness of the object and the respective factor.

Results and Discussion

The issue of assessing quality of life is problematic for two main reasons. The first is its content demarcation: so far there has been no generally acceptable definition of it. The second is its measurability: until now, no indicator has appeared that would capture quality of life in its complexity (Holková & Veselková, 2019). The essential problem of the last few decades has been well presented by Macků and Voženílek (2019) who declare that research in the sphere of quality of life has focused on the calculation of aggregated numerical indicators – indexes that in many cases (e.g. Distaso, 2007; Murgaš & Klobučník, 2016) are easily perceivable and comparable but do not enable us to understand wider connections and the core of the evaluated problem.

Our research concentrates on the identification of factors using the PCA method. Thanks to this ap-

proach it is possible to perceive the mutual relation between the variable and the object and thereby eliminate the author's subjective feelings that are often present when assessing quality of life. At present, we can see a certain shift in ways of assessing quality of life as there are papers that see the PCA method as a suitable tool to interpret the results of research – see e.g. Pöldaru and Roots (2014), Singh (2015), Finch et al. (2017). In this context, we can also mention the paper of Rao et al. (2012) who used the Factor Analysis to interpret input parameters for assessing the quality of life index. Generated indexes were further processed to estimate the overall index of quality of life in Uttarákhand, India.

Decrease of the Dimensionality of the Space and Selection of Principal Components

The Cattel Index Graph of the Base of Eigenvalues (Figure 1) shows that a significant breaking of the curve can be seen with number five. The first five principal components clarify 77.8% of variance of the original variables. According to the Kaiser Criterion which identifies significant and insignificant factors we might speculate about six principal components that together clarify 83.2% of data variability. It serves the most reliable results for 20 up to 50 original features. In the case of a lower number of factors, as here, an incorrect tendency to compile too many factors might appear (Meloun et al., 2012) hence a graphic representation in the form of the Cattel graph is essential. As mentioned in Meloun et al. (2012), with regard to the social-scientific character of the data and the objective of assessment, we may consider the threshold 77.8% of covered variance sufficient. To compare, for example in the paper written by Macků and Voženílek (2019), via the robust PCA the authors identified three principal components that cover 68% of variance. The first component explained 27.5% of variance in data, the second 23.9%, and the third 16.8%. When assessing quality of life, Birčáková et al. (2016) accepted eight principal components with total variability of almost 53%. Taking into consideration the number and the character of variables the authors considered it sufficient. Similarly, when assessing the internal structure of Bratislava from the quality of life conditions point of view, Andráško (2008b) also identified eight principal components that involved more than 83% of the total variance of original variables.

After decreasing the dimensionality of space to a 5-dimensional one, the factor loadings were calculated. Values lower than 0.3 (expressed in absolute value) were considered insignificant. Attention was drawn to the variables whose contribution to the relevant factor was the most significant.

Graph of Component Weights or Loadings (Figure 2) shows the first two factors that may clarify the biggest part of variance of the original variables (35.6% of the variability of the original variables by the first factor, by the second factor 18.1% of variability of those uninvolved in the first factor). The variables with a lower level of significance, such as P (pollution, grime or other environmental problems) and D

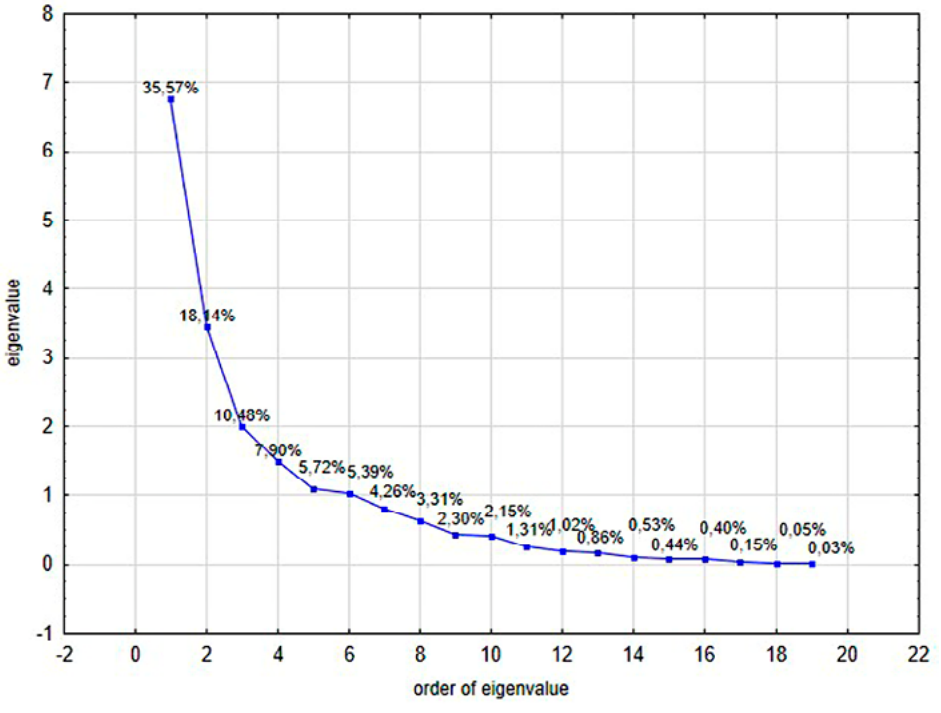

Figure 1. Cattel Index Graph of the Base of Eigenvalues
Source: Own calculation

(persons reporting a work-related health problem) are displayed in the graph of projection of variables closer to the beginning of the coordinate system; variables with higher significance are closer to the circle. The angle between the respective variables indicates the intensity of correlation.

