

# *Economic growth monitoring and the Russian regions typology in terms of quality of life in the digitalization of territories*

Elena Petrova  
Volgograd State University,  
Institute of Management and Regional Economics  
Volgograd, Russia  
[ea\\_petrova@mail.ru](mailto:ea_petrova@mail.ru)

Anna Trukhlyaeva  
Volgograd State University,  
Institute of Management and Regional Economics  
Volgograd, Russia  
[ann.tru@mail.ru](mailto:ann.tru@mail.ru)

Elena Fokina  
Volgograd State University,  
Institute of Management and Regional Economics  
Volgograd, Russia  
[fokina-ea@mail.ru](mailto:fokina-ea@mail.ru)

**Abstract** — In this paper, the authors propose a comprehensive monitoring system for the quality of life of the population in the Russian regions, including methodological assessment tools and information-analytical system using Data Mining methods, allowing public authorities to justify and adjust programs aimed at its improvement. The comprehensive monitoring system includes: descriptive and comparative analysis of statistical and analytical materials for a certain period of time, characterizing the quality of life of population in the Russian Federation regions; the rationale and implementation of choosing the most important basic components of this assessment; development of a system of indicators to measure the quality of life of population in the Russian regions; the choice of a particular method of synthesis of partial indicators into a single integrated index. The information and analytical system for monitoring the quality of life of the population in the Russian Federation regions is based on a data warehouse containing statistical indicators and an analytical platform that allows to evaluate data using Data Mining processing technologies: multidimensional data presentation; rating analysis; cluster analysis of the quality of life of the population in the Russian regions using the Kohonen learning rule. At the final stage of monitoring, the priority strategic directions for improving the quality of life of the population in the Russian regions are identified.

**Keywords** — *population's quality of life, Russian regions, comprehensive monitoring system, information and analytical system, data warehouse, multi-factor evaluation, data mining methods, multidimensional data presentation, rating analysis, cluster analysis*

## I. INTRODUCTION

At the present stage of development of Russia as a social state, one of the most important tasks is to develop efficient

social mechanisms and methods of administrative impact on the quality of life of the population in the country, including the quality of life of the population in the Russian regions and cities [1].

The use of efficient management decisions in the framework of social policy is the basis for the formation of qualitatively new living conditions. The indicative figures system used to conduct systematic measurements of the quality of life of the population in the regions of the country will allow the regional authorities to timely identify the sources of social tension and make efficient management solutions and to stabilize the socio-economic situation [2].

Despite the variety of scientific works devoted to population's quality of life there is still no unified methodological approach to its assessment (the existing methods of assessing population's quality of life complicate the process to identify the problem areas of structural components of population's quality of life, and do not allow to provide operational comparative and dynamic characteristics of the subjects), while the use of a comprehensive monitoring and intellectual analysis system in the management system for the quality of life in the regions is not clearly understood which is the reason to choose this research topic for research.

The most widespread statistical methods of data analysis include: correlation and regression analysis, method of factor, canonical analysis, contrast of means method, frequency analysis, etc. [3, 4]. However, these statistical methods have limits of applicability and do not work with fragmentary or "noisy" data. As an alternative approach to solve semi-structured and non-formalized problems, neural network technologies and intelligent information systems developed on their basis can be used [5, 6].

The research is aimed at developing a comprehensive monitoring system for the quality of life of the population in the Russian regions, including methodological assessment tools and information-analytical system using data mining methods, allowing public authorities to justify and adjust programs aimed at improvement the quality of life of the population in the Russian Federation regions. The following data processing technologies were selected for data analysis: multidimensional representation of data, calculation of a rating of regions and cluster analysis.

## II. MATERIALS AND METHODS (MODEL)

The assessment of the quality of life of the population in the Russian regions includes the tools of system analysis and analytical research based on the accumulated statistical data and a comprehensive monitoring system.

*The monitoring of the population's quality of life* is understood as a scientifically based system of periodic collecting, consolidating and analysing information about the living conditions of the population in a certain territory, their social well-being, about the needs, values, motivations, relations to the current situation in their natural, social environment and the mandatory submission of processed data for decision-making at the state, regional and municipal levels. Therefore, *monitoring of quality of life* should be considered as an integral system of continuous monitoring, analysing and forecasting of the development of the main socio-economic processes in the country; it should become the basis for the preparation, adoption and control of decisions in the structures of all branches of the Russian Federation government.

*The objects of monitoring the population's quality of life* are the Russian Federation regions.

*The subject of the study of monitoring the population's quality of life* is a set of socio-economic, medical, demographic, environmental factors in the country regions.

