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## *Agricultural sciences*

### **PRESERVATION, ENRICHMENT, AND UTILIZATION OF THE MULBERRY GENE POOL AND SILKWORM BREEDS' GENE POOL IN AZERBAIJAN**

V. Maharramova  
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R. Huseynova  
A. Mammadova

#### **Abstract**

*The article emphasizes the importance of preserving genetic resources in the development of sericulture and their use in future breeding work. Azerbaijan's favorable soil and climatic conditions provide opportunities both for the production of environmentally friendly products and for the conservation of biodiversity. Preservation of the mulberry plant and silkworm breeds' gene pool is considered a key factor in forming the feed base of sericulture and increasing productivity. The article presents work carried out on the collection, study, and use of local and foreign mulberry varieties to create high-yielding varieties. It also states that as a result of breeding work on silkworm breeds, breeds, and hybrids with high cocoon productivity have been created. The combined use of local and introduced breeds enriches the genetic base of sericulture and ensures its sustainable development. The article substantiates the necessity of preserving the gene pool, improving breeding, and refining feeding technologies for the scientific development of sericulture.*

**Keywords:** *breeding, gene pool, mulberry cultivation, mulberry varieties, productivity, sericulture, silkworm breeds.*

#### **INTRODUCTION**

*The preservation of biodiversity, collection of genetic resources, creation of a gene pool, and their transfer to future generations are considered among the main tasks ahead. The preservation and maintenance of the gene pool and the future development of this sector depend on the diversity of the genetic fund.*

*Azerbaijan's natural climatic conditions are favorable for the development of sericulture. The country's rich and favorable soil and climate conditions, along with the ability to produce environmentally friendly products and conserve biodiversity, create fertile grounds for producing highly competitive goods for the global market.*

*Without creating a feed base, it is impossible to establish sericulture. The full restoration of sericulture depends greatly on the restoration and development of mulberry cultivation. Using the mulberry gene pool, it is possible to conduct various scientific research in different directions.*

*The creation of new mulberry varieties largely depends on the richness of forms and varieties within the gene pool. Currently, mulberry trees are planted in more than 20 countries worldwide. In the People's Republic of China, mulberry orchards cover 626 thousand hectares; in India, 20,080 hectares; and in Thailand and Brazil, 35 thousand hectares each [1], [2].*

*For many years in Azerbaijan, along with local mulberry varieties, varieties and forms from Japan, China, Bulgaria, Russia, Uzbekistan, and Georgia have been collected in collection orchards, studied, and used in breeding programs [3], [4]. Azerbaijani mulberry scientists have created various mulberry varieties based on productivity and the feeding quality of the leaves [7], [8], [9], [10].*

*These include AZNIJ-7 (1,2,3,4,5,6), Bağça tut, Yunis tut, Kamil tut, Zümrud tut, Nağı tut, Qədir tut, Adilə tut, Gözəl tut, and Şəmkir-Teymur tut [7], [9], [10]. Currently, scientific research continues. Most varieties created in Azerbaijan belong to the *Morus alba* species.*

*The newly developed mulberry varieties have shown different results compared to the control samples in terms of productivity indicators.*

TABLE I. PRODUCTIVITY INDICATORS OF NEWLY DEVELOPED MULBERRY VARIETIES

| Names of mulberry varieties | Indicators              |                         |                     |                       |
|-----------------------------|-------------------------|-------------------------|---------------------|-----------------------|
|                             | leaf yield per tree, kg | yield per hectare, c/ha | cocoon yield, kg/ha | raw silk yield, kg/ha |
| Gozal mulberry variety      | 11,6                    | 72,9                    | 555,4               | 95,2                  |
| Arzu mulberry variety       | 11,23                   | 70,2                    | 528,0               | 89,9                  |
| Galib mulberry variety      | 10,24                   |                         | 545,0               | 92,1                  |

In the past decade, the Şamkir, Teymur, and Samux mulberry varieties have demonstrated high results [8], [9]. Silkworm breeds fed with mulberry leaves of high quality have also differed in cocoon quality. Along with preserving the mulberry plant, the conservation of silkworm breeds is of great importance. Currently, the silkworm breeding laboratory of the Scientific Research Institute of Animal Husbandry maintains 91 breeds of silkworms – 59 local and 32 foreign [5], [7].

These breeds are preserved in a live collection, studied, and used annually to select initial material for breeding work with more promising breeds. The history and experience of breeding show that, just like the gene pool of sericulture, the preservation and improvement of collection breeds are essential.

Preserving the silkworm gene pool for future use in various breeding works, as well as the creation of new hybrids, is one of the main tasks ahead.

The creation of a feed base for sericulture requires not only the preservation of the mulberry gene pool but also the preservation of the silkworm gene pool. This is necessary for producing new silkworm breeds, using them in breeding, and improving existing breeds.

The study of biotechnological indicators in the silkworm gene pool and their improvement is ongoing. The gene pool contains 43 local and 19 introduced silkworm breeds. Foreign silkworm breeds include Yapon 5, Ukranya 1, Plovdi 15, Miziuri 1,2,3,4,5, and Vratsa, which are used in creating new silkworm breeds [5], [6].

In recent years, various breeds and hybrids of the mulberry silkworm have been developed. Currently, at the Animal Husbandry Research Institute (Az.ETİİ), new silkworm breeds have been created using 8 local breeds in 15 hybrid combinations of direct and reverse crosses. These include Ordubad-1, Ordubad-2, Muğan-1, Muğan-2, Namazalı-3 x Mizuri-1 hybrid, and Uğur silkworm breeds. These newly created breeds and hybrids have shown better results than the existing Mayak-2 x Mayak-3 hybrid and other hybrid combinations in terms of egg hatching percentage, larval survival rate, and average cocoon weight [5], [7], [8]. Since the average cocoon weight plays a decisive role in cocoon productivity, it is a key factor in determining the yield per box.

The preservation of the silkworm gene pool, its use in breeding work, and the improvement of silkworm breeds remain relevant.

TABLE II. MAIN BIOLOGICAL INDICATORS OF LOCAL AND FOREIGN BREEDS

| Row No. | Breed name            | Egg hatching rate, % | Average weight |                 | Silk content of live cocoon, % |
|---------|-----------------------|----------------------|----------------|-----------------|--------------------------------|
|         |                       |                      | Live cocoon, g | Cocoon shell, g |                                |
| 1       | Rəhimli 4 (Rahimli 4) | 90,2                 | 2,06           | 337             | 22,4                           |
| 2       | Pioner 1              | 86,3                 | 2,14           | 313             | 20,8                           |
| 3       | Pioner 2              | 83,2                 | 1,9            | 324             | 19,1                           |
| 4       | Yubiley               | 93,5                 | 2,2            | 366             | 21,2                           |
| 5       | Gəncə 5 (Ganja 5)     | 91,5                 | 2,09           | 370             | 19,2                           |
| 6       | Gəncə 6 (Ganja 6)     | 68,0                 | 2,08           | 433             | 21,7                           |
| 7       | Gəncə 8 (Ganja 8)     | 64,5                 | 2,1            | 400             | 20,6                           |
| 8       | Murov                 | 87,0                 | 1,90           | 363             | 19,0                           |
| 9       | Mayak 2               | 89,2                 | 2,15           | 466             | 21,7                           |
| 10      | Mayak 4               | 89,2                 | 2,15           | 466             | 21,7                           |
| 12      | Bəxtiyar (Bakhtiyar)  | 87,5                 | 2,11           | 436             | 20,6                           |
| 12      | Vətən (Vatan)         | 72,2                 | 1,92           | 364             | 21,0                           |
| 13      | Xəzər (Khazar)        | 92,2                 | 2,25           | 433             | 19,5                           |
| 14      | Araz                  | 90,3                 | 2,12           | 400             | 18,8                           |
| 15      | Qəbələ (Gabala)       | 91,3                 | 2,1            | 366             | 20,4                           |
| 16      | Qafqaz (Caucasus)     | 72,2                 | 2,17           | 433             | 20,0                           |
| 17      | Oro                   | 91                   | 1,90           | 300             | 15,7                           |
| 18      | Sichuan (Sichuan)     | 90,5                 | 1,90           | 363             | 19,1                           |
| 19      | Polivoltin 09         | 85,8                 | 2,1            | 373             | 17,7                           |
| 20      | Yapon 5 (Japanese)    | 89,2                 | 2,43           | 430             | 17,6                           |

Currently, the silkworm breeding laboratory is successfully carrying out breeding work aimed at creating new breeds and hybrids.

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## PRELIMINARY PROCESSING, ANALYSIS AND HEMATOLOGICAL INDICATORS OF MILK OBTAINED FROM HOLSTEIN-FRIESIAN AND SIMMENTAL BREEDS

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### Abstract

*In this research, the preliminary processing stages and quality indicators of milk obtained from Holstein-Friesian and Simmental breeds were studied comparatively. The main physicochemical parameters of the milk samples – fat content, protein, dry matter, and density – were analyzed. In parallel, the hematological parameters of the animals (erythrocyte count, leukocytes, platelets) were examined, providing essential insights into the animals' physiological condition, stress resistance, and productivity.*

*The analyses revealed that Holstein-Friesian cows are distinguished by higher milk productivity; however, Simmental cows had higher fat and dry matter content in their milk. These characteristics underscore the necessity of selecting breeds according to breeding direction and farm requirements. Hematological indicators not only confirmed the animals' health status but also enabled comprehensive evaluation of factors affecting milk quality.*

*Overall, the study once again confirmed the importance of adhering to zoohygienic requirements, appropriate breed selection, and application of modern processing technologies to improve milk quality and productivity in animal husbandry. The obtained results are of significant value for future management of dairy farms and the development of scientific-practical recommendations.*

**Keywords:** *Holstein-Friesian, Simmental, milk analysis, hematological indicators, processing technology*

**Introduction.** *Investigating the relationship between blood composition and milk productivity in dairy cows is of great relevance in today's agricultural sector. Enhancing milk yield and preserving animal health are crucial both economically and from an animal welfare perspective [1]. In this context, analyzing the biochemical parameters of cows' blood allows for the evaluation of their general health condition, metabolic activity, and key physiological factors affecting milk yield.*

*Studies show that cows with high milk productivity exhibit differences in the levels of certain blood substances (e.g., calcium, phosphorus, glucose, total protein, urea, etc.). These substances play essential roles in energy balance, hormonal regulation, and mammary gland function. Therefore, a clear correlation is often observed between increased milk yield and changes in blood biochemical parameters [3].*

*Studying this correlation is vital for effective breeding programs and scientifically-based ration formulation [2]. Based on blood analysis, factors that negatively affect milk production can be identified and addressed in time. As a result, both increased productivity and improved animal health can be achieved.*

**Rationale for the Study.** *The milk-producing ability of high-yielding cows is directly linked to the metabolic processes within their bodies. The condition of these processes is largely evaluated through blood composition. Biochemical indicators in the blood—such as glucose, total protein, urea, calcium, phosphorus, and magnesium—reflect the animal's ability to absorb nutrients and perform physiological functions. The balance of these substances ensures the supply of key energy and structural components necessary for milk synthesis [5].*

*Cows with high milk yield have a higher demand for energy and nutrients. This demand is reflected in their circulatory system. For instance, glucose levels decrease at the beginning of the lactation period because glucose is used for the synthesis of lactose, the main sugar in milk. Similarly, changes in calcium levels affect the milk secretion process, as calcium is a fundamental mineral component of milk and plays a vital role in muscle function, including that of the mammary glands [7].*

Analyzing changes in blood parameters allows for the assessment of the relationship between health status, feeding effectiveness, and milk productivity. This is of great practical importance for increasing milk yield and preventing metabolic disorders (e.g., hypocalcemia, ketosis, etc.) [6].

Therefore, the correlation between blood composition and milk productivity provides a scientific explanation of the interrelationship between feeding, health, and milk secretion mechanisms in animals. Investigating this relationship facilitates a scientifically grounded approach in modern animal husbandry and demonstrates the necessity of such research.

**Methodology of the Scientific Research.** The scientific research was carried out according to the methodology of M.M. Aliyev and G.V. Aliyev in "Examination of Milk and Dairy Products" (2005) [4]. The economic efficiency of the research will be presented in the annual report (Kobolenko 2004) [8].

**Location of the Study.** The research was conducted at the cattle farm of the Auxiliary Experimental Facility of the Scientific Research Institute of Animal Husbandry.

**Aim of the Study.** The aim of the study is to investigate the preliminary processing, analysis, and hematological indicators of milk obtained from imported high-yielding cattle breeds.

**Objectives of the Study.** To study the biological and economic characteristics of Holstein-Friesian and Simmental cows, to compare the chemical composition of milk and blood obtained from both breeds depending on housing conditions, and to determine the correlation between the composition of milk and blood.

**Object of the Study.** The research was conducted on 2 Holstein-Friesian and 2 Simmental cows.

#### **Discussion of Results**

In accordance with the 2025 calendar plan, 2 Holstein-Friesian and 2 Simmental cows were selected from the cattle herd kept at the cattle farm of the Auxiliary Experimental Facility (YTT) of the Scientific Research Institute of Animal Husbandry. The data obtained from the milk and blood samples of these animals are presented in the table below.

**Table 1**

**Information about the cows**

| Breed             | Live Weight, kg | Distinctive Features / Color |
|-------------------|-----------------|------------------------------|
| Simmental         | 670             | Yellow-white                 |
| Simmental         | 647             | Yellow-white                 |
| Holstein-Friesian | 580             | Black and white              |
| Holstein-Friesian | 578             | Black and white              |

**Table 2**

**Chemical composition of milk from Simmental and Holstein-Friesian cows**

| Breed Name        | Total Dry Matter, % | Non-fat Dry Matter, % | Milk Fat, % | Protein, % | Lactose, % | Ash, g | Densit, A <sup>0</sup> | Water, % | Temp. C <sup>0</sup> |
|-------------------|---------------------|-----------------------|-------------|------------|------------|--------|------------------------|----------|----------------------|
| Simmental         | 12,45               | 9,15                  | 3,8         | 3,2        | 5,0        | 0,73   | 30,28                  | 86.97    | 24,0                 |
| Holstein-Friesian | 11,35               | 8,15                  | 3,6         | 3.0        | 4,7        | 0,65   | 27,02                  | 88.69    | 23,1                 |

According to the analysis of the chemical composition of milk using the Lactoscan device, the milk from the Simmental cow contained 12.45% dry matter, 3.8% fat, 3.2% protein, and 5.0% lactose. In the milk from the Holstein-Friesian cow, the dry matter was 11.35%, fat 3.6%, protein 3.0%, and lactose 4.7%.

Table 3

*General blood test indicators of the Simmental cow*

| Indicator                                                                                | Result | Unit                  | Reference Range | Note   |
|------------------------------------------------------------------------------------------|--------|-----------------------|-----------------|--------|
| WBC – White Blood Cell Count (Leukocytes)                                                | 10,2   | $10^9/\mu\text{L}$    | 5,0-13,0        | Normal |
| LYM % – Lymphocyte Percentage (Reflects immune system status)                            | 53,3   | %                     | 45,0-75,0       | Normal |
| MID % – Sum of Monocytes, Eosinophils, and Basophils (Intermediate cells)                | 5,9    | %                     | 2,0-7,0         | Normal |
| GRAN % – Neutrophil Percentage (Indicates body's response to bacterial infections)       | 40,8   | %                     | 15,0-50,0       | Normal |
| LYM# – Lymphocyte Count (Indicates immune system activity)                               | 5,5    | $10^9/\text{L}$       | 2,5-7,5         | Normal |
| MID# – Monocyte Count (Reflects immune function)                                         | 1,0    | $10^9/\text{L}$       | 0,3-1,5         | Normal |
| GRAN# – Neutrophil Count (Body's response to bacterial infections)                       | 4,0    | $10^9/\text{L}$       | 1,0-6,0         | Normal |
| RBC – Red Blood Cell Count (Erythrocytes)                                                | 7,0    | $10^{12}/\mu\text{L}$ | 6,0-8,0         | Normal |
| HGB – Hemoglobin (Main oxygen-carrying component in blood)                               | 10,0   | g/l                   | 8,0-12,0        | Normal |
| HCT – Hematocrit (Volume percentage of erythrocytes in blood)                            | 32,0   | %                     | 35-40           | Normal |
| MCV – Mean Corpuscular Volume (Average volume of a red blood cell)                       | 48,0   | fL                    | 50-60           | Normal |
| MCHC – Mean Corpuscular Hemoglobin Concentration (Hemoglobin density per red blood cell) | 32,0   | g/ $\mu\text{L}$      | 31-34           | Normal |
| RDW-SD – Red Cell Distribution Width (Indicates variation in red blood cell size)        | 30     | fL                    | 37-42           | Normal |
| PLT – Platelet Count (Thrombocytes)                                                      | 340    | $10^9/\mu\text{L}$    | 250– 850        | Normal |
| MPV – Mean Platelet Volume                                                               | 8,0    | fL                    | 7,5-12,5        | Normal |
| PDW – Platelet Distribution Width                                                        | 13,0   | %                     | 12-18           | Normal |
| PCT – Plateletcrit (Platelet volume as a % of blood)                                     | 0,22   | %                     | 0,15 - 0,45     | Normal |
| PLCR – Percentage of Large Active Platelets                                              | 30     | %                     | 15 - 35         | Normal |
| PLCC – Absolute Count of Large Platelets                                                 | 20     | $10^9/\text{L}$       | 55-75           | Normal |

