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# Quality of Life Modelling on the Basis of Qualitative and Quantitative Data

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## 1. Introduction

In the chapter the problematic of the Quality of Life (QL) modelling in the Czech Republic (CR) is presented. These models are suggested on the basis of the definitions QL analysis, approach to the measuring of QL and with using the complex system model of the QL, which can be used as a feedback information in the process of managing the public administration. At the basis of the systematic approach the models working with qualitative and quantitative data were suggested. In the first case it is the data from the questionnaire survey using the different methodology approaches. They are the data sets from the Institute of Sociology of the Academy of Sciences (ISAS) of the CR and a project of the civic association Team Initiative for Local Sustainable Development (TILSD). The methods cluster analysis (CA) and decision trees (DTs) were used for classifying the “satisfaction of respondents” with the selected part of QL and recommended decision making regulations. In the second case it was the quantitative data from the public accessible sources in the CR, e.g. Public database of the Czech Statistical Office (CSO), Institute of Health Information and Statistics of the CR, Czech Hydrometeorological Institute, CSO of Pardubice’s region, Portal of Regional Information Service etc. When selecting the indicators of QL, which represent the input variables of the model, it was resulted of the Strategic Framework (SF) of the sustainable development in the CR. The methods regression analysis were used for predicting the values of the indicators, DTs for classification of the QL levels in the regions of the CR and methods of the multidimensional statistics for the suggestion of the aggregated indicators of QL.

An expression QL is closely related to an expression life’s satisfaction. It is obvious that defining of the expressions satisfaction and QL brings many dilemmas and it is necessary to take into considerations the differences in the opinion of this theme. Reaching the life’s satisfaction is either conscious or unconscious effort of every individual. It is very subjective figure, which is changing in time and the expression “satisfaction” itself is vast and indefinite. Also the satisfaction determines, to the considerable extent, individual perception of the QL. This expression can be partly overlapped in some theories with well-being and life satisfaction could be a superior expression (Baštecká & Domkařová, 2011).

An asset to the creation of the opinion “satisfaction” is presented in the work (Hamplová, 2006), who summarizes pieces of knowledge of many authors, such as (Diener & Lucas,

2000; Kim & Hatfield, 2004; Stach & Eshleman, 1998, as cited in Hamplová, 2006), who characterize this expression as a state, when the positive emotions predominate the negative and in satisfaction then it is reflected a sensible evaluation of the own life. With reference to (Averill & More, 2000, as cited in Hamplová, 2006), satisfaction (the expression correlates with the expression happiness) is the state of joy, high spirits, peace and poise. In this case on the other hand, the expression happiness brings a lot of other questions, not really closer specification to the overall problem.

Much more pragmatic is the opinion of satisfaction (Půček et al., 2005). He uses the common reactions of the human who answer the question "What does this expression mean to you?" The human usually answer either "When I do well" or "When everything goes according to my wishes."

In reality it means the attitude (perception) of the specific state or situation, to what extent the human fulfilled his/her expectations of need, wishes etc. Satisfaction reflects the degree of the requirements fulfilment. This perception is then connected to the emotions and presents very subjective (relative category).

If we deal with the defining the expression QL, we must realize the historic, social and cultural changes in the society. Moreover by (Duffková et al., 2008), the QL includes the individual way of life, life conditions of the individuals, groups or society as a whole.

A great number of the literature brings different views of QL e.g. (Dvořáková et al., 2006; Philips, 2006; Rapley, 2003; Tokárová, 2002a; Tokárová et al., 2005) and also it argues that the QL is greatly discussed theme for many disciplines. As it is described by (Řehulková & Řehulka, 2008; Tokárová, 2002b) the QL was at first the economy object of interest (20s in the 20<sup>th</sup> century) as an indicator of satisfaction and social welfare, which is not primarily influenced by the number of consumed goods, but is presented as a subjective experience perception. Then the expression spread into sociology (50s in the 20<sup>th</sup> century) and psychology and medicine (in this case the QL represents a very important aim). Interdisciplinary approach towards the overall phenomenon brings a lot of advantages. The subjective as well as objective aspect can be expressed. On the other hand this complexity of the overall phenomenon does not enable to create a unified generally applicative model, but the result approach is always influenced by the professional interest of the researcher of the theories, which he/she prefers. This can cause often quarrels during the discussions and the results which can be applicable in reality, e.g. when strategic decision making of the public administration, must be interpreted with paying attention to all possible aspects of the solved reality. Difficult determinableness of the expression is in the subjectivity, when every individual understands it differently. By (Křivohlavý, 2004, p. 10) "About QL it is possible to discuss and have in mind a different range of an expression - human".

Complexity of the phenomenon also shows the characteristics and determinants of the QL where all the fields of the human life are reflected. Besides the factors which are mentioned below, we must realize (Blažej, 2005), that the 21<sup>st</sup> century brings new tendencies and aspects in the QL; from the most important ones are: globalization, development of the information activities, sustainable development and new economy influenced by the actual pieces of knowledge, where the important influence has the

human capital to the socio-economical development. World Health Organization (WHO) differentiates four basic dimensions of the human life determining its quality. They are absolutely independent on the factors of age, gender, ethnic or disability (Mühlpachr, 2005, p. 61):

- Physical health and level of independency – energy and tiredness, pain, relaxation, mobility, everyday life, dependence on the medical help, ability to work etc.
- Mental health and psyche – self-conception, negative and positive feelings, self-evaluation, thinking, learning, memory, concentration, belief, spirituality, religion etc.
- Social relationships – personal relationships, social support, sexual activity etc.
- Environment – financial resources, freedom, safety, accessibility of health and social care, domestic environment, opportunities for gaining new knowledge and skills, physical environment (pollution, noise, traffic, climate) etc.

The social determinants of the QL are thought these (Halečka, 2002, p. 67):

- Complex, optimal environment
- Adequate usage of human activity and drive
- Overall quality of human relationships
- Developing division of the competences and conceptual routing of the other human development
- Full respect of the human dignity as a bio psychosocial personality
- Mutual contribution to the higher values realization, to the full human being, his/her transcendence

Synthesized social indicators (conditions of life) in their work are presented by (Vaďurová & Mühlpachr, 2005, p. 8). These are<sup>1</sup> :

- Health
- Quality of working environment
- Purchase of the goods and services
- Possibility of free time spending
- Feeling of the social certainty
- Possibilities of the personality development
- Physical quality of the environment
- Possibility of social life attendance

## 2. Problem formulation

The way how to study the QL (Fig. 1) is offered by (Blažej, 2005, p. 25), who also encourages an acceptance of the social and international objectively measurable criteria, which would be studied and evaluated regularly. Considering different approaches determining the QL seems the creation of generally accepted categories unreal, as the other text shows it is very hard to express all the aspects of human life in context of his/her subjective and objective sides. Another question is how much this synthesis is necessary and covetable, as it is highlighted e.g. by (Miovský, 2006) scientific cognition is not united, homogenous complex of methods or universal rules, by which this cognition should be realized.

