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ESTIMATION OF REGIONAL INNOVATION ACTIVITY

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Abstract: *In the article, the estimation of the regional innovation activity, the general methodology of the estimation of the innovation development of the regions in this direction were analyzed by the author. The innovation index was formed based on the principles accepted in the international world to assess the innovation potential. According to the comparative evaluation of Azerbaijan's innovation potential, an innovation index was found for each region, zones were ranked according to this index, and cluster analysis was conducted. The selected system of indicators allows us to evaluate the level of innovation development in different areas, and to analyze the factors affecting the innovation index in the regions.*

Keywords: *Azerbaijan, innovation, regional innovation, global Innovation Index.*

INTRODUCTION

Today, the formation of the innovation structure in the regions in Azerbaijan is still at the initial stage. The assessment of the regional innovation system (RIS) is still in the formative stage. Various scientists (A.Huseynova, and T.Aliyev) have investigated and evaluated the methods of regional innovation activity assessment in the republic in their studies.

The existence of numerous approaches to the assessment of RIS is due to the complexity of its structure. A special system of indicators should be developed to reveal the internal structure of the region's innovation-oriented economic system and to evaluate the interaction mechanisms of its main elements.

The main goal is to identify a more effective regional innovation system by conducting an estimation.

The "European Innovation Scoreboard" methodology, which we consider as a basis, determines the information source, the composition of criteria and indicators, organizational ways, and common rules for the analysis and evaluation of the scientific and technical complex on the basis of the innovation index.

The "European Innovation Scoreboard" methodology, which we take as a basis, determines the information source, the composition of criteria and indicators, organizational ways, and general rules for the analysis and evaluation of innovation potential on the basis of the innovation index. This methodology consists of 4 stages.

