

Automation of the Process of Regional Development Management Based on the Use of Smart Benchmarking Technology

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Abstract: The process automation is one of the effective approaches to process management based on the use of information technology at the present stage of the society development. This approach allows to increase productivity, reduce the process execution time, reduce costs, increase the accuracy and stability of operations. The automation of processes has currently covered both industries and services fields of economy. This article presents an algorithm for automating the procedure for regional benchmarking with a view to its further use in a software environment for statistical data processing. The tasks of regional benchmarking are the selection of the leading region for comparison in a certain area of development, the identification of differences between it and the region being analyzed, as well as an analysis of the key success factors of the leading region. A special feature of strategic planning for regional development based on smart benchmarking is the preliminary identification of structurally similar territories. The authors revealed the essence and advantages of this approach, defined criteria for comparing regions and made their systematization. The algorithm of benchmarking procedure is developed and its testing is carried out in the regions of Russia. The practical significance of the algorithm developed by the authors of the benchmarking procedure is that it can be used by government authorities to justify the priorities of regional development. And further automation of the proposed model will allow the software product to be applied to any government authority, regardless of the initial parameters of its development.

1 INTRODUCTION

Realization of modern tasks, projects, management programs and business-engineering is difficult to imagine without the use of specialized software products, i.e. without automation. Automation of processes allows the management of operations, data, information and resources through the use of software that reduces the degree of human participation in the process, or completely excludes it. The main purpose of automation is to improve the quality of the process.

Questions about the need for continuous improvement and automation of processes are actual and widely discussed. Scientists came to the conclusion that the existing methods of economic evaluation are cumbersome and difficult, and it leads to huge losses of time and resources, therefore

achievement of effective work results requires the automation of these processes.

K. S. Braunwarth, M. Kaiser and A. L. Müller [1] actualize the issue of implementation of information systems in the processes of economic analysis. The scientists concluded that automation increases the speed of searching and analyzing information, as well as increasing the efficiency and quality of the assessment.

Speaking about the automation of regional management systems, we should note the work of P. V. Stankevich, M. V. Kopnov, A. V. Kudinov and A. I. Finko [2]. They describe the opportunities for improving regional management systems by automating applied management tools in detail.

One of the modern tools for regional management is territorial benchmarking. Benchmarking in the broad sense is understood as

the process of improving the activity of the analyzed object by transplanting the best practices. Initially, the term "benchmarking" was related to the concept of "dantotsu", meaning "effort, concern of the leader to become even better leader". It is believed that this definition was formed in the late 50th in Japan, after the Japanese experts visited the leading companies of the USA and Western Europe in order to study and subsequently use their experience in management. The name of the method "benchmarking" comes from the English words "bench" (level, height) and "mark" (a mark), the combination of which is treated as "reference mark", "elevation mark", "reference comparison", etc.

Initially, the methodology of the benchmarking procedure was developed to improve business processes in various fields of activity: marketing, assortment policy, personnel management, logistics, pricing policy, etc. At the same time, benchmarking is widely used at present to solve regional problems with the aim of the identification of unique opportunities in the territories [3] - [5]. In this case, the term "regional benchmarking" refers to "interregional comparisons of types of activities, processes, practices, policies and the use of this information to improve regional development" [6].

So, in the majority of the analyzed works of Russian authors in the field of regional benchmarking research the authors used a method based on the selection of "best samples" by comparing individual criteria for socio-economic and innovative development. At the same time, the regions were compared with those that showed the best indicators of socio-economic development, regardless of whether they have similar characteristics or not.

At the same time, the latest developments of foreign regional scientists have indicated the objective shortcomings of this approach, which they call "simplified benchmarking" [7]-[9]. The essence of the criticism lies in the absence of a preliminary analysis of the reasons and prerequisites for achieving leadership by the best regions. Indeed, the initial conditions for the development of territories are determined by formal and informal institutions that have developed historically and are essential for innovation [10]. Simply put, for objective reasons, not all indicators of the development of leading regions can be achieved by outsider regions in practice in the foreseeable future. Therefore, the results of "simplified benchmarking" represent nothing more than regional ratings, and therefore

cannot be an acceptable basis for developing an effective development strategy for the territories.