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<sup>1</sup>Synthesis was realized in 1974 by the European Commission of the United Nations

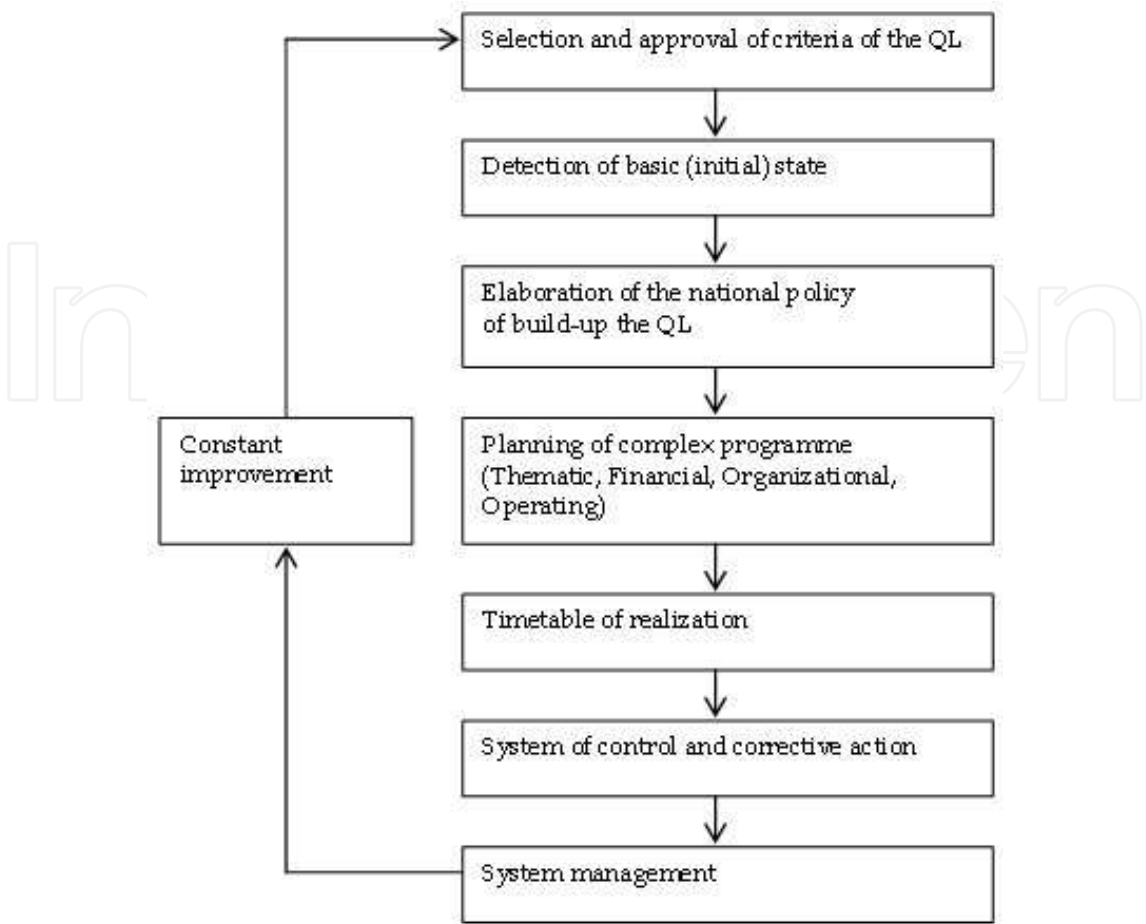


Fig. 1. Complex system of the QL.

The QL is necessary to view as a subjective appraisal of the own life situation. The QL consists of data about psychosocial state of the individual, which are influenced by the factors such as age, gender, education, social status, economic situation, values or personal well-being (Philips, 2006). Similarly the QL is defined by (Vad'urová & Múhlpachra, 2005), who say that this expression means the individual's perception in the place of life. This perception is influenced by culture, value system, by relations towards the human's aims, expectations, norms and worries. As the other variables there is also psychosomatic condition of the individual, social relations, personal religion and also the relation towards the key fields of his/her environment.

If we deal with the analysis of approaches towards the QL, we can study five main directions; which concepts influence the most understanding the QL, compare e.g. (Dvořáková et al., 2006; Křivohlavý, 2011; Maříková et al., 1996; Možný, 2002; Payne et al., 2005; Phillips, 2006; Vad'urová & Múhlpachr, 2005):

- Psychological concept (or socio-psychological): Psychology is in the given example oriented to the individual aspects of experiencing feelings of personal satisfaction and well-being. Sometimes the expression happiness is used. Foreign terminology related to the QL also uses besides the expression of well-being, the expression QL, subjective or psychological, life satisfaction, mental health status or happiness. Well-being then de facto means the long-lasting emotional status, marks out by the time stability and

consistence in different situations. Personal well-being of the individual is leant on the cognitive components, such as life's satisfaction or moral principles. In more details about construct of well-being (Šolcová & Kebza, 2004)

- Sociological concept: According to the sociological view there are also other factors (social) besides the individual factors (e.g. culture, religion, health, income, age, job satisfaction, mobility, transport etc.). The object of the interest is then the standard of living, way of life or welfare, which is represented as welfare in the foreign literature
- Philosophical concept: Behind the important characteristics of the QL we can consider meaningfulness of life (heading towards). If the human sets the superior general aim of life, then the aim is the main indicator of his/her life's meaningfulness. This aim shows where the sense is and where not. The big role plays the conscience, which must balance the procedures chosen when filling the aim to reach it. The expression of QL is related to understanding to the human existence
- Physiological concept (medical): A big amount of literature deals with the problematic of the QL at the people with illnesses. And in the field of measuring the QL it can be very well connected to the problematic of subjective and objective perception of the QL. Definition of the QL can help us, which is set by WHO, where the health is understood as a state of total physical, mental and social well-being. This definition takes note of psychologically-sociological aspects as well as biological aspects in the expression of health. Value of health is generally accepted throughout the human cultures
- Economic concept: This concept goes from mainly objective indicators of the QL (method of measuring, which will be described below). Because the QL from this point of view goes from the consumption, wealth, poverty and globalization, in our conception it is rather logical framework of the overall problem

All advanced views are partly taken in the work by (Rapley, 2003), who presents the options of the QL research according to these areas:

- QL as a psychological object
- QL of the selected population groups
- QL from the view of health and social care
- QL as an object of cultural impact

As one of lots of models of the QL can be illustratively used e.g. graphical visualization of the model (Rapley, 2003, p. 54) including essential factors of the personal well-being, which also contains all important variables (objective or subjective), which creates the QL (Fig. 2). That the QL is an object of a high interest is supported by (Vaďurová & Múhlpachr, 2005, pp. 9-10) list of organizations and research groups (Table 1).

The QL can be considered as universal category, which describes the satisfaction of people in their personal as well as social life. This information can then be useful for creation of local developing activities at the certain area. It is necessary to choose the adequate method of the collection of this data (for their usage) in respect to multidimensionality of the phenomenon.