Figure 1. Let's explain each stage separately

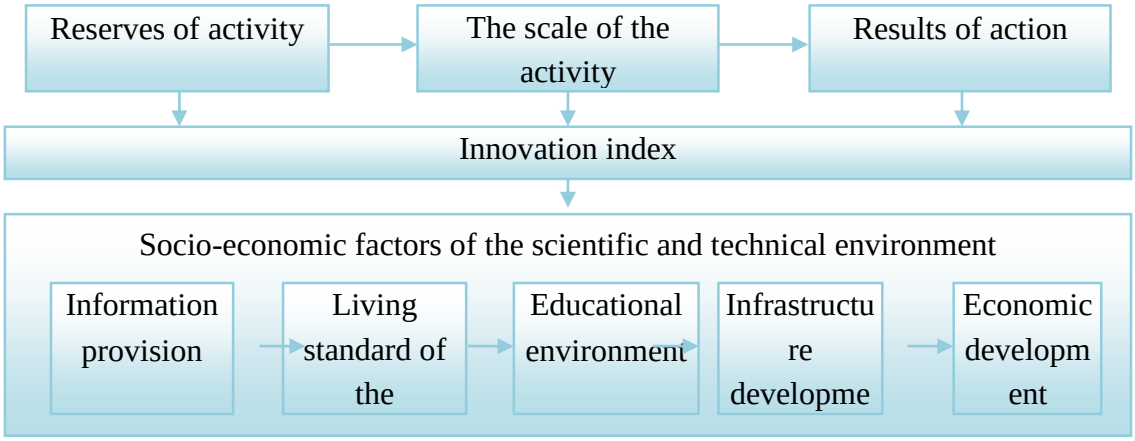


Figure 1. Indicator system of innovation activity
Source: author's work

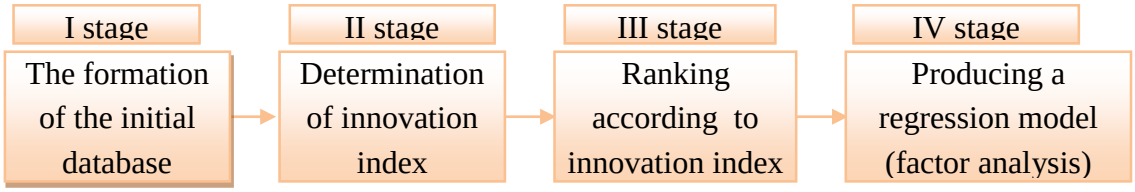
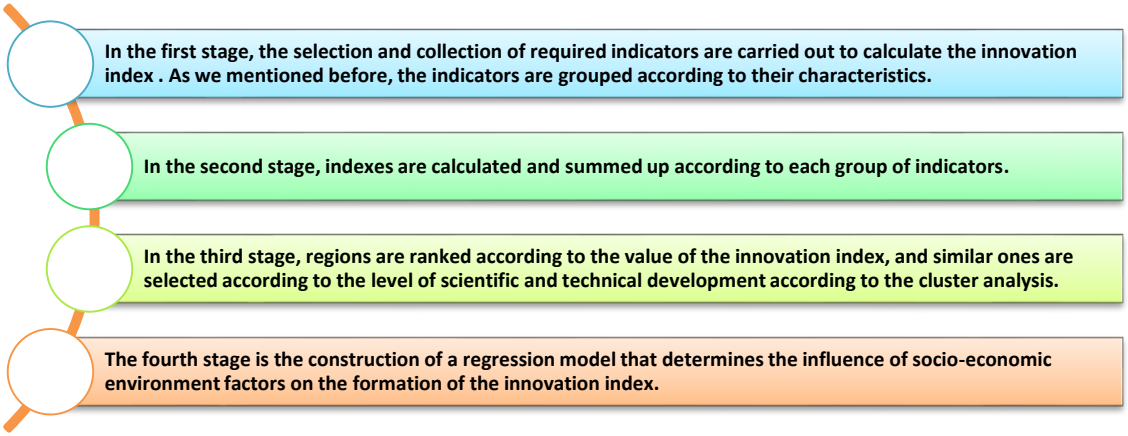


Figure 2. Stages of the methodology
Source: author's work



Source: author's work

In our case, regions are taken as objects. In fact, we consider states, ministries, organizations, research institutes, universities, etc. as objects. It depends on the existing issue. As mentioned, the system of indicators characterizes the innovation potential and socio-economic environment of the region. All indicators correspond to the statistical system (Huseynova, A., Mazanova, O. , 2013). During the development of the methodology, the development of innovation, the indicators of the socio-economic environment, their interrelationship and complex compatibility, the proposed indicators, and the methods of evaluation and analysis with the application of the system of indicators were considered.

METHODOLOGY AND ANALYSİS

The tool of this methodology is the multidimensional statistical method. We used the SPSS 17 statistical package and MS Excel spreadsheet as economic modeling tools. First of all, the used indicators are made comparable, in other words, a single scale of indicators is created.
Normalization of indicators is carried out by linear scaling methodology:

$$G_{nor} = \frac{G_i - G_{\min}}{G_{\max} - G_{\min}} \quad (1)$$

where G_{nor} – is the normalized value of the indicator; G_i – is the initial value, G_{min} and G_{max} – are the smallest and largest values, respectively.

The linear transformation procedure scales the data. All quantities are located in the interval [0; 1]. Such data is easy to interpret. The normalization procedure does not affect the results of the analysis, since our goal is a qualitative assessment based on the examination of numerical indicators.

The normalized values of the indicators are combined in the first level indicators corresponding to their functional structure. For example: first, the average value of the normalized indicators for subgroups is determined, and then a special index for the group is determined. In other words, the special index of the group ("Reserves") is calculated according to the average value of the normalized indicators of the "Labor reserves" and "Materials and technical base" subgroups of the "Reserves" group (Appendix 2).

Average indicators for groups ($\overline{G}_j$, j=1,2,3 indicate groups) are calculated by the following formula:

$$\overline{G}_j = \frac{\sum_{i=1}^{n} G_i}{n} \quad (2)$$

where G_i - is the i-th indicator included in the group, n- s the number of indicators. It forms the basis of the resulting ranking and cluster analysis. Special indices obtained $\overline{G}_j$ by groups allow to determine the innovation index. Special indices obtained by groups allow to determine the innovation index.The innovation index (I) is calculated as follows:

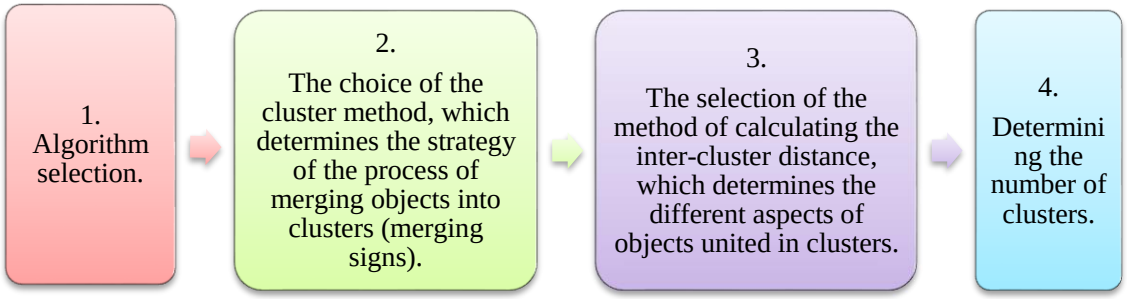
$$I = \frac{\overline{G}_1 + \overline{G}_2 + \overline{G}_3}{3} \quad (3)$$

where $\overline{G}_j$ - j=1,2,3 is the average price for groups.

The analysis of the division of objects is carried out according to the system of indicators selected on the basis of the reports on the standardization of indicators. Based on the ranked set of economic zones, they are grouped into clusters.

The cluster method is a multidimensional statistical procedure (Arzu Huseynova, 2022, pp. 867-875). This method arranges the objects in groups according to relatively similar characteristics based on the available information. The cluster analysis method consists of several steps:

Figure 3. Steps for the cluster analysis method



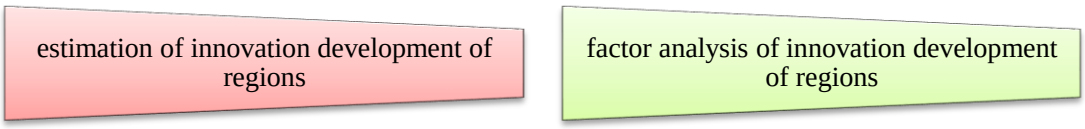
Source: author's work

In our case, since the number of objects is small, the hierarchy algorithm Ward method is chosen. The method of analysis allows us to analyze the factors. Here, too, indicators are initially normalized. Then they are checked.

Socio-economic factors can have both positive and negative effects on the environment. Therefore, they should be divided into two groups accordingly. The initial data prepared in this way can be used in the construction of the regression model. Then, the formation of a correlation model to determine the effect of the factor indicators on the final signs is necessary.

In the modeling process, the important indicators for the final signs are determined. The structure given for economic zones is divided into stages corresponding to the functional structure of the factor indicator. In the first stage, the influence of the education level on the innovation index; the level of information provision infrastructure elements of the region; standard of living; level of economic development, etc. the parameters of the reflective regression equation are calculated. The next stage of modeling is the calculation of variance and coefficient of determination for each factor characteristic. Based on these coefficients, a decision is made to include special indicators in the regression model and a pair regression model is built for each cluster. This model allows predicting the value of the innovation index, which depends on the change in the values of the factor indicators. Calculations were made according to two main methods:

Figure 4. Methods for innovation development regions model



Source: author's work

Both methodologies are based on the system of indicators characterizing the internal and external environment and socio-economic factors of RIS. The proposed methods use widely applied tools in the international world. In order to evaluate the regional innovation system, an innovation index was formed based on internationally accepted principles. According to the comparative evaluation of the innovation potential of Azerbaijan, the innovation index was calculated for each region (Arzu Huseynova 2022, pp. 867-875).

This methodology has been refined considering the national and specific characteristics of Azerbaijan, statistical indicators in this field, information that can be collected and processed, and the innovation potential of the regions, the system of indicators has been changed and calculated for Azerbaijan. Calculations were made on 2 blocks (reserves and activity scale), 4 groups, and 14 indicators. The special index indicator is denoted by G_{ijl} where i=1, 2; j=1, 2; and l depends on the number of indicators in each group.

Table 1. Division of the indicators system [Huseynova A.]

Block	Group	Division of the indicators system
Reserves	*Labor resources*	4
	Material-technical base	2
Scale	*Scientific activity*	6
	Innovation activity	1

Data were collected and calculated according to the methodology we mentioned. The calculation results are not much different from previous years. This is proof that there was no great progress in this field in the regions, the situation has not changed. The obtained results are given in the table.