It should be noted that the advantages of using another type of benchmarking, called "smart / system benchmarking" were described in detail in 2001 [11]. The meaning of this type of benchmarking is based on a preliminary analysis of the baseline development conditions of the compared subjects. Thus, smart benchmarking of regional systems involves the creation of a development strategy based on comparison with territories that have similar institutional conditions and development indicators.

This article presents an algorithm for automating a regional management system based on smart benchmarking technology for its further use in a software environment for statistical data.

2 DATA AND METHODOLOGY

The methodology developed by the Basque Institute of Competitiveness [12] and used by regions and countries of Europe to create effective innovative strategies for territorial development was used as a methodological basis for conducting a benchmarking procedure. As the basic factors used to compare the regions, those factors were selected that, firstly, reveal the strengths and weaknesses of the territory to the best way, and secondly, do not tend to change in the short term.

The authors singled out seven criteria for regional development: the geo-demographic criterion, the criterion for the formation of the population, the criterion for the development of innovations, the criterion of the sectoral structure of the economy, the criterion of business conditions, the criterion of openness in foreign economic activity, the criterion of institutions and values. Each criterion includes a system of statistical indicators (a total of 34 indicators), on the basis of which the territories are compared.

3 CONCEPTUAL MODEL OF SOFTWARE PACKAGE

In order to automate the "smart benchmarking" procedure for further use in software environments for statistical data processing, you need to create a model. For more visual visualization, we divided it into several stages (Figure 1).

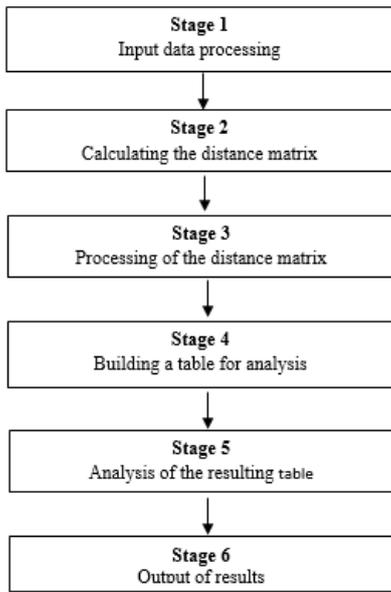


Figure 1: Stages of automation of the process of managing regional development based on the use of smart benchmarking technology.

The first stage is responsible for the mobilization and processing of input data that will be used in the software product. At the second stage, the structural distances indices are calculated to construct the distance matrix. Distance matrices are the basis for conducting a smart benchmarking procedure. At the third stage, the distance matrix is processed to determine identical areas for the analyzed region. At the fourth stage analytical tables of data on identical regions are formed. The fifth stage analyzes the regional data obtained. During the sixth stage, the user can make the necessary visualization of the data in the form of convenient tables in Excel and graphs. Let's take a closer look at each stage of automation.

3.1 Input Data Processing (Stage 1)

To start the program it is necessary to download statistical data from the website of the Federal State Statistics Service, so the user specifies the year in which he wants to conduct the benchmarking procedure. Then the data is loaded into a multidimensional array. After that, the average Russian values in each criterion will be calculated and placed in a separate array, which will be used in the analysis in step 4. It is also necessary to bring the values of all statistical indicators to a single scale.

Step 1.1. Evaluation of the asymmetry of the each indicator distribution.

The importance of asymmetry characterizes the degree of asymmetry in the distribution of the statistical indicator relative to the average value of the indicator for the country. If the asymmetry value is greater than 0.5, then to smooth out the "emissions" (extreme values), each value of the indicator is transformed by the formula (1):

$$x_{ij} = k \sqrt{x_{ij_0}} \tag{1}$$

where x_{ij} – transformed value of the j-index of the i-region;

x_{ij_0} – initial value of the j-index of the i-region;

k – degree of asymmetry (takes values from 2 to 4, depending on the magnitude of the asymmetry coefficient).

Step 1.2. Reduction of values to one scale.

The indicators expressed in percentage remain unchanged, the rest ones are converted into percentages relative to the sum of the values of the variable of the corresponding indicator (2):

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_j x_{ij}} \cdot 100\% \tag{2}$$

Where \bar{x}_{ij} – normalized value of the j-index of the i-region.