Table 4

*General Blood Test Indicators of the Holstein-Friesian Cow*

| Indicator                                                                           | Result | Unit               | Reference Range | Note   |
|-------------------------------------------------------------------------------------|--------|--------------------|-----------------|--------|
| WBC – White Blood Cell Count (Leukocytes)                                           | 8,2    | $10^9//\text{L}$   | 4,0-12,0        | Normal |
| LYM% – Lymphocyte Percentage (Reflects immune system status)                        | 48     | %                  | 45,0-70,0       | Normal |
| MID% – Sum of Monocytes, Eosinophils, and Basophils (Intermediate cells)            | 5,0    | %                  | 2,0-7,0         | Normal |
| GRAN% – Neutrophil Percentage (Body's response to bacterial infections)             | 40,8   | %                  | 20-45           | Normal |
| LYM# – Lymphocyte Count                                                             | 3,5    | $10^9/\text{L}$    | 2,0-7,5         | Normal |
| MID# – Monocyte Count (Reflects immune system function)                             | 1,0    | $10^9/\text{L}$    | 0,2-1,2         | Normal |
| GRAN# – Neutrophil Count (Response to bacterial infections)                         | 4,0    | $10^9/\text{L}$    | 1,5-6,0         | Normal |
| RBC – Red Blood Cell Count (Erythrocytes).                                          | 6,0    | $10^{12}/\text{L}$ | 5,0-7,0         | Normal |
| HGB – Hemoglobin (Oxygen-carrying protein in blood)                                 | 9,0    | g/dl               | 8,0-10,0        | Normal |
| HCT – Hematocrit (Erythrocyte volume percentage in blood)                           | 32,0   | %                  | 30-36           | Normal |
| MCV – Mean Corpuscular Volume (Average size of red blood cells)                     | 48,0   | fL(femtolitr)      | 45-55           | Normal |
| MCHC – Mean Corpuscular Hemoglobin Concentration (Hemoglobin concentration per RBC) | 28,0   | g/dl               | 30-33           | Normal |
| RDW-CV – Red Cell Distribution Width (Cell size variability)                        | 11,0   | %                  | 12 - 13         | Normal |
| RDW-SD – Red Cell Distribution Width - Standard Deviation                           | 38     | fL                 | 35-40           | Normal |
| PLT – Platelet Count (Thrombocytes)                                                 | 300    | $10^9/\mu\text{L}$ | 200-800         | Normal |
| MPV – Mean Platelet Volume                                                          | 8,0    | fL                 | 6,0-10,0        | Normal |
| PDW – Platelet Distribution Width                                                   | 13,0   | %                  | 8-17            | Normal |
| PCT – Plateletcrit (Platelet volume as a % of blood)                                | 0,22   | %                  | 0,15 - 0,25     | Normal |
| PLCR – Large Platelet Ratio (Percentage of large active platelets)                  | 23     | %                  | 18- 28          | Normal |
| PLCC – Large Platelet Count (Absolute count of large platelets)                     | 50     | $10^3\mu\text{L}$  | 40-60           | Normal |

**Note:** Using the URIT 2900 analyzer, the chemical composition of the blood — specifically the number of formed elements such as leukocytes (WBC – white blood cells), erythrocytes (RBC – red blood cells), and platelets (PLT) — was determined.

Leukocytes (WBC): Simmental –  $10,2 \times 10^9/\text{L}$ , Holstein-Friesian –  $8,2 \times 10^9/\text{L}$

Erythrocytes (RBC): Simmental –  $7,0 \times 10^{12}/\text{L}$ , Holstein-Friesian –  $6,0 \times 10^{12}/\text{L}$

Platelets (PLT): Simmental –  $340 \times 10^9/\text{L}$ , Holstein-Friesian –  $300 \times 10^9/\text{L}$

These results indicate that both leukocytes and platelets share the same unit of measurement —  $10^9/\text{L}$  — since both values reflect the number of cells per liter.

Table 5

*Milk products derived from cows*

| Breed             | Cheese         | Butter        | Cottage Cheese (şor) |
|-------------------|----------------|---------------|----------------------|
| Simmental         | 6,5liters-1kg  | 21 liters-1kg | 30 liters-5kg        |
| Holstein-Friesian | 7,0 liters-1kg | 23 liters-1kg | 34 liters-5kg        |

As seen in the table, the dairy products obtained from Simmental cows are economically more efficient compared to those from Holstein-Friesian cows. This is due to the fact that the milk of Simmental crossbreeds contains a higher percentage of dry matter (12.45%) than that of Holstein-Friesian crossbreeds (11.35%) [6].

**Conclusion**

1. WBC – The total white blood cell count (leukocytes) was 10.2 in the Simmental breed and 8.2 in the Holstein-Friesian breed.

2. RBC – The red blood cell count (erythrocytes) was 7.0 in the Simmental breed and 6.0 in the Holstein-Friesian breed.

3. PLT – The total platelet count was 340 in the Simmental breed and 300 in the Holstein-Friesian breed.

4. The hematological indicators observed in the Simmental breed were within the range of physiological norms. In other words, the hematological values for the Simmental breed were consistent with accepted standard ranges.

5. Dairy products were processed from the milk of the cows:

- From 6.5 liters of Simmental milk and 7.0 liters of Holstein-Friesian milk, 1 kg of cheese was obtained.

- From 21 liters of Simmental milk and 23 liters of Holstein-Friesian milk, 1 kg of butter was obtained.

- From 30 liters of Simmental milk and 34 liters of Holstein-Friesian milk, 5 kg of cottage cheese (şor) was obtained.

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## *Economic sciences*

### **MODELS OF ASSESSMENT OF THE PERFORMANCE OF ACADEMIC STAFF**

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#### **Abstract**

*Managerial framework for evaluating the performance of academic staff in higher education institutions constitutes an essential aspect in building a standardized quality academic system. The models used by higher education institutions for this purpose are different, often conditioned by the public/non-public institutional nature, the legal framework and the managerial capacities of their individual/collegial management structures.*

*System evaluation refers to the processes that countries use to monitor and evaluate the performance of their education systems. A strong evaluation system serves two main functions: improving educational performance and holding government and other stakeholders accountable for meeting national objectives[1].*

*It is important that, through a comparative analysis of the models, we identify how the managerial framework influences the effectiveness and objectivity of performance evaluation as well as the motivation of academic staff towards academic, professional and scientific development [2]. Direction and motivation, as the main functions of effective management, are also two very important elements and indicators of the performance evaluation aspect of academic staff [3].*

*Further, the evaluation of personnel performance, as one of the main procedural functions of human resources management, constitutes another important element in the evaluation of the system, in terms of completing the framework of good management of higher education institutions and increasing the performance and quality of the entire academic and scientific process.*

*Effective and objective management of human resources in higher education institutions, by implementing and considering the most appropriate indicators for evaluating the performance of academic staff, establishes a standard that acts as a mechanism, which then brings about increased performance and quality of academic and scientific activity in higher education institutions.*

**Keywords:** *Performance Evaluation, Academic Staff, Performance Evaluation Model, Evaluation Indicator, Legal Framework, Institutional Framework.*

#### **Introduction.**

*Identification and implementation of performance evaluation models that rely on measurable, objective and standardized indicators serves as a sustainable guiding framework for the academic and scientific development of personnel and for the advancement of institutional quality in a harmonized and comparable manner [4].*

*Identifying the model and indicators used for performance evaluation would serve:*

*first, as a catalyst and an important mechanism for promoting accountability and improving the performance of academic staff of higher education institutions, by identifying the most appropriate model, through the most effective performance assessment indicators and practices;*

*secondly, in focusing and analyzing performance evaluation indicators in three main components: teaching, scientific research and service to third parties. This process, of course, is generated based on the characteristics of each country's educational systems, their managerial and institutional aspects, the legal and regulatory framework, - specifically the case of Albania;*

*thirdly, as a process that includes internal structures for evaluating the performance of academic staff, starting - in the case of Albania, from the basic unit which is the department, and then the faculty and the academic senate, this process being reflected in the internal assessment of staff quality, which*

continues with the performance of higher education institutions (HEIs) themselves and is finalized with their ranking at the national and international level;

**fourth**, as a comparative analysis between performance assessment models implemented in higher education institutions in Albania and other countries, highlighting the most standardized practices and model, also referring to the education system.

To ensure that evidence serves as a basis for strategic planning, priority setting and the achievement of national objectives in education, in the case of Albania but also in global practices in general, the demand for information and analysis within central structures should be strengthened, while developing institutional capacities and procedures that support a culture of system evaluation. The challenge of drafting new educational strategies offers countries an important opportunity to integrate evaluation more prominently into planning and policy-making processes in line with the unification of steps with the large family of the European Community and beyond [5].

A unified performance evaluation model will ensure transparency, objectivity and efficiency in the management of academic staff performance. The results of this process can also help in building sustainable policies for the standardization, organization, motivation and development of academic staff. Motivation and performance are closely related to each other. Motivation theories cannot be viewed in isolation, as many of the ideas underlying these theories are complementary, and knowledge about individual motivation is maximized if these theories are combined together [6].

#### **Albania in the evolution of academic staff performance evaluation.**

The development of academic staff performance evaluation in Albania has gone through several phases, influenced by political, economic and educational transformations after the 1990s. In the period before the adoption of Law No. 80/2015[7], performance evaluation did not represent a standardized and comprehensive mechanism in the higher education system.

Higher education in Albania, after the centralized communist system, was regulated by Law No. 7491, dated 29.04.1991 "On Higher Education in the Republic of Albania", which was the main legal act of the period after the changes in the political system of 1990. This law brought about some important conceptual changes as far as the education system itself is concerned.

We can say that initially it changed the previous socialist regulatory framework, replacing the regulations approved by the governing structures of the time in the 70s-80s.

The merit and innovation for the time, defined by this law was the determination of the limited autonomy of HEIs, giving them some competencies of internal academic organization but maintaining centralized control over curricula, programs, finances and recruitment of management levels, establishing standards for student admission and the diploma system.

Also, the opening and closing of study programs, the planning of scientific degrees and academic titles, and the determination of the status of academic personnel were regulated by the central government.

This law remained in force throughout the 1990s, with some changes over time, until it was replaced by Law No. 8461, dated 25.02.1999 "On Higher Education in the Republic of Albania", which brought clearer elements of university autonomy and alignment with European processes that were later included in the framework of the Bologna Charter.

To provide an overview of the evolution of the education system regarding the performance evaluation of academic staff in Albania, prior to the entry into force of Law No. 80/2015 "On Higher Education and Scientific Research in Higher Education Institutions in the Republic of Albania", it is important to mention the two legal acts that preceded this law and their impact on the way academic staff are evaluated.

Law No. 8461, dated 11.3.1999 "On Higher Education in the Republic of Albania" [8] marked a period of transition in all sectors, including education, aiming for university autonomy, which became the main theme of educational policies in the following years and the approach of European systems in Albania.

This law emphasized institutional autonomy, but did not provide structured criteria for performance evaluation. The evaluation was based mainly on academic titles, experience and internal decision-making of academic senates, without relying on measurable indicators of the quality of teaching or scientific research. In this context, promotion and academic careers depended more on formal aspects than on real performance.

The aspects related to performance evaluation regulated by this law would be highlighted as follows:

1. The evaluation of academic staff was not standardized on a national scale; it was left to the internal competences of higher education institutions (HEIs);

2. A strong focus on academic titles and qualification criteria for promotion, rather than on a proper performance measurement system;
3. Lack of measurable indicators for the quality of teaching and scientific research;
4. Academic senates had a central role in decision-making on promotion, without external monitoring or unified mechanisms.

Later, Law No. 9741, dated 21.5.2007 "On Higher Education in the Republic of Albania" [9] (amended several times until 2010), represents an attempt to increase the quality and harmonize Albanian higher education with the Bologna Charter and European standards.

This law brought a moderate innovation by including elements of quality assurance and emphasizing the role of internal structures for staff evaluation. It attempted to align with the objectives of the Bologna Process, promoting the creation of institutional mechanisms for internal evaluation. However, the lack of a unified methodology and national indicators for the performance of academic staff remained a challenge, making practices different and not comparable between institutions.

New aspects related to the performance evaluation of academic staff regulated by this law would be highlighted:

1. Creation of internal quality assurance structures, as a mechanism to begin performance evaluation by HEIs.
2. The need for periodic staff evaluations was foreseen, but a clear institutional model for measuring performance in all HEIs was not established.
3. The creation of the Public Agency for Higher Education Accreditation (APAAL) was foreseen, but the evaluation remained more at the institutional level, as an external assessment made to HEIs.
4. Criteria for promotion and advancement of academic staff began to include scientific publications, but there was still no scoring system or evaluation model at the national level.

We can say that the period before 2015 was characterized by a difficult institutional transition, where performance assessment was more a matter of institutional form than of the qualitative content of academic work. Assessment depended on the internal procedures of universities and often lacked elements of transparency, objectivity and standardization. The 2007 law made some steps towards a reformed approach, but it was only with Law 80/2015 that the implementation of more structured assessment models began, including the importance of performance in scientific research, teaching and institutional engagement.

Law No. 80/2015 is the basic law covering quality assurance in higher education institutions, dedicating separate chapters to it. Articles 97–103 provide for the modalities of internal and external quality assessment; Articles 104–107 provide for the competences of the Agency for Quality Assurance in Higher Education (ASCAL), which drafts quality assurance standards and organizes institutional and study program accreditation in higher education institutions. Article 108 provides for the internal standards and regulations for quality assurance that each HEI must adopt.

In December 2021, the Ministry of Education and ASCAL approved the Quality Code in Higher Education as a unified document for the standardization of higher education evaluation that summarizes all standards, indicators and quality assurance practices for internal and external evaluation. This document aims to harmonize the European Standards and Guidelines for Quality Assurance (ESG 2015) and coordinate the work of HEIs and ASCAL [10].

The Quality Code of December 2021 does not change the legal nature, it remains a standardizing technical document, but simplifies and harmonizes the accreditation process according to ESG.

- Prior to the approval of the Quality Code of December 2021, the regulatory acts that determined the modalities of quality assurance in HEIs, where within them there was space and indicators and indicators of the PE of academic staff were also foreseen, in chronology are:

- DCM No. 109, dated 15.2.2017 "On the accreditation of study programs in higher education institutions". This decision links the evaluation of staff performance to the quality of study programs. According to its provisions, without evaluated and qualified staff, the program risks non-accreditation or a low rating.

- DCM No. 41, dated 24.01.2018 "On the approval of state quality standards in higher education". This decision extends performance assessment from a simple administrative process to an integrated quality system, where each HEI must have internal performance measurement mechanisms in accordance with state standards.

Instructions and bylaws of the Ministry of Education for 2015-2021, on the internal evaluation report and the accreditation process. These instructions turn performance evaluation into a documented and audited process, where internal reports become the basis for external evaluation by ASCAL.

*These acts together functioned practically as a "quality code" by providing standards for the level of evaluation of HEIs, study programs and also incorporating indicators and indicators in the Performance Evaluation of academic staff in Albania.*

#### ***The strategic importance of academic staff PE models in HEIs.***

*In the framework of Albania's integration into the EU, in the context of developments in higher education in Albania and integration into the European Higher Education Area EHEA, the evaluation of the performance of academic staff is presented as an essential process for guaranteeing the quality and sustainable management of institutions. The evaluation of the performance of academic staff means the measurement of individual and collective achievements in teaching, scientific research, institutional contribution and service to the community, providing a basis for evidence-based decision-making by Abramo & D'Angelo [11].*

*In Albania, the importance of this process is based on the legal and regulatory framework, particularly in Law No. 80/2015 "On Higher Education and Scientific Research in Higher Education Institutions", as well as in the relevant sub-legal acts such as VKM No. 109, dated 15.02.2017 on the accreditation of study programs and VKM No. 41, dated 24.01.2018 on state quality standards. These acts, together with the instructions of the Ministry of Education on the internal evaluation report and accreditation, create a complete framework for the assessment and quality assurance of higher education institutions and academic staff.*

*The importance of models and indicators for evaluating the performance of academic staff in HEIs can be seen and analyzed from several perspectives, such as:*

#### ***Importance for scientific studies***

*From this perspective and in the context that the scientific studies address, the performance evaluation of academic staff constitutes a conceptual foundation to carry out:*

- the analysis of existing models in Albanian public and non-public universities;*
- the identification of factors that influence the perception of the importance of this process such as financing, educational policy, legal/managerial factors, etc.;*
- the proposal of a national performance evaluation model, based on the best European and international practices.*

*This positioning makes performance evaluation an indispensable instrument not only for measurement, but also an instrument for individual/institutional development and innovation in higher education.*

#### ***Scientific and institutional importance***

*The assessment of the performance of academic staff implies a sustainable process of measurement and analysis of professional achievements in the fields of teaching, scientific research, institutional activities and community service. In the context of European integration and the Higher Education Area (EHEA), this assessment is not only a formal legal obligation (Law 80/2015, Council Decision no. 109/2017, Council Decision no. 41/2018), but a strategic tool for quality management and sustainable development of institutions.*

*The performance evaluation process is considered essential for improving the quality of teaching and scientific research, helping to identify strengths and areas for improvement. This process meets the requirements of the European Standards and Guidelines for Quality Assurance (ESG, 2015) and contributes to strengthening the international competitiveness of higher education institutions in Albania. The evaluation results also serve as a basis for the effective allocation of financial resources and the planning of academic advancement policies, ensuring that investments support quality and innovation in the education system.*

#### ***Managerial and strategic importance***

*From a managerial perspective, performance appraisal acts as a tool for career planning and development. It enables the determination of professional training needs, provides an objective basis for decisions such as promotions and rewards, and strengthens a culture of meritocracy (OECD, 2021).*

*In this way, the process contributes to:*

- motivation and accountability of academic staff;*
- increased transparency and credibility in decision-making processes;*
- improved institutional image, making the institution more attractive to students and international collaborations.*

#### ***The importance of research and innovation***

*Performance assessment has a direct impact on the identification of research and innovation, helping institutions to determine priority areas for development. In a globalized context, this approach helps to:*

*Identify trends and innovation: It identifies research potentials and creates a basis for incentive policies in priority areas;*

*Strengthen international competitiveness: It helps to increase academic reputation and position in global rankings, (Abramo & D'Angelo, 2014).*

### **Conclusion**

*In summary, the evaluation of academic staff performance represents a multidimensional process with a broad impact on the development of higher education. It serves not only as an instrument for assessing the quality of teaching, research, and institutional contribution, but also as a mechanism for the effective management of human and financial resources. Through this process, institutions are able to identify strengths and areas for improvement, thereby reinforcing a culture of accountability and transparency. Its significance is further linked to the enhancement of international competitiveness and the promotion of sustainable institutional development. In the Albanian context, performance evaluation stands as a key element for the full integration of the higher education system into the European Higher Education Area (EHEA), while simultaneously contributing to the strengthening of the scientific, social, and institutional impact of universities.*

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## PARADIGM INNOVATION IN CONSUMER DECISION-MAKING PROCESSES THROUGH SOCIAL MEDIA: THEORETICAL AND PRACTICAL PERSPECTIVES FROM DOUYIN AND XIAOHONGSHU

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### Abstract

The transformation of consumer decision-making paradigms in the digital era has been driven largely by the rise of social media platforms. Traditional models, such as Engel-Kollat-Blackwell (EKB) and Howard-Sheth, assume rational, stepwise decision processes. However, algorithm-driven and interactive environments like Douyin (Chinese TikTok) and Xiaohongshu (RED) have disrupted this linearity. This study reconstructs the theoretical foundation of consumer decision-making through the lens of social and cognitive psychology, presenting a revised S-O-R model that describes continuous interactions between stimuli, cognitive states, and behavioral responses. Empirical observations from Chinese platforms demonstrate that algorithmic mediation, social validation, and parasocial trust reshape consumer cognition, making decision-making more cyclical, emotional, and community-based.

