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SUSTAINABLE DEVELOPMENT OF REGIONS: ASSESSMENT METHODOLOGY AND ANALYSIS (APPROBATION FOR KAZAKHSTAN)[4]

The research is aimed at developing, substantiating and testing a methodology for constructing an integral indicator for assessing regional sustainable development. The indicators were grouped into three main areas (subsets): economy, ecology and level life, and each direction consisted of 4 indicators. All data for calculating the indicator are taken from official statistics. Expert evaluation is not used. The research methodology is based on the calculation of the integral stability indicator. The study reflects a comprehensive approach to assessing the efforts of Kazakhstan's regional authorities to achieve sustainability at the sub-national level. The study lays the foundation for a regular analysis of sustainability and its dynamics in Kazakhstan's regions, which will assess the current state and development potential in Kazakhstan's regions and can serve to improve regional socio-economic policy.
Keywords: sustainable development; analysis; region; instability; governance; regional economy; integrated indicator; sustainability assessment; indicator-based assessment
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1. Introduction

Humanity has recently asked the question of environmental safety and environmental protection and how much it affects the economy and the social side of development. The platform for the paradigm of sustainable development was created at the very first international meeting held at a conference in Stockholm in 1972 dedicated to the environment. In order to assess the level of these indicators, a system of indicators was naturally needed.

For the first time, the idea of the importance of monitoring the process of transition to sustainable development was voiced in 1993 at the UN Conference. Also, in the adopted documents, the idea was fixed that when measuring sustainable development, it is necessary to move away from classical macro indicators to specific ones, of which 132 were proposed (Indicators of Sustainable Development, 1994). The development of indicators was initially carried out by the UN Commission on Sustainable Development (Recommendations of the Conference of European Statisticians, 2014).

The aim of the study is to develop a modified methodology for assessing the sustainability of regional development and its testing on the example of the regions of Kazakhstan, in order to identify development imbalances and provide public administration with tools for planning and monitoring the achievement of sustainability goals, taking into account the specifics of the country.

The following **research tasks** are set in the work:

- systematization of approaches and methods for assessing regional differences in their sustainable development;
- selection of the indicator system, description of the research methodology;
- an algorithm for constructing an integral indicator and an assessment of regional sustainable development;
- approbation of the methodology on the example of the regions of Kazakhstan;
- identification of risks for the development of the country's regions;
- analysis and evaluation of the results obtained.

The hypothesis of the study was the assumption that industrial regions, as well as large cities, are more stable than medium-sized and small agricultural regions.

Limitations include various aspects that limit the scope, accuracy, or general applicability of the study:

- The lack of available data and their reliability can be a serious limitation.
- The chosen methodology may not take into account certain aspects of sustainable development, this may affect the breadth of the analysis.
- Some aspects of sustainable development can be difficult to measure, which can lead to incomplete analysis.

The study is divided into several parts. We start with the analysis of available methods and indicators used to assess the sustainable development of regions and their applicability to the regions of Kazakhstan. Then we present indicators and methodology that are based on the availability of data for all regions of Kazakhstan for a certain period of time and take into account all three components of sustainable development and allow you to compare the position of each region of Kazakhstan among other regions. Next, we will test the methodology for the regions of Kazakhstan. The last section of the article presents a discussion of the evaluation results and the main conclusions.

2. Literature Review

Kazakhstan is among the top ten in the world by its area. The country is a unitary state consisting of 17 regions and 3 large cities, with a population of more than 1 million people. At the same time, there is a very low population density in Kazakhstan, about 20 million people live in the country. The landscape, nature and climatic conditions, due to the large area of the country, are very diverse. The north and east are characterized by a cold climate, harsh winters and short summers, but it is here that fertile lands suitable for agriculture, in particular livestock and wheat cultivation, and dense forests are concentrated. The proximity to the territory of Russia negatively affects the demographic situation of the northern regions, almost all of them show a negative balance of external migration, however, due to the current geopolitical situation, this fact is changing. It is worth noting that there is a trend in internal migration in the country as a whole, interested and able-bodied young people tend to leave villages and small towns to move to large agglomerations, which in turn negatively affects the demographic situation in the regions. The central part of the country is rich in mineral resources, coal and other minerals are being actively mined. The south of the country is characterized by a high population density, as it has the most favourable climatic conditions and mild winters, gardening is developed in this region, but the industrial sector is poorly developed. The western part of Kazakhstan is rich in minerals, especially oil, and production is also actively conducted. Another feature of Kazakhstan is that the country is located in the very centre of the continent, which means it is adjacent to many states. Historically, Kazakhstan has been at the centre of many geopolitical events and now the ongoing global conflict significantly affects the country.

The whole world is characterized by the problem of differentiation of the development of regions within one country (Arkhipova, 2020). The issue of sustainable development of the regions and its measurability determines the pressing problems that Kazakhstan and its regions need to solve. Negative phenomena in the economy confirm that its well-established raw materials orientation should be changed, as it contradicts the concept of sustainability, and also makes Kazakhstan dependent on world prices for raw materials, stimulating an increase in environmental pollution, which in turn negatively affects the health of the nation as a whole. The progressive world experience of the most developed countries of the world, as well as natural phenomena occurring in the world and in Kazakhstan, indicate that it is urgently necessary to change the priorities of the country's development, towards trends of sustainable growth, and therefore move to a green economy (Durdyeva, 2014).