*The main purpose of monitoring* is to prevent deterioration of living conditions associated with the impact of various economic, social and environmental factors.

**In this study, the authors propose a comprehensive system of monitoring the quality of life of the population in the Russian regions, consisting of the following stages:**

**At the first stage of the complex monitoring system,** statistical and analytical materials characterizing the quality of life of the population in the Russian regions are collected (the existing conceptual approaches to the study of the concept of "population's quality of life" are considered, a comparative analysis of the structural components of the concept of "quality of life" is carried out, and the existing systems of indicators and approaches to assessing the quality of life of the population in regional economic systems are analyzed).

The category "*population's quality of life*" refers to a complex synthetic category that accumulates all the important human conditions of existence, level of development and the degree of satisfaction of the whole complex of material and intangible needs and interests.

The most important components of the quality of life are such indicators of the population's economic well-being as income and savings, the level of social security and consumption of material goods and services. In addition, it includes conditions of work and employment, life and leisure, housing, health, education, spiritual and moral development, environmental and social security of life.

The system of indicators is grouped into three main structural blocks, which have the following form:

1. The block "*Welfare of the population*", reflecting the degree of satisfaction of material wants of the population and consisting of the following sub-blocks – the cost of living and consumer prices, employment and working conditions, the level of income and expenditure of the population;

2. Block "*Quality of population*", including education and health systems, the ability of the population to reproduce (fertility, life expectancy, morbidity, disability and mortality), and the ability to form and maintain families, education and skills. This block of indicators consists of the following sub-blocks: education and health, family, demographic situation;

3. Block "*Quality of the social sphere*" (*living conditions of the population*), which characterizes the provision of housing, infrastructure and communications, connection, climatic conditions (data on pollution of air space, water, etc.); the state of spiritual life and cultural, sports and recreation facilities; the level of physical and property security.

All presented private indicators have both positive and negative relationship with the population's quality of life.

**At the second stage of the complex monitoring system** "Multi-factor assessment of the quality of life of Russian regions" the authors developed a method of assessing the quality of life of the population of regional economic systems (for example, the regions of Russia), including [7]:

- descriptive and comparative analysis of statistical and analytical materials for a certain period of time characterizing the quality of life of the population in the Russian regions;

- justification and implementation of the selection of the most important basic components of this assessment;

- development of a system of indicators to assess the quality of life of the population in Russian regions;

- choice of a specific method of synthesis of private indicators in a single integral indicator;

**The third stage of the comprehensive monitoring system** "Design and development of information and analytical system for assessing the quality of life of the population in Russia."

The main purpose of the monitoring is to provide full timely and reliable information to citizens, government and business about the processes taking place in various sectors of the economy, the current social situation for decision-making aimed at supporting positive and weakening negative trends. It becomes possible on the basis of creation and introduction of information-analytical system in this process [8].

Monitoring, organized on the basis of information and analytical system, allows tracking the dynamics of the system of indicators and study the change of the study object over time. This makes it possible to identify sustainable connections and relationships in it, to determine the patterns of its change. The results of monitoring can be used in forecasting the development of the studied processes by regions.

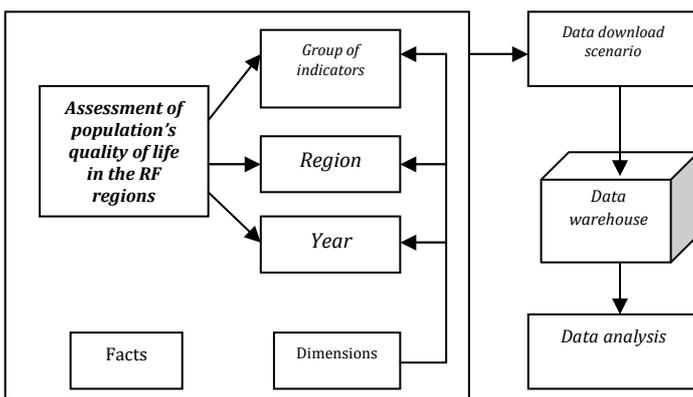
The accumulation of a large pile of data allows not only to compare the values of indicators of different measurements, but also to conduct a joint analysis of the data obtained at different stages of the study. The advantage of this approach is the ability to reduce the maximum statistical error. In addition, large data piles can be used to analyze differences between the groups identified by the combination of multiple characteristics.

To monitor the quality of life of the population in the regions of the country, a large amount of information to be analyzed is used, so it is advisable to use new information technologies for data processing, in particular intellectual analysis. At the same time, the obtained information is contained in the data warehouse and is the information basis for the work of analysts.