In the basis, we can divide the approaches of the research into two main groups and one associated. For indicating the actual reality it seems to be the best to use both approaches together. Due to the demandingness of the research this solution seems to be hard realizable for practical usage, because it collides with the options of the research submitter and his/her



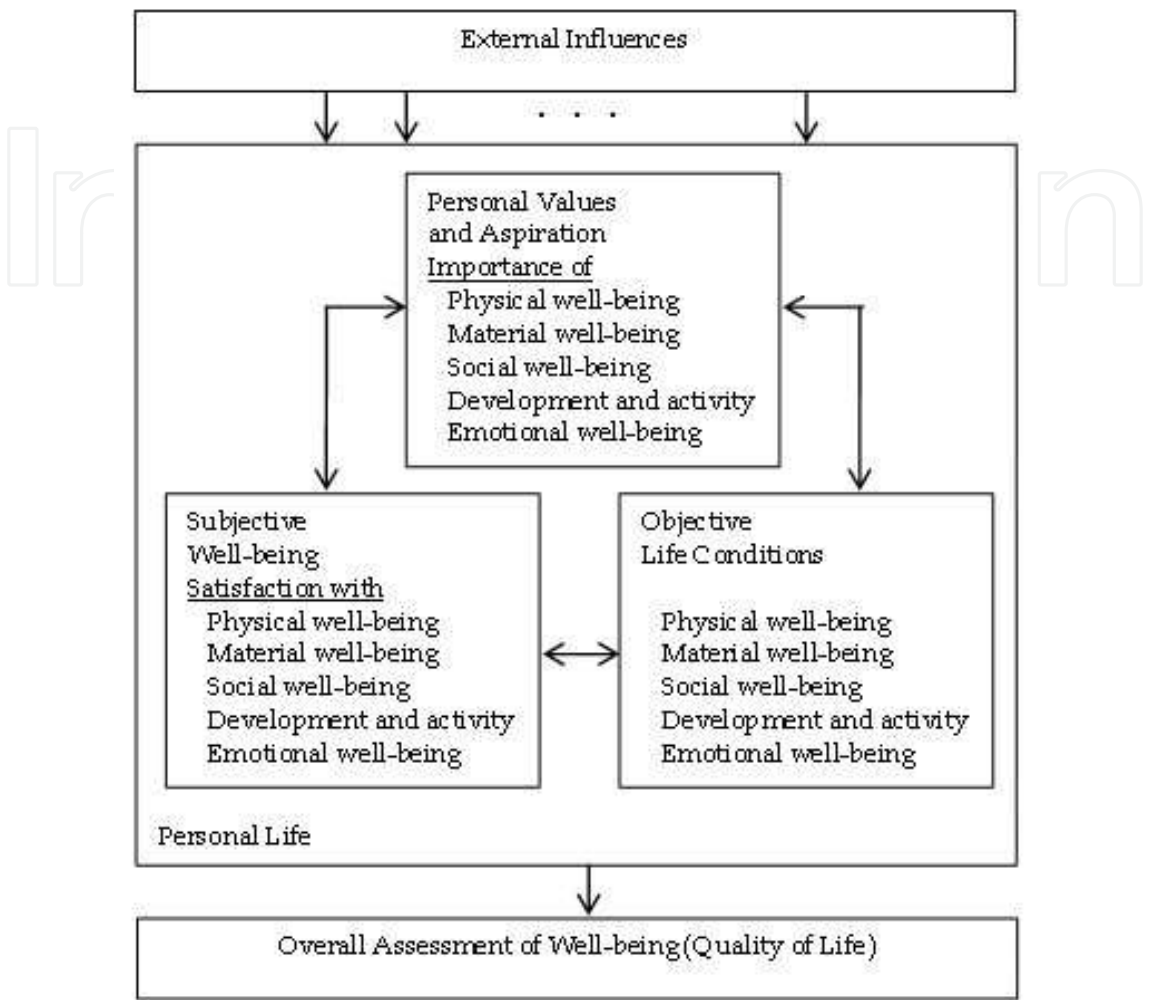


Fig. 2. Model of the QL.

willingness to invest into this process of data collection. The main parameter of the approach of the QL research is also reviewing the different indexes and parts of the values of respondents by variable scales:

- Subjective indicators of the QL: we can say simply that the personal satisfaction is measured, opinions of the people towards the certain phenomenon. Among the methods we can de facto include every researching technique, which ask the respondents their satisfaction. (Vaďurová & Múhlpachr, 2005) say, that the evaluator is the person himself/herself. In more details we will deal with the particular tools below
- Objective indicators of the QL: into this category we can include internationally accepted indicators of the state of the society and its development (see below). (Vaďurová & Múhlpachr, 2005) say, that in this case the objective procedure of the measurement can be considered the situation, when the state (situation) is evaluated by the second person
- Combined indicators: are represented by collected constructions of both above

Organization and Research Groups	Organization and Research Groups
American Thoracic Society – QOL Group	EORTC Quality of Life Study Group
Australian Centre on Quality of Life	Health Services Research – UCLA
Australian Health Outcomes Collaboration	Health Assessment Lab (HAL)
Behavioural Sciences at Nottingham University	Health & Quality of life Research Centre
Cancer and Leukemia Group B (CALGB)	Health & Survey Research Unit
Cardiff Research Consortium	Health Outcomes Research Europe
Center for Health Outcomes, Policy and Evaluation Studies (HOPES), The Ohio State University	National Centre for health Outcomes Development (include the patient-assessed Health Instrument database)
Centers for Disease Control and Prevention’s Division of Adults and community Health	Health Services Research Unit, University of Oxford
Center for Health Program Evaluation (CHPE)	Health Utilities Group (HUG)
Center for Health Outcomes and Policy Research, University of Pennsylvania	Human Research Services Institute
Center for Health Quality, Outcomes & Economic Research (CHQOER).	Institute for Health Services Research and Policy Studies
Center for Outcomes Research, University of Massachusetts	International Society for Pharmacoeconomics and Outcomes Research (ISPOR)
Center for Pharmaceutical Outcomes Research, University of North Carolina at Chapel Hill Scholl	International Society for QOL Studies (ISQOLS)
Chartered Society of Physiotherapy	International Society for QOL Research (ISQOL)
Cochrane Collaboration	Irish Clearing House on Health Outcomes
Connaissances et Décision en Economie de la Santé (base CODECS)	MAPI Research Institute
Department of Health Care Policy Harvard Medical School	Medical Outcomes Trust
Department of Health Services, University of Washington	Medical technology & Practice pattern institute (MTPPI)
Department of medicine, Clinical Epidemiology and Biostatics, McMaster University	European Clearing Houses on Health Outcomes (ECHHO)
Department of Palliative Care and Policy, London	

Table 1. Main organization and research groups dealing with the QL.

Besides the translated typology of division, we can distinguish the methods according to their specifications.

2.1 Methods of survey of subjective and objective QL

It is necessary to remind, that subjective indicators can be considered all answers of the human about his/her situation, which reflects his/her attitudes. Among the methods of survey of the subjective QL belongs: questionnaire of the WHO QL (WHOQOL) and its equivalents, Lancashire QL Profile (LQoLP), Schedule for the Evaluation of Individual QL (SEIQoL), questionnaire SQUALA and others.



In case of questionnaire WHOQOL and other equivalents it is one of the most used methods of studying the QL. Authors of questionnaire WHOQOL-100 conclude from the definition of the QL, which says that the QL is how the individual perceives his/her position in life (in the cultural context, in relation to his/her aims, expectations and interests). WHOQOL-100 consists of 24 aspects of life unified into 6 domains, where there are e.g. physical health, experiencing, level of independence, social relations, environment, spirituality and overall QL. The questionnaire is intended for population up to 65 years old. For older people the modification WHOQOL-OLD is used. WHOQOL-100 distinguishes among the groups of people with different level of health problems and between the men and women. Retested reliability of questionnaire domains WHOQOL-100 measured in the range of two weeks shows the relative stability of the answers in this time interval. An alternative can be a usage of the questionnaire WHOQOL-BREF. It consists of 24 items unified in 4 domains and two separate items evaluating an overall QL and health condition (26 items altogether). The questionnaire is not suitable to use for registering the impact of the immediate mood or the short-term changes (Miovská, 2011; Dragomirecká, 2006). For the people with HIV then the specific questionnaire is used WHOQOL-HIV and WHOQOL-HIV-BREF (Vaďurová & Múhlpachr, 2005). This questionnaire and its variations is primary used for measuring the health problematic and its outputs can be used also for the results in the ordinary population.