Both individual States and large international organizations have been engaged in the creation of diverse indicators, and very often they contain a variety of indicators. Currently, these include the human development index, the index of economic well-being, the index of adjusted net savings, etc.

So, the author (Lee, 2012) created a methodology for building a passport of sustainable development of the region, which includes three components: social, economic and environmental. All stakeholders were identified as the basis for selecting the indicators included in it, and the principles of development within the framework of sustainability were also taken into account. The complexity of the study lies in the fact that the integral index is calculated on the basis of a large list of indicators, 25 in environmental and economic blocks and 19 in social, which significantly complicates the calculation procedure. It is also difficult, in our opinion, to correctly identify all interested parties.

The authors (Chub, 2014; Chub, Polyakova, 2018) tested their own quantitative methodology for measuring the stability of Russia's regional systems, namely, calculating an integral indicator taking into account factors such as the institutional environment, innovation, and social and economic factors. The basis of the structure of the integral indicator was the UNDP human development index (HDI) and calculation methods included multivariate regression analysis. The authors identify the innovative and institutional components and investigate how economic development and innovation implementation correlate. However, in this study, there is no assessment of the ecological block at all, which in our opinion is very important.

The work (Xu, 2020) developed and tested methods for quantifying progress towards achieving 17 RMS at the national and regional levels in China. Between 2000 and 2015, each province increased its SDG Index score (a cumulative score reflecting overall performance in achieving all 17 SDGs). There were large spatial and temporal differences between the regions. For example, in the 2000s, Eastern China had a higher SDG Index score than Western China, and Southern China had a higher SDG Index score than Northern China in 2015. At the national level, the indicators of 13 of the 17 SDGs have improved over time, but the indicators of four SDGs have decreased. This study indicates the need to monitor the spatial and temporal dynamics of progress in achieving the SDGs at both the national and regional levels.

A number of authors (Bobylev, 2012, 2013; Minakov, 2012) stand out especially, as in their works they developed a full-fledged methodology for calculating the integral indicator of sustainability and also assessed the development of the country's regions based on the results of calculations. According to the authors of the methodology, as a basis for calculating the integrated sustainability indicator, it is worth using a theoretically developed and well-based index of adjusted net savings (adjusted net savings) in the form of statistical data. However, during the calculations, some of the index components were replaced by those calculated by national statistics. This means that it is impossible to talk about the full-fledged comparability of the calculations with international ones. At the same time, this index is important because it provides an aggregated assessment of sustainable development, and shows the need to compensate for damage from environmental pollution by increasing economic and social sustainability.

Another work (Krasnikova, 2007) examines the problems of the human development index while presenting its variation for calculation, and defining existing limitations. The approach of this researcher is particularly close to our development due to the fact that it justifies the reason for the change in the existing composition of the index calculation.

The authors (Feraru, Orlova, 2014) developed a comprehensive methodology for assessing the level of sustainable development of the regions, based on statistical indicators reflecting the development of the region, carried out a procedure for their rationing in the future, based on them, an integral assessment of the development of the region was carried out. However, the ecological component is not highlighted in this study. And instead of the traditional three, six sustainability components are taken into account.

Researchers from the Czech Republic also faced difficulties in constructing a regional sustainability index, who in their study tested national indicators for their applicability to assess the regional level of development. The availability of data at the regional level was checked, and a significant amount of work was done to supplement the regional indicators (and their time series) with specific data. (Fischer, 2013). It is worth noting that the need for additional calculations for setting missing indicators is extremely time-consuming, and cannot always be made due to the lack of necessary resources. At the same time, the author's approach to the study is extremely thorough, and the requirements for the methodology for calculating all indicators are carefully observed, especially within the framework of international organizations.

As a rule, when assessing the regional level of development, developers use a limited list of indicators. Thus, researchers Raszkowski and B. Bartniczak (2018) selected only ten indicators that, in their opinion, allow assessing the sustainable development of Polish regions. The indicators considered by the researchers represent all three components of the sustainable development of the region, economic, social, environmental and include indicators such as GDP per capita, indicators of employment and unemployment, the percentage of municipal garbage collected, the risk of poverty, the growth of fertility, the use of renewable energy, the share of a state-protected zone and the number of public organizations based on ten thousand inhabitants in the region. The indicators proposed in this study are selected and compiled in accordance with the data available to the Statistical Office of Poland, and in turn allow us to assess and compare the degree of stability of different regions of the country (Raszkowski et al., 2018). The author's approach is close to ours, but the use of the same indicators for Kazakhstan is impossible since the national statistical service does not provide such information about Kazakhstan's regions.

Despite the fact that such a direction of research is not popular in Kazakhstan, there are representatives of the scientific community who have studied this direction and (Varavin, Kozlova, 2018) have calculated the integral indicator of sustainability for Kazakhstan, according to the methodology proposed by researcher Bobylev, and subsequently compared the obtained groups with the results of clustering regions for economic development. Also, a group of researchers calculated the integral index for the Almaty region using a methodology in which four groups of factors were taken for calculation, in addition to social and economic, the natural environment and infrastructure were present (Tamenova et al., 2020).

