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How can we apply the models of the quality of life and the quality of life management in an economy based on knowledge?

Amelia Bucur

Faculty of Sciences/Department of Mathematics and Informatics, Lucian Blaga University of Sibiu, Sibiu, Romania

ABSTRACT
The scientific substantiations of quality have been applied to models that pertain to mathematical statistics, the probability theory, the information theory, fuzzy systems, graphic methods, time series, and algebraic and numerical methods. To these, this article aims to present a new method of applying mathematical modelling in an economy based on knowledge, by using the concept of the definite integral, the composite function, and mathematical optimisation. The research methods used in the realisation of this article are bibliographic research, creation of new models, and problem-solving. Mathematical modelling, the simulation of the quality of life, etc. are methods and techniques of both theoretical and practical scientific approach, which are likely to lead to a better understanding of the role of quality in this field, as well as leading to the sustainable development of quality by providing new practical solutions to achieve a quality, always superior to the one obtained previously. In this article, the author presents some personal contributions to the scientific approach to quality, through modelling and simulation of the quality of life, and management of the quality of life in an economy based on knowledge.

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1. Introduction

Modelling is a known human practice that has been used since antiquity. Aristotle declared that 'everything is a number', Ptolemy created a geocentric model of the universe, Copernicus and Kepler created the heliocentric model, culminating later with Euclid's model, which elaborates the model of the geometric point, and geometry.

In the last few centuries, specialists in several fields of life have developed the mathematical modelling of macro- and micro-economic systems, as well as the mathematical modelling of socio-human sciences.

Over the years, the mathematical model has proven to be a tool for the scientific research of the world, for the immediate analysis of reality, with which experts have been able to verify

CONTACT Amelia Bucur amelia.bucur@ulbsibiu.ro

the consistency of various ideas and scientific theories, in order to find explanations, new concepts, and new relationships between phenomena, processes and socio-human activities.

Nowadays, using modelling and simulation as scientific and practical approaches to the surrounding world has become an objective necessity, as urgent requirement to introduce rigour and abstractisation in the analysis of the essence and laws of real world phenomena.

So far, the results in the field of modelling and simulation were possible only through the scientific study of the subject analysed through two main methods at least: *fundamental research* (*experimental, real*), in order to produce creations and innovations, and *applied research* (*artificial experimenting*), in order to obtain information, conclusions on the reality necessary to make decisions to optimise the researched field, as well as establish future research directions.

Applied research, as opposed to fundamental research, is faster and with immediate benefits, easy to use for managers and other specialists, has low costs, and produces efficiency.

Over the years, specialists and practitioners have used applied research to describe and to understand the realities of their concerns, using schematic models of the socio-economic reality, through which they were able to draw conclusions on reality and future development directions.

Nowadays, qualitative techniques and instruments are widely used at all levels of management, as well as in executive activities of production, business, research, etc. with positive results, however, at an individual, organisational, and a social level, quantitative management techniques are, unfortunately, less applied, given the fact that globalisation and the permanent changes in all areas of life impose the approach and application of the methodological and technical tools of modelling and simulation.

It is known that for the scientific substantiation of quality there have been applied models that pertain to mathematical statistics (e.g., Isaic-Maniu & Vodă, 2008), the probability theory (e.g., Bucur & Blaj, 2011), the information theory (e.g., Dinu, 2007), fuzzy systems (e.g., Gogoncea, 2007; Marasini, Quatto, & Ripamonti, 2016), graphic methods (e.g., Isaic-Maniu & Vodă, 2006a), time series (e.g., Boşcaiu & Vodă, 2008), operational research (Bucur & Oprean, 2014; Ionescu, Cazan, & Negruşa, 1999) and algebraic and numerical methods (e.g., Bucur, 2013, 2014a, 2014b; Damasio da Silva, Batista, & Dumke de Medeiros, 2014; Militaru, 2008; Oprean & Bucur, 2012, 2013, 2015; Petrescu & Vodă, 2009; Ţîţu & Bucur, 2016; Vodă, 2008; Neelaveni & Manimaran, 2016).

In this context, it is considered that mathematical modelling, the simulation of the quality of life, etc. are methods and techniques of both theoretical and practical scientific approach, which are likely to lead to a better understanding of the role of quality in these fields, as well as lead to the sustainable development of quality by providing new practical solutions to achieve an adequate quality, always superior to the one obtained previously.

In this article, the author presents some personal contributions to the scientific approach to quality, through modelling and simulation of the quality of life, and management of the quality of life in an economy based on knowledge.

2. Modelling and the simulation of the quality of life in an economy based on knowledge

The term 'quality of life' is a concept used by theoreticians and practitioners from various fields such as economics, geography, literature, environmental sciences, philosophy, medicine, sociology, psychology and advertising, etc. This term is also used in everyday life, each person assigning it different characteristics with respect to their needs and aspirations.

