

# Rule-based System for Quality of Life Evaluation in Socio-Cultural Field

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**Abstract:** This article deals with the quality of life in European Union. The objective of this article is to analyse the possibilities of quality of life evaluation on the European level based on selected indicators. For evaluation of quality of life is used expert system and fuzzy sets. User gives the value of a total of thirteen indicators of socio-cultural field, which are divided into three areas. The indicators are selected from several methodologies for evaluating the quality of life and are divided into areas with similar principles and characteristics. Selected methodologies are Active Aging Index, Eurofound, the Economist Intelligence Unit and the Better Life Index. The expert system determines rating for each area and for total rating of quality of life for the selected country. In the conclusions of this paper are other options for adjustments and expansion.

## 1 INTRODUCTION

Quality of life evaluation (QL) (Mandys et al., 2009; Qlru, 2011) is not a simple matter and often can be this evaluation problematic in many regards. It was produced (and will be produce) a lot of different types, different methodologies and approaches to the QL evaluation. So QL evaluation is very complicated issue, then is appropriate to "take the help of" software or programming tools such as decision making models, expert systems or just rule-based systems. QL can be viewed as availability of options, from which an individual can pick during filling his life (Phillips, 2006; Royuela et al., 2010). This term refers to human existence, comprehension of meaning of life itself of individual being. QL includes individual way of life (lifestyle), not only individual living conditions, but also living conditions of wider groups of society as a whole (Rapley, 2003).

## 2 QUALITY OF LIFE EVALUATION

The concept of QL is difficult to define and various authors and various organizations approach to the concept of QL it differently. For the evaluation of the QL it is necessary to use indicators, using which you

can specific areas or issues of QL quantify. Any such assessment is complex, it is necessary to assemble the various indicators with regard to the subject and evaluation criteria (Mederly et al., 2004; Šanda and Křupka, 2015).

### 2.1 Subjective, Objective Quality of Life

Enhancing the QL is an explicit policy goal of many countries, yet it is rarely studied using models that relate objective measures to the subjective evaluations of residents (Von Wirth et al. 2015).

Subjective QL (Mederly et. al., 2004) is the sum of each individual's subjective inputs, such as opinions, attitudes, personal system of values, adaption, manner of perceiving the environs, etc. Research of subjective QL of people is very difficult - every human life is unique and each person has their own individual notion. This unfortunately poses problems such as the willingness of respondents, their uncertainty in responses or their different system of values in job, in family etc.

Objective QL (Mederly et. al., 2004) can be considered as specific, measurable generally living conditions and living standards achieved by an individual person or whole population. Among the factors influencing the objective QL belong a number

of indicators such as average wage, access to services and education, access to health care, quality of the natural environment etc.

## 2.2 Indicators of Quality of Life

QL is evaluated by use of indicators. The evaluation of QL is a difficult thing. Number of similar opinions and approaches (Křupka et al., 2010; Šanda and Křupka, 2015) exist regarding the relevant set of indicators and the concrete evaluation tools used for this area. For example in the Czech Republic, the Czech Statistical Office (CSO) includes among the QL indicators (CSU, 2013) “changes in demographic developments”, and “security of inhabitants”, other QL indicators used by the CSO are: GDP per inhabitant, revenues per inhabitant, level of employment/ unemployment, housing, security and health expenditures, culture expenditures and expenditures for travelling as free-time and aging related activities.

Individual indicators then form a set of indicators or the whole methodologies for evaluating the QL.

## 2.3 Selected Methodologies for Quality of Life Evaluation

We have selected following assessment methodologies (approaches) of QL evaluation in this paper (and for this rule-based system): Active Ageing Index (AAI, 2015); Economist Intelligence Unit Limited (EIU, 2015); Eurofound (EF, 2015); Better Life Index (OECD, 2015).

### 2.3.1 Active Ageing Index

Active ageing index (AAI) is a tool to measure the untapped potential of older people for active and healthy ageing across countries. It measures the level to which older people live independent lives, participate in paid employment and social activities as well as their capacity to actively age.