**Keywords:** consumer decision-making, social media, Douyin, Xiaohongshu, algorithmic persuasion, digital behavior, S-O-R model, social validation, China

### 1. Introduction

With over 1.1 billion monthly active users on Douyin and more than 300 million on Xiaohongshu (QuestMobile, 2024; WalkTheChat, 2024), Chinese social media platforms have become central to understanding modern consumer behavior.

Unlike traditional advertising that relies on one-way brand communication, platforms like Douyin integrate user-generated content, influencer marketing, and AI-based recommendation systems to shape both perception and preference.

Social media now functions not merely as an information channel but as a behavioral environment where algorithms predict, nudge, and reinforce consumption. This shift challenges classical theories of rational choice and linear evaluation. The aim of this paper is to construct a theoretical framework explaining how social media restructures consumer decision-making processes through algorithmic, emotional, and social mechanisms.

### 2. Theoretical Basis of the Consumer Decision-Making Process

#### 2.1 Classical Frameworks

The classical consumer decision-making models, such as EKB (Engel, Blackwell & Miniard, 1995) and Howard-Sheth (1969), conceptualize the process as a linear sequence of stages—problem recognition, information search, evaluation of alternatives, purchase, and post-purchase evaluation. These frameworks assume that consumers are rational and capable of making objective, utility-maximizing choices.

However, social media environments have fragmented and accelerated these stages, making decisions more iterative and socially mediated.

#### 2.2 The S-O-R Framework and Cognitive Mechanisms

The Stimulus-Organism-Response (S-O-R) model offers a dynamic approach to understanding these transformations:

Stimulus (S): algorithmic exposure, influencer content, and peer interactions;

Organism (O): cognitive processing, emotional arousal, and social identification;

Response (R): behavioral reactions such as purchase intention, sharing, or advocacy.

For instance, Douyin's short-form videos create sensory and emotional stimulation that encourages impulsive buying, while Xiaohongshu's note-style posts rely on authenticity and community trust to foster social proof (Cialdini, 2009).

#### 2.3 Algorithmic Mediation and Social Validation

On social media, algorithms—not consumers—determine which products appear and when. Douyin's "For You" feed and Xiaohongshu's "Discovery" interface embody algorithmic curation, which reverses the traditional flow of information.

*Social validation (likes, comments, shares) strengthens this influence through normative conformity (Babić Rosario et al., 2016), reinforcing perceived credibility and desirability.*

#### 2.4 Cultural Context: Douyin vs. Xiaohongshu

*Douyin focuses on entertainment-driven commerce ("interest e-commerce"), where enjoyment converts directly into transactions.*

*Xiaohongshu emphasizes lifestyle identity and authenticity, positioning consumption as a social and aesthetic act.*

*Both reflect a co-created social meaning of consumption, transforming the consumer decision process from an individual evaluation to a public negotiation of value.*

#### 2.5 Model and Hypotheses

##### Structural Framework

*An extended S–O–R model for social media consumer behavior is proposed:*

$$TR = \alpha_1 CQ + \alpha_2 SP + \alpha_3 AE + \varepsilon_1$$

$$PV = \alpha_4 CQ + \alpha_5 AE + \varepsilon_2$$

$$PI = \beta_1 TR + \beta_2 PV + \beta_3 SP + \varepsilon_3$$

$$PB = \gamma_1 PI + \gamma_2 TR + \varepsilon_4$$

*Variables:*

*AE = Algorithmic Exposure, CQ = Content Quality, SP = Social Proof, TR = Trust, PV = Perceived Value, PI = Purchase Intention, PB = Purchase Behavior.*

*Hypotheses:*

*H1. AE positively affects CQ and PV.*

*H2. SP positively affects TR and PI.*

*H3. CQ positively affects TR and PV.*

*H4. TR and PV positively affect PI.*

*H5. PI positively affects PB.*

*H6. Platform moderates these effects: SP→TR is stronger on Xiaohongshu, AE→PV is stronger on Douyin.*

*These relationships can be empirically tested through PLS-SEM or CB-SEM (Hair et al., 2011; Kline, 2023).*

#### 3. Social Media and Behavioral Transformation

##### 3.1 Platform Data and Consumer Behavior

*According to Business of Apps (2025), Douyin has 766 million daily active users, while Xiaohongshu surpassed 300 million monthly active users and achieved profitability in 2023 (Financial Times, 2024).*

*McKinsey (2023) reports that live commerce conversion rates in China reach approximately 30%, ten times higher than traditional e-commerce.*

*These figures support the model's assumption that algorithmic exposure and social proof have measurable behavioral and economic effects.*

##### 3.2 Behavioral Implications

*Douyin: Emotion-driven immediacy results in impulsive purchases, often within minutes of exposure.*

*Xiaohongshu: Peer trust and community identity lead to slower, more deliberate consumption.*

*The findings suggest a dual-path mechanism of decision-making—instant algorithmic persuasion vs. delayed social deliberation.*

#### 4. Challenges and Ethical Considerations

*The integration of algorithmic mediation and social interaction raises several ethical concerns:*

*Data Privacy: China's Personal Information Protection Law (PIPL, 2021) enforces strict consent and minimal collection principles.*

*Algorithmic Transparency: Users rarely understand recommendation logic, creating potential biases.*

*Authenticity and Manipulation: Influencer-brand collaborations may blur distinctions between opinion and advertisement.*

*A balance between innovation and accountability is crucial to sustain consumer trust (Stanford DigiChina, 2021).*

#### 5. Conclusion

*Social media platforms like Douyin and Xiaohongshu exemplify the paradigm shift from linear, rational decision-making to algorithmically mediated and socially co-constructed consumption.*

*The extended S–O–R model proposed in this paper integrates cognitive, emotional, and social elements, offering a comprehensive framework for understanding consumer behavior in digital ecosystems.*

*This conceptual model underscores the need for transparency, digital literacy, and ethical algorithm design to protect consumer autonomy in the age of social commerce.*

#### *6. Limitations and Future Research Directions*

*This study is conceptual in nature, aiming to construct an extended S–O–R framework rather than empirically test specific hypotheses. It synthesizes insights from existing literature, platform data, and behavioral observations to propose a theoretically grounded model.*

*Future studies may empirically test these relationships using quantitative or mixed methods. For example, survey-based structural equation modeling (PLS-SEM or CB-SEM) could validate causal links among algorithmic exposure, social proof, trust, perceived value, and purchase intention.*

*Alternatively, behavioral data from Douyin and Xiaohongshu can be analyzed to examine real-time algorithmic mediation and engagement patterns.*

*Longitudinal research could further explore how algorithmic personalization and community interaction shape trust and loyalty over time. Such empirical work would provide stronger support for the conceptual model and enrich understanding of algorithmic consumer behavior in China's digital ecosystems.*

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**Abstract**

*The article discusses the technological application of Building Information Modeling, an important component of digitalization in the construction segment in modern times, and its impact on construction efficiency. The impact of information models on the coordination, multifunctional partnership environment, and optimization of construction resources distinguishes this innovation from classical methods. The results of the study show that in construction projects where a digital building model is applied, time loss, cost loss, and information inaccuracy are reduced to zero. In parallel, this innovation implements systematic planning and implementation of construction projects. It creates conditions for achieving high results from both financial and technical perspectives. BIM is considered the main vector of the digital transformation of the modern construction sector. BIM innovation presents a comprehensive approach that ensures information integration, analytical accuracy, and management efficiency at all stages of the project implementation period. The article examines the theoretical foundations, application spectrum, innovative potential, and role of BIM technology in the economic-engineering context within the framework of scientific methodology.*

**Keywords:** *construction segment, digitalization, construction information modeling, technological application, construction efficiency, construction resource.*

**Introduction.** *In a globalized world, the ability of the construction sector to achieve concrete results is related to the perspectives it develops towards the future. Taking advantage of emerging opportunities or taking into account existing situations directly depends on determining the appropriate strategy. All this necessitates the adoption of strategic decisions in order to achieve the set goals and achieve the desired results.*

*The construction and architecture sector is developing rapidly in the 21st century under the influence of high-tech transformation. Traditional design approaches are often characterized by inefficient use of resources, operational delays, and coordination problems. [15, 16, 18, 19] Its complex structure, numerous partners, and long-term implementation processes make this area difficult to manage. In many cases, projects implemented using classical methods are characterized by time loss, resource loss, and coordination problems. These problems negatively affect the quality and effectiveness of the project. Therefore, the need to transition to modern technological solutions arises. Digital technology effectively solves the problems arising from this necessity. [1, 2, 9, 13]*

*The construction sector is developing rapidly and needs the application of new innovations. The increasing complexity of infrastructure projects, optimization of resource management and raising quality standards highlight the importance of modern approaches.*

*BIM technology makes a significant contribution to eliminating these limitations by creating a single, multidimensional and information-oriented model at the design, construction and operation stages. BIM acts as a strategic technological platform that ensures the integration of the fields of architecture, engineering and management.*

*Building Information Technology is considered an innovative system of strategic importance. Building Information Modeling is a modern digital approach in the field of architecture. Simply put, it allows you to prepare a digital model of buildings and infrastructure facilities before the start of the project. This model is not only visual, but also reflects all the information related to construction. BIM technology data refers to material, time, financial and technical indicators.*

**Analysis of recent research and publications.** *Today, a number of important studies have been conducted both in Azerbaijan and internationally on the application of BIM technology in the*

construction sector and its impact on productivity. Among them, the studies of C. Eastman, S. Azhar, R. Volk, E. Yusifov, R. Gurbanov, T. Guliyev and others can be cited.

**The purpose of the work** is to analyze the application of BIM technology in the construction sector and its impact on productivity, and to make recommendations based on the relevant results.

**The main material of the study.** The impact of BIM technology on the construction sector has the potential to fundamentally transform in areas such as the optimization of infrastructure projects, the application of sustainable development principles, and increasing energy efficiency. At the same time, it forms new paradigms in long-term asset management by integrating with digital twins and artificial intelligence-based analysis systems. [11]

What are the main advantages of this innovation:

1. Data integration and coordination: information exchange is ensured between project participants at all stages through a single model.

2. Resource optimization: Accuracy of time and financial planning increases economic efficiency.

3. Risk management: Visual simulations and analytical forecasts allow for the early detection of project errors.

4. Innovative management potential: A multidimensional database supports strategic decision-making on a scientific basis.

5. High quality: Prevents errors in projects and raises standards.

6. Increased efficiency: Minimizes loss of time, money, and resources.

7. Collaboration: Engineers, architects, project managers, and other parties can work on the same platform. [3]

Precise planning: A detailed analysis of all phases is carried out before construction begins.

BIM is a digital model of construction and building objects, as well as a system that covers the entire time period of the project. Through this technology, the design, construction, operation and even demolition stages of the object are managed through a single system. Not content with only 3D models, BIM also integrates 4D- time planning, 5D- finance and budget, 6D- operation and maintenance, and 7D- sustainability and environmental sustainability dimensions. [5]

✓ 3D – Accurate visualization of design and architecture

✓ 4D – Time coordination of construction stages

✓ 5D – Automatic generation of cost reports

✓ 6D – Technical operation and maintenance management

✓ 7D – Energy consumption monitoring and environmental sustainability planning. [3]

Thus, BIM is not just a visual design, but a strategic technology that manages the entire project cycle. [4]

Building Information Modeling – creates great advantages at the project preparation stage. Since architects, designers and engineers can work synchronously on the same model, mutual conflicts in plans are minimized. BIM programs automatically detect inconsistencies with the “clash detection” function and allow them to be eliminated in a timely manner. At the same time, all technical drawings and graphic reports are updated in real time, which facilitates the adoption of operational decisions on the project. [11]

Thanks to BIM technology, the construction process optimizes the planning and use of time resources. Through 4D modeling, work stages are linked to time, which helps to prevent delays. The 5D component ensures that the financial aspect of the project is more transparent and accountable. The need for construction materials is determined in advance, material waste and excess inventory are prevented. Coordination between technical personnel is carried out centrally, which leads to more efficient use of labor. [8]

Building information innovation is not limited to design and construction. [10, 12, 14, 17] After the facility is put into operation, technical operation and maintenance processes are managed through a digital twin. The service history and operational data of important technical systems are recorded in the BIM model. This database provides a great advantage in planning future repair and renovation works. At the same time, energy efficiency and sustainability analyses are conducted, and building performance is improved. [6]

There are a number of projects in the world where BIM technology has been successfully applied. As a result of the application of BIM in the Crossrail project in the UK, project time was reduced by 15% and costs were saved by 10%. The Singapore government has made BIM mandatory and thus reduced the time for obtaining construction permits by 60%. The application of construction information innovation in the Baku-Heydar Aliyev Airport project in Azerbaijan has allowed the project to be carried

out in a transparent and coordinated manner, preventing errors during the construction phase. These examples prove that BIM is one of the key tools in increasing productivity.

The application of BIM technology is accompanied by a number of challenges:

1. Licensing costs – Licensing of BIM software (Autodesk Revit, ArchiCAD, etc.) requires high funding. [4]

2. Staff shortage – There are few experienced BIM specialists and the development of human resources in this field is slow.

3. Resistance – Traditional managers and project managers sometimes resist the transition to new technologies.

4. Lack of standards – The lack of unified national and regional regulatory documents for BIM makes integration difficult.

These problems prevent the rapid spread of the technology.

The following measures are proposed to overcome the difficulties:

1. Training and education – Organization of special courses on BIM in universities and vocational education centers.

2. Pilot projects – Implementation of pilot projects on the application of BIM in cooperation with the public and private sectors

3. Creation of national standards – Azerbaijani standards for BIM should be developed and regulated by regulatory acts.

4. Cloud-based platforms – Storing and sharing data in the cloud enhances collaboration and facilitates technical coordination. [7]

**Conclusion.** Scientific results show that the application of BIM technology, in addition to increasing the productivity of the construction industry, strengthens the innovation potential and ensures the economic sustainability of projects. It improves the strategic management qualities in the urbanization process. Therefore, the expansion of the Building Information Model should be considered one of the priority directions of future construction policy. Building information model technology plays a transformative role in the construction sector. By ensuring transparency, accuracy and high coordination in the planning, implementation and operation of projects, productivity increases significantly. At the same time, indicators such as environmental sustainability, technical safety and economic savings also improve. If the technology is applied with the right strategies, it can make a significant contribution to the digitalization of the construction sector in Azerbaijan. BIM - Building Information Modeling technology plays an important role in increasing quality in the construction sector, optimizing costs and shortening the implementation period of projects. This approach allows for accurate planning, real-time information exchange and effective cooperation at all stages of the project. Compared to traditional methods, BIM is considered a more transparent, flexible and economically superior solution. In the future, the application of this technology, the acceleration of digitalization processes and its combination with sustainable construction principles will be one of the main directions of innovative development in the construction industry. The application of digital technology has become a necessity in the globalized construction industry. Building Information Modeling is one of the most effective tools in this direction. Research shows that the application of BIM technology not only increases accuracy in the process of planning, managing and implementing projects, but also minimizes financial and time losses. Advanced coordination, high-level visualization and efficiency of information exchange are the main advantages that distinguish this technology from traditional methods. At the same time, BIM contributes to supporting the principles of sustainable construction, optimal use of resources and reducing environmental risks. Global experience proves that BIM is not only a technical innovation, but also leads to a qualitative change in management culture. In the future, improving the legal and regulatory framework of this technology, strengthening professional personnel training and integration with other digital platforms will further expand the application capabilities of BIM.

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## Geographical sciences

### THE ECOLOGICAL PROBLEMS OF KANGARLI KAHRİZ SYSTEMS

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#### **Abstract**

Today, the Araz lowlands, which are considered economically important, are continuously exposed to anthropogenic influences. Among the main causes of the ecological problems occurring in the area, the most significant is the problem of water scarcity. In the Kangarli inclined plain, as well as in the territory of Shahtakhti village, the demand for water throughout the year—especially during hot periods—has long been one of the main challenges. Therefore, kahrizes (underground hydraulic structures) have been used to meet this need. Since the kahriz system differs from surface water flows by maintaining a stable discharge, its water is collected in artificial reservoirs over a certain period and then supplied for use.

