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Methodological articles

PRACTICAL ASPECTS OF QUALITY DATA PROCESSING AND A RULE –BASED EXPERT SYSTEM FOR QUALITY OF LIFE EVALUATION

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Abstract

One of the most important challenges the European Union was facing at the beginning of the 21st century was to balance economic development with the improvement of quality of its citizens life.

A new approach for assessing the quality of life using the ten-degree global scale is revealed in this article. The aptness of this approach to exploring the social area and determining the quality of life of people in different countries and regions are also discussed. There are being examined some practical aspects of setting up an expert system for social area.The article describes the implementation of such a system for evaluating the quality of life – QLIFEX. The expert system is an innovative research project based entirely on qualitative methods, which aims at helping in understanding of how in an era of great changes residents from different countries live and work in diverse economic organizations, and how they would rate their work and life.

1. Introduction

One of the most important aspects of an expert system development process is to find experts in the expert system specific field. Expertise is not onlythe possession of knowledge and skills, but is alsosolving problems, which are specificto a certain domain. To achieve a relevant expertise for evaluating the quality of life is sufficient to reconsider the following elements to solve the problem:

- Experience in the social sphere;
- Knowledge of the objective and subjective conditions;
- Skills and experience in the usage of knowledge.

The main purpose of setting up an expert system for assessing the quality of life is to build a quality model of the knowledge base of the expert system.
The following requirements are in force in the construction of this expert system:

- Extracting qualitative knowledge from experts or by other methods (well-known);
- Guides and rules for choosing the knowledge engineer;
- Establishing the degree of uncertainty and ambiguity of the knowledge;
- Procedures to generate valid inferences from the knowledge base;
- Selecting the rules for testing and evaluation of the expert system;
- Recruitment and training staff (users) to operate with the expert system.

This expert system is particularly important for organizations that can not relyon people with specific knowledge in the social area and its sub areas.The expert system QLIFEX has the following advantages:

- QLIFEX is always accessible with a constant level of expertise;
- QLIFEX is logical and it does not depend on emotional elements;
- QLIFEX could help in improving the qualification of less trained users;

QLIFEX only works with the best and tested solutions.

2. Problem definition

What determines a good society? How people's lives can be improved? (Griffin (1986), Schuessler & Fisher, (1985)). These have always been core issues in different studies during the years and for the diverse cultures. For centuries philosophers, theologians and politicians have offered their own definition of quality of life, according to various legal, religious or ideological assumptions.
In 2003, the European Commission encouraged the collection of statistics in the European Union on income and living conditions within the project EU-STLC, to calculate the Laeken indicators. In addition, the European Foundation for the Improvement of Living and Working Conditions (EUROFOUND) launched European Quality of Life Survey - European study on quality of life, aimed at collecting data on subjective perceptions of the various components of well-being (Alber & Fahey, (2004), Eurofound, (2012), European Commision, (2009a, b, 2002)).
After reviewing many literature sourcesconnected to the assessment of quality of life, it can be noted that there is a very high level of scientific consensus regarding the identification of the areas of well-being (Commision, (2002), Hantrais, (2007), Sharpe & Smith, (2005), W.H.O. (2013)). As highlighted by Alkire, (2010) multidimensional approaches to measuring human well-being and progress proposed by different authors have shown significant similarities to, at least, at the level of some basic categories such as healthcare, education, economic and personal security, social ties and political voice, environmental conditions, subjective well-being and use of time.
The main point in the analysis of quality of life is the selection of indicators. The selection usually depends on the availability of comparable data, on their statistical reliability, and the advantages they offer. When selecting indicators should be fulfilled a cardinal rule - the indicator groups must not oppose to each other.
Conceptual frame work: The above-mentioned review of the literature related to this problem, and the already existing expert systems for the social area serveus as a basis for the formulation of the conceptual framework, presented in Figure 1.
As Figure 1 shows the fields for examination were identified, thus is intended to set up an efficient expert system to evaluate the quality of life. The examination fields are the following:

- Economic situation (Indicators: Equal protection by the law; Right to vote; Right to be treated equally without regard to gender, race, language, religion, political beliefs, nationality, socioeconomic status and more; Revenues from environmental taxes; Territorial development and utilization of land; Frequency of food shopping);
- Housing and environment (Indicators: Insufficient space; Moisture and leaks; Old windows and floor; Phosphates and nitrates in the water; Generation of municipal garbage; Presence of smog);
- Employment, education and skills (Indicators: Free education; Long life education; Pressure at work; Actual working hours; Job uncertainty; Requirements for promotion; Duration of work; Right to fair pay; Equal pay for equal work; Freedom from

discrimination; Freedom of thought; Free choice of employment);
- Structure of the household and family relationships (Indicators: Time for housework; Support for household (payments, kinship, friendship, neighbourhood); Good relations in the family; Presence of a partner; Income);
- Balance between work and life (Indicators: Social relationships; Children at home; Additional learning and training; Autonomy in work; Support from the employer for balance of work – life; Right to privacy; Right to rest and leisure);
- Health and healthcare (Indicators: Free healthcare; Disease control and prevention; Regular immunization; Rehabilitation and socialization; Extent of free dental services);
- Urban subjective (Indicators: Current life satisfaction; People's optimism about their future; Expectations);
- Concepts of the quality of society (Indicators: Trust in others; Assessing the quality of social services; Alienation in society; Despair; Uncertainty in their own communities (Tension in society)).