Our study is similar to the approach of the authors (Nurlanova et al., 2023), who developed a methodology for calculating the sustainability of cities in Kazakhstan based on an integral index. However, in our opinion, the assessment of cities is impossible without assessing the region as a whole. The difference between the research of Kazakhstani authors is that the assessment of the stability of systems was not carried out in all regions of the country, either a separate region or only regions or cities participated in the study, while the development of other types of regions was not taken into account. Also, the chosen calculation method is extremely time-consuming and does not allow us to properly compare the results obtained for Kazakhstan regions with the regions of other countries, due to the replacement of some indicators.

Researchers of Ukraine, similar to Kazakhstan in its historical heritage and form of statehood, faced the same problem of the lack of indicators necessary for measuring sustainability at the subnational level (Semenenko et al., 2019; Semenenko et al., 2022).

Some of them offer their own sets of indicators that reflect all three components of the sustainability of the region's development, but the composition of these indicators is strikingly different. Or it is proposed to calculate the cumulative regional index of sustainable development, which allows you to compare different regions. S. Nesterenko proposed to calculate the aggregate index of sustainable development of one of the regions of Ukraine using three smaller indices of environmental, economic and social development. The environmental development index consists of indicators of environmental potential, regional environmental management, and ecological systems. The economic development index consists of an indicator of economic freedom and an index of competitiveness. The Social Development Index includes indicators of human development, quality of life, knowledge-based society, and institutional development (Nesterenko, 2015). At the same time, it is worth noting the subjectivity of the selected indicators, since there is no official methodology for collecting and calculating the designated indicators. In this regard, such a calculation will probably require the involvement of third-party experts from all three spheres to carry it out, at the same time, different experts may evaluate the same indicators differently, which will entail different estimates for the same region, which means that the comparability of the regions will be reduced to zero.

In general, aggregating the experience gained in the conducted studies, it can be noted that sustainability indicators should strive to meet the following requirements:

- use and possibility of calculation both at the country-wide and regional level;
- taking into account three aspects of sustainable development – economic, environmental and social;
- clarity in interpretation for making managerial decisions based on them;
- quantification of the index;
- as a basis for calculating the index, available statistical data should be used, with a good retrospective range of dynamics, and not requiring any additional costs for their calculation;
- comparability with international calculations (Bobylev, 2012).

Also, the analysis of the literature revealed that there are two common approaches to the integral assessment of the sustainability of development: the first of them involves the calculation of an integral indicator aggregated by three groups of factors (environmental, social and economic), which makes it possible to make a judgment on the sustainability of a particular region (Bobylev, 2013; Hens, Shkarupa, Karintseva, Kharchenko). The second one proposes the compilation of a set of indicators, each of which belongs to one of the three groups of factors of sustainable development (Lee, 2012; Leshchenko, 2015).

A growing body of literature indicates the applicability of integral indices in assessing sustainability. At the same time, a large number of different methods prove that there is no generally accepted methodology for assessing sustainability, especially at the regional level. This is also the main purpose of this article, which attempts to link this approach with the study of urbanization and its environmental and economic consequences at the subnational level.

3. Data and Methodology

In recent years, the Republic of Kazakhstan has been actively developing a variety of strategic documents, both dedicated to the idea of sustainable development and including sustainability indicators – programs, plans and projects, but they use existing macro indicators of the development of the country and regions as benchmarks and indicators.

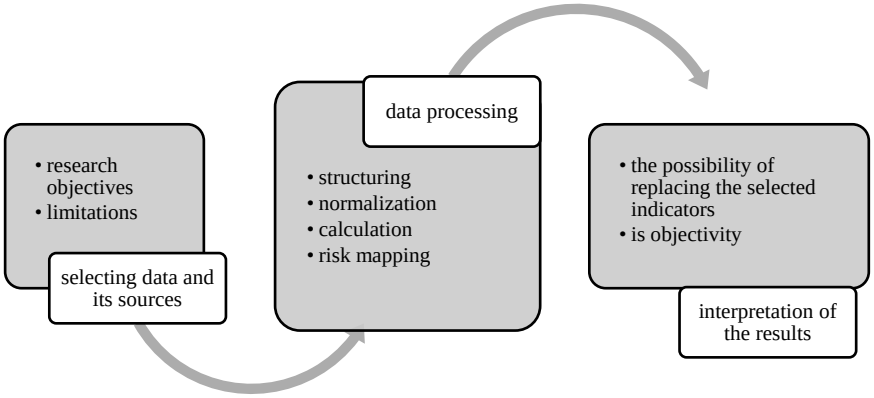
Kazakhstan has approved the Sustainable Development Goals (SDGs). According to the 2030 Agenda for Sustainable Development, global indicators should be complemented by indicators developed at the national and regional levels, as well as efforts to fill the gap in baseline data at the national and global levels (United Nations, 2015).

The National Statistical Agency (NSA), and the Bureau of National Statistics (BNS) of the country, in collaboration with members of five interdepartmental working groups formed within the framework of the Coordinating Council for Sustainable Development Goals (CCSDG), developed a set of customized indicators for Kazakhstan to track the SDGs. The set consists of 280 indicators, out of which 162 are global indicators that were adopted without change, 44 underwent minor modifications, 30 were proposed as alternative or proxy indicators, and 44 are national indicators. However, despite these measures, statistics that provide information by region of the country are not always available, and not all indicators include a regional breakdown. There is also a considerable delay in obtaining up-to-date data. A review of most studies on related topics indicates that selecting data sources for assessing and measuring sustainability levels, even when compiling voluntary national reports within the EU, presents a challenge for both regional and national authorities (Ciambra, 2021).

