Quality of Life for People with Disabilities - the Study Realized on the NUTS3 Regional Level in the Czech Republic

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Abstract - This article is focused on the problem of the data acquisition and analysis of data about quality of life of hearing disabled people in the region. Data were obtained from disabled citizens of Pardubice region, Czech Republic. To obtain the data was used a questionnaire survey. For processing the obtained data were used the statistical methods, selected visualization techniques and data mining method. The achievements of this research are relations and links influencing quality of life of disabled people and basic characteristics of hearing disabled people. This is the basis for future social policy making in the Pardubice region. The methods used in solving the problem can be implemented also in other regions (in the level Nomenclature of Units for Territorial Statistics 3).

Keywords— Quality of life, people with disabilities, data mining, cluster analysis, regional development, sustainable development, questionnaire survey.

I. INTRODUCTION

This paper is focused on the problem of the analysis of data about quality of life of hearing disabled people, while its results should serve regional management for his decision-making. Regional management develops and implements regional policy. One of the main goals of regional policies is optimal providing of public services availability and accommodating of citizens' needs. Regional policy has to create conditions for citizens living within the region to have the best possible living conditions. In order for public administration to manage and plan regional policy, it is necessary to measure and analyze many indicators. One of the most important of aggregate indicator is quality of life (QL). QL is also crucial element of sustainable development. In other words QL is as a key indicator of sustainable development (SD), often disregarded due to its difficult objective expression and interpretation [1],[2],[3]. That is why other indicators, which are easier to measure, are preferred.

II. PROBLEM FORMULATION

According to [4] SD is generally understood as such a development to ensure the fulfillment of the needs of contemporary society without jeopardizing the opportunity to meet the needs of future generations. Modern view on SD emphasizes the need for improving the quality of human life. The Czech legislation is based on the EU concept [5]. Each of the SD strategy identifies priority areas and assigns long-term objectives to them.

SD is important aim for public administration (PA). PA uses many information systems and advanced methods [6] .

In particular we are interested in following. How can we measure the quality of life for people who are disabled in some way? In our case, the hearing-impaired people living in a particular region. Can we use questionnaires for data collection and data mining methods for their processing?

A. Quality of Life

The term 'quality of life' may be described by different points of view (psychological, sociological, philosophical, and medical) but can be defined only with difficulty, particularly because of two reasons. Firstly it is subjective concept [8] . Secondly there are many sorts of scientific branches which affect the definition and there is no universal generally acknowledged definition across all of them. Subjective and objective metrics are described in [9].

The examples of objective indicators are:

 • Gross domestic product: monetary expression of total value of goods and services newly created in given time period within a certain territory. Material welfare determined by gross domestic product, monetary expression of total value of goods and services newly created in given time period within certain territory. It is actually the level of living of a society.

 • Level of living of individual or household: level of income and consumption, wealth and poverty. Direct calculation of volume of consumed services and goods, eventually also financial income and belongings, free time, resources given from budget to public services. Further there are also volume of pollutants emitted into air and water, average life span, infant mortality, crime level. It states that

"expression of living level stems from thought that living level can be comprehended as the rate of satisfaction of material and non-material needs and desires of an individual and household by goods and services, or in other words relation between real state and state comprehended as desirable or at least suitable".

• Personal development index: contains these three components: wealth, health and education. These items were assigned with minimal and maximal fixed values [7]: 25 and 85 years (average expected life span); 0 and 100 % (literacy of citizens older than 15 years); 0 and 100 % (combined portion of population from respective age group attending schools of first, second or third level); $100 and $40 000 (gross domestic product per person in purchase power parity).

QL is subjective assessment of one's own life situation [8]. QL contains information on psycho-social state of individual, which is influenced by factors such as age, sex, education, social status, economic situation, values or personal comfort of individual. The idea stated is elaborated in [10], where QL includes also how individual perceives his/her own place in life.