In this context, quality of life is a controversial multidimensional and multidisciplinary concept. It has been defined in various ways, such as (Casas, Bălţătescu, Bertran, González, & Hatos, 2013): 'the necessary conditions for happiness' (McCall, 1975); 'personal satisfaction' (Terhune, 1973); 'adaptive potential' (Colby, 1987); 'the major importance given to life' (Jolles & Stalpers, 1978); 'the degree to which a person meets their goals in life' (Cella & Cherin, 1987); 'the desired effect of policies and programs' (Schuessler & Fisher, 1985); 'the significance of a human being's life to themselves' (Zamfir, 1993); 'to have (material and impersonal needs), to love (social needs), to be (personal development needs)' (Allardt, 1993), etc. The DEX online dictionary defines the quality of life as 'a sociological category designating all possibilities offered to the individual by society in order to organise his existence based on his own needs and desires' (http://dexonline.ro/calitate). Thus, there is no unanimity in defining the concept of quality of life, and it may not even be possible, because humans, as unique bio-psycho-social products, as well as the communities they belong to, perceive and interpret the process of quality of life through multiple conceptual filters and languages influenced by environmental factors and individual systems of values.

If one were to summarise the aforementioned opinions about the quality of life, one could emphasise that this refers to the more or less 'good' or 'satisfactory' character of human life, which includes the concepts of happiness, life satisfaction, and subjective well-being at the living standards and the existing environmental conditions at a certain moment in time.

In light of these conclusions, and considering the need to model and simulate the quality of life, this process of research and concretisation into models and simulations of the quality of life is not an easy or simple task. From this point of view, specialists in social sciences have not agreed on a definition of the quality of life. According to an opinion, 'in practical empirical measurements of the quality of life we see comparisons between pears with oranges' (Veenhoven, 2006).

In the next section, a mathematical model of the quality of life created according to the principles of mathematical modelling is presented.

2.1. The mathematical model of the quality of life in an economy based on knowledge problem to solve create a model of the quality of life

2.1.1. Solution

The model construct required a multitude of interrelated synergetic activities, as well as methodological issues, such as: model components; model structure; mathematical relations; model validation (Costanza et al., 2008).

Moreover, outlining the main elements of the quality of life, establishing the controllable and uncontrollable variables in the model structure respectively, involved the consideration of the objective and subjective requirements and needs of the people of the modern society, in order to determine 'the degree to which a person enjoys the important possibilities of his life' (Centre for Health Promotion, *The Quality of Life Model,* University of Toronto; Michalos, 2014).

An important source of the model is represented by the indicator of the quality of life, 'Human Development Index' (HDI) defined by the economist Mahbub ul Haq (Palazzi & Lauri, 1998) as well as other researched bibliographic sources, in order to build the model that represents the objective and subjective human needs as requirements for the quality of life (http://www.economist.com/media/pdf/QUALITY_OF_LIFE.pdf).

2.1.2. Result of modelling

The variables included in Figure 1 are numerical values associated to the following quality features: x_1^t- health; x_2^t- family life; x_3^t- community life; x_4^t- financial situation (GDP per capita, in \$); x_5^t- political stability and security; x_6^t- climate and geography; x_7^t- job safety (unemployment rate); x_8^t- political freedom; x_9^t- gender equality; *LE* - life expectancy at birth; *LEI* - life expectancy index; *EI* - degree of access to education; *MYSI*- education period; *II* - revenue indicator; *GNIpc* - gross national income at purchasing power parity per capita, where $x_1^t,\dots, x_9^t$ represent the mathematical notations for the objective characteristics of the quality of life, giving the members of a society the subjective satisfaction at a given time '*t*', assuming their statistical independence.

Considering the *HDI* indicator as a function of time, $HDI = HDI(t)$, over a period of time $[t_0, t_1]$, it can now be calculated a new indicator of the quality of life, which the author denoted by HDI_m (since it is a type of average of the $HDI(t)$ values that were calculated for the interval $[t_0, t_1]$). This new indicator also takes into account aspects regarding the variables $x_1^t,\dots, x_9^t$.