In this regard, in order to group the regions of Kazakhstan and comprehensively address the issue of measuring the sustainability of regional development, which involves assessing environmental, social, and economic factors (Jovović et al., 2017), we believe that the use of an integrated index would be most appropriate.

The construction of the integral index takes place in several stages (Figure 1). In the **first stage,** the goal should be defined and the data necessary for calculations should be selected.

Figure 1. Stages of building a sustainability index



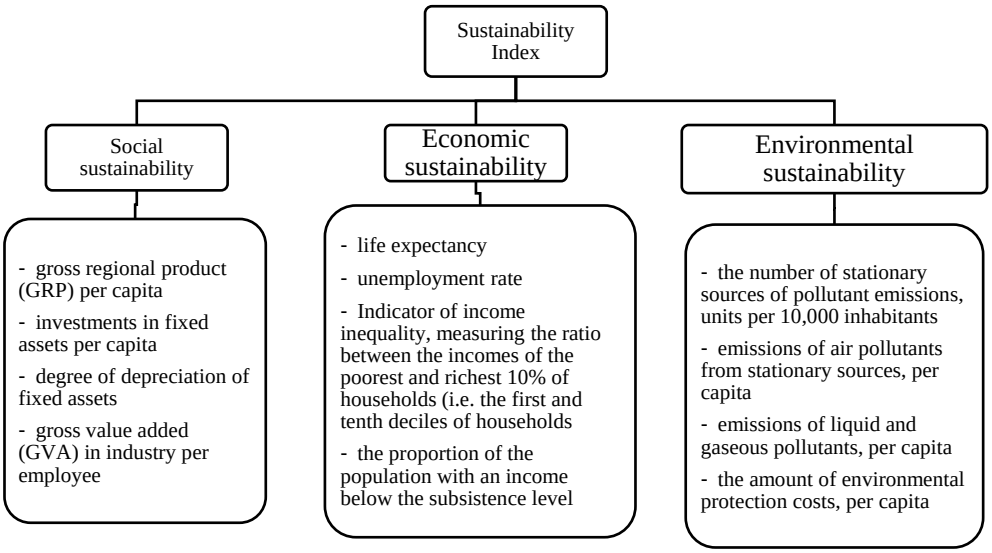
It should be noted that indices used globally to assess the level of stability align with our approach. Numerous studies on the calculation of sub-national sustainability indices have indicated that local governments often face challenges in achieving sustainability goals, as statistics describing SDG indicators do not directly provide information on the priorities of specific issues due to their inconsistency (Yamasaki, Yamada, 2022). It is also essential that the proposed index composition does not require a lengthy and meticulous search for components and complex additional calculations. Local government authorities can obtain all relevant information on the website of the National Statistics Bureau and conduct appropriate analysis.

Additionally, the components of the proposed integrated indicator model have a long history of development, meaning that it is possible to further forecast each component, thereby obtaining insights into the sustainability prospects for each region. Furthermore, a long-time series of dynamics enables us to assess variability in the sustainability index over multiple years, providing an understanding of the extent to which measures taken by national and local government bodies impact the sustainability of specific regions. The resulting composite index will allow for the comparison of all three dimensions of sustainability and an understanding of the effectiveness of government policy in all three areas (Sigora et al., 2017; Zubarevich et al., 2015; Lange et al., 2010).

Following its calculation, the regions will be grouped. From a set of statistical indicators, we have selected measurable regional indicators for 2021 that are grouped into three sub-categories (dimensions): economic, environmental, and social. Each sub-category consists of four indicators (see Figure 2). The calculations are based on publicly available official statistical data, primarily from the official website of the National Bureau of Statistics of the Republic of Kazakhstan. The calculation methodology utilizes a composite indicator.

A composite indicator is a measure that combines various indicators that vary in their content. The benefits of the integrated indicator are that it provides an aggregated form of data, allowing for a more comprehensive view. It is also more convenient to use such indicators, as they attract public attention (Saltelli et al., 2006).

Figure 2. Structure of Sustainable Index Title



Using a single integrated indicator is preferable to attempting to identify trends from several indicators simultaneously. Our research draws on a combination of various methods for calculating an integrated indicator of the region's sustainable development. In order to analyze the available academic literature on the topic of calculating integrated stability indicators, comparative and contrastive methods were employed.

The number of indicators used in our study is lower than that suggested by other researchers. Due to the lack of data on economic, social, and environmental development as well as on environmental policy, a significant amount of relevant data is either not available or is only available on a national level. The indicator system currently available in the country and being developed within the framework of nationally approved Sustainable Development Goals (SDGs) has several significant drawbacks that limit its applicability in Kazakhstan. In particular, there is a lack of regional breakdown for all necessary data and not all indicators are published in a timely manner. Therefore, we have chosen those indicators that are available for all regions of the country and, for future research purposes, these data can be tracked over a long period of time. This list of criteria must be followed in order to increase the objectivity of the study.

Stage 2: Data Processing. The MS Excel software was used for the calculations. Information on the indicators used in the study is published by official statistical sources, but additional calculations were carried out for some indicators in order to account for the dependence of the indicator values on the population size of the region. For this purpose, the indicators for pollutant emissions and the number of pollution sources per 10,000 people or per capita were normalized. The normalization process is essential due to significant differences in

population sizes between different regions. The indicator of environmental protection expenditure per capita was also calculated in order to assess the significance of the amount spent on environmental protection in each individual region.