After that, it is possible to go to the next stage.

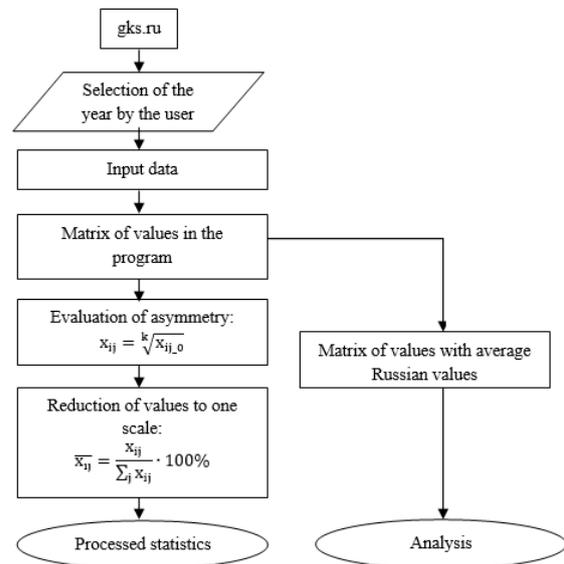


Figure 2: Input data processing.

3.2 Construction of a distance matrix (Stage 2)

At this stage the user selects the analyzed region and the program calculates the distance matrix based on the statistical data grouped in the criterion. It is assumed that each statistical indicator makes the same contribution to the formation of the criterion value. This assumption is based on the results of the study (Navarro et al., 2014), which proved that the use of different weights does not give significant changes in the final results. At the same time, the use of different weights substantially increases the subjectivity of the method as a whole. In view of this, each of the 7 criteria for comparing regions is given an equal weight, which is distributed in equal parts between the variables (3) that enter into it:

$$m_j = \frac{1}{7} / k \quad (3)$$

where m_j – weight coefficient;

k – number of indicators characterizing the criterion.

Further, the index of the structural distance is calculated using the formula (4), along which the distance matrix is constructed:

$$d(i, i') = \sum_{j=1}^k m_j (\overline{x_{ij}} - \overline{x_{i'j}})^2 \quad (4)$$

where $d(i, i')$ – index of structural distance of i -region;

$\overline{x_{ij}}$ – value of the j -value of the i -initial region;

$\overline{x_{i'j}}$ – value of the j -value of the i – «other» region.

After the distance matrix is constructed, it is stored in a separate array of values.

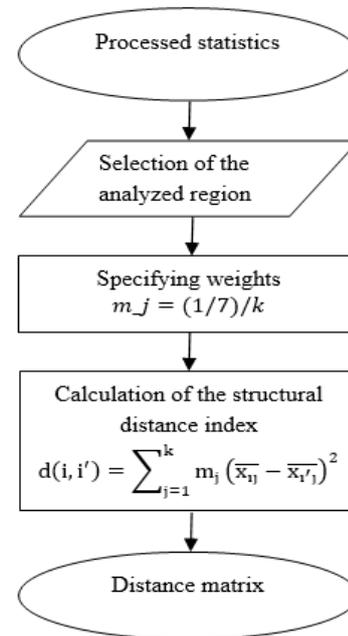


Figure 3: Construction of a distance matrix.

3.3 Processing of the distance matrix (Stage 3)

At this stage the received values are sorted for the region selected by the user. Sorting is done in ascending order with reference to the names of regions. After that the user will be asked to enter, with how many identical regions the program will need to work. Next, the program will display the required number of regions in order of increasing the index of the structural distance. In addition, the region closest in terms of structural characteristics will be singled out separately.

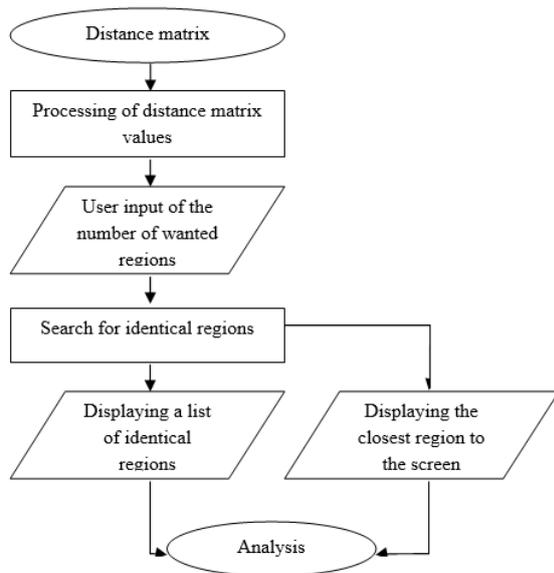


Figure 4: Processing the distance matrix.