The mathematical model for the quality of life in an economy based on knowledge that the author created and proposes to be used by economists, sociologists, etc. is the expression from formula (1)

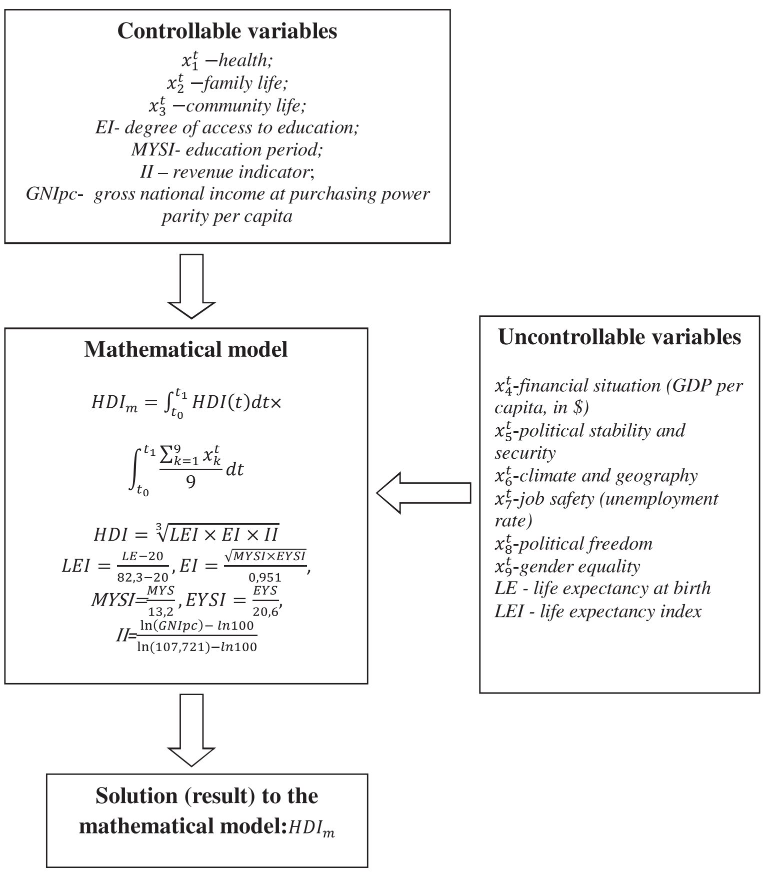

Figure 1. General elements of a mathematical model of the quality of life. Source: Bucur, 2014c.

$$HDI_m = \frac{1}{\left(t_1 - t_0\right)^2} \int_{t_0}^{t_1} HDI(t)dt \times \int_{t_0}^{t_1} \frac{\sum_{k=1}^{9} x_k^t}{9} dt, \qquad (1)$$

where:

- HDI_m - represents the indicator of the quality of life, obtained as a product of two integrals, of time functions, mathematical expressions of controllable and uncontrollable variables from Figure 1;
- $HDI(t)$ – is the HDI at the time point t;
- $\frac{1}{t_1-t_0}\int_{t_0}^{t_1} HDI(t)dt$ – is the average of $HDI(t)$ the values over a period of time $[t_0, t_1]$;
- $\frac{1}{t_1-t_0}\int_{t_0}^{t_1} \frac{\sum_{k=1}^{9} x_k^t}{9} dt$ – is the average of the values of controllable and uncontrollable variables over a period of time $[t_0, t_1]$.

The model from formula (1) was created by the author assuming that the integrals can be calculated, and that they represent integrals of continuous, monotone etc. functions respectively, as can be seen in the following simulation.

2.1.3. An example of model simulation

2.1.3.1. The purpose of the simulation. *Establishing the level of the HDI_m indicator presented in formula (1), by simulating the mathematical model in the Maple software.*

The simulation has the following steps:

- For the controllable and uncontrollable variables within the model, the functions $HDI(t)$ şi $x_k^t = x_k(t)$, $k = 1, ...,9$ are considered to be linear, in the shape of $HDI(t) = 20t + 30$, $x_k(t) = 40t\text{-}2\,k$, $k = 1, ...,9$.
- Selected the time interval $[t_0, t_1] = [0,1]$, which represents a period of time of one year.
- Enter the mathematical expressions of the integrals from formula (1) into Maple software, with the analytical representations given to the functions, $I(t) = 20t + 30$, $x_k(t) = 40t - 2k$, $k = 1, \dots, 9$ respectively.
- Press Enter from the keyboard, and the programme automatically calculates and displays the result of each integral and their product representing the numerical value of the HDI_m indicator, as shown in formula (2).

$$HDI_m = \int_0^1 (20t + 30)dt \times \int_0^1 \sum_{k=1}^{9} \frac{40t - 2k}{9} dt = 400. \qquad (2)$$

2.1.4. Simulation results

The Maple software offered three results, namely:

- 40 – represents an average of the HDI for a time period of over a year;
- 135 – represents an average of controllable and uncontrollable values;
- 400 – represents the HDI_m indicator calculated by the software, as product of the two integrals, from time functions.