Overall quality of human relations; complex, optimal living environment; adequate usage of activities and constructiveness of person; development division of competence and conceptual direction of further development of person; full respect of personal dignity as a bio-psycho-social personality; mutual contribution to realization of higher values, to richness of human existence and its transcendence are social determinants of QL [11]. This article is focused on the subjective side of QL. Subjective view is determined from personal well-being of an individual. Variable characteristics such as current mental state, reaction to life events or mood swings are also considered. Personal well-being belongs to boundary among affects, moods and traits of character. Dimensions of objective and subjective well-being are described in [12]. Categories of individual welfare are in Tab1.

TABLE 1 Categories of Individual Welfare [12].

Living conditions - (objective)	Well - being (subjective)	
	good	bad
good	Well-being	Dissonance
bad	Adaptation	Deprivation

B. Data acquisition

For measurement, analysis and modeling of QL for people with disabilities we must reflect many differences. Individual way of life (lifestyle) of disabled people is different than lifestyle of healthy people. The first problem was to prepare questionnaires [13]. Will be questionnaires appropriate for hearing impaired people? We prepared special questionnaires to suit their abilities and language specifics. The necessary data were then obtained through a questionnaire survey of hearing-impaired persons in Pardubice region. For the data collection was used also the sign language interpretation, which helps respondents to understand the questions.

III. PROBLEM SOLUTION

The scheme of the solution process is shown on the fig. 1. For processing the obtained data were used the statistical methods of data processing, data mining and data visualization methods[14],[15],[16],[19],[17],[18]. First you can see the distribution of respondents according to various criteria.
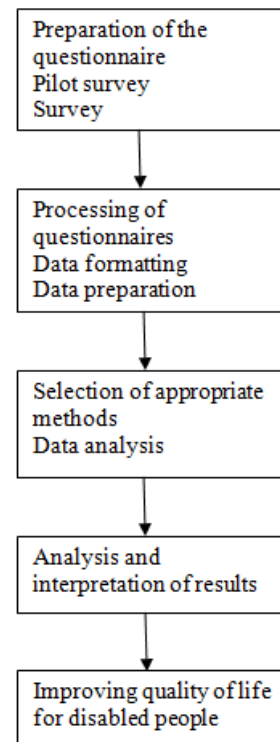

FIG. 1 Solution process

On the fig.2 are 5 age groups: 1- people to 20 years; 2- people between 21-35; 3- people between 36-50; 4- people between 51-65 and 5 - people older than 66. It is clear, that most are hearing impaired are elderly people - more than 50% are older than 51 years.

FIG. 2 Respondents by age

Next figure (fig.3) shows distribution of respondents by their educational attainment. Where 1 is elementary education, 2 is study without GCE, 3 is study with GCE, 4 - college, 5 - university degree. Unfortunately, we see that among the hearing-impaired people are few college or university-educated. Most of them have less education

Value ▲	Proportion	%
1.000		30,34
2.000		46,07
3.000		14,61
4.000		2,25
5.000		6,74

FIG. 3 Respondents by education

Next figure (fig.4) shows distribution of respondents by their gender. 3,37 % of respondents did not answer this question, value 1 - man, value 2- woman. The distribution by gender is appropriate.

Value ▲	Proportion	%
$null$		3,37
1.000		47,19
2.000		49,44

FIG. 4 Respondents by gender

On the fig.5 is distribution by type of disability. Here value 1 means hard of hearing, 2 = deaf and 3 is turn deaf. We can see, that majority of respondents had a hearing loss. 39,33 % is deaf and 10,11 % respondents turn deaf.