3.4 Formation of analytical data tables for identical regions (Stage 4)

At this stage, a new multidimensional array of values from the original data will be created. This array can be imported into Excel tables. The tables will contain statistical data for a given number of identical regions.

At the end of the resulting table the program calculates the average and maximum values of each column. The last line records the average Russian values that have been received in stage 1 (Table 1).

Table 1: Example of a table for the analysis of the selected number (n) of identical regions.

	Criterion x ₁	Criterion x ₂	...	Criterion x ₁
Analyzed region	76,6*	672	...	84125
The nearest region	76,1	668	...	28632
Region (2)	77,3	659	...	26385
...
Region (n)	76,9	671	...	39712
Maximum value	79,3	675	...	84125
Average value	73,2	670	...	42748
The average Russian value	70,4	625	...	27985

* - values are random

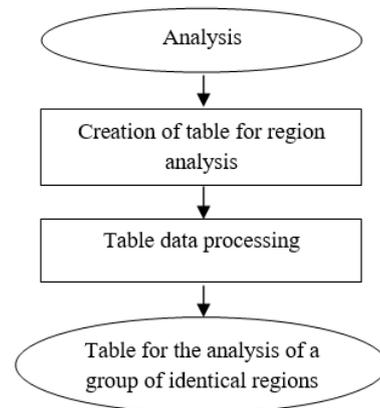


Figure 5: Formation of analytical tables of data by identical regions.

3.5 Analysis of the obtained data (Stage 5)

At the beginning of this stage, the best indicators are determined among identical regions for each of the 7 criteria (column). To do it, a maximum value was found in step 4 in each of the columns representing the best region indicator by this criterion.

After that the strengths and weaknesses of the region analyzed by the user are determined in relation to the average values for Russia, as well as for a group of identical regions (these values were also found in step 4). To determine the strengths and weaknesses of the analyzed region in comparison with the average Russian values for each criterion, the value of R_i is calculated using formula (5):

$$R_i = \frac{x_{i \text{ chosen region}}}{x_{i \text{ average Russian value}}} \quad (5)$$

To determine the strengths and weaknesses relative to the average value among identical regions, the value is calculated in the following way I_i (formula 6):

$$I_i = \frac{x_{i \text{ region chosen}}}{x_{i \text{ identical regions}}} \geq 1 \quad (6)$$

If the obtained ratios $R_i < 1$ and $I_i < 1$, then the i-criterion refers to the weak side of the region in comparison with the average Russian value and average value among the identical regions values, respectively. Conversely, if the value of

$R_i \geq 1$ and $I_i \geq 1$ refers to the strong side of the analyzed region.

The received data is stored in a multidimensional array, which will be presented to the user in the form of a table 2:

Table 2: Multidimensional array, reflecting the strengths and weaknesses of the analyzed region (a schematic distribution of criteria in the cells of the table).

	Strengths		Weaknesses	
Comparison of the analyzed region with the average Russian indicators	A	The criterion x1 The criterion x2 The criterion x3	B	The criterion x4 The criterion x5
Comparison of the analyzed region with identical regions		C		The criterion x2 The criterion x4 The criterion x5

As can be seen from Table 2, some criteria in the columns in the comparison of the indicators of the selected region with the average Russian indicators and with the indicators of identical regions coincide. Thus, the identification of the priorities for the development of the territory on the basis of "smart" benchmarking should be carried out by a consistent double comparison of the average all-Russian indicators and the average indicators of identical regions.