As an environmentally clean and reliable water source, it represents the most efficient natural water system. Considering that global ecological problems today call for more efficient use of natural resources, greater attention should be paid to the protection and restoration of kahriz systems, which are environmentally friendly, have a continuous flow, require minimal maintenance, and meet the population's needs for drinking and irrigation water.

**Keywords:** Kahriz system, groundwater, ecology, inclined plain, water resources

**Introduction.** One of the regions in our country with the least water resources is the Nakhchivan Autonomous Republic. The main reasons for this are the natural climatic conditions of the area, the uneven distribution of surface runoff throughout the year, and the persistent droughts that have occurred in recent years. In addition, the fact that the amount of fresh water per capita is below the established norms has highlighted the importance of the efficient use of groundwater resources.

From time to time, in the semi-desert and arid-steppe climate—especially under desert-like conditions such as those in Kangarli District—the local population has used and improved the kahriz system to meet their needs for drinking and domestic water.

It should also be noted that the oldest kahriz systems in the Autonomous Republic are located within the territory of Kangarli District. In the villages of Garabaghar, Yurdchu, Givrag, Shahtakhti, and Khok, there are approximately 108 kahrizes, of which 96 are currently operational (Habibbeyli, 2010: p.135). In the Kangarli inclined plain, ancient kahrizes such as "Tolkhuch," "Uch Goze," "Penah," "Suleyman," "Almammad," "Chay Kahrizi," "Boyuk Gol," "Najaflar-1," "Agsu," "Alekberegoglu," and "Kalba Alekber" can be mentioned.

These kahrizes have long met the population's need for drinking water and have also been used for household and agricultural purposes. In recent years, the restoration of collapsed kahrizes due to neglect, as well as the detailed study of the discharge, regime, mineralization level, and chemical composition of operating kahrizes and groundwater, is essential for solving the region's water supply problems and remains highly relevant.

The collapse of the socialist economic system and the transition to a market economy have brought about new challenges in the use of natural resources across various sectors. The increasing annual demand of the population for different natural resources, including water, has created a necessity for the scientific study and evaluation of water facilities, including kahrizes. From this perspective, the research and investigation of kahrizes are highly relevant and significant today.

**Analysis and Discussion.** The Kangarli Plain is mainly composed of metamorphosed travertines located in flat and partly low mountainous areas. Depending on the inclination, exposure, and absolute elevation of the slopes, the configuration of the area forms a complex relief system within the inclined plain, characterized by variations in climate, vegetation cover, and hydrological features.

From a geological perspective, Quaternary deposits in the region consist of alluvial gravels, sands, sandy loams, and aleurites. Geologically, the Sharur-Julfa anticlinorium that cuts across the Kangarli

Plain is composed of terrigenous-carbonate and carbonate facies belonging to the Devonian, Lower Carboniferous, Permian, and Triassic strata, with a total thickness reaching 3000–3600 meters. These are sedimentary rocks of the Daralayaz continental marginal open-sea basin (Babayev, 2000: p. 27).

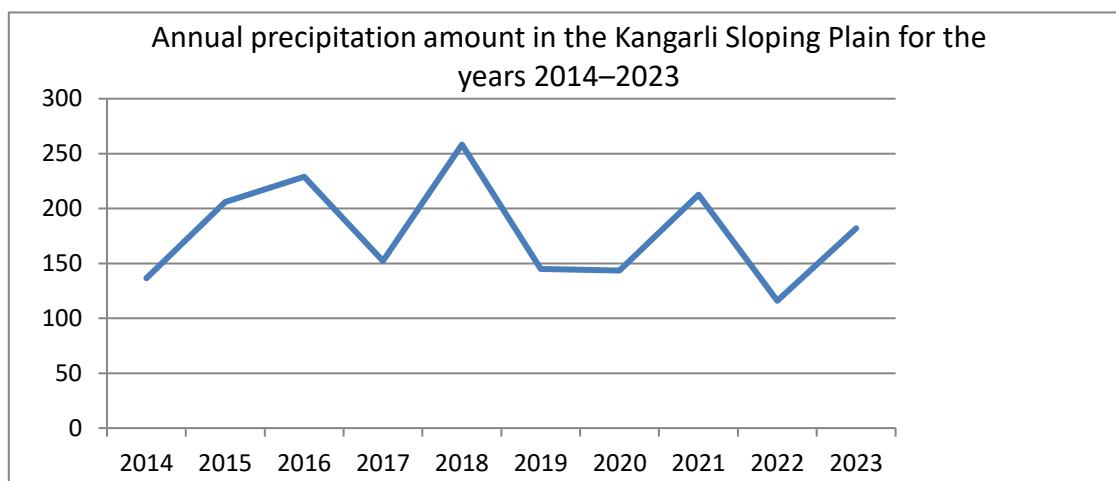
The formation of the geomorphological structure of the area has been significantly influenced by a combination of endogenous and exogenous processes. The region is located within a cold semi-desert and dry-steppe climatic zone, where summers are arid, and the annual duration of sunshine amounts to 2600–2800 hours. As a result of the high number of sunny hours, the total solar radiation and radiation balance are relatively high.

In the Kangarli inclined plain, the annual radiation balance is 40–45 kcal/cm<sup>2</sup>, half of which occurs during the summer months. The maximum radiation balance is observed in July, while the minimum is recorded in January. The mean annual air temperature ranges between 12–14°C. The average temperature of the coldest month (January) varies between -6°C and -10°C, while that of the hottest month (July) fluctuates between 24–28°C.

In the plain, the average absolute minimum air temperature in winter is between -15°C and -18°C, whereas the average absolute maximum temperature in summer reaches 40–43°C. According to meteorological observations conducted over the past decade in the territory of Shahtakhti village, the average annual maximum temperature ranges between 39–40°C, and the average annual minimum temperature between -18°C and -21°C. The period when the temperature exceeds 6°C begins around March 10, while the transition to below 0°C occurs around November 20. The amount of annual atmospheric precipitation in the Kangarli inclined plain is relatively low compared to other parts of the Nakhchivan Autonomous Republic.

**Annual precipitation and hydrogeological features.** the annual amount of precipitation in the area varies between 210–230 mm. The thickness, formation, and melting periods of the snow cover differ from year to year. On average, the formation of the snow cover begins after December 20, while its continuous melting starts around February 25. The duration of a stable snow cover is approximately 40 days, and its maximum thickness during the year does not exceed 15 cm. The thickness and persistence of the snow cover play a crucial role in increasing both surface and groundwater levels, as well as soil moisture, which directly affects the recharge of kahrizes.

Diagram 1



Relative humidity in this region is also lower compared to other parts of the Nakhchivan Autonomous Republic. The average relative humidity is 20%, with a humidity coefficient of 0.2. The moisture deficit is between 1100–1200 mm, a difference that becomes more pronounced during the summer months (Mirzayev, 1972).

The winds observed in the area are mainly local winds, and their direction is largely influenced by the region's complex relief structure.

Hydrologically, the Kangarli inclined plain is one of the most favorable and water-abundant zones within the Autonomous Republic. The travertine deposits forming the plateau retain groundwater throughout the entire area. Groundwater is mainly of the fractured type and occurs at various depths. In the northeastern and central parts, groundwater lies at depths of 3–15 meters, while on the northwestern, southwestern, and southeastern slopes, it emerges to the surface in the form of springs. The discharge of these springs varies from 0.05 liters per second to 5 liters per second.

The slope of the groundwater surface is about 0.75 in the northeastern part of the plateau and 0.02 in the southwestern part. The water retention and permeability of the travertine deposits depend on their degree of fracturing, grain size, and structure. The process of travertine deposition began in the early Quaternary period (Qashqay, 1975: p.129). This process depends on the chemical composition of groundwater and continues to this day. Modern travertine formations can be observed at the bottoms of water channels and around springs near Garabaghlar village.

As a result of continuous deposition, the water-holding capacity of fractures within the travertine deposits gradually decreases. Consequently, their filtration coefficient ranges from 0.1 m/day to 42 m/day. The mineralization of groundwater is generally up to 0.5–0.6 g/l, with a hydrochemical composition of hydrocarbonate-calcium type, sometimes containing 5–10 mg/eq of other ions. The temperature of the groundwater ranges between 9–14°C.

In the Shahtakhti area throughout the year—especially during the hot season—the demand for water in the Shahtakhti area has historically been one of the main challenges. To address this problem, kahrizes (traditional underground hydraulic structures) have been used. Since the kahriz system differs from surface water flows by maintaining a stable discharge throughout the year, its water is collected in artificial reservoirs and supplied for use.

In the territory of Shahtakhti village, there were approximately 30 kahrizes in the past (Habibbeyli, 2010: p.136). At present, most of them have ceased to operate due to various reasons. The kahrizes located in Shahtakhti village, along with their main characteristics, can be systematically described in the form of the following table.

Table 1.

Characteristics of the Kahrizes in Kangarli (Shahtakhti)

| No    | Name of Kahriz                  | Length (m) | Number of Wells | Actual Water Discharge (l/s) | Previous Water Discharge (l/s) | Purpose of Use        | Condition | Notes              |
|-------|---------------------------------|------------|-----------------|------------------------------|--------------------------------|-----------------------|-----------|--------------------|
| 1     | Boyuk Gol (Big Lake)            | 362        | 13              | 10                           | 40                             | Drinking / Irrigation | Poor      | 50–60 ha irrigated |
| 2     | Shivili-1                       | 79         | 3               | 2                            | 5                              | Drinking              | Poor      | –                  |
| 3     | Shivili-2                       | 43         | 2               | 2                            | 12                             | Drinking              | Poor      | –                  |
| 4     | Sheril Golu (Sheril Lake)       | 403        | 17              | 12                           | 35                             | Drinking              | Poor      | –                  |
| 5     | Molla Abdulla                   | 90         | 4               | 3.2                          | 8                              | Drinking              | Poor      | –                  |
| 6     | Agamammad Golu (Agamammad Lake) | 188        | 7               | 4                            | 15                             | Drinking              | Poor      | –                  |
| 7     | Batiran                         | 300        | 10              | Dried up                     | 4                              | Drinking              | Poor      | –                  |
| 8     | Seyidler Suyu (Seyidlar Water)  | 150        | 4               | 0.5                          | 3                              | Drinking              | Poor      | –                  |
| Total | 8 kahrizes                      | 1615       | 60              | 33.7                         | 122                            |                       |           |                    |

In the eastern part of the village, in an area known as Iydali Pir, approximately 1000–1500 meters away from the residential zone, there is a kahriz called Boyuk Gol ("Big Lake"). At the time it was constructed, this kahriz served 26 families, which is why it was also referred to as "26-lar" (The Twenty-Six). It is known that this kahriz originates from the foothill zone, and therefore its main sources of recharge are groundwater from fractures and subsurface flows.

The Boyuk Gol kahriz in Shahtakhti village has 13 wells and a length of 362 meters. Although its current water discharge is 14 l/s, it was previously 40 l/s, indicating that the kahriz is currently in poor condition.

The ecological status of Shahtakhti's kahriz waters has only been partially studied in recent years. At present, certain restoration works are being carried out by the Kahriz Restoration Department in the district.

The quality of kahriz water is determined by its physical properties, including temperature, transparency, color, odor, taste, density, viscosity, electrical conductivity, and radioactivity. The temperature of the kahriz waters largely depends on the geological structure of the area, its geological development history, the physical-geographical characteristics of the water, and its recharge regime, and it can vary within a wide range. When the groundwater level is relatively shallow, the annual temperature fluctuation typically ranges between 5°C and 15°C, depending on local climatic conditions and hydrogeological factors.

*The transparency of the kahriz water depends on the amount of dissolved salts and minerals, the mechanical composition of the water, and the content of colloidal and organic substances. Based on transparency, kahriz waters are classified into four categories:*

1. Transparent
2. Slightly turbid
3. Turbid
4. Very turbid

*Most of the kahriz waters in the area are colorless, as they are free from external impurities. Stagnant waters that contribute to the kahriz recharge, such as those from lakes and marshes, can impart distinctive odors. In some cases, water odor may result from certain bacteria. However, these bacteria do not belong to pathogenic groups, and therefore the water is considered safe for use according to ecological and sanitary standards.*

*The density of the kahriz waters in the area ranges from 1.2 to 1.5 g/cm<sup>3</sup>, slightly above established norms. No radioactive elements have been detected in the kahriz waters studied in the research area.*

*Water Chemistry, Ecological Status, and Recommendations for Shahtakhti Kahrizes*

*The normal cation content in kahriz waters is approximately 7.0 mg/eq, and in the Shahtakhti area, this value remains within the normative range, reaching 6.7 mg/eq (Guliyev, 2008: p.47).*

*In the fresh and slightly saline waters of Shahtakhti kahrizes, HCO<sub>3</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup>, and Ca<sup>2+</sup> ions predominate, whereas in saline and brackish waters, Cl<sup>-</sup> and Na<sup>+</sup> ions are dominant. SO<sub>4</sub><sup>2-</sup> and Mg<sup>2+</sup> ions occupy a moderate position. Carbonate salts are least soluble, chloride salts are most soluble, and sulfate salts have intermediate solubility. Therefore, chloride salts are the most frequently encountered in kahriz waters.*

*Within the recharge areas and flow zones of Shahtakhti kahrizes, organic matter of animal origin and decomposition products of plants are present. The abundance of organic compounds, especially colloidal complexes, imparts color to the water. Microorganisms in the kahrizes are primarily unicellular, though sometimes multicellular, and play an active role in shaping the chemical composition of the water, the cycling of individual elements, and the conversion of organic into inorganic matter.*

*The occurrence and spread of infectious diseases are generally linked to bacteriological contamination of water, which accounts for approximately 80% of global cases. However, no bacteriological contamination has been detected in water samples taken from the kahrizes of Shahtakhti, indicating that these kahrizes have remained free from ecological pollution.*

**Conclusion and Recommendations.** *In the Kangarli inclined plain, the kahrizes that are still operational today remain the primary water source for household and agricultural use. However, to ensure their continued functionality and protection, the following measures should be implemented:*

- *Kahriz ponds, channels, and outlets should be cleaned of silt and debris, and water outflow should be restored.*
- *Kahriz tunnels should be cleared of silt and deposits.*
- *Collapsed or merged retaining walls (saybends) should be reconstructed.*
- *Damaged wells should be cleaned, and collapsed shafts repaired.*
- *Wells should be reinforced with reinforced concrete rings, and their mouths sealed with concrete covers.*

*Restoration of kahrizes in any area of the Autonomous Republic ensures access to ecologically clean water, supports agricultural development, and guarantees sustainable settlement of the population. Studying, restoring, and preserving these systems for future generations is a responsibility we must uphold.*

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**INVESTIGATION OF ENVIRONMENTAL ISSUES IN THE ALINJA RIVER BASIN****Naile Z. Aliyeva**

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**Abstract**

The article provides information on the environmental problems of the Alinjachai basin under the influence of natural and anthropogenic factors. It is noted that the Alinjachai basin is one of the largest river basins in the Nakhchivan Autonomous Republic. The history of human settlement here dates back to ancient times, and at the same time it is one of the fastest growing areas of agriculture and animal husbandry. Provides information about the morphometry of the river, gives detailed information about the climatic features of the area, climatic types, distribution of precipitation by seasons and months, types of landscape. Ancient settlements in this area, agricultural development, population growth, climate change have led to an increase in anthropogenic impact on nature, and, thus, environmental problems have arisen. In particular, climate change has led to a decrease in biomass, accelerated erosion and desertification. In the past, the Alinja river provided the population's water needs throughout the year, but today the Alinja river is one of the drying up rivers.

If in 1961, when carrying out a hydrological assessment of the rivers, it was planned to build several hydroelectric power plants on Alinja river, today it is impossible to think about it downstream. Due to the creation of cascade-type reservoirs in its middle mountainous part, the energy resources of the river are used and the needs of agriculture in water are partially satisfied. To solve the problems in the region, it is necessary to optimize the development of economic sectors.

**Keywords:** Alinja river, river basin, settlement, ecological problem, anthropogenic impacts

**Introduction.** The territory of the Nakhchivan Autonomous Republic (NAR) is characterized by a predominantly arid and semi-arid climate, with limited annual precipitation and high evaporation rates. These conditions have historically influenced patterns of human settlement, making proximity to rivers a crucial factor for survival and development. Rivers have served as the main sources of fresh water, enabling not only domestic consumption but also irrigation and livestock watering, which in turn facilitated the growth of settlements. Among these rivers, the Alinja river stands out as one of the major rivers in the region in terms of basin area. Its presence has historically supported dense riverine settlements, with communities relying heavily on the river for their daily needs and economic activities.

Within the Alinja river basin, traditional economic practices such as agriculture and animal husbandry have long been well-developed. Fertile soils along the riverbanks, coupled with relatively favorable microclimatic conditions, have allowed for crop cultivation, orchards, and pastures to thrive. The abundance of water and grazing lands supported the emergence of a well-established rural economy that shaped the social and cultural life of the local population.

However, over time, a combination of factors—including population growth, the expansion of settlements, increased agricultural demand, and intensification of livestock farming—has placed considerable pressure on the river basin's natural environment. The continuous exploitation of natural resources, land reclamation, and irrigation practices have led to soil degradation, vegetation loss, and disturbances in local hydrological regimes. Issues that were once minor or localized have, due to neglect and lack of systematic management, escalated into serious ecological problems that now require significant financial and technical resources to address.