The projection of variables into a factor level made from the first two factors revealed that the highest factor loadings (in absolute value) were identified by variables A – net income in PPS (0.8847, Table 1), L – time spent on health-enhancing (non-work-related) aerobic physical activity - 300 minutes or over (0.8450), and B – main GDP aggregated per capita in PPS (0.8385). Variables C – households making ends meet with great difficulty and I – arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards, were strongly positively correlated (0.93, Table 3). This was similar in the case of variables A – net income in PPS, and B – main GDP aggregated per capita in PPS (0.92). A close relation was also shown between education and net income or level of GDP (in both cases the correlation was 0.52), what corresponds to findings of Simonescu et al. (2021).

The square of factor loadings expressed the volume of the total variance of a feature explained by a corresponding factor. As much as 69.7% of the clarification of the variance of the original feature expressed by **factor 1** could be observed in variable S – percentage of the population rating their satisfaction as high. Variable C – households making ends meet with great difficulty, reflects worsened economic problems of a family, where the square of the factor loading reached 0.609. This corresponds to 60.9% of the clarification of the variance via factor 1. Even variables E – persons reporting an accident at work, F – long term unemployment, G – employment rate, H – inability to face unexpected financial expenses, I – arrears (mortgage or rent, utility bills or hire purchase), and K – frequency of heavy episodic drinking, have a negligible impact on the mentioned factor; the absolute value of Pearson correlation coefficient in all of these variables is higher than 0.58 and the determination coefficient reached the value higher than 0.33 here (Table 1). Along with the above variables that significantly contribute to factor 1, it would be possible to sum up the observed and name **factor 1** as **material-economic conditions**.

Factor 2 clarifies more than 59% of the variance of variable N – frequency of contacts with family and relatives several times a month, and 57.7% of the variance of variable O – frequency of getting together with friends several times a month, with a high positive correlation (0.69, Table 3). Significant contributions to the factor 2 are also evinced by variables J – healthy life years (0.2063), and R – crime, violence and vandalism in the area (-0.6237) - see Table 1, Figure 3. Also variable F – long term unemployment, makes some contribution to factor 2 (correlation -0.5826). A close interconnection between long-term unemployment (F) and the ability to provide for the family´s essential existential needs (C) is reflected by a high level of positive correlation (0.75). Long-term unemployed persons have substantial problems handling the economic situation and ability to provide for their family. This can be seen from the medium-high negative dependence between overall satisfaction with life (judged based on subjective feelings) and long-term unemployment (-0.44). Despite the fact that the majority of detection of variable I – arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards, falls to factor 1, this can be partially explained by factor 2 (22.2%), that negatively correlates with variables G – employment rate (-0.58), A – net income in PPS (-0.50), B – main GDP aggregated per capita in PPS (-0.45), and positively correlates with variables C – households making ends meet with great difficulty (0.93), F – long term unemployment (0.67), and H – inability to face unexpected financial expenses (0.55) - see Table 2. Even though factor 2 totally clarifies 38.9% of the variance of variable R – crime, violence or vandalism in the area, according to data analysed, it has almost nothing to do with long-term unemployment (correlation of 0.10, Table 3). Considering and summarizing the facts above, we would name **factor 2** as **social contacts and existential issues**.

Unquestionable contributions to **factor 3** can be seen in variables P – pollution grime or other environmental problems (0.8661), and Q – noise from neighbours or from the street (0.6577) - see Table 1, Figure 3. Both are strongly positively correlated (0.65) and reflect a negative impact on the quality of human environment. Other variables´ contributions to factor 3 are less notable or even negligible. That is why we can name **factor 3** as **environmental issues and quality of environment** in order to sum up our observation.

Factor 4 detects 60.5% of the variance of variable D – persons reporting a work-related health problem, and 37.1% of the variability of variable K – frequency of heavy episodic drinking. Strong episodic alcohol consumption has some influence on occupational diseases (correlation -0.34) and lower alertness at work (correlation of 0.36 with variable E – person reporting an accident at work), but regarding the negligible contribution (0.1159) of variable E to factor 4, we do not see it as significant (Table 1). With respect to the above, we could name **factor 4** as **healthy limitations related to work and alcohol consumption**.