Value ▲	Proportion	%
1.000		50,56
2.000		39,33
3.000		10,11

FIG. 5 Respondents by disability

Using statistical methods were analyzed relationships between attributes. To express the leakage of stochastic linear relations between the different attributes were used correlation coefficient. The most widely-used type of a correlation coefficient is Pearson correlation coefficient ρ_{ij}. It is calculated as (1)

$$\rho_{ij} = \frac{cov\left(\xi_i, \xi_j\right)}{\sigma_i \sigma_j} \qquad (1)$$

The Pearson correlation coefficient ρ_{ij} can range from -1.00 to +1.00 and can be expressed by the following way: if $\rho_{ij} > 0$ it is a positive correlation of variables; if $\rho_{ij} < 0$ it is a negative correlation of variables; if $\rho_{ij} = 0$ this value represents a lack of correlation between variables; if $\rho_{ij} = 1$ it is a perfect positive correlation between variables [16].

Next used method was cluster analysis. Cluster analysis divided objects into the groups, or clusters, so that the degree of association is stronger between members of the same cluster and weak between members of different clusters. SPSS (software used in our experiments) has three different procedures that can be used to cluster data: hierarchical cluster analysis, k-means cluster, and two-step cluster [15]. In this work was used the third method.

A. Previous research

Research and modeling of QL was the theme of some our previous works. In the article "Approaches for the Comparison of the Quality of Life Investigation" [20] was presented an analysis of two methods in the QL research in the Czech Republic based on system approach. By approach based on data mining techniques we selected a group of attributes that describe monitored area by ISAS (Institute of Sociology of the Academy of Sciences) approach and on the algorithms of decision trees. By application three selected algorithms C&RT, C5.0 and C5.0 with boosting method classification models were created [23],[24],[25],[26]. In term of accuracy rate (quality of model) the best result was achieved by method C5.0 with boosting method by use of reduced number of inputs attributes. Second work "System Approach to Determinants of Quality of Life within a Region" [21]. We focused here on the main areas which influence the QL and tried to describe the connections among them. The goal of this paper was not the experimental examination based on real data; however, creation of a framework and a basis for the future QL research in a region which should cover - if possible - all the main indicators of the QL. This work described the main components which figure in this "system" and defined also some chosen connections (the environment-health, quality of life-health) among them.

Next work, entitled „Quality of Life Investigation Case Study in the Czech Republic" [22] was focused on the possibilities of the decision theory that can be used in the modeling of the QL in a given city in the Czech Republic. Its goal was to classify citizens into classes by determination their satisfaction with quality of environment. Classification models on the basis of algorithms C5.0, CHAID, C&RT and C5.0 with boosting method were designed and tested. Based on the results we can say, that decision trees methods are suitable and that was achieved comparable results. In other work, we focused on one of the inputs affecting the quality of life - environment.

B. Experiments

The data obtained from the survey between hearing disabled people in Pardubice region were preprocessed (incl. data cleaning, formatting, understanding). The input data matrix **D**(89×35) contain 89 objects and 35 attributes. Every object we can describe as a vector:

$$q_i = (x_{i1}, x_{i2}, x_{i3}, ..., x_{i35}) \qquad (2)$$

where q_i is an i-th object, x_{i1} is value of the first attribute of the i-th object.

Attributes are defined as follows:

Number of questionnaire - ID of the questionnaire
Type of disability - describes the type of hearing impairment of the respondent. Value 1- means hard of hearing, 2 - means deaf and 3 is turn deaf.
Use of cochlear implant - considering whether to use or used a cochlear implant. Value 1- means using cochlear implant, 2 - means thinking about KI, 3 means no - "I do not have and I do not want KI".
Method of communication - how respondents communicate in everyday life. Value 1 is signed Czech, 2 is signed language, 3 is lip-reading.
Barries - whether the respondent faces in everyday life communication barriers. Value 1 means yes, everyday. Value 2 means yes often, value 3 means yes but rarely and finally 4 means no.
Usage of Health services - is degree of utilization of health services. It takes values 1 - very often, 2 - often, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Attribute *Offices* is degree of utilization of offices (regional, local government etc.). It takes values 1 - very often, 2 - often - occasional, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Usage of social services - is degree of utilization of social services. It takes values 1 - very often, 2 - often, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Usage of educational courses - is degree of utilization of different types of educational courses for disabled people. It takes values 1 - very often, 2 - often, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Free-time activities - is degree of utilization of organized free-time activities. It takes values 1 - very often, 2 - often, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Attribute *Internet usage* is degree of utilization of internet. It takes values 1 - very often, 2 - often, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Transportation is degree of utilization of public transportation. It takes values 1 - very often, 2 - often, 3 - I do not use, 4 - I do not use (but I would like to used it in future), 5 - I'm not interested
Sign language interpreter - offices is attribute describing using a sign language interpreter in the offices. It takes values 1- always, 2- sometimes, 3 - never.
Sign language interpreter - doctor is attribute describing using a sign language interpreter by the doctor. It takes values 1- always, 2- sometimes, 3 - never.
Sign language interpreter - work is attribute describing using a sign language interpreter in the work. It takes values 1- always, 2- sometimes, 3 - never.

Sign language interpreter - public institutions is attribute describing using a sign language interpreter in the public institutions. It takes values 1- always, 2- sometimes, 3 - never.
Sign language interpreter – free-time is attribute describing using a sign language interpreter in the during the free-time activities. It takes values 1- always, 2- sometimes, 3 - never.
Inform. Accessibility describes availability of information necessary for the respondent. It takes values 1 - information easily available, 2 - information available with little problems, 3 - information available with problems, 4 - information are not accessible.
Form of education - integration - answer on question "How to be educated people with hearing impairments? - By integration into the education system". It takes values 1- yes, 2- I do not know, 3 - no.
Form of education - special - answer on question "How to be educated people with hearing impairments? - By specialized schools". It takes values 1- yes, 2- I do not know, 3 - no.
Form of education - retraining - answer on question "How to be educated people with hearing impairments? - By retraining and courses". It takes values 1- yes, 2- I do not know, 3 - no.
Form of education - modules answer on question "How to be educated people with hearing impairments? - By special education modules". It takes values 1- yes, 2- I do not know, 3 - no.
Employment - is the answer to whether or not employed. 1 - employed, 2- unemployed.
Occupation - What is the respondent's profession.
Unemployed - How long is unemployed? It takes values 1 - less than one month, 2 - one to six months, 3 - six to 12 months, 4 - 12-24 months, 5 - more than 24 months.
Cause of the unemployed - What is the reason for unemployment, according to respondents mind.
Children - Number of children. It takes values 1 - no children, 2 - one, 3 - two children, 4 - three and more.
Disabled children - Are your children disabled? Value 1 means hard of hearing, 2 means deaf and 3 is turn deaf, 4 no disabled children.
Special social services - Question on the use of social services for families with children.
Ambulance services - Use of ambulance services. Takes values 1-yes (once), 2- yes (repeatedly), 3-no.
Education- is attribute describing level of educational attainment of respondent. Where 1 is elementary education, 2 is study without GCE, 3 is study with GCE, 4 - college, 5 - university degree.
Age - Age groups of respondents - 1- people to 20 years; 2- people between 21-35; 3- people between 36-50; 4- people between 51-65 and 5 - people older than 66.
Status - is marital status. 1- single, 2- married, 3- divorced, 4- widow-er.
Living - is place where the respondent lives. Value 1- in town, 2 - in village.
Gender - this attribute means the gender of the respondent. Value 1 - man, value 2 - woman.

Firstly were computed correlations between selected attributes. Important are only strong correlations, which can be seen in Table 2. Strong correlations are between type of disability (degree of hearing impairment) and age, education (level of educational attainment), barriers (communications barriers in everyday life). Further between age and employment (is employed or not and how long); age and information accessibility (access to information in everyday life) and finally we found strong correlation between education and internet usage (frequency- use the Internet in everyday life).