Table 2. Innovation index by regions according to innovation development

Regions	**On reserve group I_1**	**On scale group I_2**	**Regional innovation index I**
Baku	0,355347	0,40469	0,380019
Nakhchivan	0,248108	0,228631	0,23837
Mountainous Shirvan	0,312987	0,048597	0,180792
Absheron	0,117459	0,234816	0,176137
Ganja-Kazakh	0,109372	0,225259	0,167315
Lankaran	0,143004	0,129577	0,13629
Guba-Khachmaz	0,087007	0,17371	0,130358
Aran	0,120869	0,104973	0,112921
Sheki-Zagatala	0,037363	0,145204	0,091283

As seen from the table, Baku is progressing in all groups.

The regional innovation system consists of 3 subsystems: regional policy, scientific-innovation policy, regional socio-economic policy.

According to the methodology mentioned above, Huseynova A.D.(Huseynova A.D.&Mazanova O.I., 2015, p. 54–72) presented the methodology for evaluating the influence of the socio-economic environment on the innovation development of regions. The evaluation was carried out on 4 factors (innovation development level, education level, population welfare level and infrastructure development level).

Table 3. Factor index (Арсентьев А.С, 2010)

№	Regions	Innovation development level index	Education level index	Population welfare level index	Infrastructure development level index
1	Baku	0,91	1	1	0,75
2	Absheron	0,50	0,28	0,21	1
3	Nakhchivan	0,28	0,24	0,20	0,41
4	Ganja-Kazakh	0,26	0,20	0,25	0,33
5	Aran	0,18	0,03	0,17	0,36
6	Mountainous Shirvan	0,17	0,03	0,13	0,33
7	Lankaran	0,16	0,04	0,18	0,27
8	Sheki-Zagatala	0,16	0,03	0,17	0,27
9	Guba-Khachmaz	0,14	0,02	0,15	0,24

As seen from the table, Baku is again sharply ahead.

The science and technology in Azerbaijan should be improved today. During the development of the national innovation system in the country, the development of scientific and technical potential and innovation in the regions is one of the essential issues.

Let's analyze the indicators of science in Azerbaijan.

Table 4. The main indicators of science by regions of the Republic of Azerbaijan

Economic regions	Number of ST organizations	Number of ST employees (people)	The volume of scientific and technical works performed during the year (thousand manats)	Total expenses incurred by ST (thousand manats)	Domestic expenses incurred by ST (thousand manats)	ST cost of fixed assets used (million manats)
on Azerbaijan	137	20 580	124 545,4	132 340,0	129 871,8	157,4
Baku	102	16292	93 745,5	108 212,0	106 042,6	137,2
Absheron	8	758	13 072,5	13 408,7	13 408,7	8,6
Ganja-Kazakh	8	2 364	3 016,4	3 712,5	3 712,4	1,2
Sheki-Zagatala	1	89	457,6	457,6	457,6	0,4
Lankaran	3	93	284,6	284,8	284,8	0,1
Guba-Khachmaz	2	140	759,2	759,2	759,2	1,3
Aran	3	6	51,1	51,1	51,1	0,5
Mountainous Shirvan	2	156	1 124,0	1 124,0	825,3	-
Nakhchivan	6	682	2 272,8	4 330,1	4 330,1	8,1

Analyzing the indicators of science in Azerbaijan, we observe that 76% of organizations engaged in scientific research are located in Baku.

For the calculation of the science index, it is necessary to bring the indicators given in Table 7 to the same unit of measurement. In other words, let's normalize the indicators and calculate the science index based on the average value of the normalized values of these indicators.

$$E\dot{I} = \frac{\sum_{i=1}^{n} E\dot{I}_i}{n} \quad (4)$$

where, $E\dot{I}_i$ – is a i-th indicator included in the group, n- is the number of indicators.