The last factor we identified from a debris graph as a significant one was **factor 5** named **criminality**. It detects 27.5% of the variance of variable R – crime, vi-

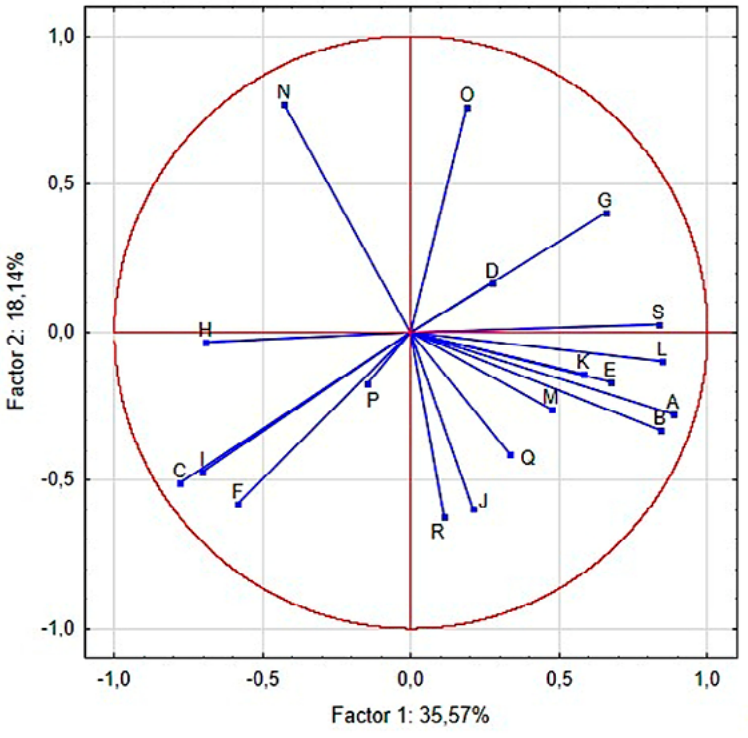

Figure 2. Projection of variables into the factor plane

Notes: **A** – net income in PPS, **B** – main GDP aggregates per capita in PPS, **C** – households making ends meet with great difficulty, **D** – persons reporting a work-related health problem, **E** – persons reporting an accident at work (from 15 to 64 years), **F** – long term unemployment, **G** – employment rate (age level 20-64 years), **H** – inability to face unexpected financial expenses, **I** – arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards - EU-SILC survey, **J** – healthy life years, **K** – frequency of heavy episodic drinking - at least once a week, **L** – time spent on health-enhancing (non-work-related) aerobic physical activity - 300 minutes or over, **M** – education, **N** – frequency of contact with family and relatives - several times a month, **O** – frequency of getting together with friends - several times a month, **P** – pollution, grime or other environmental problems, **Q** – noise from neighbours or from the street, **R** – crime, violence or vandalism in the area, **S** – percentage of population rating their satisfaction as high (16 years and over)

Source: Own calculation

Table 1. Factors' coordinates of variables according to correlation

Variable	Factors´ coordinates according to correlation				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factors of material living conditions					
A - net income in PPS (2018)	0.8847	-0.2761	-0.0572	0.0739	-0.0228
B - main GDP aggregates per capita in PPS (2018)	0.8385	-0.3325	-0.0963	-0.0121	-0.0958
C - households making ends meet with great difficulty (2018)	-0.7803	-0.5091	-0.0950	0.0589	0.1119
Productive and other main activities					
D - persons reporting a work-related health problem (2013)	0.2742	0.1675	-0.1475	0.7775	0.3228
E - persons reporting an accident at work (from 15 to 64 years) (2013)	0.6705	-0.1728	-0.2700	0.1159	-0.3740
F - long term unemployment (2018)	-0.5850	-0.5826	-0.1377	0.2389	-0.2809
G - employment rate - age level 20-64 years (2018)	0.6552	0.4022	0.1632	-0.1589	0.3851
Economic security					
H - inability to face unexpected financial expenses (2018)	-0.6969	-0.0347	-0.2799	-0.3669	-0.0293
I - arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards (2018)	-0.7050	-0.4717	-0.0987	-0.1151	0.1263
Health					
J - healthy life years (2018)	0.2063	-0.5965	0.3077	0.2315	0.2065

Variable	Factors´ coordinates according to correlation				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
K - frequency of heavy episodic drinking - at least once a week (2014)	0.5813	-0.1437	0.1651	-0.6091	-0.1671
L - time spent on health-enhancing (non-work-related) aerobic physical activity - 300 minutes or over (2014)	0.8450	-0.0986	-0.1060	0.2237	-0.0895
Education					
M – education (2018)	0.4750	-0.2619	-0.4257	-0.3532	0.3793
Social interactions					
N - frequency of contact with family and relatives -several times a month (2015)	-0.4299	0.7710	0.2183	0.0944	-0.0308
O - frequency of getting together with friends – several times a month (2015)	0.1888	0.7595	0.2820	-0.0845	0.1069
Living environment and physical safety					
P - pollution, grime or other environmental problems (2018)	-0.1469	-0.1736	0.8661	-0.0270	-0.1230
Q - noise from neighbours or from the street (2018)	0.3345	-0.4153	0.6577	0.0795	-0.1951
R - crime, violence or vandalism in the area (2018)	0.1119	-0.6237	0.3049	-0.1187	0.5247
Life satisfaction					
S - percentage of population rating their satisfaction as high (16 years and over) (2018)	0.8350	0.0242	-0.1525	-0.0825	-0.1112

Sources: Eurostat (2021), own calculation

olence and vandalism in the area, almost 15% of the variance of variable G – employment rate, and 14.3% of the variance of variable M – education. As can be easily seen from Table 3, there was only a small correlation (less than 0.22) between these variables.