For this purpose, the program will have a separate cycle to understand whether it is necessary to use the direction of development of the leading regions among identical regions, or whether the program of the analyzed region should be left unchanged. The symbols of the location of the criteria are entered in the table, which reflects the strengths and weaknesses of the analyzed region (see Table 2). For example, A is a cell in which a strong criterion of the analyzed region is located in comparison with the average Russian values. To determine whether it is necessary to change the development priorities of the analyzed region, it is required to check each available criterion from the table. If the "Criterion xi" is simultaneously presented in cells "A" and "C" or in cells "B" and "D", then priorities should not be changed in the development direction of the analyzed region, expressed by the criterion xi, since this is the

strength of the chosen region. However, if the "Criterion xi" is not repeated in cells "A" and "C" or in cells "B" and "D", then for the analyzed region in the direction of development expressed by the criterion xi, it is necessary to adopt the best experience in the leading region for this criterion among identical regions.

Also, for greater visibility, a table of priorities for the development of the analyzed region is proposed. This table will be compiled from the statistical data of the selected region, the average for identical regions, the best indicator for identical regions, the average Russian indicator, the leader region among identical ones, and also the column with the results of the criterion check. At the same time, if the criterion is tested positively, there will be a "+" (it means that the directions of development of the leading region should be taken into account), with negative "-" (it means that this criterion should remain unchanged, since this is the strength of the chosen one region). An example of the priority table is shown in Table 3.

Table 3. Priorities for the development of the analyzed region.

	Selected region	Average for identical regions	Best among identical regions	Average for Russia	Leading regions among identical	Is it worth taking the direction of development
The criterion x1	76.6*	73.2	79.3	70.4	Kaluga region	+
The criterion x2	667	670	675	625	Arhangelsk region	+
The criterion x3	2230	1763	1305	1681	Kirov region	+
...
The criterion xn	884	427	841	279	Perm region	-

* - values are random

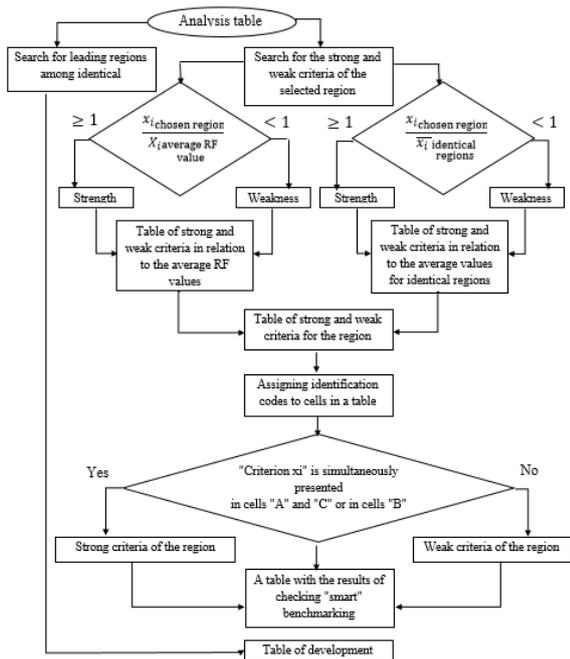


Figure 6: Analysis of received data.

3.6 Output of results and visualization (Stage 6)

At this stage, the user can perform the necessary visualization of the data in the form of selected tables in Excel and graphs according to the data of the multidimensional array.

The user selects the table numbers in the dialog box himself.

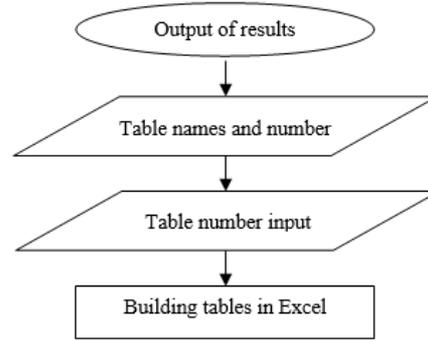


Figure 7: Output of results and visualization.

4 APPROBATION OF METHODOLOGY

The automation of the "smart benchmarking" procedure was carried out in accordance with the steps described in section 3.

Statistical data of Russian regions for 2016, published by the Federal Service for State Statistics, were used as an experimental base. The Republic of Crimea and Sevastopol did not participate in the regional benchmarking because of the lack of data for comparison. As a result, a complete matrix of distances was constructed for the regions of Russia. The Perm region was chosen as the analyzed region. To determine the regions identical to the Perm region, a common matrix of distances was constructed for the regions of Russia, the elements of which are structural distance indices. Figure 8 shows a fragment of the matrix containing regions identical to the Perm region.