Table 5. Normalized values of science and science index by region

Regions	Number of ST organizations	Number of ST employees (people)	volume of scientific and technical works performed during the year (thousand manats)	Total expenses incurred by ST (thousand manats)	Domestic expenses incurred by ST (thousand manats)	ST cost of fixed assets used (million manats)	Science Index (SI)
Baku	1	1	1	1	1	1	1
Absheron	0,069307	0,046175	0,138977	0,123497	0,126025	0,062682	0,094444
Ganja-Kazakh	0,069307	0,144787	0,031649	0,033851	0,034543	0,008746	0,053814
Sheki-Zagatala	0	0,005096	0,004339	0,003758	0,003835	0,002915	0,003324
Lankaran	0,019802	0,005342	0,002492	0,002161	0,002205	0,000729	0,005455
Guba-Khachmaz	0,009901	0,008228	0,007558	0,006547	0,006681	0,009475	0,008065
Aran	0,019802	0	0	0	0	0,003644	0,003908
Mountainous Shirvan	0,009901	0,00921	0,011451	0,009919	0,007304	0	0,007964
Nakhchivan	0,049505	0,041508	0,023712	0,039561	0,040371	0,059038	0,042283

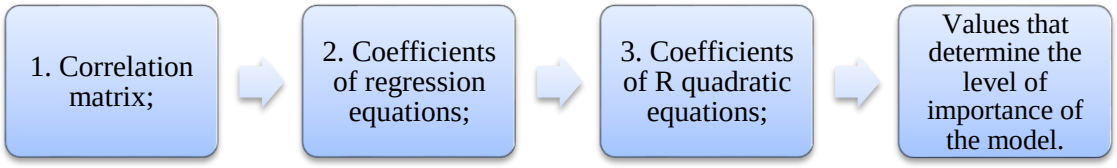
Note: Developed by the author

An unequal distribution of science in the republic and the low volume of scientific and technical works performed by regions during the year, the low share of innovation in the development of the economy of Azerbaijan's regions is a negative trend.

At the next stage, regression models showing the dependence between indicators included in different factor groups of innovation activity are built. As a result, equality was obtained for all blocks. As we know, regression analysis determines the relationship between dependent and independent variables. SPSS software was used to construct regression equations.

Here, the factor variable is given with the outcome variable in the input. But in the output:

Figure 5. Output



Source: author's work

The obtained regression equations and statistics are given in table 4.3. A linear regression model was constructed for the following indicators:

- ✓ G_{13} – Number of students per 1000 people;

- ✓ G_{23} – unemployment rate, %;
- ✓ G_{41} – Number of mobile phone subscribers per 1000 people.

Table 6. Linear regression equations for the factors group

A group of factors	A linear regression equation	Determination coefficient R	Darbin-Watson coefficient DW
Education level	$I=0,15+0,80I_{təh}$	$R^2=0,93$	1,575
The level of population welfare	$I=0,11+0,82I_{rif}$	$R^2=0,76$	0,831
Level of infrastructure development	$I=0,03+0,60I_{inf}$	$R^2=0,56$	1,530

Note that the coefficient of determination is completely dependent on the indicator of the innovation index, and since the Darbin-Watson coefficient is less than 2, it means that the autocorrelation is adequate for the indicators involved in the equation.

The coefficients of determination in the models of the dependence of the innovation index on the level of education, the level of welfare of the population, and the level of infrastructure development show that the innovation index depends on the indicators included in the model: the most on the level of education (93%), and the least on the development of infrastructure level (56%).

A multidimensional regression model was given. Here, the dependence of the innovation index with the indices calculated by factor groups is established:

$$I = 0,337I_1 + 0,332I_2 + 0,329I_3 + 0,01 \quad (5)$$

I_i – is a factor groups index, a_i – is their coefficient.

DW=2; R^2=1

When the coefficients of this equation are calculated, it is obtained that since the Darbin-Watcon coefficient is equal to 2, autocorrelation is not possible for the indicators involved in the equation. Therefore, this model cannot be a worker. It means that there is no general dependence of the innovation index on the whole group of factors.

Let's form the model using stepwise regression. In this model, the variables are entered into the equation one by one, and the coefficient of determination is above R^2=0,93 as a result of the first step regression model at each stage.

$$I = 0,15+0,80I_{təh} \quad (6)$$

where I_{edu} - are educational elements.

In the multidimensional regression model, the elements of education seem to be the main ones. Thus, 93% of the change in the innovation index depends on the educational elements of the region.