A questionnaire LQoLP is the questionnaire combining the subjective and objective sides of the QL. It consists of the following fields: work and education; free time; religion; finance; life situation; law status and safety; relationships with the family; social relations and health. The questionnaire is used for work with people who are mentally ill (Oliver, 1992; Vaďurová & Múhlpachr, 2005).

Other very much used method of the survey the quality is presented by (Křivohlavý, 2011; O'Boyle et al., 1993; Vaďurová & Múhlpachr, 2005) SEIQoL. It is the basic research technique, which is a structured interview. Interviewer finds out five basic life aims (impetus for life) of the respondent. Respondent indicates the level of satisfaction at all aims. The most often the impetus health, family, work, religion, finance, education, culture, hobbies etc. are mentioned.

A questionnaire SQUALA (Dragomirecká et al., 2006; Vaďurová & Múhlpachr, 2005) goes from Malowov theory of needs. It concludes from the opinion, that the QL means finding out the difference between the wish and expectations of the individual and the real state how this wish is fulfilled. The questionnaire is divided into two parts of the satisfaction evaluation. The evaluation of importance means: be healthy; be physically independent; feel mentally fit; nice environment and living; sleep well; family relationships; relationships with other people; have and educate children; take care of ourselves; love and be loved; have a sexual life; be interested in politics; believe in something (e.g. religion); relax in the free time; have hobbies in the free time; be in safety; work; justice; freedom; beauty; truth; money and good food. To the evaluation of satisfaction it is included: health, physical independency, mental well-being, environment of living; sleep; family relationships; relations with other people; children; care of ourselves; love; sexual life; membership in politics; belief; relax; hobbies; feeling of safety; justice; freedom; beauty and art; truth; money and food.

Among the other methods of survey the QL we can include e.g. (Vaďurová & Múhlpachr, 2005): Behaviour and Symptom Identification Scale (BASIC 32), Groningen Social Disabilities Scale (GSDS-II), General Satisfaction Questionnaire (GSQ), Psychosocial Adjustment to Illness Scale (PAIS), QL Enjoyment and Satisfaction Questionnaire (Q-LES), Social Behaviour Schedule (SBS) and Social Functioning Schedule (SFS), and others.

Among the methods of survey of the objective standards of living are: Human Development Index (HDI), Gross Domestic Product (GDP), Standard of Living of the Households or Individuals (SLHI) etc.

HDI consists of these three components: wealth, health and education. At these items were set minimal and maximal fixed values: 25 and 85 years (average length of life – hope of spending the rest of life of the member of the population); 0 and 100 % (literacy of population older than 15 – school attendances, length of studies etc.); 0 and 100 % (combined portion of population from the age group attending schools of first, second and third grade); 100 and 40,000 USD (GDP per person in parity of purchasing power). This index was topped up with the index of gender, index of women presence in social life (Blažej, 2005; Charles University Environment Centre, 2010; Tokárová, 2002b).

GDP presents the financial expression of the overall value of the estates and services newly created in the given period of time at the specific area. Material welfare, which is expressed by the GDP, financial expression of the overall estates and services newly created in the given period of time at the specific area. It is about the standard of living of the society (Kubátová, 2010; Czech Statistical Office [CSO], 2010). It is necessary to view this indicator critically, because (Možný, 2002, p. 17):

- Assumption of that people always select things according to their benefits and towards their benefits is not always true. People do not often select what they need
- Maximization of the individual benefits leads to the maximization of the social welfare
- Our behaviour does not bring any intended consequences to the others, and if yes, they can be ignored
- Distribution of the income (or division of the prosperity) is technically all right
- Those, who make a choice (spend money), are always those, who consume things or have some benefits from them
- All kinds of consumption are equal
- Things have the value connected to the market value right now

SLHI means the standard of income and consumption. They give evidence about the wealth and poverty. Particularly it presents the direct numeration of consumed goods and services, or pertinently financial income and estates, free time, resources from the budget paid for the public services. Then there is also number of harmful substances discharging to the water or polluting the air, average life expectancy, infant mortality, crime rates (i.e. demographic indicators). In other words expressing the standard of living consider, that we can imagine it as a degree of answering the material and non-material needs, wishes of the individual or the household. It is expressed by goods and services in particular it means the relation between the real state and the wished (satisfying) state (Červenka, 2011; Kubátová, 2010).

All these indexes can be understood with some reserve in their given evidence value. On the other hand they are the internationally accepted indicators, which are able to be compared,

and they present the guidance (practical) data studied throughout the cultural specifications of the individual nations (Možný, 2002).

A lot of methods of the research of the QL are concentrated to the medicine. For example (Křivohlavý, 2011; Vaďurová & Múhlpachr, 2005): Index of the quality of patient's life (ILF), Acute Physiological and Chronic Health Evaluation System (APACHE II) and others. The core of the method ILF is that the subjective evaluation of the patient is added by the opinion of the other interested people (medical personnel etc.). Among the studied criteria belong, e.g. patient's self-service, social support of the patient, managing the distress connected to the illness, pain of the patient and overall emotional state of the patient etc. APACHE II is the evaluating system of the acute and chronically changed health and gives a true picture of the overall state of the patient by means of physiological and pathophysiological criteria. The other methods are: Karnofsky index (The Karnofsky Performance Scale), Visual Analogue Scale (VAS), Spitzer Duality of Life Index – QL etc.

The problem of the QL in the CR is one of the main parts of the Strategy of national policy of quality in the CR for the period 2008 to 2013. The concept of the strategy (Vorlíček, 2008) is based on a result analysis of the present fulfilment of the national policy of quality support and on the basis of the evaluation of the current situation; it defines sending, vision, framework and the long-term strategic goal for the next period. The effort is to create an environment that would improve society life in all areas (including the improvement of the QL of individuals) in the CR (Křupka et al., 2009, 2011a).

Very important external factors of the QL are different regulatory instruments. These can be divided into several categories. First, they are laws and regulations in the areas related to the QL and affecting the QL. It is the external influence which affects many objective life conditions (see Fig. 2). Examples are strict standards of environmental protection and emission limits. These are forcing manufacturers to reduce emissions or cancel too "dirty" industrial plants. As a result, can this improve the quality of the environment that is important indicator of the QL (see the introduction of this chapter). Another instrument is municipal legislation. Municipal legislation states in general terms the jurisdiction of council and provides the legal structure and framework for municipal councils to provide governance and to make decisions at a local level. It affects the QL at the regional and local level. Finally, the regulatory instruments are subordinate standards and documents. Various institutions, associations, communities can issue such documents governing various aspects of the QL. People are governed by them voluntarily and on the basis of their beliefs. Their influence on the QL is not only local, only rarely broader.