Quality of Life in Countries of the European Union

The Dispersion Diagram of the Component Score (Figure 4) uncovers the structure of objects, i.e. clusters, isolated and outlying objects or anomalies. The objects placed far from the beginning of the coordi-

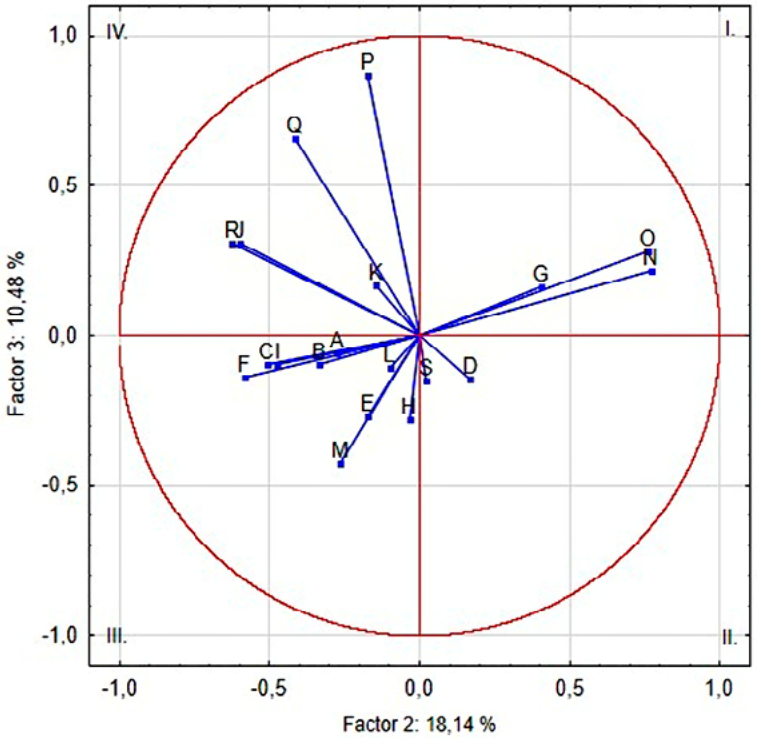

Figure 3. Projection of variables into the factor plane
Note: The description of variables is the same as in Figure 2
Source: Own calculation

nate system in the diagram represent the extremes; the ones that are closer to the beginning are the objects with the most typical properties.

The quality of life in the EU as a whole is best expressed by Portugal and Slovenia and their properties (via the first two factors that have the highest significance).

Economically advanced and developed countries of Northern and Western Europe, such as Finland, Sweden, Denmark, Great Britain, Ireland, Netherlands, Belgium, Luxembourg, Germany and France are characterized by a high level of GDP per capita in PPS what clearly affects the quality of life. Compared to the other EU countries, higher purchasing power is visible here. In the graph of component score (Figure 4) all these countries are located in quadrant I and II. Among these states the highest contributions to factor 1 are from Sweden, Finland and Denmark (Table 2). The above facts also confirm the closeness of vectors of variables A – net income in PPS, and B – main GDP aggregated per capita in PPS, to the named countries if we overlay the graph of component weights with the graph of component score. Within this context Luxembourg leads, its level of main GDP aggregated per capita in PPS reaching 32,060 € and net income in PPS 32,158 €.

Considering the indicator related to alcohol consumption (included in the forth factor affecting the quality of life according to our analysis) the higher percentage within EU countries can be observed by some countries of Western and Northern Europe. The frequency of heavy episodic alcohol consumption is higher especially in Ireland (13.3%), Luxembourg (11.2%), and Finland (11.0%). Among other countries a high percentage is noticed in Romania (10.6%). Compared to the EU average (3.0%), France, Sweden and Finland also record more occupational injuries (Finland 8.7%, Sweden 5.3%, France 5.2%). The correlation value between episodic alcohol consumption and occupational injuries was about 0.36 here. Considering these criteria Ireland is an outlier, because even though it has the highest consumption of alcohol (13.3%), it recorded only 1.5% of occupational injuries. On the contrary, an active approach to health positively influencing quality of life, is declared by as many as 30.4% of Swedes, 29.4% Austrians, 21.9% inhabitants of Luxembourg, 28.2% Finns and 26.4% Germans (see the closeness of variable L – time spent on health – enhancing (non-work-related) aerobic physical activity – 300 minutes or over, to the mentioned countries when overlaying the graph of component weights with the graph of component score). Those people do some aerobic physical activity in order to strengthen their physical condition 5 and for more hours a week.

In the graph of component score (Figure 4) the highest similarity (from the factor 1 and 2 point of view) is visible between Denmark and Austria, Latvia and Hungary, Lithuania and Slovakia. Even though their