2.2. The factor method for creating indicators of the quality of life in an economy based on knowledge

The quality of life, the standard of living and the economic status can be described through numerous variables. The difficulty is caused by the fact that, in most cases, the number of variables is large and their volume increases the level of complexity of the analysed issues. A solution to this situation may be applying a method of factor analysis, such as *analysing the main components*, through which those variables that significantly influence the quality of life, standard of living, the economy, and the human development can be identified and analysed.

The quality of human life is influenced by various factors, such as: life expectancy, GDP, poverty level, human development level, etc. There are a great number of variables and quality features with a certain influence on the quality of life, with different influences, therefore, it is useful to find those variables/factors/components with significant role in increasing or decreasing the quality of life.

A factor analysis method is the *analysis of the main components*, called *Hotteling Transformation* or *Karhunen-Loeve Transformation*, which uses its own vectors and aims to reduce the number of variables originally used by taking into consideration a limited number of representative variables, in fact, by reducing the volume of data in a structure to contain as much common variability (Gorunescu, 2006).

The method analyses the linear correlation matrix of the variables and evaluates the existing common variance, and then it extracts the factor that incorporates the greatest amount of variance, then the second factor with the greatest amount of variability of the remaining factors, and so on.

The final solution has as many factors as there are available variables, even if it is unlikely that all factors meet the criteria for retention. Such identified factors are orthogonal.

To summarise, *the analysis of the main components* is said to be limited to the algebraic decomposition of the data matrix of a structure of components (factors) that accumulate a great amount of common variability and generates orthogonal factors.

One example of software that can perform such an analysis is SPSS. In this software, the *Descriptive Statistics* table provides the average, the standard deviation, and the number of analysed cases for each variable, and the *Correlation Matrix* describes the correlation between the analysed variables.

In order to compare the sizes of the correlation coefficients with the sizes of partial correlation coefficients, we interpret the value of the *Kaiser-Meyer-Olkin* (KMO) *index*, namely if it is very close to 1; and if the value of the *Barlett's of Sphericity test* is small enough, it will lead to the rejection of the hypothesis that the variables are uncorrelated, and in such cases one could conclude that there is a strong relationship between data.

The common character/communality of a variable represents that part of the variable's variance that is common with the variance of other variables. If SPSS displays the minimum values of the common nature of certain variables, then they are not well represented by the factor model applied.

The first specific information of the factor analysis is provided by the *Total Variance Explained* table displayed by SPSS. The main components of this table are also known as 'factors', and they correspond to eigenvalues that are equal to or greater than 1.

The columns *Extraction Sums of Squared Loadings* of the *Total Variance Explained* table are those that contain in the column *Total* the values for the eigenvalues, the explained variance (*column % of Variance*) and *cumulative variance* (*column cumulative %*) in the context of the original solution, before rotation. And the columns *Rotation Sums of Squared Loadings* present the values of the factors after the rotation procedure.

The *Component Matrix* provides the list of variables and their contribution to each of the selected factors in terms of correlation, and the *Rotated Component Matrix* displayed by SPSS is one that contains the data obtained after applying the rotation to the factors, for converting them in order to approximate the given structure.

The *Rotated Component Matrix* is the one that allows the tracing of final conclusions regarding the structure of the factors for the analysed variables.

The first factor displayed by the software, composed of a sequence of initial variables, is actually an *indicator of the quality of life*. The initial variables can be chosen as: health, family life, financial situation (GDP per person in $), political stability and security, climate and geography the rate of unemployment, gender equality, life expectancy at birth, life expectancy index, education period, revenue indicator, gross national income at purchasing power parity per capita, etc. The values of these variables are presented chronologically on the website of the National Institutes of Statistics from Romania, on the website of the statistical office of the European Commission.

2.2.1. Problem to solve

Create an indicator for the quality of life based on the following variables: gross domestic product (GDP, in billions of RON), unemployment rate, gross national income (percentage of GDP), gross savings of the population as % of GDP, energy consumption/capita, mortality rate, poverty rate, public expenditure on education as % of GDP, life expectancy at birth.

2.2.2. Solution

The data used is gathered from the websites of the National Institutes of Statistics from Romania and of the website of the statistical office of the European Commission, for the years 2000–2013, for the variables mentioned in the problem statement. The variables and data are entered into the sheets *Variable View* and *Data View* from SPSS (Table 1).

After using the dialogue *Analyse-Dimension Reduction-Factor*, SPSS displays the window *Factor Analysis*. In this window, the selected variables can be analysed by choosing *analysis of the main components*. Afterwards, in the same window, the buttons *Descriptives*, *Extraction*, *Rotation*, *Scores*, *Options* are clicked consecutively, in this order.

From the *Descriptives* dialogue, in the option group *Statistics,* selecting the option *Initial solution* will display the initial communality, the eigenvalues, etc.