After verification, validation and putting in to practice of the expert system,there is also an opportunity for feedback to make sure that the developed expert system is working properly and correctly. Thereby the established aims for setting up an expert system for assessing the quality of life are achieved.

3. Establishment of expert system QLIFEX for quality of life evaluation

Like all the other expert systems, the proposed in this article expert system QLIFEX (Atanasova & Krupka, (2013a,b)) consists of:

- An interactive interface that provides consumers with the communication and transforms the external information for internal usage, and viceversa;
- An engine inference that based on an analysis of these mantics of knowledge searches ways of solving the problem and chooses the best solution;
- A knowledge base that provides storage and access to different types of knowledge used by the expert system during its operation process (interface knowledge, knowledge of the problem (knowledge of social area, economic status, algorithms for assessing the quality of life), knowledge of the procedure, knowledge of the structure);
- A data base – the facts that represent the initial condition of the problem.

The acquisition of knowledge is defined as "the transfer and transformation of potential problem - solving expertise from some knowledge source to a program" (Buchananet al., 1985). QLIFEX is designed to help novices, also in learning and education, and scientific research groups in the field of sociology.

To answer the general question, namely - “What is the quality of life of each individual or groups of people?”, the expert system should have enough knowledge about this domain – social area. Inthe knowledge gathering process regarding the social area domain, a specific module for building the knowledge base has not been used, but it was based on the traditional methods - interviewing experts in the domain area, long discussions, and research on various literature sources.The acquired knowledge was well documented in the form of everyday language.

Sometimes in the process of expert system development, the main bottleneck when it comes to the elicitation of knowledge by a domain expert is the fact that it is a time consuming process.

4. Implementation of Rule Based System QLIFEX

Rule based algorithm:

Step 1: Input the values of indicators for assessing the quality of life; if there is no value of an indicator, the system assigns the corresponding variable with a value unknown. During the input process, the indicator value is checked whether it belongs to the set of accessible values; if it does not belong, the system provides the opportunity for other inputs of the answer until the answer finally belongs to the above-mentioned set (value of the indicator).

Step 2: If there is an exact matching of the left side of the rule found in the knowledge base to the indicator values–entered by the user, the system produces an intermediate answer, namely a value of a factor (Economic situation; Housing and environment; Employment, education and skills; Structure of the household and family relationships; Balance between work and life; Health and healthcare; Urban subjective; Concepts of the quality of society);

Step 3: Work with the uncertainty factor: if there are two rules and their THEN-part is as follows:

(<name> is <value> with certainty $C1$) and

(<name> is <value> with certainty$C2$),

i.e. it gets to two different values for the uncertainty factor $C1$ and $C2$ under the condition of the same value of the name, then the uncertainty factor gets new value

$$\left(C1 + \frac{C2 * (100 - C1)}{100}\right)$$

by using the method Probability sum.

Step 4: The system produces a result (logical inference) - one of the grades from the ten-degree global scale for quality of life.

Example:

To see how the expert system works with qualitative data, the following example is provided:

Indicators – 49
Factors – 8
Quality of life degrees – 10
Input – indicator values
Output– 1 degree of the ten-degree global scale for quality of life

The format of the result is as follows: the degree of quality of life (according to the ten-degree scale) followed by the degree of uncertainty (the value of the uncertainty factor).

Let us consider the following list of possible answers to the questions of the expert system (indicator values) obtained during the **step 1**:

((always, often, yes, same-what-satisfied, often, sometimes) (maybe, always, no, no, maybe, sometimes) (yes, no, sometimes, yes, no, every-five years, yes, some-what-satisfied, often, never, yes, important) (yes, important, yes, definitely, no) (unimportant, always, maybe, important, no, yes, always) (yes, no, yes, often, yes) (no, often, sometimes) (very-important, important, no, important, sometimes))

For clarity purposes, the values of the indicators are separated into eight sublists corresponding to the eight factors.

If the user fails to enter a value, the indicator gets the value unknown. If the user enters an incorrect value, the system offers the same question again to enter the correct value or omit the value.

Step 2: On the basis of these values of the indicators and some of the rules from the knowledge base, the values of the eight factors are determined. As part of the knowledge is uncertain or unclear the uncertainty factor is used (in this system the uncertainty factor obtains values in the closed interval [0, 100], as the threshold of uncertainty is 20). The process of determining of the values of only two of them will be presented here, as the values of the other factors can be determined in a similar way.