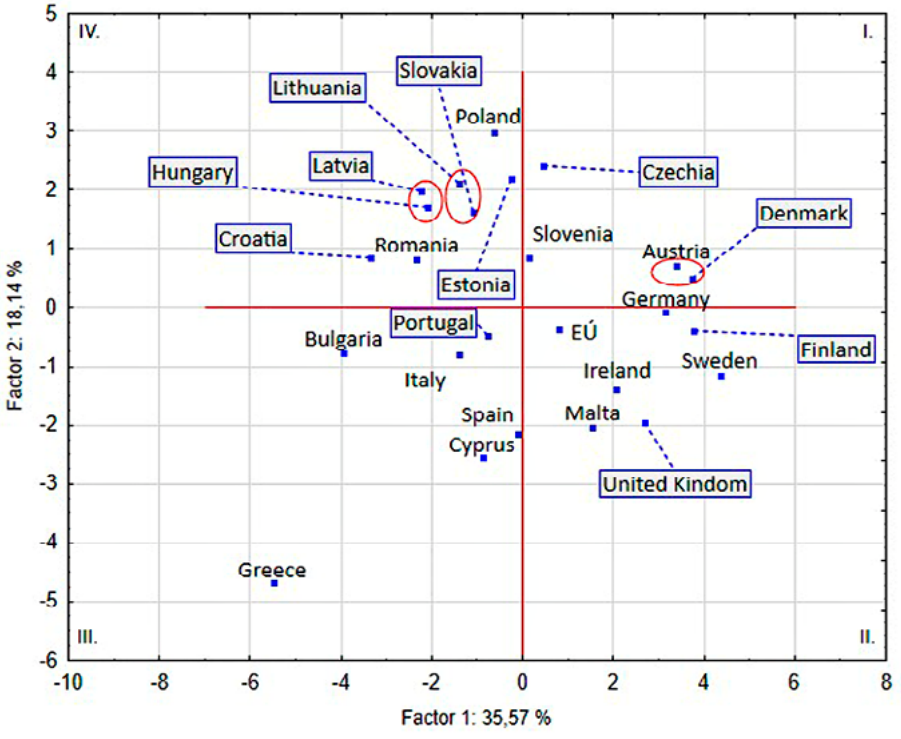

Figure 4. Projection of objects into the factor plane
Note: The graph contains countries with complete data from the Eurostat database
Source: Own calculation

contributions related to factors 1 and 2 are similar, in factors 3 and 4 they are often different.

The biggest contributions (in absolute value) to factor 3 are from Malta and Germany (Table 2). Although the environmental issues apply most to residents of the above countries, they are also important for inhabitants of other countries. As stated in the Communication of the Commission (Oznámenie Komisie, 2019) document, only a few EU Member States (Belgium, Netherlands, Germany, and Slovenia) succeeded in reaching 50% level of communal waste recycling by 2020; more EU Member States (Bulgaria, Cyprus, Estonia, Finland, Greece, Croatia, Latvia, Hungary, Malta, Poland, Romania, Slovakia, and Spain) were in danger of not reaching it in the near future.

Overlaying the graph of component weights with the graph of component score shows certain coherences. This step needs to be taken very carefully, however, when analysing data, as the risk of misunderstanding observed features is high. This relates to different reduction of dimensionality of the space in terms of objects and variables.

The relative closeness of variable F – long term unemployment, is evident in Greece. Apart from a high negative contribution to factor 1, it also has the highest contribution to factor 2 - social contacts and existential issues, of all EU countries (Table 2). In Greece, there was significantly higher long-term unemployment among economically active inhabitants culminating in 2014 (it culminated at 19.5%). Although by 2018 it had dropped to 13.6%, it was still 4.5-times higher than the EU average (3%). The second country with a high level of long-term unemployment was Spain. Even though it was not as high as Greece, its rate of 6.4% was still double the average of the EU as it was in Italy (6.2%). Long-term unemployment as such generally causes serious problems not only in the social sphere in the form of lost self-confidence, work habits, communication, social position, financial income and risk of poverty, but also in the economic sphere: taxes, GDP, loss of savings etc. (Brožová, 2003).

In Greece and Italy, the high level of long-term unemployment was also negatively manifested in their high share of people at risk of poverty or social exclusion. According to Eurostat data (2018a), Greece was in this respect the third worst within the EU with 31.8%, only behind Bulgaria (32.8%) and Romania (32.5%). Italy occupied the sixthworst place (27.3%). Behind Romania (42.6%) and Bulgaria (34.3%), Greece also recorded the third worst score in material and social deprivation with 33.9% (EU average was 12.8%) (Eurostat, 2018b).

In the case of Greece the coherence between variables C – households making ends meet with great difficulty, and I – arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards, was also visible and reached the highest level of all EU countries (in variable C – 38.2%, in variable I – 43.0%).

Quality of life notably concerns the feeling of happiness, but primarily reflects how people perceive it. In this context, Easterlin´s ideas (1974) were inspirational. His findings revealed that despite the fact national income in the USA almost doubled between 1946 and 1970, Americans became no happier. Easterlin´s ideas were supported by Frank (2005) via his statement that a person will be happier with a yearly salary of 110,000 USD, if everyone else earns 85,000 USD rather that with a salary of 110,000 USD in a society where everyone earns 200,000 USD a year. Layard (2003) remarked that happiness and income are interrelated, but only to the point when the country reaches a specific level of development. If the income of inhabitants reaches a certain level, the feeling of happiness does not increase with growing income.

As many as 45.0% of Irish, 41.3% of Danes, 41.1% of Finns, and also more than 34% of Austrians, Poles and Swedes feel high satisfaction with their quality of life. Unlike Poland, a country of the former Eastern Bloc, the share of highly-educated persons in these countries exceeds 30%.

Satisfaction with quality of life is closely related to length of life in health. This was monitored as the highest in Sweden (72.8 years), followed by Malta (72.7 years) and Ireland (69.4 years).