The latest document within the CR is the SF of the sustainable development in the CR from 2010. It is a strategic material which is used as a long lasting guideline for a political decision making in the context of international obligations. The SF introduces four so called global aims according to the renascent Strategy of the sustainable development of the EU from 2006. They are these: Protection of the Environment, Social Cohesion, Economic; Prosperity and International Responsibility. Within these documents the sustainable development is defined as a development, which will carry out the needs of the present generation without threatening the needs of the future generations. There are priority axis and aims defined because of reaching a desirable situation of the sustainable development. According to (Ministry of Environment CR, 2010) they are these: Priority axis 1 – Society, Human, Health; Priority axis 2 – Economics and Innovation; Priority axis 3 – Area Development; Priority axis

4 – Countryside, Ecosystems and Biodiversity; Priority axis 5 – Stable and Safe Society (Křupka et al., 2011b, 2011c).

### 3. Quality of life modelling

When analyzing QL problems we work with notions as: quantitative and qualitative data, methods, research, evaluation and similar. Quantitative data (we can also use the terms “hard” data) are numeric characteristics (variables) of the observed phenomenon. Qualitative data (“soft” data) are non-numeric characteristics of the observed phenomenon (Křupka et al., 2011b). In quantitative research (Disman, 2005) multidimensional social and human reality is reduced to a limited number of a couple of variables and to a small number of analyzed relations between such variables. Qualitative research is a non-numerical examination and interpretation of social reality the objective of which is to uncover the meaning of the interpreted information.

On the basis of data sets of research inputs and output indicators (attributes, variables) for a model creation were defined.

#### 3.1 Models work with qualitative data

These models are devoted to the issue of the design of “citizen satisfaction” classification models. Real opinions on the QL problem were taken in to consideration when creating the classification models “citizen satisfaction” with regards to the quality of environment at the regional level in the CR (Křupka et al., 2011a). We worked with two methodology approaches (ISAS and TILSD), we compared them and defined common categories, e. g. environment, education, health service and possibility to participation in local decision making (Křupka et al., 2011a). The ISAS realizes monthly research in a wide spectrum (political, economical and social topics, respectively) covering the opinions of the inhabitants of the CR. The TILSD engages in the QL from the European Common Indicators (ECIs) point of view. The TILSD realizes a questionnaire inquiry for a given town, whereas the ISAS has a wide target group of informants and the place of residence represents only one of the variables (attributes) in the questionnaire inquiry. In regards to the representation of the QL, the TILSD uses an evaluation index of satisfaction and the ISAS uses a percentage expression (Křupka et al., 2011a).

On the basis of (Turban et al., 2005, p. 24) a model of citizen satisfaction might be defined in Fig. 3. The classification model of satisfaction was designed by means of algorithms of DTs (Maimon, & Rokach, 2005; Rokach, & Maimon, 2008) and their optimization. Based on the research conducted by the ISAS and TILSD in 2007 (Křupka et al., 2011a) real data sets were defined. In the first case (using the ISAS methodology) we worked with data matrix that included 1,132 results from a survey (objects) and 28 questions (attributes) from the questionnaire were selected. The modelling was focused on satisfaction of inhabitants with the environment in their place of residence using the ISAS methodology. Types of attributes are ordinal, nominal and continuous. The used data matrix does not content missing values and outliers. In the second case (using the TILSD methodology) we dealt with QL, it means citizens satisfaction with the quality of the environment in Chrudim. We used the data set from the questionnaire survey. On the basis of the chosen attributes come from the ECI indicator A1 “Citizen satisfaction with the local community”, a data file was created,



containing 701 data logging (objects, informants) and 10 original attributes (variables, questionnaire questions). Processes of data analysis, data preparation (data cleaning, data discretization and creation of binary attributes), splitting of data matrix, synthesis and analysis models, on the basis of decision trees (C5.0 and C5.0-boosting method), Classification and Regression Trees (C&RT), Chi-square Automatic Interaction Detection (CHAID), and Quick Unbiased Efficient Statistical Tree (QUEST)), were realized.

The designed classification models were created in Clementine ver. 10.0. Standard type nodes were used in the models. Common methods were used in the evaluation of achieved results, see more in (Křupka et al., 2010a, 2011a).

The accuracy rate  $A_c$  belongs to easy characteristics determinative quality of found knowledge. General calculation of accuracy rate  $A_c$  is defined as follows:

$$A_c = ( TP + TN ) / ( TP + TN + FP + FN ), \tag{1}$$

where TP is true positive, TN is true negative, FP is false positive and FN is false negative classification.

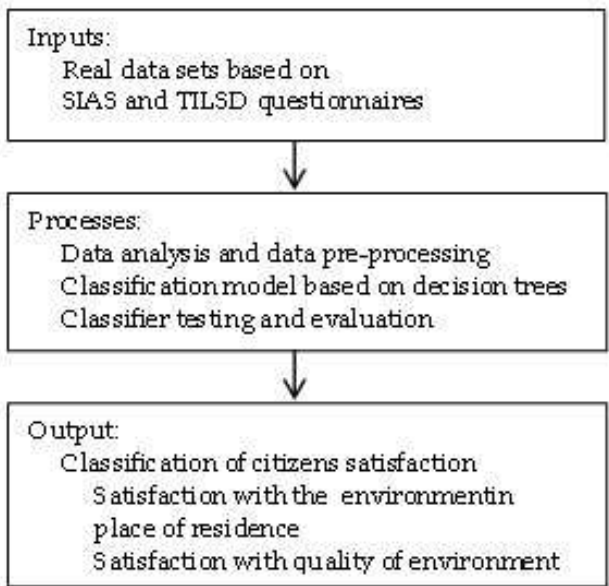


Fig. 3. Classification model of citizen satisfaction.

Partial results of classification accuracy  $A_c$  for model (it means model component works only with TILSD data) were compared with  $A_c$  of models (Křupka et al., 2010a) based on Radial Basis Function and Probabilistic neural networks (PNNs) , too (Table 2).

Methods of classification	$A_c$ in %
C5.0	70.00
C5.0-boosting	70.00
CHAID	68.18
C&RT	67.73
PNN	66.52

Table 2. Average values of accuracy rate of selected classification models for TILSD data set.



3.2 Models work with quantitative data

These models are dedicated to the issue of the design of “quality of health state” classification models, regression models of a sustainable indicator and “composed indicator set” (see the chapter 3.2.1) on the basis of principal components analysis (PCA) and factor analysis (FA).

We focused on Quality of Health State (QHS) in the CR regions with using health and environmental areas. Designed QHS models (Fig. 4) use data received from public sources. These are real data coming from the Czech Statistical Office, the Institute of Health Information and Statistics of the CR etc. (Křupka, 2010b). It represents real yearly data for QHS from 1997 to 2007 from the regions of the CR and model defines three linguistic levels of QHS in the regions. QHS model works in two steps (Křupka, 2010b). In the first step a cluster analysis (CA) is used for linguistic level. Selected health attributes are inputs for CA. In the second step we apply selected algorithms of DTs (Maimon, & Rokach, 2005; Rokach, & Maimon, 2008) for classification model creation. Input matrix contains demographic attributes oriented to health, appendix attributes (number of physicians and hospitals) and selected environmental attributes. Used inputs have a wider significance and mutual relations, which are described below. The chosen attributes (parameters, indicators) are also selected in accordance with the probability of causes of death. Data file contains 140 objects (regions in the studied years) and 17 attributes.