The *Correlation Matrix* group contains information about the correlation coefficients, and other useful information for the multicollinearity study. Out of these, *Bartlett's Test of Sphericity* tests whether the correlation matrix is approximately equal to the unit matrix (as null hypothesis), which denotes a strong multicollinearity. The KMO tests only the partial correlations between global variables, which is not useful in identifying the uncorrelated variables. Accepting the null hypothesis of the Bartlett test leads to the idea that the variables are not correlated, thus an attempt to reduce the dimension is unsuccessful, as each variable has a significant contribution that cannot be complemented by other variables. It should be noted that if a variable is not well correlated with the others (and therefore does

Table 1. Variables from the *Variable View* sheet and their values entered into the *Data View* sheet.

Years	Gross Domestic Product (1)	Unemployment rate (2)	Gross National Income (3)	Gross savings as % of GDP (4)	Energy consumption/ capita (5)	Mortality rate (6)	Poverty rate (7)	Public expendi-ture on education as % of GDP (8)	Life expectancy at birth (9)
2000	116.70	11.40	99.20	3.70	1.621	11.40	17.00	3.20	70.53
2001	151.40	11.20	98.20	4.00	1.694	11.60	17.00	3.80	71.19
2002	189.10	9.00	98.90	−0.50	1.674	12.40	18.10	4.20	71.18
2003	238.70	10.20	97.70	−6.20	1.796	12.30	17.30	3.60	71.01
2004	289.00	7.60	95.80	−4.70	1.797	11.90	17.90	3.70	71.32
2005	344.60	6.80	97.10	−7.00	1.751	12.10	18.20	3.60	71.76
2006	416.00	5.80	96.70	−9.50	1.833	13.00	18.60	4.30	72.22
2007	514.70	4.30	97.10	−1.70	1.844	11.70	23.40	4.40	73.03
2008	501.10	4.00	98.60	−1.20	1.599	21.00	22.40	4.30	73.33
2009	522.60	6.29	98.80	−1.40	1.625	12.00	21.10	4.00	73.43
2010	557.30	7.60	98.70	−2.70	1.669	12.10	22.20	4.10	73.31
2011	587.50	5.38	98.60	−2.00	1.600	12.00	22.60	3.80	73.00
2012	650.50	5.08	98.60	−3.10	1.610	12.10	22.60	3.90	73.01
2013	669.50	5.25	98.70	−2.20	1.620	12.10	22.40	3.70	73.43

Source: created by the author based on data provided on the websites of the National Institutes of Statistics from Romania and of the European Commission, www.insee.ro, www.ec.europa.eu.

not contribute to the multicollinearity), then that variable can be omitted from the analysis. The option *Reproduced* displays the correlation matrix estimated from the factor solution, and it also displays the debris.

Next, from the list entitled *Method*, from the *Extraction* dialogue, the method of analysis is chosen as *Principal components* and the type of analysis is given by the *Covariance matrix.*

In the option group *Extract* is indicated at the exact number of factors and the threshold for their eigenvalues. Selecting *Scree plot* displays the eigenvalues diagram that can afterwards be used to establish the number of factors. *Unrotated Factor Solution* leads to the display of the loaded information, communality and eigenvalues of the solution. Due to the fact that the solution is obtained after an iterative process, the maximum number of iterations may be fixed in *Maximum Iterations for Convergence*.

In order to obtain a better 'point of view', the rotation of the benchmark of the factor axes can be selected in the *Rotation* dialogue. The following methods are available: *varimax* (minimises the number of variables with high loadings on each factor, simplifying the interpretation of the factors), *direct oblimin* (oblique rotation), *quartimax* (minimises the number of factors needed to explain each variable), *equamax* (combination of the varimax and quartimax methods) and *promax* (oblique rotation that allows correlated factors).

As explained in SPSS software manuals and tutorials, for the solution obtained after the rotation we can find the solution or diagrams of the loadings for the first two or three factors. Also, for the rotation process, the maximum number of iterations can be specified in the *Maximum Iterations for Convergence*.

The *Scores* button can be used to save the final factor scores as new variables, each factor producing a variable. Also, the method of calculating the scores can be established by selecting one of the options: *regression* (the resulting scores have an average equal to zero, and a dispersion equal to the square of the multiple correlation between the estimated factor scores and the real factor coordinates), *Bartlett* (the resulting scores have an average equal to zero, and the sum of squares of the detained factors media is minimised), or *Anderson-Rubin* (the scores have an average equal to zero, a unitary standard deviation, and they are uncorrelated).