A part of the rules for determining the value of the factor *Health and healthcare*:

(rule
(if free-healthcare is yes
and disease-control is no
and dental-services is
yes)
(then best-health-care is
partially-accessible with
certainty 60))

(rule
(if free-healthcare is yes
and disease-control is yes
and rehabilitation-
socialization is often)
(then best-health-care is
completely-accessible))

(rule
(if regular-immunization is
yes and disease-control is
no and rehabilitation-
socialization is often)
(then best-health-care is
partially-accessible with
certainty 70))

(rule
(if free-healthcare is no
and dental-services is no
and regular-immunization
is yes)
(then best-health-care is
inaccessible with
certainty 50 and best-
health-care is partially-
accessible with certainty
20))

(rule
(if dental-services is no
and rehabilitation-
socialization is often and
disease-control is yes)
(then best-health-care is
partially-accessible with
certainty 40))

A part of the rules for determining the value of the factor*Urban subjective*:

(rule
(if life-satisfaction is yes
and optimism-future is
often and expectations is
sometimes)
(thenbest-urban-subjective
is optimism))

(rule
(if life-satisfaction is no
and optimism-future is
often and expectations is
sometimes)
(then best-urban-subjective
is optimism with certainty
30 and best-urban-
subjective is pessimism
With certainty 50))

(rule
(if life-satisfaction is no
and optimism-future is

sometimes and expectations
is sometimes)
(then best-urban-subjective
is pessimism with
certainty 60 and best-
urban-subjective is
absolute-pessimism with
certainty 40))

(rule
(if life-satisfaction is no
and optimism-future is
never and expectations is
often)
(then best-urban-subjective
is pessimism with
certainty 70 and best-
urban-subjective is
optimism with certainty
30))

(rule
(if life-satisfaction is yes
and optimism-future is
always and expectations is
always)
(then best-urban-subjective
is absolute-optimism))

(rule
(if life-satisfaction is no
and optimism-future is
never and expectations is
never)
(then best-urban-subjective
is absolute-pessimism))

(rule
(if life-satisfaction is yes
and optimism-future is
sometimes and expectations
is always)
(then best-urban-subjective
is optimism with certainty
70 and best-urban-
subjective is absolute-
optimism with certainty
20))

The expert system starts to search in the base with rules, and when there is an exact matching of the IF-condition of a rule with the entered values of the indicators, the system produces an intermediate result. In this example, the second rule from the group of rules for the factor *Urban subjective* exactly coincides with the entered values, which means that the factor *Urban subjective* gets value optimism with certainty 30, or value pessimism with certainty 50. In that case, the program moves on to step 4 from the algorithm.

There is an interesting case when it comes to the factor Health and healthcare, where form the first rule the factor *Health and healthcare* obtains the value partially-accessible with certainty 60, or the value partially-accessible with certainty 70 from the third rule. In that case, the program moves on to step 3 from the algorithm.

Step 3: During the step 3 the value of the uncertainty factor is recalculated as using the formula

$$\left(C1 + \frac{C2 * (100 - C1)}{100}\right)$$

for the value partially-accessible of the factor *Health and healthcare*.

Step 4: The quality of life and the value of uncertainty factor as a result of the expert system.

5. Conclusions

In this article is presented an expert system for assessing the quality of life. It is revealed how such a system can be designed and how it operates, and is depicted its main feature related to the fact that all the information derived from the system questions is quality and the result obtained after the application of the rules is also qualitative.

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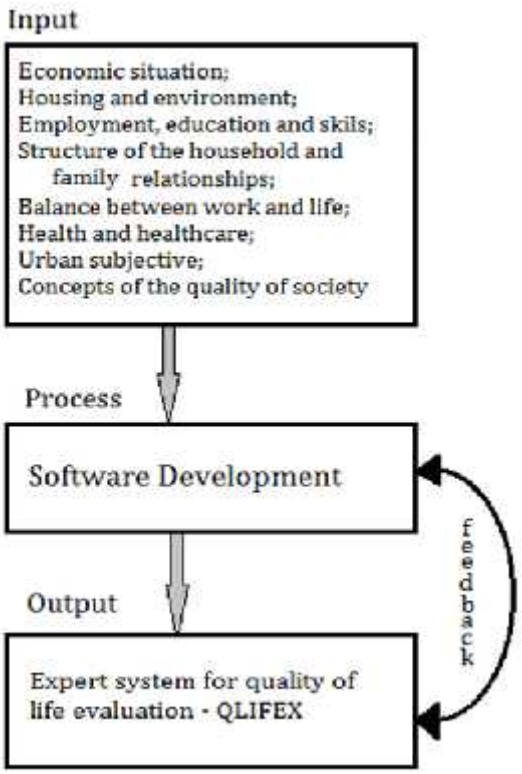

Figure 1. Conceptual framework.