Methodology AAI comprises four basic areas for QL evaluation (AAI, 2015):

- Employment (indicators: Employment rate for the age group 55-59, 60-64, 65-69 and 70-74);
- Participation in society (Voluntary activities, Care to children, grandchildren, Care to older adults, Political participation);
- Independent, healthy and secure living and capacity (Physical exercise, Access to health and dental care, Independent living arrangements, Relative median income, No poverty risk, No

severe material deprivation, Physical safety, Lifelong learning);

- Enabling environment for active ageing (Remaining life expectancy achievement of 50 years at age 55, Share of healthy life years in the remaining life expectancy at age 55, Mental well-being, Use of ICT, Social connectedness, Educational attainment of older persons).

### 2.3.2 Economist Intelligence Unit

The Economist Intelligence Unit (EIU) evaluation (EIU, 2015) has a large scale of usage, such as perceived level of development comparison. The EIU evaluation quantifies problems that could be presented to inhabitants regarding life style in a given area. The EIU evaluation makes possible direct comparison between individual places. The result of this evaluation can be also used for e.g. decision about allocating subsidies or grants for an individual city for its further development and support. Basic areas (indicators) are (EIU, 2015):

- Stability (indicators are Prevalence of petty crime, Prevalence of violent crime, Threat of terror, Threat of military conflict, Threat of civil unrest/conflict);
- Healthcare (Availability of private healthcare, Quality of private healthcare, Availability of public healthcare, Quality of public healthcare, Availability of over-the-counter drugs, General healthcare indicators)
- Culture and Environment (Humidity/ temperature rating, Discomfort of climate to travellers, Level of corruption, Social or religious restrictions, Level of censorship EIU rating, Sporting availability, Cultural availability, Food and drink, Consumer goods and services);
- Education, (Availability of private education, Quality of private education, Public education indicators)
- Infrastructure (Quality of road network, Quality of public transport, Quality of international links, Availability of good quality housing, Quality of energy provision, Quality of water provision, Quality of telecommunications).

### 2.3.3 Eurofound

The Eurofound (EF) has developed (Eurofound, 2015) three regularly repeated surveys to contribute to the planning and establishment of better living and working conditions. The European Quality of Life Survey (EQLS), implemented in 2003, 2007 and 2011-12, provides a comprehensive portrait/picture of living conditions in European countries. It contains

a broad range of indicators on different dimensions of QL, both objective and subjective.

The EU evaluation works with seven basic areas (Grijpstra et al., 2014):

- Subjective well-being (indicators are Life satisfaction, Happiness);
- Living standards and deprivation (Proportion of households with both rent or mortgage and utility arrears, Satisfaction with standard of living);
- Work-life balance (Proportion of employees coming home from work tired at least several times a month, Proportion of employees having difficulties at least several times a month fulfilling family responsibilities, Proportion of employees having difficulty concentrating at work at least several times a month);
- Family and social life (Satisfaction with family life, Satisfaction with social life);
- Home, housing and local environment (Mean number of rooms, Satisfaction with accommodation)
- Health, healthcare, education and other public services (Satisfaction with health, Perceived quality of healthcare, Satisfaction with education, Perceived quality of educational system, Perceived quality of public transport, Perceived quality of state pension system);
- Quality of society is represented by tension index. It use scale of 5–15, where 5 is no tension and 15 is a lot of tension. Respondents could indicate on a scale from 1 to 3 (1 is no tension, 2 is some tension, 3 is a lot of tension) how much tension they perceive between the following groups: 1) poor-rich; 2) management-workers; 3) men-women; 4) old-young; 5) different racial and ethnic groups. The tension index is the sum of these variables, which gives a tension index score for each respondent that ranges from 5 (no tension) to 15 (maximum tension).

### 2.3.4 Better Life Index

Organisation for Economic Co-operation and Development (OECD) have their QL evaluations. The OECD (OECD, 2015) executes evaluation of primarily member states by means of OECD Better Life Index (BLI), where the evaluation of QL is a part of sustainable and inclusive growth, the OECD BLI evaluation works with basic areas (OECD, 2015):

- Housing (indicators are Dwellings without basic facilities, Housing expenditure, Rooms per person);
- Income (Household net adjusted disposable income, Household net financial wealth);

- Jobs (Employment rate, Job security, Long-term unemployment rate, Personal earnings; indicator of Community is Quality of support network);
- Education (Educational attainment, Student skills, Years in education);
- Environment (Air pollution, Water quality);
- Civic engagement (Consultation on rule-making, Voter turnout; indicators of Health are Life expectancy, Self-reported health);
- Life Satisfaction (indicator Life satisfaction);
- Safety (Assault rate, Homicide rate);
- Work-Life Balance (Employees working very long hours, Time devoted to leisure and personal care).