Display factor score coefficient matrix displays the correlation matrix between the scores and the coefficients that are multiplied with the variables in order to obtain factor scores. Afterwards, the software displays the principal components matrix (Table 2), the components matrix after rotating the variables (Table 3), and the matrix of variable correlation (Table 4):

The method of extraction used is *principal components analysis*, which extracts three variables out of the total of nine, which are considered principal components, because they have the highest common variability.

The rotation method used is *varimax with Kaiser normalisation*.

For each variable, the component score is calculated by multiplying the case's standardised variable values by the component's score coefficients. The resulting three component score variables can be used in place of the nine original variables with only an insignificant loss of information.

Afterwards, clicking the *Options* button indicates how the programme should handle missing values, as well as how to display the matrices, i.e., coefficients with an absolute value below a certain threshold may be omitted.

Table 2. Components matrix for the nine analysed variables.

	Component		
	Gross Domestic Product (1)	Unemployment rate (2)	Gross National Income (3)
Gross Domestic Product	0.932	0.026	−0.336
Unemployment rate	−0.934	0.238	0.004
Gross National Income	0.023	0.947	0.033
Gross savings as % of GDP	−0.234	0.835	0.114
Energy consumption/capita	−0.265	−0.894	0.039
Mortality rate	0.437	0.103	0.807
Poverty rate	0.939	0.167	−0.167
Public expenditure on education as % of GDP	0.635	−0.272	0.456
Life expectancy at birth	0.964	0.109	−0.137

Source: created by the author by simulation in the SPSS software.

Table 3. Components matrix obtained after rotating the nine analysed variables.

	Component		
	Gross Domestic Product (1)	Unemployment rate (2)	Gross National Income (3)
Gross Domestic Product	0.990	0.003	0.028
Unemployment rate	−0.865	0.242	−0.350
Gross National Income	0.032	0.947	−0.009
Gross savings as % of GDP	−0.239	0.841	−0.023
Energy consumption/capita	−0.283	−0.889	−0.016
Mortality rate	0.114	0.146	0.905
Poverty rate	0.939	0.153	0.180
Public expenditure on education as % of GDP	0.418	−0.248	0.670
Life expectancy at birth	0.950	0.097	0.221

Source: created by the author by simulation in the SPSS software.

Table 4. Matrix of correlation of the nine analysed variables.

	Component		
	Gross Domestic Product (1)	Unemployment rate (2)	Gross National Income (3)
Gross Domestic Product	0.322	−0.009	−0.222
Unemployment rate	−0.203	0.093	−0.081
Gross National Income	0.002	0.369	0.013
Gross savings as % of GDP	−0.083	0.330	0.065
Energy consumption/capita	−0.080	−0.344	0.030
Mortality rate	−0.189	0.083	0.761
Poverty rate	0.265	0.055	−0.073
Public expenditure on education as % of GDP	−0.025	−0.081	0.469
Life expectancy at birth	0.259	0.034	−0.042

Source: created by the author by simulation in the SPSS software.

The first information specific to factor analysis is provided by the table *Total Variance Explained* displayed by SPSS. This table shows the principal components, also known as factors, meaning the ones that correspond to eigenvalues equal to or greater than one (Table 5):

The columns *Extraction Sums of Squared Loadings* from the table *Total Variance Explained* contain in the *Total* column the eigenvalues, the explained variance (column *% of Variance*), and *cumulative variance* (column *cumulative %*), in the context of the initial solution, before rotation. The columns *Rotation Sums of Squared Loadings* display the values of the factors after rotation.

2.2.3. Result of modelling and simulation

An *indicator of the quality of life*, displayed by the software, is composed of a sequence of variables: *gross domestic product (GDP, in billions of RON), unemployment rate* and *gross national income (percentage of GDP).*

3. The mathematical model of the management of the quality of life in an economy based on knowledge

The management of the quality of life should include the following steps: identification of elements related to financial, social, and individual life in connection with the levels of Maslow's pyramid; objectives to be achieved in order to meet and identify the needs of characteristics of the quality of life; designing strategies for harmonising the needs mentioned in Maslow's pyramid model for achieving and increasing the characteristics of the quality of life; the designing of strategies to assure, control, and assess the achievement of characteristics of the quality of life; the analysis of results regarding the economic situation, housing and environment, jobs, education and training, home structure and family, work–life balance, health and medical services, subjective well-being and quality of life in society.