Although material welfare plays significant role in subjective feeling of happiness, the contacts with friends and family relations are of at least the same importance here. As for frequency of contacts (several times a month), in almost all the EU countries (the exceptions were Croatia (19.5%), Greece (11.2%), Hungary (20.8%), Lithuania (26.6%), and Portugal (13.9%)) contacts with friends prevail over contacts with family and relatives. In countries of Northern and North-Western Europe contacts with friends are far more intensive (e.g. 24.9% contacts with friends versus 10.7% contacts with family and relatives in Netherlands, 29.0% with friends versus 14.9% contacts with family and relatives in Denmark, 18.8% contacts with friends versus 7.4% contacts with family and relatives in Ireland). Compared to the EU average (16.6%), contacts with family are below-average and contacts with friends are above-average (EU average is 23.0%) here. Data concerning meeting friends was compared also on a weekly basis. The highest values were recorded in the countries of Northern and North-Western Europe. Contact with friends is very important for the inhabitants of Scandinavian countries - Sweden and Finland. As many as 51.6% of Swedes (the most in the EU) and 46.5% of Finns state that they meet their friends every week. Regular weekly contact with

friends play an important role for more than 47.9% of Dutch, 47.6% of Belgians and 45.1% of Austrians. Regarding weekly meetings with family and relatives the leading positions are occupied by inhabitants of Finland (55.4%), Sweden (54.8%), Belgium (50.9%), Netherlands (48.5%), and Austria (45.9%).

One of the countries characterized by high satisfaction with quality of life is Poland (35.9%). It contributes to factor 2 the most (2.9761, Table 2). Even though the economic strength of some Northern and North-Western European countries, for example Luxembourg (net income in PPS 27,529 € and main GDP aggregated per capita in PPS 32,060 €), Denmark (21,646 € and 25,390 €), Sweden (20,414 € and 23,900 €), Netherland (21,528 € and 24,240 €), is approximately double that of Poland (11,513 € and 14,890 €), family contact several times per month in Poland is the highest of all EU countries (30.4%). However, regarding frequency of contact with family and relatives on a weekly basis (30.2%) Poland did not even reach the EU average (41.2%).

In the graph of component score, which displays contributions to factors 1 and 2 (Figure 4) we can notice smaller clusters of objects (states), what reflects to similar perception of life quality in countries grouped in respective clusters. The first cluster is formed by Slovakia and Lithuania; the second by Hungary and Latvia, the third by Estonia, Czech Republic, and Poland (except for Czech Republic all of these countries can be found in quadrant IV). These Visegrád Group and Baltic countries are connected not only territorially, but also historically (former Socialist Bloc countries), economically and culturally. Moreover, in the case of Slovakia and Czech Republic, they have had a common history as one state (1918 – 1992) and intensive family bonds. Even the subjective assessment of quality of life by inhabitants of Czech Republic and Slovakia is similar – in Czech Republic 29.5% and in Slovakia 27.5%, which is more than twice that of Hungary (only 13.1%). A low percentage of people considering their quality of life to be high was also recorded by inhabitants of Greece (13.5%) and Bulgaria (only 9.5%). We presume that in the case of Bulgaria the situation mainly arises from a lower income, problems to provide for their families and/or the lower purchasing power of its inhabitants (net income in PPS 7,218 €, main GDP aggregated per capita in PPS 10,740 €). In Greece the GDP is higher than the majority of Eastern European countries, but the low overall satisfaction of its inhabitants with quality of life is probably the result of the fact that Greeks lived beyond their means for a long time. The global financial crisis in 2008 resulted in significant austerity measures there that became most evident between 2010 and 2014, and which were often accompanied by the outrage of its inhabitants (Finančný trh (Financial Market), 2021).

According to Easterlin's model, the feeling of happiness in these countries will certainly grow along with increasing income for a certain period of time. Conversely, in those economically strong countries where residents currently show a high satisfaction with quality of life (with the high level of GDP per capita or purchasing power of inhabitants), which are characterized by a higher percentage of university-educated people and also longer healthy life expectancy, the feeling of satisfaction with the quality of life will be the result of non-material factors e.g. frequency of contacts with friends (mainly in Sweden, Finland, Netherlands, Belgium, and Austria) or healthier lifestyle in the form of declared more intensive aerobic physical activities (mainly Sweden, Austria, Finland, and Germany) etc.

Last but not least, we witness some common activities of all EU Member States oriented towards the minimization of risks for climate, human health and biodiversity (Európska komisia (European Commision), 2021) that create a wider framework for the quality of life itself.

Table 2. Factor coordinates of cases according to correlation

Countries	Factor coordinates of cases according to correlation				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
EU	0.7839	-0.3528	0.5785	0.2467	-0.0493
Austria	3.3867	0.7227	-0.8347	1.9426	0.0022
Bulgaria	-3.9432	-0.7744	0.8959	-0.2041	2.5508
Croatia	-3.3663	0.8610	-2.0393	0.2969	-0.8100
Cyprus	-0.8900	-2.5589	-1.2519	-0.6607	1.3996
Czech Republic	0.4345	2.4259	0.9875	0.4402	0.2811
Denmark	3.7256	0.4970	-0.5028	-0.4608	-0.6379
Estonia	-0.2612	2.1977	-1.0846	-0.9203	0.9642
Finland	3.7714	-0.4012	-1.9613	-1.4376	-1.9725
Germany	3.1451	-0.0778	3.1421	0.2845	-0.4125