CONCLUSIONS

We can conclude that the field of science and technology in Azerbaijan should improve today. In the period when the national innovation system was developing in the country, the development of innovation potential and innovation in the regions was one of the main issues. The formation of the national innovation system requires the development of regions. As a result of the research, two

methodologies were adapted to Azerbaijan and calculations were made: evaluation of innovation potential development and factor analysis methodologies of innovation potential development. Both are based on a system of indicators that characterize the internal and external environment and factors of innovation potential.

The proposed methods use widely applied tools in the international world.

In order to justify the indicators, the studies conducted in the world on the basis of inter-country and inter-regional comparisons were studied, and based on those models, a system of characteristic indicators for Azerbaijan was selected and calculated.

The system of selected indicators allows us to evaluate the level of innovation development in different areas, and to analyze the factors affecting the innovation index in the regions.

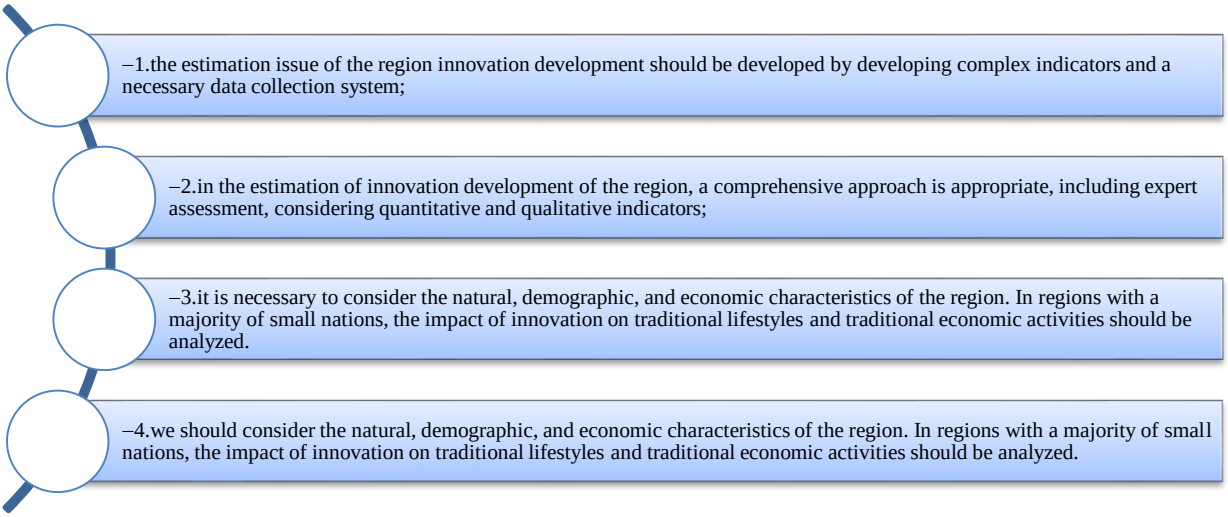
A methodical approach to the assessment of regional economic systems was proposed. The proposed approach considers the shortcomings of local experience and can be the basis for the development of management decisions related to innovation development and improvement of the efficiency of the economic system (Егорова М.В., 2009).

In the study, local and foreign methodological approaches to the assessment of regional innovation development were reviewed and analyzed, the general directions and general characteristics of methodical approaches to the assessment of regional innovation development were determined, and the innovation index was calculated for each region according to the comparative assessment of Azerbaijan's innovation potential.

The methodology used in the study was refined considering the national and specific characteristics of Azerbaijan, statistical indicators in this field, information that can be collected and processed, and the innovation potential of the regions, the system of indicators was changed and calculated for Azerbaijan. As a result of the conducted research, proposals were made to determine the role and competitiveness of the regions in the development of the economy of the republic.

The following results were obtained according to the results of the analysis of methodical approaches for the evaluation of the innovation development of the regions:

Figure 6. Results



Source: author’s work

Thus, a comprehensive estimation of regional innovation development should be developed. The results of this evaluation can be the basis for the improvement mechanism of the state policy.

The proposed model is an efficient tool for the analysis of RIS. It allows us to assess the origin and structure of resource flows, and to predict the risks that occur during the operation and development of the system under the influence of external factors. This also creates profiles of the regional innovation development to determine the individual characteristics of the territories.

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