According to Figure 8, Kaluga Region has the smallest value of the structural distance index with the Perm region.

Region	Perm region	Kaluga region	Arhangelsk region	Republic of Tatarstan	Ulyanovsk region	Kirov region	Vologda Region	Vladimir region	Tver region
Perm region		0,428	0,476	0,598	0,642	0,714	0,828	0,865	0,953
Kaluga region	0,428		0,655	1,528	0,591	0,655	1,443	0,311	0,845
Arhangelsk region	0,476	0,655		0,863	0,998	0,516	1,470	1,210	0,628
Republic of Tatarstan	0,598	1,528	0,863		1,180	0,886	0,935	1,897	1,040
Ulyanovsk region	0,642	0,591	0,998	1,180		0,621	0,667	0,776	0,688
Kirov region	0,714	0,655	0,516	0,886	0,621		1,021	1,205	0,076
Vologda Region	0,828	1,443	1,470	0,935	0,667	1,021		2,151	1,015
Vladimir region	0,865	0,311	1,210	1,897	0,776	1,205	2,151		1,503
Tver region	0,953	0,845	0,628	1,040	0,688	0,076	1,015	1,503	

Figure 8: Matrix of distances of identical regions for the Perm region.

Further, the characteristics of the Perm region development were determined, which have low criteria values in comparison with the average and maximum indices of identical regions, and also in comparison with the average country indicators. The systematization of the obtained statistical data is given in Table 4.

Table 4: Systematization of statistical data characterizing the development of the Perm Territory.

	Strengths	Weaknesses
Comparison of the analyzed region with the average Russian indicators	A <ul style="list-style-type: none"> - The volume of innovative products; - Number of enterprises and organizations; - Foreign economic activity 	B <ul style="list-style-type: none"> - Age structure of the population; - Transport accessibility - The level of education - Crime level
Comparison of the analyzed region with identical regions	C <ul style="list-style-type: none"> - Number of enterprises and organizations - Foreign economic activity 	D <ul style="list-style-type: none"> - Level of culture, recreation and tourism - Transport accessibility - The level of education - The volume of innovative products

Table 4 highlights with bold the criteria for which attention must be paid. Thus, the indicator "the volume of innovative goods, works, services", the value of which for the Perm region is above the national average, at the same time, in comparison with identical regions, shows a significant lag. Thus, the identification of the priorities for the development of the territory on the basis of "smart" benchmarking should be carried out by means of a consistent double comparison of the average countrywide indicators and indicators of identical regions.

On this basis the main priorities for the development of the Perm region were identified. They include increasing the transport accessibility of the region, raising the level of education, increasing the volume of innovative goods, works and services, as well as raising the level of culture and leisure in Perm region. The identified priorities are the basis for identifying and analyzing best practices among identical regions in terms of their development

programs and the application of innovative policy tools.

5 CONCLUSIONS

A given algorithm for the automation of the process of the benchmarking procedures could make a meaningful contribution to the process of developing, implementing and monitoring innovative strategies of territory development by identifying weaknesses and competitive advantages of the region.

This method of benchmarking is universal and can be applied to any territorial units of both regional and municipal levels.

In the future we plan to register a specialized software tool that allows us to identify structurally similar subjects of the Russian Federation in order to model the optimal development for a particular territory.

As the most significant results of the study we note the following.

First, we justified that the technology of smart benchmarking is a successful decision to enhance the effectiveness of territorial development. The purpose of using this concept is to inform the authorities about the main directions, conditions and opportunities for further development of the region. At the same time, the key objectives of benchmarking remain: the selection of a region-leader for comparison in a certain area of development, the identification of differences between it and the region being analyzed, and an analysis of key success factors for the region-leader.

Secondly, we have empirically proven that identification of territorial development priorities based on smart benchmarking should be carried out by means of a consistent double comparison of the average countrywide indicators and indicators of identical regions.

Thirdly, for the first time, the algorithm of the benchmarking procedure for territorial units was presented and tested.

We believe that the development and improvement of the regional benchmarking procedure with respect to territorial entities requires further research and is of scientific interest in creating an interactive tool that synthesizes statistical data in order to create an innovative national economy.

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