## 3 RULE-BASED SYSTEM

Rule-based system (RBS) for QL evaluation in the European Union is based on selected indicators (from the socio-cultural field) and their values. RBS's first operation is that the user enters a value of the concrete indicator. These indicators are divided into three areas (according to similarities, principles and common characteristics). RBS then determines the rating for these three areas, which are the basis for total rating. The total rating is based on the evaluation of three areas and defined rules in this system.

### 3.1 Indicators for Evaluation

For this system were used thirteen indicators selected from stated methodologies (AAI, 2015; EIU, 2015; EF, 2015 and OECD, 2015) within the socio-cultural field. Selected indicators are in Table 1.

Table 1: Selected indicators.

Indicator	Approach
Employment	AAI
Participation in society	AAI
Social or religious restrictions	EIU
Level of censorship	EIU
Sporting availability	EIU
Cultural availability	EIU
Tension index	EF
Perceived quality of state pension system	EF
Satisfaction with social life	EF
Satisfaction with family life	EF
Satisfaction with standard of living	EF
Civic engagement	BLI
Work-Life Balance	BLI

These indicators are divided into three areas: The first areas (labeled as AREA-MIN) comprise

Employment, Social or religious restrictions, Level of censorship and Tension index, because are in this area all indicators that are minimalist (minimum values in the ideal case). The second area can be called "public administration" (AREA-PA) because the indicators are associated with public administration - Perceived quality of state pension system, Participation in society, Civic engagement, Cultural availability, Sporting availability. The third area is "Satisfaction" (AREA-S). As the name suggests, these are indicators that assess satisfaction - Satisfaction with family life, Satisfaction with social life, Satisfaction with standard of living, Work-Life Balance.

### 3.2 Structure and Principle of RBS

RBS structure can be divided into three basic layers - the lower layer are the above-mentioned indicators, the middle layer is created of three areas and high layer is the total rating or goal QL evaluation. The principle RBS can be describe in three steps: 1) the user enters name (or symbol) of the evaluated state and values of all indicators into the RBS; 2) RBS saves the values and consequently according to defined rules determines ratings for three areas; 3) RBS determines total QL evaluation in the country based on the rating of areas (according to defined rules).

The user enters the rating of indicators 0-100 (so it is a percentage value). Some of the selected 13 indicators are in the range 0-10, then will be modified at range 0-100 (in percent). An indicator Tension Index is then necessary to convert (value 5 is 0% 6 is 10%, ..., 10 is 50%, ... and 15 is 100%).

The areas are then evaluated for average values of indicators, with the exception AREA-MIN - In this area is average rating of indicators still deducted from one and then has area finally rating. Similar case is in the total evaluation. Fuzzy sets for areas rating is in Figure 1.

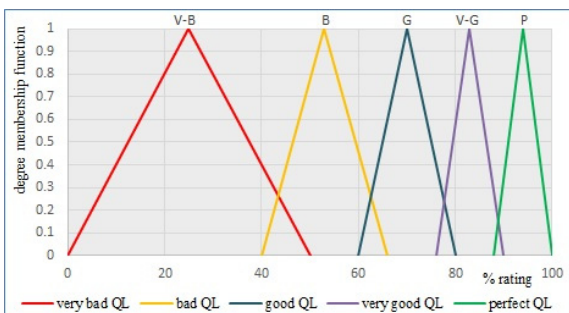


Figure 1: Areas rating with fuzzy sets - % rating of area and membership function of % rating.

Every area can be evaluated from four options: very-stable (84-100%), stable (68-88%), unstable (46-74%) and very-unstable (0-56%). The area rating is tuned sensitively using fuzzy sets and based on the fact that the QL evaluation is resembles as exponential curve (AAI, 2015; BLI, 2015; EF, 2015; EIU, 2015).

Total evaluation of QL are based on rating of areas (according to defined rules). Options for total rating are: perfect-QL (88-100%), very-good-QL (76-90), good-QL (60-80%), bad-QL (40-66%) and very-bad-QL (0-50%) in Figure 2.