3.1. Problem to solve converting the schematic model from Figure 2 into a mathematical model

3.1.1. Solution

Another mathematical model that can be associated with Figure 2, suggested by the author, is a functional model, as each arrow in the figure represents, in fact, a functional dependency relationship:

$$f_5(n_1, n_2, \ldots, n_m) = f_5 o f_4 o f_3 o f_2 o f_1(n_1, n_2, \ldots, n_m), \tag{3}$$

where:

f_5 – represents the function that quantifies the degree of achievement of results; it depends on function f_4 that quantifies the quality degree of outputs from the stage of control and evaluation;

f_4 – represents the function that quantifies the degree of fulfilment of the objectives from the stage of assurance, control, evaluation of the overall model of life quality management; it depends on function f_3 that quantifies the quality level of the output in the stage of design and implementation;

f_3 – represents the function that quantifies the degree of fulfilment of the objectives from the stage of design and implementation of the general model of life quality management; it depends on function f_2 that quantifies the quality level of the output from the stage of identifying needs;

Table 5. Table *Total Variance Explained,* containing the principal components that correspond to eigenvalues equal to or higher than 1.

	Initial Eigenvalues			Extractions Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.272	47.470	47.470	4.272	47.470	47.470	3.838	42.647	42.647
2	2.574	28.598	76.068	2.574	28.598	76.068	2.569	28.545	71.192
3	1.034	11.494	87.562	1.034	11.494	87.562	1.473	16.370	87.562
4	0.645	7.163	94.725						
5	0.278	3.090	97.815						
6	0.099	1.105	98.919						
7	0.053	0.594	99.513						
8	0.033	0.369	99.883						
9	0.011	0.117	100.000						

Source: created by the author by simulation in the SPSS software.

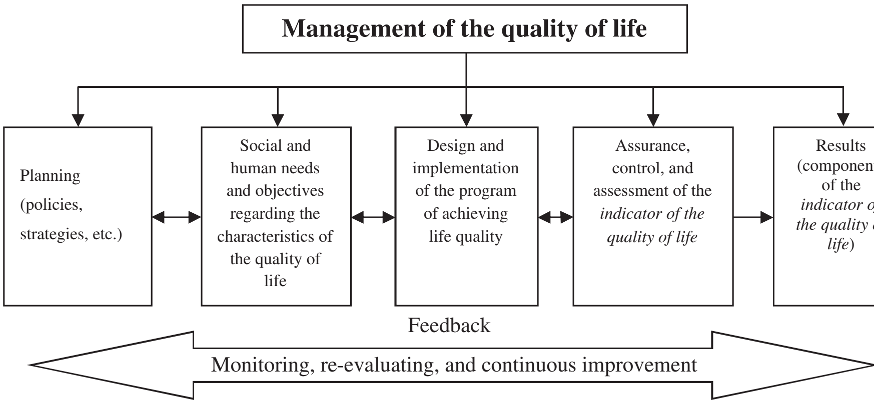

Figure 2. A mathematical model of the management of the quality of life. Source: Bucur, 2014c.

f_2 – represents the function that quantifies the degree of fulfilment of the objectives from the stage of identifying needs of the general model of quality management; it depends on the function f_1 that quantifies the quality level of the output from the stage of planning the quality management;

f_1 – represents the function that quantifies the degree of fulfilment of the objectives from the stage of planning the quality management; its variables are the needs/requirements, $n_1, n_2, \ldots, n_m$ regarding the quality characteristics of the product, service, activity etc.;

$n_1, n_2, \ldots, n_m$– represents an 'm' number of needs/requirements on the characteristics of quality of life, expressed by numerical values, if they are quantitative entities, or through associated values on a Likert scale, if they are qualitative entities.

3.1.2. Modelling results

The functional model mentioned in this section can be applied to a variable number of quality of life characteristics in general, or to its various fields, in particular cases: living conditions, education, health, employment, family, social environment and chances at social access, political environment, community conditions, people's mood and leisure concerns, etc.

3.2. Model of assessing the management of the quality of life regarding human health

Health is a dimension of the quality of life. The management of the quality of life regarding human health should include the following steps: identification of elements related to individual life; targets to be achieved in order to meet and to identify the needs for quality characteristics; designing strategies for achieving and increasing quality characteristics; establishment of strategies to assure, control, and assess the achievement of quality characteristics; analysis of the results regarding work–life balance; and health services.

Research actions related to human health quality of life were started by several organisations across the world. One example is the World Health Organization, which, in 1991, initiated a research project on the quality of life that has developed tools that include subjective indicators: assessment, perception, and satisfaction.

Recent sources for the quality of life from other regions of the globe are several barometers that are applied to the continents: Latin America – Latino barometro, Asia and Africa – Asian–African Barometer.

It is known that individual human health depends on many interrelated factors, such as genetic inheritance, social status, options regarding lifestyle, behaviour, attitudes, and values on health. The socio-economic status can also influence a person's health status: it determines the immediate circumstances of a person's life, their working conditions, housing, access to social services (health care or education, etc.).