TABLE 2 Strong Correlations - Pairs of Attributes

attributes	
Type of disability	Barriers
Type of disability	Education
Type of disability	Age
Employment	Age
Age	Information accessibility
Education	Internet usage

Second, we focused on associations between attributes, especially on the strength of the associations. We used a special data graph called web graph [15]. This tool helps indicate the strength of associations between attributes. Thicker lines indicate larger binding. Very good is the visualization of the graph and its interpretation. Example is on the fig.6. There is a visualization of relationships between attributes (exactly between the values of attributes), while the number of connections was defined by at least 20.
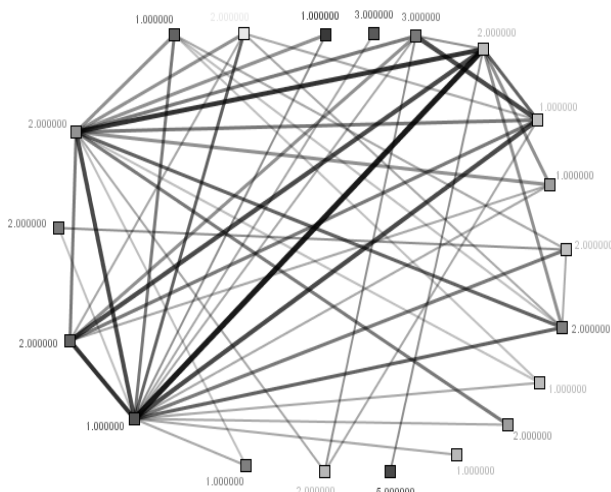

FIG. 6 web graph for input attributes

Strong associations (number of connections at least 30) were found in five cases (see also Fig.7). The strongest association is between employment =2 and living=1, where first attribute means that respondent is unemployed and second that lives in town. Strong association was also between attributes employment=2 and offices=2 (where offices=2

means occasional use of official services); living=1 and Gender=2 (value 2 means women); disability=1 and living=1 where disability=1 means hard of hearing; and finally between attributes living=1 and offices=2.

Links	Field 1	Field 2
36	employment = "2.000000"	living = "1.000000"
33	employment = "2.000000"	offices = "2.000000"
33	living = "1.000000"	sex = "2.000000"
31	disability = "1.000000"	living = "1.000000"
31	living = "1.000000"	offices = "2.000000"

FIG. 7 strong associations between attributes

Another used visualization technique represents the relationship between attributes in two-dimensional graph. An example of the output of this technique is shown in Fig. 8. Graphically, there is shown a relationship between the level of access to information and communication barriers in the everyday life of disabled people. Is valid, that the higher value of the attribute barries means fewer barriers in respondents life. And the higher value of the attribute inf. accessibility means less available information. The graph foreshadow that people who have more barriers in everyday life, they feel a lack of information.
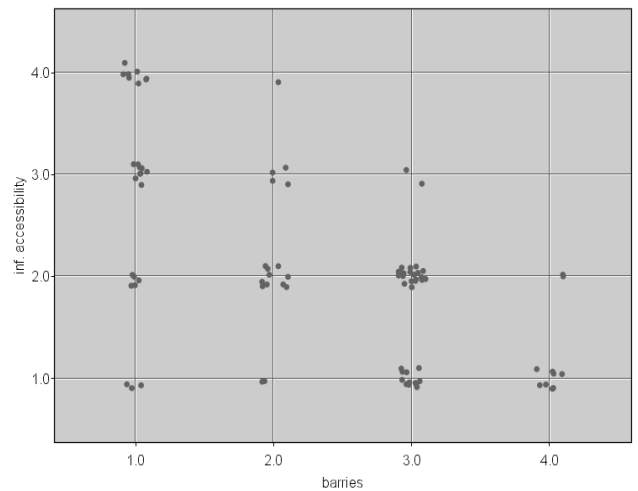

FIG. 8 relationship between selected attributes

We also considered using Two Step cluster analysis. The procedure begins with the construction of a Cluster Features (CF) Tree [28],[29]. The tree begins by placing the first case at the root of the tree in a leaf node that contains variable information about that case. Each successive case is then added to an existing node or forms a new node, based upon its similarity to existing nodes and using the distance measure as the similarity criterion. A node that contains multiple cases contains a summary of variable information about those cases.