The indicators used aid in assessing progress towards achieving the Sustainable Development Goals at the regional level and identifying areas that require additional attention and efforts to enhance the sustainability of each region. To summarize the preparatory work, it is necessary to clarify that in order to calculate the overall indicator of sustainability, 12 indicators were used, divided equally between three categories – social, environmental, and economic. Additionally, it should be noted that although there are currently 20 regions within the country, our study provides information on only 17 regions, as three regions were recently formed and it is challenging to obtain statistical data for them. The initial data used for calculating the overall sustainability index for the regions of Kazakhstan was taken for the year 2021. In various sources, there has been a debate on which of the three pillars of sustainable development should receive priority. In our view, all three are equally important and interdependent. As part of future research, it may be possible to increase the number of composite indicators, adjust their number within each pillar, or assign different weights to them based on their significance or the results of an expert survey. However, the involvement of experts can be expensive and complex, and not always guarantee objectivity. Therefore, to simplify and increase the objectivity of our analysis, we have chosen to distribute the weights of indicators equally. It may also be possible to modify the mathematical methods for calculating normalized and integrated indicators. For the current study, however, we have adopted the above assumptions.

The construction of integral indicators is a complex process and requires compromises and consideration of subjective assessments. It is also important to take into account the context and objectives of the analysis, as well as to involve stakeholders and experts to ensure the reliability and relevance of indicators (Verenikin et al., 2023).

There are various approaches to the construction of integral indicators. The following methods are used for multidirectional and ambiguously interrelated processes:

- Weighting of indicators. Each key indicator is assigned a weight reflecting its relative importance. Weights can be determined based on expert assessments or prioritization methods, such as hierarchy analysis;
- Normalization and standardization. Bringing indicators to a common scale to make them comparable and take into account differences in units of measurement and ranges of values. Normalization may include standardization (for example, reduction to the mean and standard deviation) or the use of normalized scales (for example, from 0 to 1);
- Aggregation and combination of indicators. This can be done using various methods such as arithmetic mean, weighted mean, or multiplicative combining;
- Hierarchy Analysis Method (AHP) or Weighted Expert Evaluation Method (WLC) to take into account various aspects and the relationships between them. These methods allow us to take into account the preferences and priorities of different stakeholders;

- Use of indexes. Composite indexes that combine several indicators into one common indicator. Indexes can be constructed using weighted summation or factor analysis methods;
- Modeling and simulation. Modeling and simulation to study the relationships between indicators and processes. Modeling can help to assess the impact of changes in one indicator on others and predict the results of interaction between processes.

Thus, depending on the analyzed phenomena, as well as mathematical expressions that are used in the calculation of integral indicators, a large number of methods for their calculation are used.

All methods have both advantages and disadvantages. For our research, we have chosen the following. We have attempted to create an integral index based on mathematical and statistical methods.

For the correct aggregation of indicators taken into account in different measurement scales, it is necessary to convert the values of all the partial indicators used to calculate the integral in order to ensure their comparability with each other.

As shown by the study of methods available in the scientific literature for calculating the integral indicator. When constructing it, it is necessary to bring the data to a single form, that is, normalize them, then aggregate them, and assign weight to aggregated values. The authors' study (Klyushnikova, Shitova, 2016) thoroughly analyzed the strengths and weaknesses of each method of rationing and calculating the integral index. In choosing the methods for our methodology, we were guided by the results of this analysis.

To normalize the indicators, since they all have different units of measurement and different planes, we chose the maximum/minimum (maximum) method.

The chosen method makes it possible to leave the existing nature of the differences between the objects of research adequate, and in parallel, we will exclude the excessive impact of any one indicator on the stability index itself, while significant differences are still taken into account (Klyushnikova, Shitova, 2016).

There are two types of baseline indicators:

- indicators whose best result is the highest among other values (GRP per capita);
- indicators, the best result of which is the minimum among other values (the coefficient of funds, the degree of depreciation).

For each type of baseline indicators, the normalization procedure is performed on the basis of different formulas:

If the best result is the maximum among other values, the formula is used:

$$U^{ma} = 8 * \frac{u - u_{min}}{u_{max} - u_{min}} + 1 \quad (1)$$

where:

U^{ma} is the normalized value of the indicator;

u — the current initial value of the indicator;

u_{min} — the lowest value;
u_{max} — the maximum value.

If we strive for the best to the lowest value, the formula is modified (Klyushnikova, Shitova, 2016):

$$U^{mi} = -8 * \frac{u_{max} - u}{u_{max} - u_{min}} + 9 \quad (2)$$

where:
U^{mi} is the normalized value of the indicator;
u — the current initial value of the indicator;
u_{min} — the minimum among all values of the indicator;
u_{max} — the maximum among all values of the indicator.

Thus, using formulas 1 and 2, depending on the values and scale of our indicators, we will transform and calculate the normalized indicators for each block by regions of Kazakhstan.