Human health status is also determined by factors that operate at a macro-social level (community, region, society), as well as the quality of health services and environmental quality. Other factors at the society level, which contribute to the health status, highlighted in specialty literature, are those related to the country's socio-economic context, to the macroeconomic, social, or health policies, but also to cultural and social norms and values.

3.2.1. Problem to solve

Create a model of assessment of the quality of life management regarding human health.

3.2.2. Solution

For health care, the objective indicators generally illustrate two dimensions: health status, and health care services. Indicators often used in international comparisons to describe the health status are: I_1 – life expectancy, I_2 – infant mortality rate, I_3 – overall mortality rate, I_4 – mortality rates by cause of death, I_5 – the incidence of disease in the population, etc. Other indicators, such as: I_6 – number of health professionals, I_7 – number of health institutions, I_8 – expenditures of the medical system as percentage of *GDP*, etc. highlight features of the health care systems.

A relevant stage of the management of the quality of life regarding human health contains the analysis of the results regarding the balance health–health services. Correlated to this is the assessment of quality of life management regarding human health.

In order to create a model of assessment of the quality of life management regarding human health we denote the possible values of the previously mentioned I_k indicators by x_k, $k = 1,\ldots,8$.

The mathematical tool proposed in this section for evaluating the management of the quality of life regarding human health is a multi-objective mathematical programming problem of the form:

$$\begin{cases} maxF(f_1(x_1, x_6, x_7, x_8), I_1, I_2, I_3, I_4, I_5) \\ minf_2(x_2, x_3, x_4, x_5) \\ a_{k1}x_1 + a_{k2}x_2 + \ldots + a_{k8}x_8 \leq b_k, \\ x_1, \ldots, x_8 \geq 0 \end{cases} \tag{4}$$

where $a_{k1}, a_{k2}, \ldots, a_{k8}, b_k, k = 1, \ldots, 8$, are real constants, and I_1, I_2, I_3, I_4, I_5 are partial indicators of the quality level on achieving the stages of the management of the quality of life from the model created in Figure 2.

3.2.3. Modelling result
The solution to the author's multi-objective problem (4) will define a way to achieve the optimal quality in the management of the quality life regarding human health.

4. Conclusion

4.1. Conclusions to section 2.1

As can be seen, the final result of the simulation of the mathematical model is represented by a numeric value, 400 respectively, which is the expression of the quality of life over the time period of a year. This value may be higher or lower, depending on the values of the analytical expressions assigned to the controllable and uncontrollable variables in the mathematical model.

Both in theoretical and practical applications, these analytical expressions can be assigned randomly or they can be determined statistically using real data collected through scientific means.

The relevance and importance of the model reside in the fact that they involve and consider *sine die* all the components proposed or established for the controllable and uncontrollable variables, thus it is not necessary to assign weighted values to these components in the structure of the variables.

The model provides a final result, being a weighted average of the values of all elements that constitute the model's variables.

The mathematical model is a tool for those that wish to make comparisons, assessments, and evaluations of HDI_m, namely the quality of life of a certain community of a certain city, region, country or continent. Of course, comparisons of the quality of life can also be made at other levels, namely the quality of life of a particular family compared to another family, of a certain organisation compared to other organisations from the same country or from different countries, etc.

The model's rigour and appropriacy for practical applications are the main features of the model. It represents a methodological tool, easy and useful, to compare and appreciate the quality of life on certain periods of time in various fields of human life.

4.2. Conclusions to section 2.2

By using this type of factor analysis, the *Principal component analysis*, one may collect useful information on the factors that have a great influence on the quality of people's lives, giving statisticians, managers and specialists the possibility to track its upward or downward evolution.

Using this type of factor analysis and simulation with software such as SPSS, one can create *indicators of the quality of life*, or, analogously, *indicator of the quality of higher education*, *indicators of the quality of human resource training, indicators for the economic field*, etc.

For example, for an indicator of the quality of human resource training at the workplace, one can use the following variable sin applying the *Principal component analysis method*: selflessness, work environment, various financial benefits, creativity, reputation, relationships with colleagues, relationships with superiors, objectified success, intellectual stimulation, etc.

For example, for an indicator of quality in higher education, one can use the following variables in applying the *Principal component analysis method*: indicators of the quality of the candidates at the entrance examination, indicators on broadening the access to higher education, indicators of research results, indicators of research productivity, indicator of students' employment, the resources allocated for teaching and research, etc.

4.3. Conclusions to section 3

The functional models, through their design, can ensure the assembly of all components that are in a functional dependency and dependency on results regarding the modelling of the management of the quality of life.

4.4. Conclusions to section 3.2

Combining the partial indicators of the stages of the quality of life management with specific variables, one can obtain mathematical models for assessing the management of the quality of life regarding human health or other specific aspects related to the different conditions and spheres of life.

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