*Alinja River*

*If these emerging ecological challenges are not addressed in a timely and sustainable manner, their effects may intensify, extending beyond the boundaries of the Alinja river basin, affecting downstream areas, and exacerbating regional environmental degradation. This highlights the critical importance of studying the Alinja river basin—not only to understand its historical and current socio-economic significance but also to develop strategies for sustainable management of its natural resources, ensuring that ecological balance is maintained while supporting the livelihoods of the local population.*

*The Alinja river, ranking third in length among the rivers of the Nakhchivan Autonomous Republic, holds substantial economic and environmental significance. It originates at an altitude of approximately 2800 meters on the northwestern slope of Mount Kirkklar, formed by the confluence of the Lekatagsu and Khazinadera rivers. From its source, the river flows in a generally southward direction and eventually joins the Araz River near the village of Gulistan at an elevation of 695 meters above sea level. In its lower reaches, the Alinja river develops low-elevation, ravine-like banks that shape the surrounding landscape. (Babayev, 1999)*

*The Alinja river basin is geographically and hydrologically bounded by the Zangezur Range watershed to the northeast, the Nakhchivan river basin to the west and northwest, and the Khoshgeri and Gilan river basins to the east. This strategic location places the basin at the intersection of several important hydrological systems in the region, making it a key area for both water resources and ecological studies.*

*Geologically, the basin is characterized by a diverse composition of rocks and sediments. Across different sections of the basin, deposits from the Upper Permian, Triassic, Paleogene, Neogene, and Quaternary periods can be found, including clay, chalk, limestone, and various intrusive rock formations. This complex geological structure contributes to the basin's varied terrain, soil types, and hydrological patterns. (Hasanov, 2001)*

*The river basin exhibits an alternating pattern of plains and mountainous areas. Structurally, it can be divided into two main parts: the plain and low-mountain area extending to the village of Abraqunus, and the middle and high-mountain region stretching from Abraqunus to the river's source. The total vertical drop of the Alinja river is 2105 meters, with an average slope of 34.2%. From the source to the mouth, the gradient gradually decreases and becomes increasingly fragmented.*

*Based on elevation, the basin can be subdivided into three zones: the upper zone, from the river's source to Lekatağ village, ranging from 2000 to 3000 meters; the middle zone, from Lekatağ to Camaldin village, with elevations between 2000 and 1000 meters; and the lower zone, from Camaldin to the river's confluence with the Araz River, ranging from 1000 to 695 meters. The average elevation of the basin is*

approximately 1610 meters, and its average width measures 9.7 kilometers, reflecting the spatial variability of this important river system.

The Alinja river is 61.1 km long, with a catchment area of 600 km<sup>2</sup> and a total water flow volume of 84 million m<sup>3</sup>. The river is mainly fed by small tributaries and springs originating from the southern slopes of the Zangezur Range, as well as by snowmelt.

The drainage density within the basin is 0.31 km/km<sup>2</sup>. The basin is asymmetric with respect to the Alinja river and is better developed toward the east. At elevations between 1000 and 2500 meters, the conditions for moisture accumulation are more favorable, and due to the highly dissected relief, the drainage network is relatively well developed. However, above 2500 meters, the reduction in precipitation, the dominance of rocky and stony areas, and the wide distribution of intrusive rocks cause the drainage density to decrease to about 0.10 km/km<sup>2</sup>. (Bababeyli, Gurbanov, & Bababeyli, 2015)

In areas located below 1000 meters, the drainage network is poorly developed. The Alinja river receives numerous tributaries in its upper and middle reaches. In total, the Alinja river has 55 tributaries. Among them, three are longer than 10 kilometers, four range between 5 and 10 kilometers in length, and the remaining tributaries are less than 5 kilometers long.

The upper, middle, and lower courses of the Alinja river differ from one another according to the basin's structure and natural characteristics. In the upper course, at elevations above 2200 meters, a cold and mountain-tundra climate prevails, typical of the subalpine and alpine meadow zones.

In the middle course, the river has formed narrow and relatively deep valleys and has a rapid flow. This section, located between 1000 and 2200 meters above sea level, often exposes bedrock in the riverbed, creating rapids and small waterfalls. In the lower course, the valley widens considerably, and the river's flow velocity decreases. This part of the basin is characterized by a semi-desert and dry-steppe climate.

The river's annual flow is greatly influenced by natural factors such as climatic conditions, relief, geological structure, soil and vegetation cover, and groundwater. At elevations of 2000–2500 meters, where precipitation is more abundant, the river's average annual discharge reaches 1.31 m<sup>3</sup>/s. In the basin, surface runoff consists of 41% groundwater (127 mm), 38% snowmelt (118 mm), and 21% rainfall (65 mm). (Gurbanov, Mustafayeva, Bababeyli, & Bekiyeva, 2013)

Both monthly and seasonal flow distributions are uneven. According to the table below, the main part of the annual flow occurs in April and May. The period of minimum flow, or the "mejen" (low-water) season, occurs from August to October, during which the river is mainly fed by groundwater. The average annual discharge of the river is 1.17 m<sup>3</sup>/s.

**Monthly distribution of the Alinja river's flow**

| Months<br>Region | I   | II  | III | IV   | V    | VI   | VII | VIII | IX  | X   | XI  | XII | Average annual discharge, m <sup>3</sup> /s |
|------------------|-----|-----|-----|------|------|------|-----|------|-----|-----|-----|-----|---------------------------------------------|
| Alinja-Arafsa    | 6.0 | 6.3 | 9.0 | 16.8 | 18.0 | 11.8 | 7.5 | 4.6  | 3.8 | 4.4 | 5.5 | 6.3 | 1.17                                        |

The table below shows the seasonal distribution of the Alinja river's flow, indicating that the lowest flow occurs in winter, while the highest flow is observed in spring and summer. During the spring months, when the river reaches its maximum discharge, it accounts for 37–60% of the annual flow. The increase in flow during spring coincides with snowmelt and the occurrence of heavy spring rains.

**Seasonal distribution of river flow (p. 58)**

| Name of the river | Name of the locality | Seasonal distribution of flow (as a percentage of the total annual discharge) |              |               |              | Period of intensive irrigation (in %) | Annual discharge volume (million m <sup>3</sup> ) |
|-------------------|----------------------|-------------------------------------------------------------------------------|--------------|---------------|--------------|---------------------------------------|---------------------------------------------------|
|                   |                      | Winter I-III                                                                  | Autumn IV-VI | Summer VII-IX | Spring X-XII |                                       |                                                   |
| Alinja river      | Khanaga              | 8.0                                                                           | 40.8         | 36.2          | 12.0         | 7.9                                   | 51.7                                              |

Although flash floods occasionally occur in the area, the Alinja river basin is classified as a low-activity basin. On August 20, 1931, a severe flood occurred on the Alinja river, causing significant damage to local agriculture and infrastructure (p. 62). These floods are primarily structural in origin.

The location of the Alinja river basin across different climate zones has led to the formation of various soil-vegetation types and landscape types. From the river's source, multiple landscape types have developed. In the high-mountain sections of the basin, alpine and subalpine meadows form the mountain meadow landscape. Forests in the area are limited and develop only as sparse patches in the Lekatağ basin. In the wider middle-mountain and plain sections of the basin, semi-desert and dry-steppe landscapes dominate.

*The basin hosts a total of 42 landscape types, ranging from grasslands on intensely dissected mountains to shrub-ephemeral vegetation on clayey soils in gently sloping plains, and to sagebrush-dominated landscapes on gray soils in moderately dissected slopes. Near the river mouth, sparse xerophytic vegetation occurs in stony deserts and in clay-saline semi-desert areas.*

*Various soil types have formed according to the landscape patterns. In the lower reaches of the Alinja river basin, gray soils are widespread. These slightly eroded soils primarily develop in plains and foothill areas. East of the village of Arazin, gray-meadow soils are found. Alluvial-submarsh soils have formed in the Alinja river valley due to the deposition of materials brought by the river and its tributaries, mainly south of the village of Milax. (Mammadova, 2012)*

*In the middle sections of the basin, particularly around the villages of Abrakunus, Bananiyar, Kirna, and Saltak, light-brown soils are prevalent. In the plains and foothill zones, ephemeral plants dominate the vegetation cover. Above the light-brown soils, in the middle-mountain areas, brown soils are widespread. These soils, usually on gently sloping areas, are used for cereal cultivation and are most commonly found around the villages of Kazanchi and Khanaga.*

*In the small depression between Mount Beridik (spelled "Berdik" in the Russian version) and Yarpaqlı Mountain, patches of black soils can also be found. The high-mountain sections of the river are part of the subalpine and alpine zones, where mountain-meadow soils have developed. Due to overgrazing in the mountain-meadow landscapes, soil erosion occurs, leading to reduced fertility, decreased biomass, and the emergence of ecological problems.*

*Gully erosion is well developed in the basin. From the source of the Alinja river to the confluence with Başkend river, as well as in the northwest of Camaldin and Gulistan villages, severe gully erosion has formed. Located in the middle-mountain arid denudation zone, the erosional problems exceed the restorative forces, causing the expansion of arid denudation areas. Sediments from eroded areas are transported downstream, enlarging erosion zones. If the erosion process affects one hectare of land, the deposited materials can cover surrounding areas, effectively multiplying the impacted zone several times.*

*Salinization in the Alinja river basin is weak in general, but more pronounced in the middle sections. In the upper reaches, washed-out soils are observed.*

*Settlements located in the basin, including Boyahmed, Lekatagh, Arafsa, Teyvaz, Milakh, Kazanchi, Khoshkeshin, Alinja, Goydara, Saltag, Benaniyar, Abraqunus, Kirna, Arazin, Jamaldin, and Gulistan, have populations engaged primarily in agriculture and animal husbandry. Summer and winter pastures, as well as cultivated lands, are widespread throughout the basin. The Alinja river plays an exceptional role in supporting local economic activities, as it is the only source of freshwater and is extensively used for irrigation. To this end, the irrigation system of the Alinja river has been rebuilt, and the Benaniyar reservoir, with a capacity of 15 million m<sup>3</sup>, was constructed. After the construction of this reservoir, 4,900 hectares of arable land were provided with irrigation water (p. 90).*

**Conclusion.** *The study of the Alinja river basin demonstrates that the Alinja river is the third-longest river in the Nakhchivan Autonomous Republic. Situated in an arid climatic zone, the river has historically served as the primary source of water for both agricultural and domestic purposes in the region. Its flat relief, favorable climatic conditions, fertile soils, and extensive grazing areas have supported dense human settlement in the basin for centuries.*

*The long-standing involvement of the local population in agriculture and animal husbandry has intensified anthropogenic pressures on the environment, leading to the development of ecological problems. Over time, these issues have expanded considerably. Problems that were once minor have, due to neglect and increasing human activity, grown into significant environmental challenges requiring substantial intervention. Whereas the Alinja river was once perennial, it now often experiences periods of drying due to climate change. During the vegetation period, water shortages are increasingly observed, which in turn lowers groundwater levels and creates a heightened demand for agricultural and domestic water. Additionally, the reduction in biomass of vegetation negatively affects livestock productivity, posing further challenges to local farming practices.*

*Although the basin contains extensive arable land and well-developed livestock farming, the existing water reservoirs are insufficient to fully meet the water demands of the region. Consequently, the construction of cascade-type reservoirs along the Alinja river is recommended. Such reservoirs would provide multiple benefits: reducing the need for extensive irrigation canals, preventing soil waterlogging, regulating the flow of excess water during periods of heavy rainfall, stabilizing the river's regime, and mitigating the risk of occasional floods.*

*Furthermore, it is essential to implement a comprehensive system of water management measures to ensure the efficient use of river water, reduce losses, and maintain the ecological balance of the basin.*

*These measures should include modern irrigation technologies, monitoring of water levels, maintenance of river channels, and policies for sustainable land use. By adopting such strategies, the Alinja river basin can continue to support both agricultural production and the livelihoods of the local population while minimizing environmental degradation.*

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## *Jurisprudence*

### **PHENOMENOLOGIES OF MUNICIPALISM AND HUMAN BEING: ON THE QUESTION OF INTERDEPENDENCE AND DETERMINATION**

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### **ФЕНОМЕНОЛОГІЇ МУНІЦИПАЛІЗМУ ТА БУТТЯ ЛЮДИНИ: ДО ПИТАННЯ ПРО ВЗАЄМОЗАЛЕЖНІСТЬ ТА ДЕТЕРМІНАЦІЮ**

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### **Abstract**

*The formation of the phenomenology of municipalism, which is based on the formation and functioning of the constitutional institute of local self-government in the state in the form of its local institutional agents, formed directly by the population - residents-members of territorial local human communities that function on the basis of municipal ideology, existential guidelines, values, profile consciousness, psychology, culture - serves not only as an indicator of democratic transformations, but also as evidence of recognition and respect for human rights and freedoms, which initially implicitly, and then explicitly arise, are formed, used and implemented at the local level of the functioning of society within the framework of profile communities - territorial communities. The phenomenology of municipalism is an immanent feature and a mandatory element of democratic legal statehood (state-forming criterion) reflecting the existence of a person, his groups and associations (subject factor) in the conditions of the self-governing space of local self-government (discursive-determining factor), within the territorial local human community (territorial community) (spatial-collective factor), in the philosophical state of everyday life (temporal factor), in the process of implementation by the above subjects of their constitutional and legal status (status factor), which is based on the implementation of human rights, freedoms and obligations (individual, group, collective) (behavioral factor), in the process of multifaceted and multi-spherical activity of local self-government bodies (power-technological factor), - moreover, each of the above factors has its own historical retrospective, current state and prospects for its development and improvement. It is worth noting that the historical and normative foundations of the formation and development of the phenomenology of municipalism are also based on a number of features, the state of which has a historical retrospective, modern issues and prospects: a) the system of communicative interaction of residents-members of the local society among themselves and between them and other subjects of the local society, including institutional structures of civil society, as well as public authorities of the local society itself and state public authorities outside its borders - such communication arises objectively on the basis of the necessary implementation of the existential interests of a person, his groups and associations, which are aimed at the implementation of the individual, group and collective needs of each person-member of the local community in the process of implementing their needs, efforts, guidelines, interests. (communicative criterion); b) the features of municipal life, i.e. individual, group and collective life, based on the principles of self-organization and self-government, are important factors in activating the process of forming special and specific values - municipal (municipal-axiological criterion), which are common to a large number of people-residents, who are members of territorial local human communities, which act as the actual primary collective subjects of human civilization, without taking into account state borders and regulatory jurisdictions, based primarily on the humanitarian-humanistic values of local life and everyday guidelines of human civilization; c) it is within its boundaries and in its conditions that a person carries out his life cycle (existential factor), initiating, developing, concentrating and realizing his existential guidelines, efforts, needs, interests in it; d) this is what transforms the space of municipalism not only into a humanistic and humanitarian everyday space of human existence, but also into a socio-dynamic space of prospective existence and development of human civilization (reproductive and prospective factor); e) the set of the above criteria shows that the phenomenology of municipalism is a vivid evidence of the formation of "sustainable constitutionalism", which is actually based on the concept of sustainable development of society (socially sustainable factor).*

*The study of the role and significance of the historical and normative foundations of the formation and development of the phenomenology of municipalism and their impact on modern local self-government has provided an understanding of the special and strategic role of local public authorities (local self-government bodies) in the process of implementing human rights, because all historical periods of the development of the phenomenology of municipalism are directly and organically connected with the process of formation of: A) municipal freedoms, B) municipal rights, and then C) municipal values, and simultaneously, with the parallel process of the emergence of D) the phenomenology of general human rights, which demonstrates their organic connection with local society, as well as the formation of D) institutions of public authority, first state, and then self-governing (municipal) authority, which is institutionalized, formed and functions at the local level.*

### Анотація

Становлення феноменології муніципалізму, в основі якого лежить становлення та функціонування конституційного інституту місцевого самоврядування в державі у вигляді її локально-інституційних агентів, сформованих безпосередньо населенням – жителями-членами територіальних локальних людських спільнот, що функціонують на основі муніципальної ідеології, екзистенційних настанов, цінностей, профільної свідомості, психології, культури – виступає не тільки індикатором демократичних перетворень, а й свідомством визнання та поваги до прав і свобод людини, що спочатку імпліцитно, а потім й явно виникають, формуються, використовуються і реалізуються на локальному рівні функціонування соціуму в межах профільних спільнот – територіальних громад. Феноменологія муніципалізму виступає іманентною ознакою та обов'язковим елементом демократичної правової державності (державотворчий критерій) відображає існування людини, її груп та асоціацій (суб'єктний фактор) в умовах самоврядного простору місцевого самоврядування (дискурсивно-визначальний фактор), в межах територіальної локальної людської спільноти (територіальної громади) (просторово-колективний фактор), в філософському стані повсякденності (темпоральний фактор), в процесі реалізації наведеними суб'єктами свого конституційно-правового статусу (статусний фактор), що базується на реалізації прав, свобод і обов'язків людини (індивідуальних, групових, колективних) (біхевіористичний фактор), в процесі багатопланової та полісферної діяльності органів місцевого самоврядування (владно-технологічний фактор), – причому, кожний з наведених факторів володіє своєю історичною ретроспективою, сучасним станом та перспективою свого розвитку і вдосконалення. Варто зазначити, що в основі історико-нормативних засад становлення та розвитку феноменології муніципалізму лежить також низка ознак, стан яких володіє історичною ретроспективою, сучасною проблематикою та перспективою: а) система комунікативної взаємодії жителів-членів локального соціуму між ними і між ними та іншими суб'єктами локального соціуму, включаючи й інституційні структури громадянського суспільства, а також органи публічної влади самого локального соціуму та органами державної публічної влади за його межами – така комунікація виникає об'єктивно на засадах необхідної реалізації екзистенційних інтересів людини, її груп та асоціацій, що скеровані на реалізацію індивідуальних, групових та колективних потреб кожної людини-члена локальної спільноти в процесі реалізації їх потреб, намагань, настанов, інтересів. (комунікативний критерій); б) особливості муніципального життя, тобто індивідуального, групового і колективного життя, заснованого на принципах самоорганізації та самоврядування, є важливими факторами активізації процесу формування особливих та специфічних цінностей – муніципальних (муніципально-аксіологічний критерій), що є загальними для великої кількості людей-жителів, що є членами територіальних локальних людських спільнот, які виступають фактично первинними колективними суб'єктами людської цивілізації, без врахування державних кордонів та нормативних юрисдикцій, виходячи насамперед з гуманітарно-гуманістичних цінностей локального життя та повсякденних настанов людської цивілізації; в) саме в його межах і в його умовах людина здійснює свій життєвий цикл (екзистенційний фактор), ініціюючи, виробляючи, концентруючи і реалізуючи в ньому свої екзистенційні настанови, намагання, потреби, інтереси; г) саме це трансформує простір муніципалізму не тільки в гуманістично-гуманітарний повсякденний простір існування людини, а й в соціально-динамічний простір перспективного існування і розвитку людської цивілізації (репродуктивно-проспективний фактор); д) сукупність наведених критеріїв свідчить, що феноменологія муніципалізму виступає яскравим свідомством формування «сталого конституціоналізму», що фактично спирається на концепцію сталого розвитку соціуму (соціально-сталий фактор).