After rationing our initial data, we have obtained comparability of all our indicators, and therefore we can proceed directly to the calculation of an integrated sustainability indicator for each region. For these purposes, a different mathematical approach is also used, Three intermediate indicators were calculated by taking the arithmetic mean of the corresponding indicators. The regional sustainability index was then calculated as the sum of these intermediate indicators (3) (Klyushnikova, Shitova, 2016):

$$\begin{cases} r_{int=C_{social}+C_{econ}+C_{ecolog}} \\ C_{social} = \frac{\sum_{l=1}^{n} a}{n} \\ C_{econ} = \frac{\sum_{m=1}^{n} b}{n} \\ C_{ecolog} = \frac{\sum_{k=1}^{n} c}{n} \end{cases} \quad (3)$$

where:
r_{int} is the value of the integral index,
C_{social} – the value social index;
C_{econ} – the value economic index;
C_{ecolog} – the value ecological index;
a – normalised social indicator;
b – normalised economic indicator;
c – normalised ecological indicator;
n – number of analysed indicators.

The values of the private indices of regional sustainability are in the range from 1 to 8 of the integral regional sustainable index from 1 to 18.

The selected factors have varying implications for sustainable development across different regions. Consequently, for regions that have an agricultural orientation, with small landmasses and populations, priority should be given to addressing economic and social issues. On the other hand, for large cities and mining-focused regions, environmental

pollution is a primary concern. Therefore, in compiling the ranking of regions, equal weight was given to all factors. It is suggested to employ the method of risk mapping for sustainable regional development for each region individually (see Table 1).

Table 1. Criteria for the development of a sustainable regional risk map

Indicators	Code	High risk	Medium risk	Low risk
Social				
The share of the population with an income below the subsistence level (%)	C_1	C_1>7.3	4.7≤C_1 ≤7.3	C_1 <4.7
Unemployment rate (%)	C_2	C_2 >5.0	4.7≤ C_2≤5.0	C_2<4.7
Life expectancy (years)	C_3	C_3 <70.0	70.0 ≤ C_3≤71.4	C_2>71.4
Indicator of income inequality, measuring the ratio between the incomes of the poorest and richest 10% of households (i.e. the first and tenth deciles of households)	C_4	C_4 >6.0	4.6 ≤ C_4 ≤6.0	C_4 <4.6
Economic				
GRP per capita (thousand tenge)	C_5	C_5<6254.5	6254.5≤C_5≤11 146.0	C_5>11 146.0
Investments in fixed assets per capita (thousand tenge)	C_6	C_6 <445,6	445,6 ≤ C_6≤696,9	C_6 >696,9
The degree of depreciation of fixed assets (%)	C_7	C_7 >50.0	30.0≤ C_7≤50.0	C_7 <30.0
GVA per employee in the manufacturing industry (thousand tenge)	C_8	C_8 <20546.3	20546.3≤C_8≤33573.4	C_8 >33573.4
Environmental				
The number of stationary sources of pollutant emissions (units per 10,000 inhabitants)	C_9	C_9 >264.8	152.2≤ C_9≤264.8	C_9 <152.2
Emissions of air pollutants from stationary sources per capita (kg)	C_{10}	C_{10} >660.0	337.0≤ C_{10}≤660.0	C_{10} <337.0
The amount of environmental protection costs per capita (thousand tenge)	C_{11}	C_{11} <26.3	26.3≤ C_{11}≤52.5	C_{11} >52.2
Emissions of liquid and gaseous pollutants, per capita (kg)	C_{12}	C_{12} >520.6	265.2≤ C_{12}≤520.6	C_{12} <265.2

Source: compiled by the authors on the basis of data from the Bureau of National Statistics of the Republic of Kazakhstan.

Risks to sustainable regional development refer to probabilistic events, limitations, and risks that, under their influence, may disrupt the balance between social, economic, and environmental aspects of regional development. Such an imbalance constitutes a risk because it significantly impairs the well-being of both current and future generations, both within the region and across the country.

4. Results and Discussion

Stage 3: Interpretation of the results. Based on the selected indicators, a ranking of the sustainable development of Kazakhstan's regions has been compiled (Table 2).

The values of the composite indicators for the regions range from 11 to 17. All three mega-cities – Astana, Shymkent, and Almaty – are among the top 10. Also included in the top ten are the main oil-producing regions – the Atyrau, West Kazakhstan, and Aktobe provinces.

An analysis of the resulting composite indicator reveals a wide range of regional values, making it essential to examine the sustainability risks. Furthermore, such a comparison must be conducted for all three dimensions of sustainability. A resulting risk map is presented in Table 3.

Table 2. Ranking of regions of Kazakhstan according to the degree of sustainability

Region	Social	Rank	Economic	Rank	Environmental	Rank	The integral indicator	Rank
Astana city	8.00	1	2.65	13	7.20	1	17.86	1
Atyrau	5.97	2	6.60	1	4.49	16	17.06	2
city of Shymkent	5.60	5	3.39	6	6.91	4	15.90	3
West Kazakhstan	5.20	8	4.42	3	6.22	9	15.85	4
Almaty city	5.72	4	3.27	7	6.83	5	15.81	5
city of Almaty	3.79	15	4.61	2	7.19	2	15.58	6
Kostanay	5.29	7	3.75	4	5.70	11	14.74	7
Kyzylorda	5.56	6	2.59	15	6.36	8	14.51	8
Aktobe	5.85	3	2.65	14	5.51	13	14.01	9
Karaganda	5.13	9	3.11	8	5.68	12	13.92	10
Zhambylskaya	5.01	11	2.46	17	6.39	7	13.86	11
Turkestan	3.94	14	2.77	11	7.03	3	13.74	12
East Kazakhstan	4.18	13	3.02	10	6.41	6	13.61	13
Mangystau	5.07	10	2.47	16	5.06	15	12.60	14
North Kazakhstan	3.36	17	3.43	5	5.49	14	12.28	15
Akmola	3.60	16	2.76	12	5.73	10	12.10	16
Pavlodar	4.31	12	3.05	9	4.12	17	11.48	17