At the second step are the leaf nodes of the CF tree grouped using an agglomerative clustering algorithm. Schwarz's Bayesian Criterion (BIC) is used to determine which number of clusters is "best" [29].

This method was used to analyze the use of various services of the hearing disabled citizens. Data from the questionnaires provided us with information on the use of health services, official services, social services, educational services, leisure activities and services, internet usage and use of public transport. An example of output is then the relationship between disability (type of disability) and use of public transport on the Fig. 9. There are created two clusters, marked by the triangle and square. Clusters clearly show the inputs by type of disability (1= hard of hearing, 2= deaf). But we can see, that the degree of disability does not affect the use of public transport.
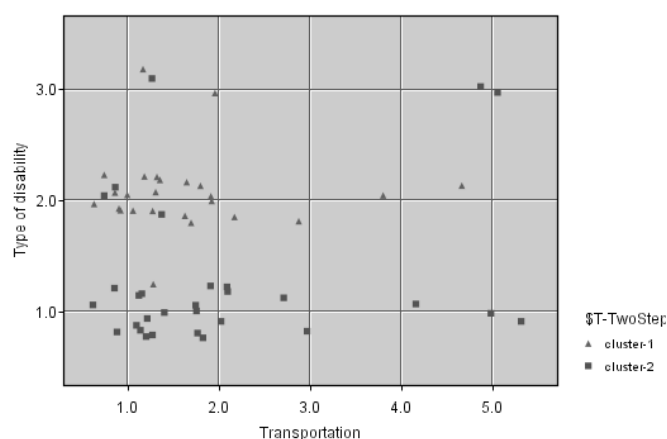

FIG. 9 the relationship between disability and use of public transport

Next fig. 10 shows the clusters generated by Two Step cluster analysis. There are also displayed objects (respondents) by type of disability. Respondents with hard of hearing are depicted with triangle, deaf respondents are depicted with squares. In the cluster 1 with are predominant deaf respondents, in the cluster 2 respondents with hard of hearing.
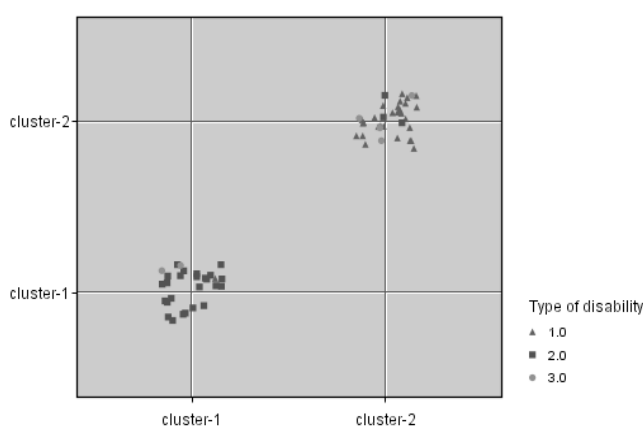

FIG. 10

IV. CONCLUSION

QL of disabled people, its measurement and modeling is important task which influences regional social policies and SD policies [31]. We have to take into account that lifestyle and needs of disabled people are different than lifestyle of healthy people, and that disabled are important part of our society. The paper analyzed the data of people with hearing disabilities through various methods.

In order to increase precision of the models and outputs, application of more input attributes which characterize examined problem, would be appropriate. Further, data from repeated questionnaire surveys should be used. This repeating significantly increases reliability of the input data and allows more objective interpretation of term QL.

In future research we want to build on this article (and also on [20],[21],[22],[30],[32]) and propose concrete steps to regional social policies aimed at improving life for disabled.

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