The information and analytical system for monitoring the quality of life of the population in the Russian Federation regions is based on a data warehouse containing statistical indicators and an analytical platform that allows evaluating data using Data Mining processing technologies:

Data warehouse is associated with OLAP technologies and Data Mining methods of intelligent data processing. OLAP-technologies will provide online access to data organized in the form of a multidimensional database. With Data Mining, you can identify hidden patterns in large amounts of information. These technologies cover various aspects of the data analysis process, mutually complementing each other, so it is advisable to use them together in the monitoring system.

The model of information-analytical system for monitoring the quality of life of the population in the Russian regions is shown in figure 1.



Process  
Fig. 1. Model of information and analytical system for monitoring the population's quality of life

This model reflects the main objects of the system (indicators, region, year), presented in the form of a set of measurements and facts, as well as the process of loading data into the warehouse.

To carry out the analysis, the data from the warehouse are loaded into the Deductor analytical platform, which allows using various Data Mining technologies for their research.

At the fourth and the final stage of monitoring, the priority strategic directions for improving the quality of life of the population in the Russian regions are identified.

To implement this stage, the main directions to improve the quality of life of the population in the Russian regions are detected in the system of general monitoring, taking into account the multi-factor assessment and analysis using methods of intellectual data processing.

### III. RESULTS AND DISCUSSION

The empirical base of the study is the data by the Russian Federal State Statistics Service for 83 regions of Russia for 2013-2017.

Forty eight socio-economic factors influencing the quality of life of the population in the regions of the Russian Federation were selected with the correlation analysis using the parametric method of calculating the Pearson-Bravais correlation coefficients ( $r > 0.5$ ).

The following data processing technologies were selected for data analysis: multidimensional representation of data, calculation of a rating of regions and cluster analysis.

A. *Multidimensional data presentation* allows to present information in different data sections (by year, by region, by private indicators), to build charts with a sample of data, to filter the data, to explore the maximum, minimum, average data, etc.

B. The next stage of data analysis is *the calculation of the rating of the Russian regions in terms of* quality of life. The rating is a multipoint system of evaluation of any activity or condition. The use of rating technology allows various indicators to lead to a single system of interval estimates.

Information and analytical system for monitoring the quality of life of the population in the Russian regions allows automating the process of calculating the rating with its own built-in tools. Thus, ratings were obtained for each block of indicators of quality of life in the regions of the Russian Federation:  $R_{wp}$  "Welfare of the population",  $R_{qp}$  "Quality of the population",  $R_{qs}$  "Quality of the social sphere" (living conditions of the population), and also  $R_{ql}$  the general rating of the integral indicator of region-wise quality of life in Russia since 2013-2017 which is represented by the following analytic expression:

$$R_{ql} = R_{wp} + R_{qp} + R_{qs} \quad (1)$$

As an illustrative example, figure 2 shows the rating of the  $R_{qs}$  block "Quality of social sphere" (living conditions of the population), which characterizes the provision of the

population with housing, infrastructure and communications, connection; the state of cultural, sports and recreation facilities and spiritual life; the level of physical and property security. The highest value of the rating for this block of indicators for 2017 is noted in the following regions: Moscow, Moscow Oblast, St. Petersburg, Sverdlovsk Oblast, Republic of Tatarstan, Rostov Oblast, Krasnodar Krai, Saratov Oblast, Belgorod Oblast, Nizhny Novgorod Oblast. The least important is the Republic of Buryatia, the Republic of Tuva, and the Republic of Ingushetia.

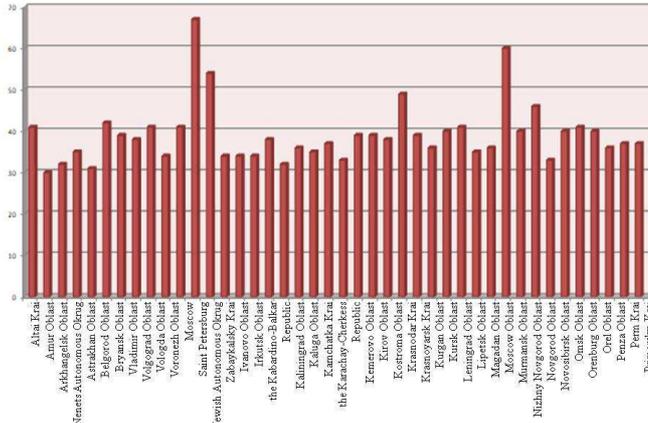


Fig. 2. The region-wise rating of  $R_{qs}$  block "Quality of the social sphere" in Russia for 2017 (fragment)

The dynamics of the overall rating of the  $R_{ql}$  integral indicator of quality of life in the regions of Russia for 2017 is shown in figure 3.