Дослідження ролі і значення історико-нормативних засад становлення та розвитку феноменології муніципалізму та їх впливу на сучасне місцеве самоврядування дало розуміння особливої і стратегічної ролі локальних органів публічної влади (органів місцевого самоврядування) в процесі реалізації прав людини, – бо всі історичні періоди розвитку феноменології муніципалізму безпосередньо і органічно пов'язані з процесом становлення: А) муніципальних свобод, Б) муніципальних прав, а потім й В) муніципальних цінностей, і одночасно, з паралельним процесом зародження Г) феноменології загальних прав людини, що

демонструє їх органічний зв'язок з локальним соціумом, а також становленням Д) інститутів публічної влади, – спочатку державної, а потім самоврядної (муніципальної) влади, що інституціоналізується, формується та функціонує на локальному рівні.

**Keywords:** *municipalism, local self-government, local self-government bodies, territorial communities, human rights, human existence, institutions of national society, national human rights mechanisms.*

**Ключові слова:** муніципалізм, місцеве самоврядування, органи місцевого самоврядування, територіальні громади, буття людини, права людини, інституції національного суспільства, національні правозахисні механізми.

### **Вступ**

Дослідження ролі і значення історико-нормативних засад становлення та розвитку феноменології муніципалізму та їх впливу на сучасне місцеве самоврядування дало розуміння особливої і стратегічної ролі локальних органів публічної влади (органів місцевого самоврядування) в процесі реалізації прав людини, – бо всі історичні періоди розвитку феноменології муніципалізму безпосередньо і органічно пов'язані з процесом становлення: А) муніципальних свобод, Б) муніципальних прав, а потім й В) муніципальних цінностей, і одночасно, з паралельним процесом зародження Г) феноменології загальних прав людини, що демонструє їх органічний зв'язок з локальним соціумом, а також становленням Д) інститутів публічної влади, – спочатку державної, а потім самоврядної (муніципальної) влади, що інституціоналізується, формується та функціонує на локальному рівні.

Завдяки визначенню і виокремленню історичних періодів розвитку феноменології муніципалізму акцентується та розкривається особлива роль діяльності органів місцевого самоврядування у виконанні ними своїх обов'язків у визнанні, охороні, захисті, реалізації та гарантуванні прав і свобод людини як стратегічної проблематики, особливо в контекстуалізації підтримки феноменології демократичної правової державності, самоорганізації та самоврядування. Ба більше, профільна проблематика набуває характер конституційно-муніципального наративу та конотації в національному конституційному та муніципальному праві та формує чітку, зриму та оптимальну тенденцію до нормування та нормативізації у межах цих галузей через визначення поведінково-діяльнісних патернів.

Історико-предметний дискурс становлення і формування феноменології муніципалізму напряду сприяє становленню динамічно-функціональних характеристик більш ширшого поняття – «буття людини», а також буття її груп та асоціацій.

Своєю чергою, сукупність характерологічних ознак феноменології муніципалізму формує відповідну та профільну управлінську парадигму, що, по-перше, детермінує її динамічні характеристики; по-друге, складається з відповідних елементів соціально-нормативного буття людини, її груп та асоціацій.

Усвідомлення і розуміння історико-нормативних засад формування феноменології муніципалізму суттєво підвищує їх інноваційну змістовність в усвідомленні і розумінні їх ролі і значення в становленні сучасних форм місцевого самоврядування. Подальші дослідження мають зосередитися на аналізі впливу історико-гуманістичних практик на динаміку інноваційного розвитку територіальної локальної людської спільноти та адаптацію стратегій розвитку і вдосконалення локальної демократії до трансформацій суспільства, що функціонує в умовах демократичної правової державності.

### **Роль і значення феноменології муніципалізму в умовах сучасної державності**

У попередніх дослідженнях авторів [1] аналізувались актуальні аспекти історико-нормативних засад становлення і розвитку феноменології муніципалізму. При цьому нами стверджувалось, що сама феноменологія муніципалізму:

а) заснована на історичній ретроспективі існування і функціонування територіальних локальних людських спільнот (територіальних громад /далі – ТГ/), що функціонують, насамперед, на міському рівні (історично-ретроспективний критерій – авт.);

б) існує та функціонує у відповідності до настанов-принципів самоорганізації та самоврядування (самоврядний критерій – авт.);

в) володіє не тільки особливою значущістю не тільки в державотворчих і нормотворчих процесах, але й стратегічним впливом на формування, існування і функціонування феноменології демократичної правової державності (державотворчий критерій – авт.);

г) саме в її територіально-просторовому дискурсі зароджуються, формуються, кристалізуються, реалізуються, охороняються, захищаються та гарантуються права людини у їх широкому функціонально-діяльнісному розумінні, а саме у вигляді їх прав, свобод і обов'язків (біхевіористично-праксеологічний критерій – авт.);

г) у її стратегічному усвідомленні і розумінні виступає наявність у цій феноменології муніципальної ідеології (специфічно-ідеологічний критерій – авт.) яка:

- репрезентує специфічну систему ідей та поглядів,

- які відображають і виправдовують інтереси певної територіальної людської локальної спільноти,

- визначають їхнє ставлення до дійсності,

- яка реалізується в межах самоорганізації та самоврядування її жителів-членів,

- а також служать основою для дій, скерованих на закріплення, збереження, а також змін (розвитку, вдосконалення) соціально-правового статусу цієї спільноти та муніципально-правового статусу кожного з її членів [2].

Нами також встановлено, що системний аналіз історичних аспектів феноменології муніципалізму дає можливість виокремити відповідні послідовні етапи і періоди становлення і розвитку у його не тільки темпоральній, але й у змістовній контекстуалізації, а саме:

а) періоду формування, існування, функціонування та розвитку первісної общини;

б) періоду формування, існування, функціонування та розвитку міст-полісів Стародавньої Греції (Еллади);

в) періоду формування, існування, функціонування та розвитку муніципій Стародавнього Риму;

г) періоду формування, функціонування, розвитку і розповсюдження (рецепції) Магдебурзького права в європейських містах Середньовіччя;

г) періоду формування і функціонування самоврядних структур доби Запорізької Січі;

д) періоду формування і функціонування земського устрою в Російській Імперії періоду знаходження на посту прем'єр-міністра О.А. Століпін;а;

е) періоду формування і функціонування в постреволюційний період першої чверті ХХ ст. в Російській імперії у Західній Європі ідей муніципального соціалізму як антиподу соціальних революцій;

є) періоду муніципальних революцій в Європі у другій половині ХХ ст. в рамках міжнародних міждержавних інтеграційних процесів;

ж) в межах сучасного європейського муніципалізму;

з) формування і функціонування феноменології «нового муніципалізму», який виникає та продукується переважно в різних державах світу, що розвиваються.

Варто зазначити, що наведені нами історичні періоди безпосередньо пов'язані з процесом становлення:

А) муніципальних свобод,

Б) муніципальних прав, а потім й

В) муніципальних цінностей, і одночасно,

Г) з паралельним процесом зародження муніципальної культури і формуванням

Г) феноменології загальних прав людини, що демонструє їх органічний зв'язок з локальним соціумом, а також становленням

Д) інститутів публічної влади, – спочатку державної, а потім самоврядної (муніципальної) влади, що інституціоналізується, формується та функціонує на локальному рівні.

Варто зазначити, що всі наведені вище положення напряму зав'язані на феноменології буття людини, яка вибирає до себе всі аспекти існування, функціонування та розвитку людини, а також її трансформації в процесі реалізації нею, а також її групами і асоціаціями свого життєвого циклу (для людини), а також існування та функціонування у відповідному статусі (для груп людини та їх асоціацій).

Основоположним у наведених процесах виступає соціалізація людини, її груп та асоціацій, в тому числі й з її правовими формами, що ведуть до нормування, нормативізації та правового регулювання атитюдно-габітусної (поведінково-діяльнісної) концепції формування, прояву та реалізації екзистенційних інтересів. Наведені позиції підкреслюються соціальною ітерацією,

тобто неодноразовим повторюванням поведінкових настанов необмеженою кількістю фізичних осіб, які виступають як жителі-члени територіальної людської локальної спільноти (громади), – що веде до формування алгоритмів та стереотипів форм поведінки та форм соціальної практики, що є результатом втілення таких форм.

#### **Доктринально-теоретична актуальність профільної проблематики**

Варто зазначити, що не зважаючи на досить активні процеси щодо дослідження місцевого самоврядування та системи його суб'єктів та органів, системних і комплексних досліджень саме феноменології муніципалізму практично немає. Основні дослідження в цій сфері вітчизняних фахівців присвячено питанням застосування зарубіжного досвіду реформування місцевого самоврядування, визначення його особливостей, проблем розподілу повноважень між інституціями державного, регіонального, місцевого рівнів у процесі децентралізації – саме вони знайшли своє висвітлення у працях таких вчених, як М. Баймуратов, О. Батанов, І. Бутко, І. Галіахметов, К. Головкин, Н. Камінська, В. Кравченко, М. Орзіх, В. Погорілко, І. Посторонка, М. Пухтинський, О. Яцунська та інших.

Разом з тим, обґрунтовано вважаємо, що праці наведених авторів тільки передують процесам глибокого та ґрунтовного освоєння профільної проблематики, тому феноменологія муніципалізму, як такого, і зокрема, сучасного муніципалізму залишається не тільки актуальною, але і вельми привабливою, соціально-орієнтованою на позитивний результат, причому як з позицій ідеологічних орієнтирів, телеології сучасної демократичної правової державності, доктринально-теоретичних позицій, так і з позицій її нормативно-правового супроводження і забезпечення. В цьому контексті проблематика взаємозалежності та детермінації муніципалізму та буття людини уявляється не тільки особливо актуальною та своєчасною, але й такою, що володіє суттєвою доктринально-теоретичною перспективою.

#### **Роль і значення проблематики буття людини в сучасній муніципалістиці**

Проблематика буття людини виступає однією з найскладніших у сучасній філософській, політичній та правових науках, розв'язання якої має свою історичну ретроспективу, сучасний стан та історичну перспективу, – бо буття людини, що на пряму органічно пов'язане з феноменологією муніципалізму у його історичній ретроспективі, сучасності та перспективному розвитку формує чіткій і однозначний екзистенційний дискурс, що лежить в основі сучасного існування та перспективного розвитку людської цивілізації.

Штучний інтелект, узагальнюючи системний комплекс знань доктринального та теоретичного характеру, визначає буття людини як філософську категорію є одним з найважливіших питань філософії, що досліджує сутність людського існування, його місце у світі та зв'язок з іншими формами буття. Воно розглядається як у контексті загального буття, так і в унікальному аспекті індивідуального існування кожної людини [3], а звідси – й групового і колективного існування людини у вигляді відповідних інституційних або неінституційних структур.

Варто враховувати, що філософська наука визначає основні аспекти буття людини саме у філософії – з них увага концентрується на таких аспектах:

А) Сутність буття людини: Філософи розглядають буття людини як унікальне поєднання фізичного, духовного, соціального та історичного існування (комплексний критерій – авт.).

Б) Людина як суб'єкт та об'єкт: Буття людини включає в себе як її суб'єктивну свідомість, так і об'єктивне існування у світі, його вплив на світ та світу на нього (суб'єктивно-об'єктивний свідомий критерій – авт.).

В) Співвідношення з іншими формами буття: Буття людини тісно пов'язане з буттям природи, суспільства та культури, і філософи вивчають ці взаємозв'язки (поліпредметний критерій – авт.).

Г) Темпоральність буття: Людське буття має вимір часу, включаючи минуле, теперішнє і майбутнє, що впливає на самосприйняття та осмислення життя (темпорально-свідомий критерій – авт.).

Д) Проблема сенсу життя: Буття людини нерозривно пов'язане з питанням про сенс існування, пошуком цілей та значень у житті (визначально-телеологічний критерій – авт.).

До додаткових аспектів визначення буття відносяться такі:

Е) Буття як дія та переживання: Буття людини не лише фізичне існування, а й сукупність її дій, переживань, взаємодій з оточуючим світом та самопізнання (свідомо-діяльнісний критерій – авт.).

Є) Екзистенціальний вимір: Низка філософів, таких як Жан-Поль Сартр та Альбер Камю, підкреслюють вільну відповідальність людини за своє буття та вибір у світі, де немає чітких гарантій (екзистенційно-індивідуальний критерій –авт.).

Ж) Свобода та відповідальність: Буття людини нерозривно пов'язане з поняттями свободи вибору та відповідальності за наслідки цього вибору (альтернативно-відповідальний критерій – авт.)

Узагальнюючи наведені критерії, можна зробити відповідні висновки: Буття людини у філософії – це складна і багатогранна категорія, що охоплює як її фізичний, так і духовний аспект, її взаємодію з світом та пошук сенсу власного існування [4].

Наведені вище характерологічні риси буття людини, а також її груп та асоціацій органічно пов'язане с феноменологією муніципалізму, включаючи й його історико-нормативне вимірювання, бо таке буття людини:

А) здійснюється в умовах місцевого самоврядування;

Б) реалізується в межах територіальної локальної людської спільноти – територіально громади;

В) проходить в філософському стані повсякденності;

Г) пов'язане з процесом реалізації людиною свого життєвого циклу, а його груп та асоціацій з процесом статусного існування та функціонування;

Д) а також з практичною реалізацією конституційно-правового статусу людини, її груп та асоціацій;

Е) пов'язана з існуванням і функціонуванням специфічного рівня публічної влади – публічної самоврядної (муніципальної) влади, що репрезентована органами місцевого самоврядування (представницькими та виконавчими), що формуються напряму або опосередковано електоральним корпусом, що існує на рівні територіальної громади.

#### **Процесуальна характеристика людського буття в контекстуалізації муніципалізму**

Варто зазначити, що наведений вище історичний дискурс становлення і формування феноменології муніципалізму напряму сприяє становленню динамічно-функціональних характеристик більш ширшого поняття «буття людини», а також буття її груп та асоціацій.

Отже, можна констатувати, що в основі формування людського буття, лежить стійка управлінська парадигма, що панує в локальному соціумі, який функціонує в умовах муніципалізму та в межах територіальної локальної людської спільноти (територіальної громади), а саме:

А) «соціальна локальна динаміка, що здійснюється в умовах муніципалізму» –

Б) «формування соціальних локальних патернів /поведінково-діяльнісних настанов людини, її груп та асоціацій/ (від англ. pattern — «зразок, шаблон; форма, модель; схема, діаграма») — схема-образ, що діє як посередник уявлення, або чуттєве поняття, завдяки якому в режимі одночасності сприйняття і мислення виявляються закономірності, як вони існують у природі й суспільстві» [5] –

В) «формування відповідної муніципальної свідомості людини, її груп та асоціацій» –

Г) «формування на її основі індивідуальних, групових та колективних форм муніципальної психології» –

Г') «формування елементів відповідної локально-муніципальної культури у розмаїті її екзистенційних та інших повсякденно-біхевіористичних проявів» –

Д) «формування відповідних муніципальних цінностей» –

Е) валідація наведених настанов історичним, географічним, нормативним, технологічним, політичним, економічним, наративним, конотаційним, комунікативним та іншим визначальним індикаторам муніципального життя, – через формування бажаних результатів повсякденної муніципальної практики вказаним наративам та конотаціям, а також нормативно-правовим настановам (включаючи нормативні патерни та ітерації – авт.), що регулюють муніципальне життя –

Є) «існування та реалізація буття людини, її груп та асоціацій» [6].

Важливою ознакою формування, існування та модифікації буття людини, її груп та асоціацій виступає його ідентифікація в умовах ординарного і екстраординарного (кризового) існування і реалізації, що напряму впливає на його статус.