Table 3. Sustainability risk map for cities in Kazakhstan

	Social sustainability	Economic sustainability	Environmental sustainability
High risk	North Kazakhstan; Akmola; city of Almaty; Turkestan; East Kazakhstan; Pavlodar	Aktobe; Almaty; West Kazakhstan; Zhambylskaya; Karaganda; Kostanay; Kyzylorda; Mangystau; Pavlodar; North Kazakhstan; Turkestan; East Kazakhstan	Karaganda; Pavlodar
Average risk level	Zhambylskaya; Mangystau; Karaganda; West Kazakhstan; Kostanay; Kyzylorda; Shymkent city; Almaty; Aktobe; Atyrau	Astana city; Almaty city Shymkent city; Akmola	Akmola; Aktobe; West Kazakhstan; Kostanay; North Kazakhstan
Low-risk level	Astana city	Atyrau	Almaty; Atyrau; Mangystau; Zhambylskaya; Kyzylorda; Turkestan; East Kazakhstan; city Astana; city Almaty; city Shymkent

This approach allows not only to classify regions according to their degree of sustainability, but also to identify and draw attention to the existing challenges of regional development in Kazakhstan. The risks associated with sustainable regional development include those processes that could lead to an imbalance within the triad "society-economy-nature" and have

implications for regional development, such as a decline in social conditions, loss of human capital, reduced economic resilience, depletion of natural resources, and environmental harm.

Three levels of risk have been identified: high, medium, and low. Average indicators for Kazakhstan have been used to assess risk levels.

The social sustainability of the regions is an important factor in determining the quality of life and health of people living in those areas. One of the most effective indicators of this is life expectancy, which reflects the improvement in health services, living standards, and environmental quality. An increase in living standards and access to quality education and medical services leads to higher life expectancy indicators. Conversely, lower indicators indicate the absence of these factors, and this can lead to social instability. Life expectancy is often considered the most important tool for tracking societal well-being and is crucial for developing public policy. The average life expectancy in Kazakhstan is approximately 70.2 years. This level can be used as a benchmark for assessing the sustainability of life expectancies in Kazakhstan's regions. If life expectancy falls significantly below this benchmark, it may indicate risks of social unrest.

The indicator of income inequality, measuring the ratio between the incomes of the poorest and richest 10% of households (i.e. the first and tenth deciles of households, was used to measure the level of income stratification in Kazakh society.

This indicator was chosen because it helps to identify how much income inequality exists in different regions of Kazakhstan. The average ratio for Kazakhstan in 2021 was 6. Five regions – Karaganda, Pavlodar, North Kazakhstan, East Kazakhstan, and Almaty – had a higher fund ratio than the national average, with values ranging from 6.5 to 7.5, and were classified as high-risk regions.

Another five regions were considered medium-risk. The proportion of people with an income below the poverty line is a crucial indicator of social well-being, which is further emphasized by the goal of the Sustainable Development Goals to eradicate poverty.

The government of Kazakhstan recognizes this as a priority and has implemented a comprehensive program to increase income until 2025. Although there are still significant disparities between regions, with some regions experiencing higher levels of poverty than others, the government has set specific targets to address this issue. According to official statistics, the share of people living in poverty in Kazakhstan was 5.2% in 2021. When tracking the dynamics, there have been no significant changes. However, a more detailed examination of this indicator reveals that the proportion of urban residents living below the poverty line increased from 3.8% to 4% and the proportion of rural residents from 7.2% to 7.3%. It is worth noting the absolute number of people living in poverty, which increased by 39.7 thousand in 2021 – from 992,100 to 1,031,000 (an increase of 4%). This issue is particularly acute among the urban population, where the number of individuals outside the poverty threshold increased by 12% in absolute terms. Efforts are underway in Kazakhstan to address these challenges. In 2021, for example, the Ministry of Labor and Social Protection of Population (MTSZN) attempted to calculate the number of poor individuals in the country using a method developed by Western scholars Alkire and Foster and recommended by the United Nations Development Programme (UNDP).

According to this methodology, families are categorized into five levels of well-being: prosperous, satisfactory, functional, crisis, and emergency. According to this method, approximately 50.5% of households in Kazakhstan, or 10.4 million people, can be considered to be at a prosperous or satisfactory level of well-being. The remaining 49.5%, or 9.1 million households, are classified as belonging to problematic categories. This means that there is also an issue with the accuracy of accounting for the poorer population in the country, as it includes 9.1 million individuals and 1 million households. As a solution, a digital family card has been created and the introduction of proactive social support (via SMS notifications about forms of social assistance) has been launched.

However, there has been no discussion of a full review of the state's support system for vulnerable segments of society.

The unemployment rate is a significant indicator of a country's economic development. It has a direct influence on social stability and the satisfaction of citizens. If there are not enough jobs available or if they do not meet the necessary requirements, there is a risk of human capital outflow, both within and outside the country. A job provides individuals with the opportunity to support themselves. However, high risks for sustainable development exist due to employment conditions. On average, the unemployment rate in Kazakhstan is not critical in most regions. Nevertheless, one of the most pressing issues is the prevalence of precarious employment, which includes various forms of self-employment. The share of self-employed individuals does not exceed 24% on average in Kazakhstan. Some of these individuals are involved in vulnerable employment and face the risk of instability. The widespread self-employment in rural areas of the country creates serious economic and social challenges.