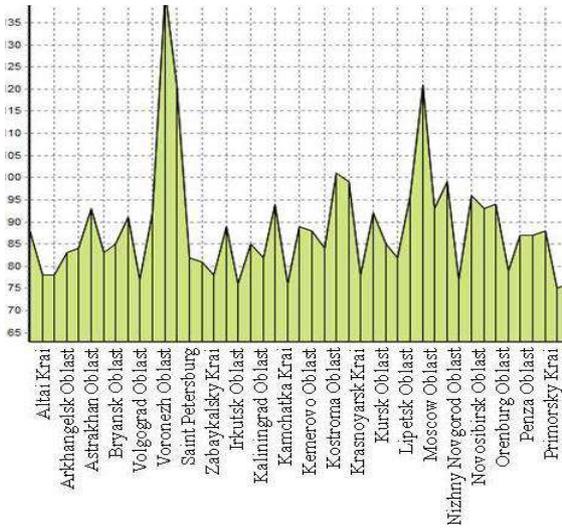


Fig. 3. The dynamics of the overall rating of the  $R_{ql}$  integral indicator of quality of life in the regions of Russia for 2017 (fragment).

It is also possible to study the integral indicator of quality of life for several years, in the regions of interest. The results can be displayed as a table, cube, or multidimensional chart (Fig. 4).

Table 1 shows the dynamics of the overall rating of the  $R_{ql}$  integral indicator of quality of life in the regions of the Russian Federation for 2013 and 2017.

Thus, having conducted a multidimensional and rating analysis of data in the Deductor information and analytical system, it should be noted that in the regions of Russia there is a different level of quality of life of the population.

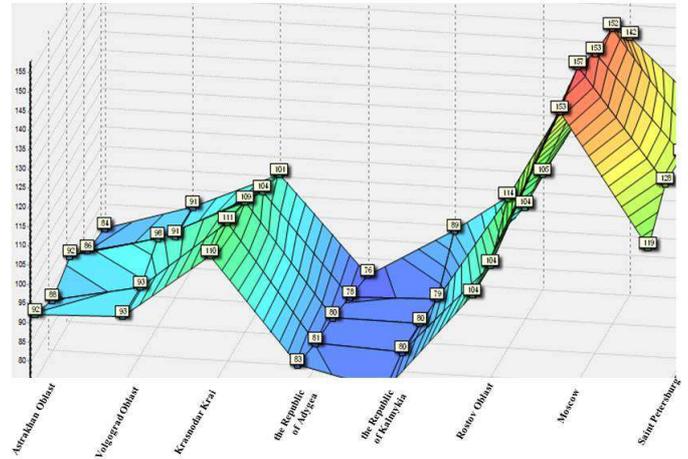


Fig. 4. The multidimensional diagram showing the dynamics of the overall rating of the  $R_{ql}$  integral indicator of quality of life in the regions of the Southern Federal District in comparison with Moscow and St. Petersburg for 2013-2017

TABLE I. THE DYNAMICS OF THE OVERALL RATING OF THE INTEGRAL INDICATOR OF QUALITY OF LIFE IN THE RUSSIAN FEDERATION REGIONS FOR 2017 (FRAGMENT)

Place	RF regions	2013 $R_{ql}$	Place	RF regions	2017 $R_{ql}$
1	Moscow	153	1	Moscow	142
2	Moscow Oblast	122	2	Saint Petersburg	121
3	Saint Petersburg	119	3	Moscow Oblast	121
4	The Republic of Tatarstan	114	4	The Republic of Tatarstan	111
5	Sverdlovsk Oblast	111	5	Tyumen Oblast	110
6	Krasnodar Krai	110	6	Sverdlovsk Oblast	106
...	...	...	...	...	...
11	Rostov Oblast	104	11	Krasnodar Krai	101
17	Belgorod Oblast	99	17	Novosibirsk Oblast	96
...	...	...	...	...	...
31	Volgograd Oblast	93	31	Smolensk Oblast	90

A high level of quality of life is observed in Moscow and St. Petersburg. However, in these cities there are a number of negative factors. Among them is the environmental factor: the air is extremely polluted; in addition to numerous industrial enterprises, the environmental situation is affected by transport exhaust emissions, etc. Despite the fact that the Moscow government is taking active measures to improve the environmental atmosphere and regulate the operation of the transport network, the environmental situation in the main city of the Russian Federation is still unfavourable.

Also, a high level of the population's quality of life in Russia in addition to Moscow and St. Petersburg is observed in the following regions: Moscow Oblast, the Republic of Tatarstan, Tyumen Oblast, Sverdlovsk Oblast, Rostov Oblast, Krasnodar Krai, Belgorod Oblast, and Voronezh Oblast.