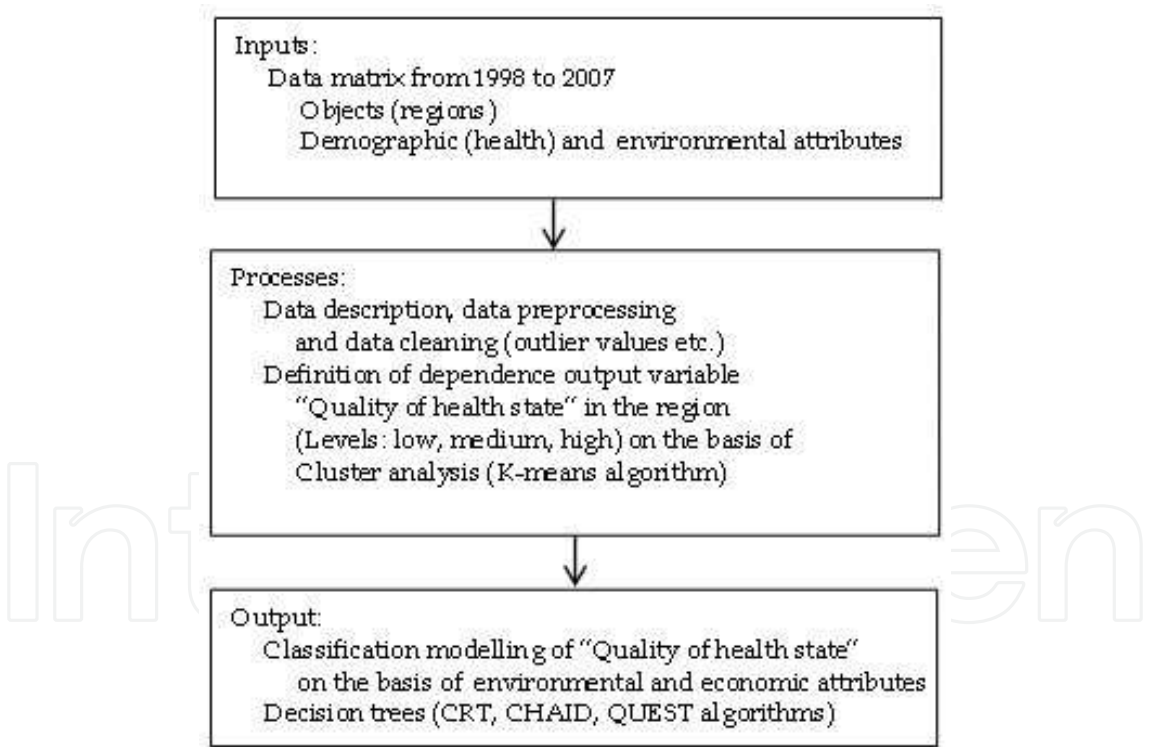


Fig. 4. Classification model of QHS.

When model creation, it is always very important to have a phase of analysis and understand the data. For the following analysis it is possible to use regression analysis. We suppose that there is an equation between the dependent y and independent x variables (Albright et al., 2006). The data is necessary to transfer to the relative values. We dealt with the analysis of selected, open accessible regional quantitative indicators from the priority

axis 1 “Society, Human, Health” and 5 “Stable and Safe Society” of the SF (Křupka, 2011b). Priority axis 1 aims to develop and improve conditions for healthy lifestyle, improve the lifestyle and health of the population and adapt the state and the regional policy of the demographic development. The other topic of the axis is a family and an inter-generation cohesion. Priority axis 5 is aimed on the strengthening of a social stability in the society, on the development of an effective public administration and the state, the development of a civic sector and on handling the global, terrorist and other threats.

We presented basic indicators and super-structural indicators for the area “Stable, safe society, health and a human being” went through a simple consultation process. One of them is basic indicator “Number of offences in the region, from them disclosed cases”.

This indicator shows the crime rate of the area. We have to realize that it brings the risk. This indicator works only with identified offences. None of the institution is not able to estimate, how much of real criminal (pathological) behaviour is in the society. However, we can consider this indicator as important indicator of the state of the society. In order to that we have to take all evidence with reserve and use other corroborative materials e.g. local documents about the crime prevention or use counsels of interested institutions (workers in the prevention, mainly in the authorities, social curators, non-governmental and non-profitable organizations, parts of the City Police or State Police etc.). The Indicator is possible to discuss only from the view of really pathological (deviant) behaviour compared to statistics of the registered offences. From the safety point of view, we can say that many deviations from the norms may cause some problems to people in their private or public life, but also they do not relate to criminal activity and therefore we cannot find any evidence. In many cases it is not possible to disclose them despite the fact that the crime happens. It is necessary to take into account this statistic evidence with the knowledge that there is not any other statistic evidence without factual findings (Křupka, 2011b).

The indicator is a basic indicator of disclosed offences in the years 2005-2009 for each district. For the years 1994-2004 the data is not possible to find for each district, but only for the separate regions. This is the crime introduced in the statistics of the Police of the CR – i.e. number of acts which are taken as offences – see the Act No. 140/1961Sb (the Criminal Law) and Act No. 141/1961Sb about prosecution (Criminal Rules).

We work with real data of districts (PCE is Pardubice, CHR is Chrudim, SVIT is Svitavy and UO is Ústí nad Orlicí) in Pardubice region for the years 2001-2009. We express these absolute values per 1,000 inhabitants. The equation of the regression (linear  $y_L$  and quadratic  $y_Q$  output of the regression model) is:

$$y_L = a_0 + a_1x \quad \text{and} \quad y_Q = b_0 + b_1x + b_2x^2, \quad (2)$$

where  $y_L$  and  $y_Q$  are expected values of offences in the territory;  $x$  is observed value of offences in the territory per 1000 inhabitants;  $a_0$  and  $b_0$  are constants;  $a_1$ ,  $b_1$ ,  $b_2$  are coefficients of the model.

The coefficient of determination R-square  $R^2$  (Albright et al., 2006; Ragsdale, 2008) was used for comparison of regression model quality. Model values for districts of region are in the Table 3. Based on comparison of  $R^2$  we can use linear trend of the district PCE, maybe for district CHR. We can not use linear trend for district SVIT and district UO like relevant information into regional planning process.

Territory	Value		
	$a_0$	$a_1$	$R^2$
District PCE	31.881	- 1.022	0.7439
District CHR	19.244	- 0.334	0.5502
District SVIT	17.344	0.039	0.0153
District UO	16.670	- 0.022	0.0164

Table 3. Values of linear regression model for district of Pardubice region.

We defined quadratic regression model for Pardubice region, its  $R^2$  is better than linear model, see Table 4.

Value of linear regression model			Value of quadratic regression model			
$a_0$	$a_1$	$R^2$	$b_0$	$b_1$	$b_2$	$R^2$
22.143	- 0.385	0.664	21.476	- 0.021	-0.036	0.695

Table 4. Values of linear and quadratic regression model for Pardubice region

The curve of quadratic regression model and observed values are in Fig. 5.