Отже, можна стверджувати, що сукупність наведених контекстів формує відповідну та профільну управлінську парадигму, що складається з відповідних елементів, – до яких відносяться наступні:

А) легалізація та легітимація інституту МСВ як конституційно-правового інституту та інституту чинного законодавства (наявність територіальних локальних людських спільнот, що існують та функціонують в умовах МСВ та визнають ідеологію, цінності та принципи муніципалізму, а також закріплення цієї фактології та соціально-правової реальності у Конституції України, у наявному законодавчому профільному масиві, а також у масиві профільних підзаконних нормативно-правових актів, включаючи й акти локальної нормотворчості, що перманентно формується). Отже, можна стверджувати, що буття людини, її груп та асоціацій формуються на основі управлінської діяльності через використання відповідних нормативних механізмів, що містять відповідні поведінково-діяльнісні габітуси наведених суб'єктів, що реалізують їх екзистенційні настанови в повсякденному існуванні та функціонуванні – (тобто, йдеться про формування нормативної основи буття людини, її груп та асоціацій – авт.);

Б) конституційна легалізація та легітимація системи локальних інституційно-управлінських структур публічної влади – публічної самоврядної (муніципальної) влади (див. ст. 5 Конституції України [7]), що здійснюють локальну управлінську діяльність від імені та в інтересах територіальної локальної людської спільноти (ТГ), бо вони або фактично сформовані нею напряду через демократичні виборчі процедури, або опосередковано через механізм демократичних призначень. Отже, можна констатувати, що буття людини, її груп та асоціацій базується на використанні низки механізмів демократичної взаємодії (прямой або опосередкованої), відносно формування органів публічної влади, що репрезентують екзистенційні інтереси наведених суб'єктів – (тобто, йдеться про формування демократично-динамічної основи буття людини, її груп та асоціацій – авт.);

В) наявність специфічного блоку компетенційних повноважень ОМСВ (права, обов'язки, строки, відповідальність) самоврядного (власного) характеру або повноважень виконавчої влади (делегованих) для більш оперативного, якісного, оптимального і ефективного виконання завдань у контексті реалізації екзистенційних інтересів жителів-членів ТГ, що зовні проявляються у їх конституційних та муніципальних правах, свободах і обов'язках. Отже, можна констатувати, що буття людини, її груп та асоціацій базується та формується на відповідних поведінково-діяльнісних настановах, управлінських принципах, концептах, рольових позиціях, патернах, що формуються – на засадах нормативних приписів, що адекватно і ефективно відображають екзистенційні інтереси наведених суб'єктів – (тобто, йдеться про формування компетенційно-управлінської основи буття людини, її груп та асоціацій – авт.);

Г) наявність сформованого на природних, організаційних та організаційно-правових засадах відповідного простору (територіального, ідеологічного, комунікативного, нормативного, управлінського, гуманітарного тощо) локальної демократії, в межах якого й здійснюється загальна і конкретна управлінська діяльність ОМСВ. Отже, можна констатувати, що буття людини, її груп та асоціацій базується на засадах управлінських нормативних настанов, що формують специфічний простір муніципального самоврядного життя, скерованого на організацію, формування та реалізацію загального муніципального простору життєдіяльності наведених суб'єктів – (тобто, йдеться про формування поліпредметної та багатоаспектної просторової основи буття людини, її груп та асоціацій – авт.);

Г') формування, створення, реалізація, розвиток і вдосконалення системи комунікативних зв'язків між органами публічної самоврядної (муніципальної) влади (ОМСВ та їх управлінськими структурами) та жителями-членами ТГ, їх групами і асоціаціями для здійснення власне управлінської діяльності. Отже, можна констатувати, що буття людини, її груп та асоціацій формується, базується та реалізується на основі системи комунікативної взаємодії наведених суб'єктів, метою яких виступає організація їх повсякденного муніципального життя – (тобто, йдеться про формування комунікативної основи буття людини, її груп та асоціацій – авт.);

Д) здійснення ОМСВ власне управлінської діяльності на основі компетенційних повноважень через використання різних форм і методів організаційної та організаційно-правової діяльності, а також за допомогою власної дискреційної діяльності (заходів адміністративно-суб'єктивного розсуду). Отже, можна констатувати, що буття людини, її груп та асоціацій базується на системній єдності різних форм і методів організаційної та організаційно-правової діяльності органів публічної влади, включаючи й ОМСВ, а також за допомогою їх власної дискреційної діяльності – (тобто, йдеться про формування організаційної, організаційно-правової та дискреційної основи буття людини, її груп та асоціацій – авт.);

Е) отримання ОМСВ та ТГ наслідків реалізації управлінської діяльності як результату використання відповідних компетенційних повноважень ОМСВ, їх дискреційної діяльності, а

також управлінського впливу діяльності останніх на правовий стан ТГ, її жителів-членів громади та конкретних результатів у вигляді відповідного соціального стану останніх (покращення, погіршення, стан без змін). Отже, можна констатувати, що буття людини, її груп та асоціацій спирається на суттєву соціальну динаміку, що демонструє наявність великого потенціалу для її трансформації в контекстуалізації розвитку і вдосконалення – (тобто, йдеться про формування соціально-динамічної основи буття людини, її груп та асоціацій – авт.).

Звідси можна говорити, що сукупність наведених контекстів, включаючи й історичний контекст, формує відповідну та профільну управлінську парадигму, що, по-перше, детермінує динамічні характеристики феноменології муніципалізму; по-друге, складається з відповідних елементів соціально-нормативного буття людини, її груп та асоціацій, – до яких відносяться наступні:

А) легалізація та легітимація інституту МСВ як конституційно-правового інституту та інституту чинного законодавства (наявність територіальних локальних людських спільнот, що існують та функціонують в умовах МСВ та визнають ідеологію, цінності та принципи муніципалізму, а також закріплення цієї фактології та соціально-правової реальності у Конституції України, у наявному законодавчому профільному масиві, а також у масиві профільних підзаконних нормативно-правових актів, включаючи й акти локальної нормотворчості, що перманентно формується);

Б) конституційна легалізація та легітимація системи локальних інституційно-управлінських структур публічної влади – публічної самоврядної (муніципальної) влади (див. ст. 5 Конституції України), що здійснюють локальну управлінську діяльність від імені та в інтересах територіальної локальної людської спільноти (ТГ), бо вони або фактично сформовані нею напряду через демократичні виборчі процедури, або опосередковано через механізм демократичних призначень;

В) наявність специфічного блоку компетенційних повноважень ОМСВ (права, обов'язки, строки, відповідальність) самоврядного (власного) характеру або повноважень виконавчої влади (делегованих) для більш оперативного, якісного, оптимального і ефективного виконання завдань у контексті реалізації екзистенційних інтересів жителів-членів ТГ, що зовні проявляються у їх конституційних та муніципальних правах, свободах і обов'язках;

Г) наявність сформованого на природних, організаційних та організаційно-правових засадах відповідного самоврядного простору (територіального, ідеологічного, комунікативного, нормативного, управлінського, гуманітарного тощо) локальної демократії, в межах якого й здійснюється загальна і конкретна управлінська діяльність ОМСВ;

Г') формування, створення, реалізація, розвиток і вдосконалення системи комунікативних зв'язків між органами публічної самоврядної (муніципальної) влади (ОМСВ та їх управлінськими структурами) та жителями-членами ТГ, їх групами і асоціаціями для здійснення власне управлінської діяльності;

Д) здійснення ОМСВ власне управлінської діяльності на основі компетенційних повноважень через використання різних форм і методів організаційної та організаційно-правової діяльності, а також за допомогою власної дискреційної діяльності (заходів адміністративно-суб'єктивного розсуду);

Е) отримання ОМСВ та ТГ наслідків реалізації управлінської діяльності як результату використання відповідних компетенційних повноважень ОМСВ, їх дискреційної діяльності, а також управлінського впливу діяльності останніх на правовий стан ТГ, її жителів-членів громади та конкретних результатів у вигляді відповідного соціального стану останніх (покращення, погіршення, стан без змін);

Є) формування людиною, її групами та асоціаціями широкого простору комунікативної взаємодії, що разом з органами публічної влади створюють макросистему логічно детермінованих та оптимально організованих поведінково-діяльнісних настанов, практична реалізація яких забезпечує існування та функціонування життєвого циклу наведених суб'єктів – причому, як в умовах ординарного та екстраординарного існування і функціонування державності;

Ж) визнання державою особливих ролі і значення конституційно-правового та муніципально-правового статусу людини, її груп та асоціацій в умовах демократичного існування, функціонування, відправлення повноважень публічної влади, що трансформує буття наведених суб'єктів на якісно нових засадах демократичного режиму та його настанов.



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*7. Constitution of Ukraine: adopted at the fifth session of the Verkhovna Rada of Ukraine on June 28, 1996. Bulletin of the Verkhovna Rada of Ukraine. 1996. No. 30. Art. 141.*

## Medical sciences

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### **BREAST CANCER: CURRENT CHALLENGES AND ACTUAL DIRECTIONS**

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East Kazakhstan region, Ust-Kamenogorsk, Kazakhstan**Abstract**

*This scientific and analytical work presents modern global and local-regional data on incidence, mortality, lethality and five-year survival of the most common oncological pathology, such as breast cancer. The issues of etiology and pathogenesis, features of distribution, modern principles of diagnostics, including screening, as well as prognosis, preventive measures of this formidable disease are covered in detail. The epidemiological characteristics of this pathology in our republic are given in the context of the regions of the country.*

**Keywords:** oncology, radiation oncology, breast cancer, phenotype, biological markers, risk factors, etiopathogenesis, diagnostics, ultrasound, treatment, epidemiology, incidence, mortality, lethality, five-year survival rate, prognosis, prevention.

*Breast cancer (BC) is the most common global malignancy and the leading cause of cancer deaths [1]. There is much evidence showing the influence of life style and environmental factors on the development of mammary gland cancer (high-fat diet, alcohol consumption, lack of physical exercise), the elimination of which (primary prevention) may contribute to a decrease in incidence and mortality. Secondary prevention, comprising diagnostic tests (e.g. mammography, ultrasonography, magnetic resonance imaging, breast self-examination, as well as modern and more precise imaging methods) help the early detection of tumours or lesions predisposing to tumours. It is estimated that nearly 70% of malign tumours are caused by environmental factors, whereas in BC this percentage reaches 90-95%. There are national programmes established in many countries to fight cancer, where both types of*

prevention are stressed as serving to decrease incidence and mortality due to cancers. Cancer prevention is currently playing a key role in the fight against the disease. Behaviour modification, as well as greater awareness among women regarding BC, may significantly contribute towards reducing the incidence of this cancer [2].

Speaking about the diagnostic criteria for making a diagnosis, women complain about the presence of a formation in the mammary gland; enlarged axillary, supra- and subclavian lymph nodes; the presence of skin changes on the mammary gland; swelling of the mammary gland. The history is noteworthy of the presence of cancer in close relatives; early onset of menstruation; age of first pregnancy and first birth, taking oral contraceptives and/or hormone replacement therapy, gynecological diseases. During a physical examination, attention is paid to the symmetry of the location and shape of the mammary glands; level of position of the nipples and their appearance (retraction, deviation to the side); skin condition (hyperemia, swelling, wrinkling, retractions or protrusions on it, narrowing of the areolar field, etc.); presence/absence of pathological discharge from the nipples (quantity, color, duration); presence of swelling of the arm on the affected side. Palpation of the mammary glands is carried out in the vertical and horizontal positions of the subject; regional and cervico-supraclavicular lymph nodes are usually performed in a vertical position [3].

From laboratory tests, if metastatic BC is suspected, it is recommended to perform detailed clinical and biochemical blood tests, and a study of the blood coagulation system. In case of hormone-dependent BC in women under 50 years of age, to assess ovarian function and plan hormone therapy, it is recommended to study the level of follicle-stimulating hormone in the blood serum and the level of total estradiol in the blood. A cytological study is also carried out (an increase in the size of atypical cells up to giant ones, a change in the shape and number of intracellular elements, an increase in the size of the nucleus, its contours, different degrees of maturity of the nucleus and other cell elements, a change in the number and shape of nucleoli); histological examination: histological type of tumor, degree of differentiation (grade - ability to form tubes, nuclear polymorphism, number of mitoses), presence of necrosis, vascular invasion, tumor of infiltrating lymphocytes, presence of calcifications. Immunohistochemical study for key markers: 1) determination of estrogen and progesterone receptors, HER2, Ki67 - it is recommended to evaluate biological markers again at least once during metastasis, if clinically possible; 2) if the result of IHC analysis of HER2 is controversial, the HER2/neu gene amplification should be determined by in situ hybridization; 3) determination of PD-L 1 in triple negative BC to decide on the prescription of immunotherapy; 4) if necessary - Cytokeratin 5/6, Calponin-1, E-Cadherin, GCDPF-15, Mammaglobin, p120 and Topoisomerase IIa.

Molecular genetic testing to determine germline BRCA1/2 mutations is indicated in all patients, regardless of age, family history, or type of BC with mBC and during progression to decide whether to prescribe PARP inhibitors (olaparib and talazoparib). In women with a positive germline mutation of the BRCA1 or 2 gene, the incidence of BC development before 70 years of age is 45-65%. More often detected: 1) with a burdened family history (close relatives have BC aged  $\leq 50$  years, BC in a man, ovarian cancer, metastatic prostate cancer, pancreatic cancer); 2) in patients under 45 years of age; 3) in patients under 60 years of age with a triple negative BC phenotype; 4) with primary multiple BC; 5) in patients with HER2 negative BC phenotype who have a high risk of relapse after surgical treatment and neoadjuvant or adjuvant therapy; 6) for BC in men. Comprehensive genomic profiling is carried out in patients with a severe clinical course, aggressive tumors, with a high risk of progression, lack of effect from traditional methods of antitumor treatment [in advanced BC (triple negative and progressive HER2+)] [3].

Instrumental studies: 1) ultrasound of the mammary glands, regional lymph nodes: the presence of a hypoechoic structure of the formation with large/small microcalcifications in the structure, the contours are uneven, stellate, there may be areas of mixed echogenicity, the structure of the node is heterogeneous, increased vascularization is possible; 2) mammography (mammograms in two projections visualize shapeless heterogeneous compactions with multiple microcalcifications in the structure, pronounced deformation of the stroma, thickening of the skin, nipple-areolar complex, the nipple can be retracted, the presence of enclosed lymph nodes); 3) contrast-enhanced spectral mammography (CESM) method, which consists of performing mammography with soft and hard images after intravenous administration of an iodinated contrast agent. The CESM method is informative in the diagnosis of early forms of BC, allows you to detect pathology in the dense part of the mammary gland, and is used as a differential diagnosis of benign and malignant neoplasms; before the study, creatinine and urea levels in the blood are assessed, an iodine-containing contrast agent is administered intravenously in an amount of 1.0-1.5 ml per kg of the patient's weight; images are taken in two projections, craniocaudal (CC) and

media-lateral (MLO), in a period of time from 2 to 7 minutes after administration of the contrast agent; 4) magnetic resonance imaging (MRI) of the mammary glands to assess the local spread of BC for the following indications: age up to 30 years; the presence of mutations in the BRCA1, BRCA2 genes; high radiological density of the mammary glands; the presence of breast implants when it is impossible to perform a high-quality mammographic examination; presence of lobular carcinoma in situ; 5) ductography (in the presence of an intraductal formation behind the nipple, it is carried out to clarify the size and distance of the formation from the nipple-areolar complex); 6) puncture biopsy of a tumor formation (cytological examination reveals an increase in the size of cells up to giant ones, a change in the shape and number of intracellular elements, an increase in the size of the nucleus and its contours, different degrees of maturity of the nucleus and other cell elements, a change in the number and shape of nucleoli); 7) trephine biopsy or sectoral resection of the mammary gland with express histology (histological verification of the tumor: histological type of tumor, degree of differentiation (grade - ability to form tubes, nuclear polymorphism, number of mitoses), absence of necrosis, vascular invasion, tumor of infiltrating lymphocytes, the presence of calcifications; 8) ultrasound of the abdominal organs and retroperitoneal space/ultrasound of the pelvis (with metastatic lesions of the liver, its structure is heterogeneous, rounded in shape with uneven clear contours, with single or multiple formations with a hypoechoic rim along the periphery); 9) computed tomography (CT) or MRI of the abdominal organs with intravenous contrast if the results of ultrasound of the abdominal organs are ambiguous or not very informative; 10) survey X-ray examination of the CT of the chest organs (in case of metastatic lesions of the lungs across all pulmonary fields or in a segment, multiple/single mid-focal shadows with clear contours, of various sizes are determined); 10) scintigraphy of skeletal bones (hyperfixation of an osteotropic drug in foci of pathological bone formation) if metastatic lesions of skeletal bones are suspected to assess the extent of BC prevalence; 11) positron emission tomography (PET) (accumulation of the drug by pathological foci), combined with CT with tumor-tropic radiopharmaceuticals (with or without contrast) (PET-CT) to assess the extent of BC spread in cases where standard methods of staging examinations are ambiguous, especially when locally advanced process, when the detection of metastases fundamentally changes treatment tactics; 12) MRI or CT scan of the brain with IV contrast to exclude metastatic lesions if the presence of metastases in the brain is suspected.

To standardize and simplify the criteria for assessing response to tumor therapy, the international Response Evaluation Criteria in Solid Tumors (RECIST) scale is used. According to RECIST 1.1, the following types of response are distinguished for targeted lesions.

1. Complete response – disappearance of all tumor foci.
2. Partial answer – a decrease in the sum of the largest diameters of each lesion by more than 30%.
3. Stabilization of the disease – reduction of the sum of the largest diameters of each lesions from 20 to 30% (for RECIST 1.0 from 25 to 50%).
4. Progression of the disease – an increase in the sum of the largest diameters of each lesion by more than 20% or the appearance of new tumor lesions.

The overall response of solid tumors to treatment is based on a combination of data on measurable lesions, non-measurable lesions and the appearance or absence of new tumor lesions. The duration of overall response is from the date of documentation of the disease until its progression. Relapse-free interval (time to progression) – from the end of treatment to the date of documented disease progression [3].