Countries	Factor coordinates of cases according to correlation				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Greece	-5.5049	-4.6889	-0.1521	0.9343	-0.8361
Hungary	-2.0826	1.7140	-0.3765	0.3340	0.2087
Ireland	2.0682	-1.3837	-1.5566	-2.5054	0.4179
Italy	-1.4053	-0.8041	-0.1572	1.2306	-1.0658
Latvia	-2.2427	1.9882	0.2626	-0.6204	0.5320
Lithuania	-1.4061	2.1252	0.2853	-1.4175	0.0283
Malta	1.5451	-2.0412	3.8694	0.1350	-0.5416
Poland	-0.6215	2.9761	0.6533	1.1260	0.4895
Portugal	-0.7851	-0.4666	0.1114	0.6182	-1.2668
Romania	-2.3350	0.8181	1.7071	-1.7568	-0.9246
Slovakia	-1.0849	1.6298	-0.9300	1.1283	-0.7085
Slovenia	0.1344	0.8569	-0.0437	0.0096	-0.3667
Spain	-0.1175	-2.1510	-0.9104	0.5739	-0.4616
Sweden	4.3498	-1.1437	-1.0739	2.6276	1.9284
United Kingdom	2.7017	-1.9683	0.3819	-1.9446	1.2511

Notes: The table contains only EU countries for which we were able to obtain information for all 19 variables. The greatest contributions to factors (in absolute value) are highlighted in blue.

Sources: Eurostat (2021), own calculation

Conclusion

The aim of the article was to identify the factors that most influence EU inhabitants´ quality of life, analysis of the input data revealing that **material-economic conditions** (marked as factor 1), **social contacts and existential issues** (factor 2), **environmental issues and quality of environment** (factor 3), **health limitations concerning work and alcohol consumption** (factor 4) and **crime** (factor 5) have the biggest impacts. Projecting the variables into a factor plane we gained a picture of their importance, contribution to the factors as well as relevant correlations:

The maximum positive correlation (0.93) was shown between households making ends meet with great difficulty, and arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards; substantial correlation was also observed between main GDP aggregated per capita in PPS, and net income in PPS (0.92). A high value was also recorded between social contacts and net income expressed in PPS, as well as level of GDP per capita monitored on a monthly basis. Considering frequency of contacts with family and relatives several times a month, and frequency of getting together with friends several times a month, on a weekly basis, a strong positive correlation between net income in PPS and frequency of contact with family and relatives (0.62) was also recorded, as was the case with contact with friends (0.66). A significant positive correlation was also seen between main GDP aggregated per capita in PPS, and already mentioned variables related to social contacts.

The feeling of subjective satisfaction with quality of life positively correlates with the amount of net income expressed in PPS (0.72) and level of GDP per capita (0,71) achieved mainly by inhabitants with a higher level of education. In terms of monitored economic indicators, the economically strongest EU countries are Luxembourg and Denmark. The highest share of inhabitants with tertiary education is in Ireland (40.5%).

In the graph of factor score, Greece performed as outlier (considering factors 1 and 2). The closeness of the vector of long-term unemployment refers to its economic problems. Those culminated in 2014, but were still noticeable in 2018, when Greece had 4.5-times higher unemployment rate than the EU average.

Quality of life is substantially influenced by the social securities. While short-term unemployment may cause a certain feeling of increased quality of life for a certain period of time though having more time for oneself and hobbies, long-term unemployment causes deprivation and a feeling of dissatisfaction with one's life. Unemployment is greatly reflected in the inability to provide for one's family and handle unexpected financial expenses. Clearly, people with higher income handle unexpected financial problems more easily

and devote more time to active support of their health e.g. aerobic physical activity.

But a subjective feeling of happiness does not often originate in material welfare, but is more the result of social bonds, especially family relations and contacts with friends. In almost all EU countries (excluding Croatia, Hungary, Greece, and Portugal) the frequency of meeting friends prevailed over contact with family (monitored on a monthly basis). But when monitoring the frequency of contacts on a weekly basis, contacts with family prevail over contacts with friends. The exceptions are Great Britain, Spain, Ireland, Greece, Cyprus, and Bulgaria. The calculation of the factor score serves to identify similarities between individual states. Portugal, Slovenia and Ireland had the most typical properties (from the aspect of all five factors) and are closest to the EU average. The states of Northern and Western Europe, which prefer contacts with friends, are, compared to the former socialist countries, economically more developed and show a higher level of GDP in PPS.

To sum up the above, quality of life is related to a feeling of happiness and primarily reflects how people perceive it. The analysed data points to the fact that the subjective perception of happiness (as presumed by Easterlin) grows along with material values (see Bulgaria, Greece and Romania and other countries of the former Eastern Bloc). It also partially indicates that if the level of economic development exceeds a certain point, quality of life will carry on increasing thanks to non-material values, such as a healthier and more active lifestyle as a result of physical activity or the need of adequate education, which also showed positive correlations. Even though the sample we analysed did not prove that the perception of happiness depends on a community way of life with frequency of contacts on a monthly basis, when analysing contacts with family and relatives on a weekly basis, we see that the community way of life played an important role. We also confirmed that the frequency of contacts on a weekly compared to monthly basis influences much more the territorial differentiation between individual states. While family bonds were more intensive in former socialist countries, the inhabitants of the countries of Northern and North-Western Europe preferred contact with friends. The feeling of happiness associated with more intensive social contacts was even intensified by alcohol consumption here.