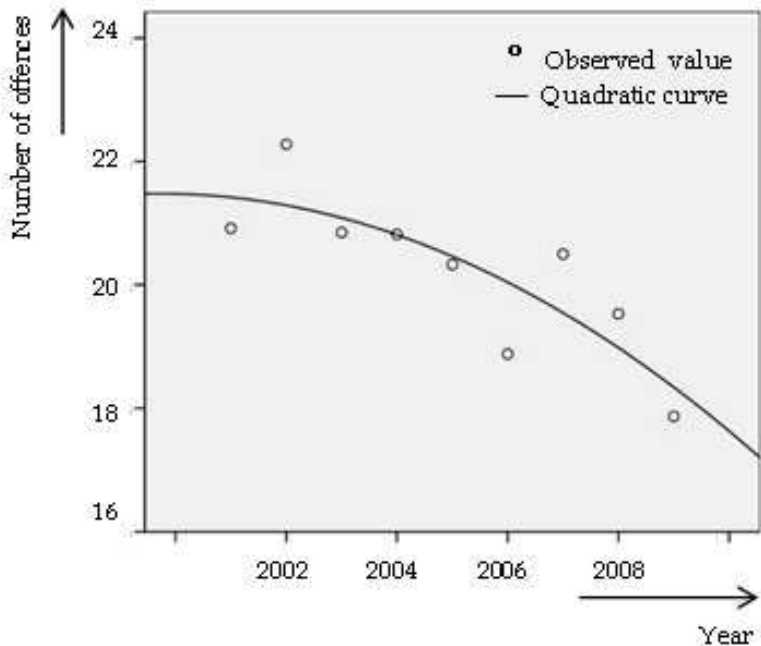


Fig. 5. Quadratic function of number of offences in Pardubice region.

3.2.1 Quality of life modelling by PCA and factor analysis

For modelling the data matrix formed by the districts of the CR studied in the years 2001, 2002, ..., 2008 was gained. After the phase of the analysis and clearing the data the resulting data matrix was used. It had the dimensions 42x529, i.e. we worked with 42 indicators (variables)  $p_i$  and 529 records (districts in the studied years). An example of the selected indicators is the following: area of the districts altogether  $p_1$ ; density of the inhabitants  $p_2$ ; average age of the inhabitants  $p_3$ ; portion of the selected kinds of property – farmland from

the overall area of the districts  $p_4$ ; completed flats, room or the set of rooms that can be used as a single housing unit where there the occupation permit came into force in the studied period  $p_5$ ; collective accommodation establishment  $p_6$ ; average monthly income  $p_7$ ; ...; made investments for the environment protection according to the districts of the investor's headquarters, single buildings and other investment measures leading to the improvement of the current environment conditions  $p_{10}$  etc. Detail description is in (Augustinová, 2010).

With intention of reducing the gained indicators, we focused on powerful techniques to reduce the complexity of data. Two similar but distinct approaches are used (SPSS Inc., 2007): There are PCA and FA. The PCA finds linear combinations of the input fields that do the best job of capturing the variance in the entire set of fields, where the components are orthogonal (perpendicular) to each other. PCA focuses on all variance, including both shared and unique variance. The FA attempts to identify underlying concepts, or factors, that explain the pattern of correlations within a set of observed fields. The FA focuses on shared variance only. Variance that is unique to specific fields is not considered in estimating the model. Principal components method and principal axis factoring method we used as methods for data reduction. The first one of methods uses PCA to find components that summarize the input fields. The second one is FA. It is very similar to the principal components method, except that it focuses on shared variance only (SPSS Inc., 2007). Design of modelling is in the Fig. 6.

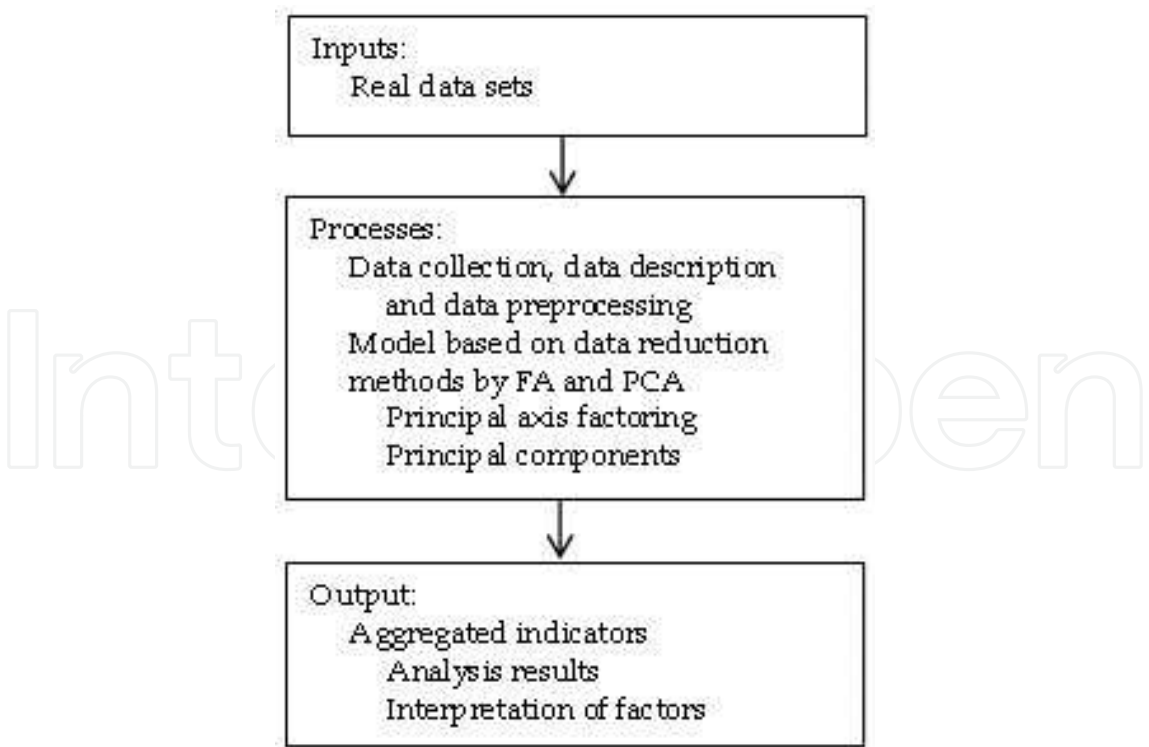


Fig. 6. Model of reduction indicators.

For the modelling the product of the company SPSS Clementine 12.0 was used and the above mentioned methods of variables reduction were applied. For the model creation the rotation method Varimax was selected (SPSS Inc., 2007): It is an orthogonal rotation method that minimizes the number of fields with high loadings on each factor. It simplifies the interpretation of the factors.

Factors were extracted using eigenvalues, output factors had the value of the eigenvalues greater than 1. Results of modelling we can see in the Table 5.

Model	Method	Number of Factors	Variance [in %]	Number of iteration for rotation
M1	Principal axis factoring	9	73.272	14
M2	Principal components	9	73.272	16

Table 5. Results of modelling by selected methods for data reduction.

Applying the mentioned methods of the variables reduction, the same number of factors was gained which gives a true picture of 73.3 % of the input data variance and the variables useful when single factors interpretation were identified. They were these factors:  $f_1$  Health,  $f_2$  Leisure activities,  $f_3$  Social situation,  $f_4$  Well-being,  $f_5$  Density of the inhabitants,  $f_6$  Area of the property,  $f_7$  Polluted air,  $f_8$  Attractivity of the region for tourists and  $f_9$  Air pollution in result of combustion process.