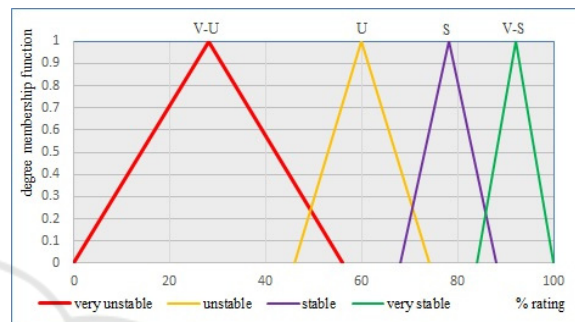


Figure 2: Total evaluation with fuzzy sets - % total evaluation and membership function of % evaluation.

The number of options for areas rating and the total evaluation is based on (EIU, 2015; Hlaváčková et al., 2010).

### 3.3 Rules and Evaluation

Rules for evaluating QL in the programming tool fuzzy CLIPS will be discussed in the following lines (Cross and Firat, 1997). The value of indicators are entered by the user, the areas are then evaluated for average values of these indicators and total evaluation of QL are based on rating of areas, as already mentioned. The code in fuzzy CLIPS is an example, that the user entered values of indicator Employment (indicators in Table 1). In the same way the user entered the remaining twelve indicators (word EMPLOYMENT would be changed to PARTICIPATION\_IN\_SOCIETY, then to SOCIAL\_OR\_RELIGIOUS\_RESTRICTIONS etc.).

```
(defrule read_EMPLOYMENT
  (initial-fact)
  =>
  (printout t "Value of employment
  is: (0-100)" crlf)
  (
  bind ?string (read))
  (assert (EMPLOYMENT ?string)))
```

In the program must be defined the range and the rules for areas's rating as well as for the total evaluating QL. This is example of code in fuzzy CLIPS for defined areas's rating (code is for area AREA-S) and based from Figure 1:

```
(deftemplate AREA-S
  0 100 %
  (
    (very-stable (pi 8 92))
    (stable (pi 10 78))
    (unstable (pi 14 60))
    (very-unstable (pi 28 28))
  )
)
```

There is example of code in fuzzy CLIPS for defined total evaluation (code is based from Figure 2):

```
(deftemplate QL-TOTAL
  0 100 %
  (
    (perfect-QL (pi 6 94))
    (very-good (pi 7 83))
    (good (pi 10 70))
    (bad (pi 13 53))
    (very-bad (pi 25 25))
  )
)
```

Rules for the total evaluation are follows:

QL is perfect if all the areas are evaluated very stable.

```
(rule
  (if AREA-MIN is very-stable and
    AREA-PA is very-stable and AREA-S is
    very-stable)
  (then QL is Perfect-QL))
```

QL is very good if all the areas are evaluated very-stable or stable (except 3x very-stable).

```
(rule
  (if (AREA-MIN is very-stable or
    stable) and (AREA-PA is very-
    stable or stable) and (AREA-S is
    very-stable or stable)
  (then QL is Very-good-QL))
```

Good QL is for all variants, which are not described. It is an "average" rating and includes for example the rare cases (rating areas will be unstable, very-very-stable and unstable); QL is bad if all the areas are evaluated very-unstable or unstable (except 3x very-unstable) and QL is very bad if all the areas are evaluated very-unstable.

At the end of the program is this information (total evaluation for country) "print out" for user.

## 4 CONCLUSIONS

QL evaluation using a rule-based system can be very beneficial - system will be evaluated based on defined rules, whether subjective or objective indicators. The rules have to be defined very sensitive because it is very important for correct function of RBS. In this case it is created with fuzzy sets.

As an added incentive for editing and development of RBS for greater sensitivity and greater credibility is QL evaluation include: take into account the weight of individual indicators (eventually of areas), it can be choose other methodologies for QL evaluation, include more (varied) indicators or it choose other of field QL evaluation (economic, health, etc.)

It could be also evolve form of the input data - values of indicators given by user.

In this case is an objective evaluation - the user enters values that are based on previous measurements or investigations. It can be developed for user's subjective evaluation - user's assessment (feelings, impressions, etc.). It can would use the (for example) range of indicators rating: excellent, average, Satisfactory, unsatisfactory and the user can applied his subjective evaluation (it would be necessary to draw up rules for evaluating areas on the basis of this supplement). QL evaluation would not have to concern only the countries, but it can be used for city's or region's evaluation.

QL evaluation of EU states could then also be supplemented with a "pattern matching" it could be the EU average and the result would be the country's position in memberships countries in EU. As another similar case can be applied to the Visegrad Group.

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