The economic sustainability of the regions is a major concern. Kazakhstan has implemented several 5-year industrial development programs, including the Industrial Development Program for 2015-2019, and each region has its own industrialization plans. The average annual investment in fixed assets per capita in Kazakhstan was 696.9 thousand tenge in 2021. The regions were grouped according to their level of risk based on this indicator. One of the key indicators of economic sustainability is Gross Regional Product (GRP) per capita, which reflects the level of economic activity and living standards. Other indicators, such as household consumption, provide a better understanding of material well-being. Another important condition for the development of regions is the development of high-quality production. This requires a gradual renewal of fixed assets and control over their level of wear and tear, as in case of excessive wear and tear, further production in the economy becomes difficult. It is worth noting that Kazakhstan has a high level of depreciation in fixed assets, which negatively affects the quality of production assets and thus the development of production. Five regions show a depreciation rate of more than 50% and eleven more regions have a depreciation rate above 30%. Despite the fact that the capital city of the republic is one of the most developed regions in the country, it has a higher level of depreciation than other regions - more than 63%. This significantly limits the development and utilization of the city's potential. The gross value added (GVA) per employee in the manufacturing sector is an important indicator that reflects the labour productivity of the industry, which plays a significant role in the economic restructuring process. This indicator is currently a central priority in the policy pursued by Kazakhstan, as it will become a catalyst for improving the

standard of living, economic and environmental conditions, and reducing reliance on global commodity market fluctuations.

The manufacturing industry is a key indicator of a region's economic potential. Analysis of data shows that in many regions, including those with a mining focus, labour productivity exceeds the national average, highlighting the importance of this sector for regional growth.

Environmental sustainability of the regions According to the Bureau of National Statistics, several regions in Kazakhstan are characterized by high levels of pollution. These include Mangystau, Akmola, Kostanay, Atyrau, Karaganda, and Pavlodar. These regions account for more than 80% of total emissions in the country. Therefore, they pose a significant risk to the environment. A second group of regions produces less than 15% of emissions, and a third group produces less than 4%. The average cost of environmental protection per capita in Kazakhstan is 9.5 thousand tenge, but there are significant differences among regions. Expenditures in this group ranged from 0.05 to 78.68 thousand tenge in 2021. Regions with costs below the national average are considered high-risk areas. The largest mining regions in Kazakhstan fall into this category, as they contribute significantly to pollution.

The classification of the largest cities in the republic as a low-risk group does not imply that the issue of environmental pollution has been resolved there. This indicates the extent of efforts to restore and maintain the environment. Mining and commodities exports are an essential source of growth for Kazakhstan, as well as for numerous developing countries. Oil and mining areas of the republic are less stable, while agricultural regions are also included in the unstable category since agricultural enterprises also contribute to pollution. According to the monitoring of national statistics on Sustainable Development Goals, the generation of pollutants (across all hazard levels) from stationary sources in Kazakhstan amounts to 126.7 kg per capita, with 100.8 kg of liquid and gaseous pollutants per capita.

It is evident that the risks to environmental sustainability in these regions are significant.

5. Conclusion

The approval of the proposed methodology for calculating the integrated indicator of sustainability at the regional level has demonstrated its suitability. The results of the calculation show that the strengths and weaknesses of each region can be assessed by analyzing the structure of the integrated indicator, where it is possible to examine the contribution of each indicator to the overall value of the rating and compare the position of each region, both as a whole and individually. Based on this comparison, it is possible to identify the indicators that drive growth and make recommendations for improving those indicators in areas where there is potential for improvement. The methodology chosen to calculate the integrated indicator has generally proved its usefulness. The results are suitable for analysis and generally correspond to the actual state of affairs. The presented results of the development and testing of the methodology for assessing the regions of Kazakhstan in terms of sustainable development allow us to draw some conclusions and make some suggestions. First, overall, the current situation can be described as regional inequality in terms of achieving sustainable development goals. Secondly, according to the results of the

tested methodology, sustainable regional development in Kazakhstan is on average. Some regions are more stable than megacities such as Almaty and Shymkent, but in agricultural and small-population areas of Kazakhstan, the risks of achieving sustainable development are higher than in other parts of the country. Thirdly, scientifically based recommendations on the application of the methodology for assessing sustainable regional development would contribute to improving the statistical accounting of the main indicators of economic, social, and environmental development in the regions of Kazakhstan. At the same time, it would be beneficial to improve national and regional statistics by focusing on and expanding urban statistics. Fourth, this study can serve as a basis for further research. Therefore, it is necessary to conduct a study based on the materials from one or two regions in order to develop a monitoring mechanism for the socio-economic development of these regions and ensure informed decisions regarding priorities and a balanced state between the environment, economy, and social spheres. The study used only official statistical data published by the National Statistical Office. However, there are some drawbacks associated with the lack of sufficient statistical information, which will need to be addressed in future research. We did not use the method of expert assessments, as it is quite complex and expensive, but this approach makes the study more objective and easier to conduct. The application of the methodology developed in this study will improve tools for monitoring and evaluating sustainable development in regions. The inclusion of the sustainable development indicators proposed by the authors in the regional planning and forecasting system allows them to be used online for making decisions on the strategic management of the region's development.

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