In our article we drew attention to the fact that the PCA method can be considered an appropriate tool for assessing quality of life, notably when it concerns selection of factors or territorial connections between the factors and the countries of selection. However, perception of happiness remains, to a great extent, a subjective category.

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Annex

Table 3. Correlation table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
A	1	0.92	-0.55	0.24	0.58	-0.29	0.38	-0.56	-0.50	0.32	0.44	0.81	0.52	-0.58	0.00	-0.08	0.36	0.22	0.72
B	0.92	1	-0.47	0.18	0.65	-0.19	0.33	-0.41	-0.45	0.27	0.50	0.73	0.52	-0,57	-0.02	-0.13	0.42	0.27	0.71
C	-0.55	-0.47	1	-0.17	-0.38	0.75	-0.67	0.55	0.93	0.09	-0.41	-0.56	-0.19	-0.02	-0.48	0.09	-0.09	0.27	-0.61
D	0.24	0.18	-0.17	1	0.20	-0.11	0.23	-0.31	-0.24	0.08	-0.34	0.36	0.05	0.11	0.14	-0.21	0.02	-0.04	0.22
E	0.58	0.65	-0.38	0.20	1	-0.13	0.29	-0.43	-0.33	-0.03	0.36	0.70	0.30	-0.40	-0.12	-0.22	0.23	0.01	0.55
F	-0.29	-0.19	0.75	-0.11	-0.13	1	-0.80	0.43	0.67	0.16	-0.38	-0.31	-0.16	-0.10	-0.51	0.17	0.00	0.10	-0.44
G	0.38	0.33	-0.67	0.23	0.29	-0.80	1	-0.44	-0.58	-0.15	0.30	0.47	0.41	0.00	0.42	0.00	0.18	0.04	0.38
H	-0.56	-0.41	0.55	-0.31	-0.43	0.43	-0.44	1	0.55	-0.40	-0.28	-0.64	0.01	0.22	-0.17	-0.04	-0.27	-0.14	-0.54
I	-0.50	-0.45	0.93	-0.24	-0.33	0.67	-0.58	0.55	1	0.02	-0.23	-0.45	-0.05	0.01	-0.37	0.14	-0.13	0.28	-0.51
J	0.32	0.27	0.09	0.08	-0.03	0.16	-0.15	-0.40	0.02	1	0.20	0.14	0.05	-0.47	-0.32	0.18	0.33	0.46	0.17
K	0.44	0.50	-0.41	-0.34	0.36	-0.38	0.30	-0.28	-0.23	0.20	1	0.36	0.30	-0.33	0.14	0.04	0.27	0.22	0.63
L	0.81	0.73	-0.56	0.36	0.70	-0.31	0.47	-0.64	-0.45	0.14	0.36	1	0.40	-0.41	0.08	-0.12	0.28	0.06	0.64
M	0.52	0.52	-0.19	0.05	0.30	-0.16	0.41	0.01	-0.05	0.05	0.30	0.40	1	-0.46	-0.17	-0.26	-0.02	0.21	0.43
N	-0.58	-0,57	-0.02	0.11	-0.40	-0.10	0.00	0.22	0.01	-0.47	-0.33	-0.41	-0.46	1	0.69	0.16	-0.30	-0.46	-0.32
O	0.00	-0.02	-0.48	0.14	-0.12	-0.51	0.42	-0.17	-0.37	-0.32	0.14	0.08	-0.17	0.69	1	0.07	-0.15	-0.20	0.24
P	-0.08	-0.13	0.09	-0.21	-0.22	0.17	0.00	-0.04	0.14	0.18	0.04	-0.12	-0.26	0.16	0.07	1	0.65	0.24	-0.28
Q	0.36	0.42	-0.09	0.02	0.23	0.00	0.18	-0.27	-0.13	0.33	0.27	0.28	-0.02	-0.30	-0.15	0.65	1	0.34	0.16
R	0.22	0.27	0.27	-0.04	0.01	0.10	0.04	-0.14	0.28	0.46	0.22	0.06	0.21	-0.46	-0.20	0.24	0.34	1	-0.33
S	0.72	0.71	-0.61	0.22	0.55	-0.44	0.38	-0.54	-0.51	0.17	0.63	0.64	0.43	-0.32	0.24	-0.28	0.16	-0.33	1

*Notes: **A** – net income in PPS, **B** – main GDP aggregates per capita in PPS, **C** – households making ends meet with great difficulty, **D** – persons reporting a work-related health problem, **E** – persons reporting an accident at work (from 15 to 64 years), **F** – long term unemployment, **G** – employment rate (age level 20-64 years), **H** – inability to face unexpected financial expenses, **I** – arrears (mortgage or rent, utility bills or hire purchase) from 2003 onwards - EU-SILC survey, **J** – healthy life years, **K** – frequency of heavy episodic drinking - at least once a week, **L** – time spent on health-enhancing (non-work-related) aerobic physical activity - 300 minutes or over, **M** – education, **N** – frequency of contact with family and relatives-several times a month, **O** – frequency of getting together with friends - several times a month, **P** – pollution, grime or other environmental problems, **Q** – noise from neighbours or from the street, **R** – crime, violence or vandalism in the area, **S** – percentage of population rating their satisfaction as high (16 years and over)*

Source: Own calculation