The results of the models M1 and M2 varies only in the number of interactions used at the rotation. For the output interpretation the model M1 is used (models did not vary much). The first factor “health” explains after the rotation 13.976 % of the overall variances of the set of variables. It is characteristic of the high loadings by the following variables: Number of doctors for 1,000 inhabitants ( $p_{22}$ ), Number of inhabitants for a doctor ( $p_{23}$ ), Average number of insured people ( $p_{26}$ ), Number of chemists and medicine counters ( $p_{25}$ ), Number of theaters ( $p_{36}$ ), Density of inhabitants ( $p_2$ ), Number of galery ( $p_{35}$ ), Number of hospital ( $p_{24}$ ), Number of vacancies ( $p_{20}$ ) and Made investements in environment protection ... ( $p_{10}$ ). The second factor “leisure activities” explains 9.732 % of the overall variance of the set of variables. The high loadings are reached at the following variables: Number of gymnasiums ( $p_{40}$ ), Number of playgrounds ( $p_{39}$ ), Number of stadiums including the indoor ones ( $p_{41}$ ), Number of cinemas ( $p_{32}$ ), Number of museums ( $p_{34}$ ), Number of winter stadiums including the indoor ones ( $p_{42}$ ), Number of swimming pools and natatoriums ( $p_{38}$ ), Number of cirques ( $p_{37}$ ). The third factor “social situation” makes clear 8.545 % of the overall varibility of the set of variables. The high loadings are reached at the following variables: Average old-age monthly pension ( $p_8$ ), Average monthly income ( $p_7$ ), Average period of one case of incapacity to work ( $p_{27}$ ), Average age of the inhabitants ( $p_3$ ).

The fourth factor “well-being” explaining 7.198 % of the overall variance of the set of variables has the high factor loadings at these variables: Divorce rate ( $p_{16}$ ), Number of offence ( $p_{29}$ ), Number of fires ( $p_{31}$ ), Number of abortions ( $p_{17}$ ). The fifth factor “density of the inhabitants” makes clear 6.890% of the overall variance of the set of variables. The



high factor loadings reach the variables: Overall increase of the inhabitants ( $p_{18}$ ), Number of accidents ( $p_{30}$ ), Rate of the registered unemployment ( $p_{19}$ ), Number of completed flats ... ( $p_5$ ), Number of marriages ( $p_{15}$ ), Average percentage of the sickness per year ( $p_{28}$ ). The sixth factor "area of the property" explains 6.575 % of the overall variance of the set of variables. The high loadings are reached at the variables: Length of the roads and motorways ( $p_{21}$ ), Area of the district altogether ( $p_1$ ), Number of public libraries including their branches ( $p_{33}$ ).

The seventh factor "polluted air" explains 5.208 % of the overall variance of the set of variables. The high loadings are characteristic for these variables: Emissions of the basic air polluting substances – sulphur dioxide ( $p_{12}$ ), Emission of the basic air polluting substances – nitrogen oxide ( $p_{13}$ ). The last two factors explain less than 5 % of the overall variance of the set of variables. The eighth factor "attractivity of the region for tourists" makes clear 4.996 % of the variance and the ninth factor "air pollution in result of combustion process" makes clear 3.555 % of the variance of the variables. The high loadings at the eighth factor are typical variables Number of collective accommodation establishment ( $p_6$ ), Number of small protected areas ( $p_9$ ), Portion of the selected kinds of properties – farmland from the overall district area ( $p_4$ ). While at the ninth factor these variables are Emission of the basic substances of the air pollution – carbon monoxide ( $p_{14}$ ) and Emission of the basic substances of the air pollution – solid emissions ( $p_{11}$ ).

#### 4. Conclusion

The effect of the modelling of the QL is a nontrivial and complex problem. It is affected by uncertainty. The uncertainty is given by the state of scientific knowledge in this area, a certain degree of error in input data and also by the high degree of the openness of the whole system. The term satisfaction itself is, like the term the QL, very wide and uncertain (multidimensional, complex). Psychological, social, medical and philosophical view projects in delimitation of these terms.

Regional development and the growth in the QL of its citizens belong to the essential goals of regional management. For the regional management, information on citizen satisfaction is an important basis in decision making and selfassessment; that is why it is necessary to assess and measure citizen satisfaction. It is important to identify not only areas in which people fulfil their personal aspirations, but also areas with negative influence on people. Region inhabitants judge their own interests by possibilities and barriers which influence fulfilling their personal needs and interests and unwind their positive or negative relation to the place where they live.

The first task occupied by the modelling of citizen satisfaction with the quality of the environment was processed as the classification task. Its goal was to classify citizens into classes by determining their satisfaction with the quality of the environment. Classification models on the basis of algorithms C5.0, C5.0 with boosting, C&RT and CHAID method were designed. The best results were achieved using algorithm C5.0 and boosting method. On the basis of achieved experience it was corroborated that the algorithm C5.0 is the best in the wide spectrum of classification tasks. The second task was defined clusters – linguistic values 'high', 'middle' and 'low' for QHS, and classify the CR regions based on QHS.

Finally we compare achievement results and apply multidimensional statistical methods to definition new composite indicators. There were two basic methods used, which showed the possibility of obtaining latent variables in the data dealing with the QL in the districts of the CR. By experimentations and application of other methods of FA and by experimentations with PCA it is possible to achieve new results not only in a sociological field. Properly designed models may also serve (Blahuš, 1895): to simplify the description of phenomena in the monitored area, to estimate the indirect measurement of the intermediate and measurable indicators; transform the original variables into a more advantageous form, the creation or verification of a structural theory of the investigated area, etc.

Future work could be focused on research in two levels. It is about the definition of the problem itself, which relates to the problematic of the QL and about the application of the new or hybrid methods. It is mainly the construction of the aggregated indicators for single priority axis SF as well as the suggestion of the aggregated indicators by cross-section of each axis. Another output can be the suggestion of the set of regulations connected to the QL for the regions in the CR and their generalization to the national level, or making a "handbook" for the public administration useful for the process of planning the social policy at the regional level. Final and very actual problem is research of the seniors' QL. Despite the fact, that this problematic is discussed at the international level in Lisbon strategy<sup>2</sup> (Portal Europa, 2011) and at the enquiry of seniors' QL is possible to use e.g. questionnaire WHOQOL-OLD, it is necessary to study possible effects of the systemic changes to the government policy at the national and regional level. The importance of the problematic of the old age in the CR is supported by the demographic and economic indicators. The results of the census in 2001 (CSO, 2011; Vidovičová & Rabušis, 2003) show that in mentioned year there were about 1.5 million people older than 65, which means 14 % of the whole population. By the year 2030 this portion will be 24 % and in the year 2050 up to 33 % of the whole population. In the year 2001 the old-age pension was 6,352 CZK and 140 billion CZK was paid altogether. The difference of gained and invested money in this chapter of the social security was 19 billion CZK (Vidovičová & Rabušis, 2003).

Related to the methods and algorithms, it will be e.g. a using of fuzzy logic and rough sets theory, hybrid fuzzy-rough sets approach, combination of DTs (it means to design a decision forest) etc. Fuzzy logic can be used for an expression of uncertainty into attributes values and rough sets theory can be used for defining "sample" cases into the cases base in Case-based Reasoning algorithm.

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<sup>2</sup> Lisbon strategy in its social pillar defines people between 55 and 65 as one of the key target groups

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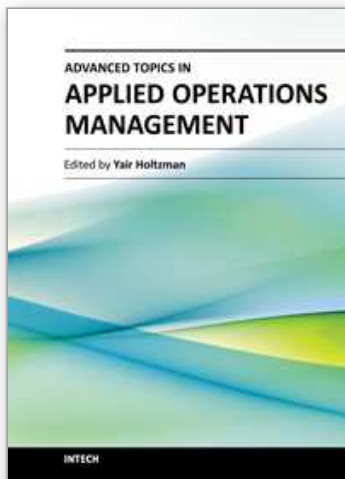
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