The outsider regions with a low level of quality include the Republic of Kalmykia, the Republic of Ingushetia, the Karachay-Cherkess Republic, and the Republic of Tuva. The main problem of these regions of Russia is the inability to generate a sufficient level of income. Because of this, these subjects of the Russian Federation live mostly at the expense of the federal budget and they are characterized by a minimum wage, a steady increase in unemployment, crime, etc.

C. In this study, the method of *cluster data analysis* based on the neural network is also used. The Kohonen self-organizing maps were chosen according to the method of neural network weights adjustment. The algorithm for constructing the Kohonen self-organizing maps is one of the options for clustering multidimensional vectors – projection algorithm with preservation of topological similarity. An important distinguishing feature is that all neurons, including class centers, are ordered into a two-dimensional structure. In the process of unsupervised learning of the Kohonen neural network, the weights of the connections of the winning neuron and the neurons lying near it are modified.

The Kohonen self-organizing maps allow to project multidimensional space into a lower dimensional space to represent the projection of multidimensional data on a plane. Thus, the algorithm of the Kohonen maps formation allows to determine the location of clusters in multidimensional space.

Figure 5 presents the results of cluster analysis, where the regions of Russia are grouped in terms of quality of life.

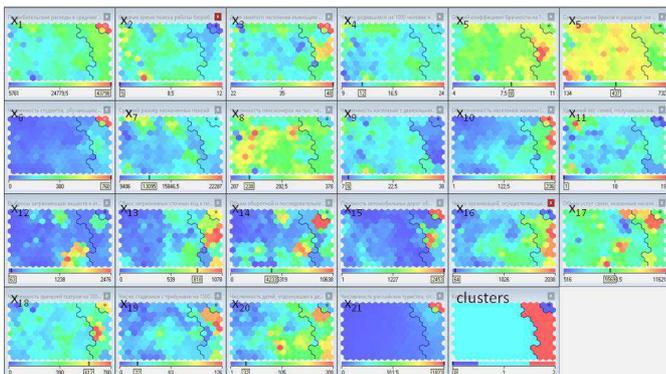


Fig. 5. The Kohonen self-organizing maps (fragment)

Having considered the Kohonen maps and the tables of profiles according to the clusters, it can be noted that there are three clusters.

The studies have shown that regions with a high level of quality of life are assigned to the zero cluster (g. Moscow, Moscow Oblast, St. Petersburg) and the second cluster (5 regions – Krasnodar Krai, the Republic of Tatarstan, Sverdlovsk Oblast, Rostov Oblast, Belgorod Oblast). The first cluster has the largest number of regions – 75 subjects.

The groups of regions included in the zero and second clusters have high average values for the following indicators: the cost of living and consumer prices, employment and working conditions, the level of income and expenditure of the population, the provision of housing, infrastructure and communications, connection, spiritual life and cultural objects.

High average values are also indicators of environmental living conditions (emissions of pollutants into the air from stationary sources (thousand tons); discharge of polluted waste water into surface water bodies, million m3).

Thus, the interpretation of the results (Kohonen maps, tables of profiles by clusters) allows us to display the regions of the Russian Federation, grouped by clusters and by each block of indicators of the quality of life of the population in the Russian Federation. Knowing which cluster the region belongs to, it is possible to analyze the obtained data, identify problem areas and influence them in order to improve the population's satisfaction with the quality of life, which in turn will lead to an improvement in the development of the socio-economic situation of the region.

#### IV. CONCLUSION

The quality of life is the most important indicator of the degree of various human needs satisfaction, which reflects the material, social and cultural well-being of the population, as well as the measure of economic growth and stability of the country as a whole. Consequently, one of the priorities of the state is to fully support and encourage entrepreneurship and initiative of citizens as a factor in the development of their abilities and desire for self-sufficiency, which ultimately leads to the growth of their well-being, and hence the welfare of the country.

The developed information and analytical system allows to monitor the quality of life of the population in the regions, is able to be modified to the conducted research with large amounts of information and using various methods of data mining.

The introduction of this information and analytical system in the regional management system will improve the quality of information and methodological support in the study and analysis of the quality of life of the population in the regions of the Russian Federation, which will contribute to the adoption of adequate, efficient management decisions.

Thus, the developed comprehensive monitoring system, according to the authors of this paper, is within the framework of the latest trends in the development of analytical and statistical research in this area and will provide an opportunity to develop measures to improve the quality of life of the population; will be the basis for the preparation, adoption and

control of decisions in the power structures of the Russian Federation.

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