As part of outpatient drug therapy, it is recommended to use hormone therapy in the adjuvant mode for patients with hormone-positive BC for at least 5 years (tamoxifen, letrozole, anastrozole, goserelin, triptorelin) and with progression or metastatic luminal BC before progression (tamoxifen, letrozole, anastrozole, goserelin, triptorelin, toremifene, fulvestrant, exemestane, everolimus). The use of bisphosphonate therapy when metastatic bone lesions are detected is recommended for two years (zoledronic and pamidronic acid, denosumab). CD 4/6 inhibitors (palbociclib, ribociclib, abemaciclib) are recommended for patients with HER2-negative metastatic luminal BC in combination with an aromatase inhibitor or fulvestrant, until progression or unacceptable toxicity develops; the use of monotherapy with Poly(ADP-ribose) polymerase inhibitors (olaparib or talazoparib) is recommended for patients with metastatic BC with germline BRCA1 or BRCA2 mutations, regardless of hormone receptor and HER2 status, as an alternative to chemotherapy. In patients with high-risk BRCA-associated BC, olaparib is prescribed as adjuvant therapy. The use of targeted therapy (trastuzumab) is recommended for patients with early and metastatic HER2-positive BC in combination with chemotherapy, targeted therapy or monotherapy (up to completion of 18 cycles). The use of targeted therapy (lapatinib) is recommended

for patients with HER2-positive metastatic BC, either alone or in combination with capecitabine and/or trastuzumab, until progression or development of unacceptable toxicity. The use of capecitabine in the adjuvant treatment of chemo-resistant triple negative BC, or in metastatic BC in combination with lapatinib and hormone therapy.

Indications for radiation therapy: 1) morphologically established diagnosis of malignant neoplasm; 2) in case of relapses, continued growth of the tumor or progression of the disease after previously carried out combined or complex treatment. Methods of radiation therapy: 1) continuous radiation therapy; 2) single-fraction radiation therapy for SRS; fractionated radiation therapy for Single Focal Dose from 1.6 Gy to 12.0 Gy 2-5 fractions per week (standard fractionation, hypofractionation, hyperfractionation, accelerated fractionation, multifractionation). In this case, external beam radiation therapy is carried out 2D, 3D, IMRT, RapidArc, IGRT conformal irradiation Single Focal Dose 1.8-2.0-2.66, 2.67, 5.2 Gy 5 fractions per week up to Total Focal Dose 50 Gy, 42.56 Gy, 40.05 Gy, 25 Gy and 60-70 Gy in independent mode, Total Focal Dose 10-16 Gy ("Boost") in the postoperative mode after organ-sparing operations. A continuous course of radiation therapy is used, using  $\gamma$ -therapy devices or linear accelerators. Tomotherapy is used as a standard fractionation technique for administering single and total focal doses. The main advantage is hypofractionation in Single Focal Dose 2.5 Gy. Intraoperative radiation therapy is used in breast-conserving operations for T1-2N0-1M0. The bed of the removed tumor is irradiated with an electron beam at a dose of 10-20 Gy in order to devitalize the remaining malignant cells [3].

Now, regarding chemotherapy. There are several types of chemotherapy that differ in purpose: 1) neoadjuvant chemotherapy of tumors is prescribed before surgery, in order to reduce an inoperable tumor for surgery, as well as to identify the sensitivity of cancer cells to drugs for further use after surgery; 2) adjuvant chemotherapy is prescribed after surgical treatment to prevent metastasis and reduce the risk of relapse; 3) curative chemotherapy is given to shrink metastatic cancers. Depending on the location and type of tumor, chemotherapy is prescribed according to different regimens and has its own characteristics.

Indications for chemotherapy: 1) cytologically and histologically verified BC; 2) in the treatment of locally advanced tumors; 3) metastases in regional lymph nodes/distant organs - lungs, liver, brain, bone structure; 4) tumor recurrence; 5) a satisfactory blood picture in the patient: normal hemoglobin and hemocrit, the absolute number of granulocytes is more than 200, platelets are more than 100,000; 6) preserved function of the liver, kidneys, respiratory system and cardiovascular system; 7) the possibility of converting an inoperable tumor process into an operable one; 8) patient's refusal to undergo surgery; 9) improvement of long-term treatment results in unfavorable tumor phenotypes (triple negative, HER2-negative cancer).

Contraindications to chemotherapy can be divided into two groups: absolute and relative. Absolute contraindications: hyperthermia  $>38$  degrees; disease in the stage of decompensation (cardiovascular system, respiratory system, liver, kidneys); the presence of acute infectious diseases; mental illness; the ineffectiveness of this type of treatment, confirmed by one or more specialists; tumor decay (threat of bleeding); the patient's serious condition according to the Karnofsky Performance Scale is 50% or less. Relative contraindications: pregnancy up to 16-18 weeks; intoxication of the body; active pulmonary tuberculosis; persistent pathological changes in blood composition (anemia, leukopenia, thrombocytopenia); cachexia.

The rationale for prescribing neoadjuvant systemic therapy for BC is: high probability of latent (micrometastatic) spread; the ability to reduce the amount of surgical intervention within the "clean" resection margins; the ability to evaluate the clinical response to therapy in vivo; availability of accurate pathomorphological assessment of the degree of tumor regression; the possibility of special studies of biopsy tumor material before, during and after completion of primary systemic treatment. For medullary carcinoma and adenoid cystic carcinoma, adjuvant chemotherapy may not be required (in the absence of lymph node involvement).

And a very important and decisive aspect when prescribing adjuvant/neoadjuvant systemic therapy is the molecular biological subtype of BC:

1. Luminal type A. In early BC (T1-2N0M0), hormone therapy is carried out only in the presence of severe concomitant diseases and/or there are absolute contraindications to surgical treatment until the maximum effect is achieved, followed by radiation therapy. For T2-4N1-3M0 locally advanced inoperable BC, it is recommended to prescribe hormone therapy with antiestrogens and aromatase inhibitors; it is advisable to carry out treatment until the maximum effect is achieved with clinical and instrumental assessment every 3 months. At the same time, in most cases, the appointment of adjuvant/neoadjuvant chemotherapy (in addition to hormonal therapy) is possible in the presence of at least two parameters:

widespread process ( $\geq 4$  regional lymph nodes affected by metastases;  $\geq T3$ ); GIII; young age; presence of pregnancy; increase in initial Ki67 values during repeat biopsy/postoperative material after neoadjuvant hormone therapy.

2. Luminal B (HER2 negative). Hormone therapy + chemotherapy in most cases. For T1a ( $\leq 5$  mm) and N0 - only adjuvant hormonal therapy. In other cases, chemotherapy with anthracycline- and taxane-containing regimens in addition to hormone therapy. Adding platinum drugs to adjuvant chemotherapy only in the presence of a BRCA1/2 gene mutation.

3. Luminal type B (HER2 positive). Chemotherapy + anti-HER2 therapy + hormone therapy. For T1a ( $\leq 5$  mm) and N0: adjuvant hormone therapy only; chemotherapy and trastuzumab are not indicated. For T1b, c ( $> 5$  mm but  $\leq 20$  mm) and N0: chemotherapy with paclitaxel (without anthracyclines) in combination with trastuzumab (followed by hormone therapy) is possible. For T2-T4 ( $> 20$  mm) or N+: the first step is anthracyclines, then taxanes + trastuzumab  $\pm$  pertuzumab (followed by hormone therapy).

4. HER2 positive (non-luminal). Chemotherapy + anti-HER2 therapy. For T1a ( $\leq 5$  mm) and N0: systemic therapy is not indicated. For T1b ( $> 5$  mm but  $\leq 10$  mm) and N0: taxane chemotherapy (without anthracyclines) in combination with trastuzumab is possible. For T1c-T4 ( $> 10$  mm) or N+: the first step is anthracyclines, then taxanes + trastuzumab  $\pm$  pertuzumab.

5. Triple negative (ductal). Chemotherapy including anthracyclines and taxanes. For T1a ( $\leq 5$  mm) and N0, systemic therapy is not indicated. Adding platinum drugs to adjuvant chemotherapy only in the presence of a BRCA gene mutation. There are also features when prescribing adjuvant chemotherapy to patients who have received neoadjuvant chemotherapy in full.

Also, a very important section is the use of hormone therapy in the adjuvant or neoadjuvant mode. In the premenopausal period, hormone therapy is used as follows. After completion of systemic chemotherapy and continued menstrual function, bilateral oophorectomy or ovarian suppression with luteinizing gonadotropin releasing hormone agonists followed by an anti-estrogen for 5 years is indicated. When menstrual function ceases after receiving courses of chemotherapy and the level of estradiol in the blood is determined, an anti-estrogen is prescribed to confirm true menopause. The following regimens with tamoxifen are used: 1) tamoxifen 20 mg/day orally daily for 5 years; 2) tamoxifen 20 mg/day orally daily, for 10 years, in the presence of at least one unfavorable prognosis factor: age  $\leq 35$  years, preserved ovarian function after adjuvant chemotherapy, T3-4, involvement of  $\geq 4$  axillary lymph nodes, GIII, positive HER2, high Ki67; 3) tamoxifen 20 mg/day orally daily for 5 years, then aromatase inhibitors (letrozole 2.5 mg/day orally daily, or anastrozole 1 mg/day orally daily, or exemestane 25 mg/day orally daily) for 5 years. For patients who have achieved stable menopause by the time they stop taking tamoxifen, with at least one poor prognostic factor: age  $\leq 35$  years, preserved ovarian function after adjuvant chemotherapy, T3-4, involvement of  $\geq 4$  axillary lymph nodes, GIII, HER2 positive, high Ki67; 4) ovarian suppression 1 + tamoxifen 20 mg/day orally daily / aromatase inhibitors (letrozole 2.5 mg/day orally daily, or anastrozole 1 mg/day orally daily, or exemestane 25 mg/day orally daily) for 5 years, and also if there are indications for adjuvant chemotherapy and preserved ovarian function after completion of chemotherapy; 5) bismacliclib 150 mg 2 times a day in combination with endocrine therapy for the adjuvant treatment of hormone receptor positive (HR+) and human epidermal growth factor receptor type 2 (HER2) negative BC in early stages with involvement of regional lymph nodes and a high risk of relapse [3].

In pre- or perimenopausal women, endocrine therapy with aromatase inhibitors should be combined with a luteinizing hormone-releasing hormone agonist. To achieve ovarian suppression, it is possible to use the following methods: 1) surgical castration (bilateral oophorectomy); the most effective method, causes irreversible shutdown of ovarian function; 2) medicinal (analogues of luteinizing gonadotropic hormone: goserelin 3.6 mg intramuscularly once every 28 days or 10.8 mg subcutaneously once every 12 weeks; or buserelin 3.75 mg intramuscularly once every 28 days; or leuprorelin 3.75 mg IM 1 time in 28 days): causes reversible suppression of ovarian function; does not always provide complete suppression of ovarian function, especially in young women; to confirm complete ovarian suppression, it is necessary to determine estradiol in the blood serum; determination of follicle-stimulating hormone during treatment with luteinizing gonadotropic hormone analogues is not informative; aromatase inhibitors should be started 6-8 weeks after the first administration of luteinizing gonadotropin hormone analogues; luteinizing gonadotropin hormone analogues are administered monthly; 3) radial; causes irreversible shutdown of ovarian function. The optimal method of ovarian suppression has not been determined; it is usually prescribed for a period of 2-5 years.

Hormone therapy for BC for menopausal patients is carried out in the following variations: 1)

tamoxifen 20 mg/day orally daily for 5 years; 2) aromatase inhibitors (letrozole 2.5 mg/day orally daily, or anastrozole 1 mg/day orally daily, or exemestane 25 mg/day orally daily) for 5 years; in the presence of at least one unfavorable prognosis factor: preserved ovarian function after adjuvant chemotherapy, T3-4, involvement of  $\geq 4$  axillary lymph nodes, GIII, positive HER2, high Ki67; 3) tamoxifen 20 mg/day orally daily for 10 years; in the presence of at least one unfavorable prognosis factor: preserved ovarian function after adjuvant chemotherapy, T3-4, involvement of  $\geq 4$  axillary lymph nodes, GIII, positive HER2, high Ki67; 4) tamoxifen 20 mg/day orally daily for 5 years, then aromatase inhibitors (letrozole 2.5 mg/day orally daily, or anastrozole 1 mg/day orally daily, or exemestane 25 mg/day orally daily) for 5 years. For patients who have reached stable menopause by the time they stop taking tamoxifen, in the presence of at least one unfavorable prognosis factor: preserved ovarian function after adjuvant chemotherapy, T3-4, involvement of  $\geq 4$  axillary lymph nodes, GIII, positive HER2, high Ki67; 5) abemaciclib 150 mg 2 times a day in combination with endocrine therapy for the adjuvant treatment of hormone receptor-positive (HR+) and human epidermal growth factor receptor type 2 receptor-negative (HER2-) BC in the early stages with involvement of regional lymph nodes and a high risk of relapse - continuously for 2 years or until disease relapse or intolerable toxicity develops [3].

And, of course, the surgical method remains one of the leading methods in the treatment of this pathology, and in some cases, it is the only method of treatment (cancer in situ). For BC, the following types of surgical interventions are performed: 1) radical mastectomy according to Halstead - single-block removal of the mammary gland along with the pectoralis major and minor muscles and their fascia, subclavian, axillary and subscapular tissue with lymph nodes within the anatomical cases; 2) extended axillary-thoracic radical mastectomy, single-block removal of the mammary gland with the pectoral muscles, subclavian-axillary and subscapularis tissue, as well as a section of the chest wall with parasternal lymph nodes and internal mammary vessels; 3) functionally sparing operations (modified radical mastectomy - differs from Halstead mastectomy by preserving the pectoralis major muscle; modified Madden mastectomy - differs from Halstead mastectomy by preserving both pectoral muscles; 4) simple mastectomy - removal of the mammary gland with the fascia of the pectoralis major muscle (indications: decaying tumor, advanced age, severe concomitant diseases; 5) radical sectoral resection - removal of the sector along with the tumor, part of the underlying fascia of the pectoralis major and minor muscles, subclavian, axillary, subscapular tissue with lymph nodes in one block; 6) sectoral resection - removal of the breast sector to the underlying fascia (performed only for diagnostic purposes or in combination with radiation therapy for cancer in situ); 7) biopsy of the sentinel lymph node is carried out for diagnostic and therapeutic purposes in the early stages of the disease (1st level lymph nodes are removed with a histological express study to determine the presence of elements of a malignant tumor); detection of sentinel lymph nodes is possible using radioactive colloid and/or blue dye; a combined determination method is preferred.

Indications for performing organ-preserving operations: the presence of a nodular form of cancer up to 2.0 cm in size; absence of multicentricity and multifocality of tumor growth (on mammograms, ultrasound data, clinical examination); slow and moderate growth rate, doubling of tumor size no faster than 3 months (according to medical history); a favorable ratio of the size of the mammary gland and the tumor to obtain a good cosmetic result of the operation; absence of distant metastases; the presence of single metastases in the axillary region is acceptable; the patient's desire to preserve the mammary gland; satisfactory objective tumor response (partial and complete tumor regression) to previous neoadjuvant systemic treatment.

Reconstructive operations can be performed for stages I-III of BC at the request of the patient at any tumor location: 1) reconstruction (primary or delayed) of the mammary gland using an endoprosthesis (implant) (this type of operation involves the installation of a temporary (expander) or permanent prosthesis under the pectoralis major muscle, which allows compensation for the defect due to its volume, after mastectomy); 2) one-stage reconstruction: a skin-skin-sparing mastectomy is performed with the fascia of the pectoralis major muscle (if tumor cells are detected in the tissue behind the nipple during express histological examination, the nipple with the areola is removed); 3) reconstruction (primary or delayed) of the mammary gland using one's own tissues (autoplasty); this type of reconstruction involves replacing the defect using one's own tissues; basically, 2 types of operations are used - breast reconstruction by replacing with a TRAM flap (using a flap based on the rectus abdominis muscles) and breast reconstruction by replacing with a thoracodorsal flap, which is used in combination with an endoprosthesis.

Types of surgical interventions for metastatic BC: 1) sanitary/simple mastectomy (if there is a threat of bleeding for health reasons); 2) open liver biopsy (diagnostic surgery for suspected liver

metastases); 3) other diagnostic manipulations on the liver (liver resection in the presence of single metastatic foci in the liver); 4) excision of the affected area or tissue of the meninges (in the presence of solitary metastatic foci of the meninges); 5) other types of excision or destruction of the damaged area or brain tissue (in the presence of solitary metastatic foci in the brain); 6) precision resection of a segment of the lung (in the presence of solitary metastatic foci in the lungs); 7) laparoscopic salpingo-oophorectomy (prophylactic bilateral removal of appendages for hormone-dependent BC tumors in premenopausal patients); 8) total hysterectomy with appendages (for metastatic lesions of the ovaries, uterine body); 9) electrochemotherapy for intradermal metastatic lesions (combination treatment that uses the administration of chemotherapeutic drugs in association with electroporation of the cell membrane).

Contraindications to surgical treatment for BC: the patient has signs of inoperability and severe concomitant pathology; distant metastases, the presence of a disseminated tumor process; synchronously existing and widespread inoperable tumor process of another localization, for example lung cancer, etc.; chronic decompensated and/or acute functional disorders of the respiratory, cardiovascular, urinary system, gastrointestinal tract; allergy to drugs used in general anesthesia.

Also, a very important point is preventive measures for BC. Primary prevention of BC is the prevention of the disease by studying the etiological and risk factors (normalization of family life, timely implementation of childbearing, breastfeeding the baby, avoiding marriages in cases of mutual cancer). Secondary prevention of BC is the early detection and treatment of precancerous diseases of the mammary glands. Tertiary prevention is prevention, early diagnosis and treatment of relapses and metastases; using a nutritious diet rich in vitamins and proteins, giving up bad habits (smoking, drinking alcohol), preventing viral infections and concomitant diseases, regular preventive examinations with an oncologist, regular diagnostic procedures (radiography of the lungs, ultrasound of the liver, kidneys, neck lymph nodes).

Prophylactic mastectomy - risk-reducing surgeries, such as mastectomy with reconstruction, may be offered to women at risk. The risk of developing BC is reduced by approximately 90-95%, however, absolute guarantees regarding the occurrence of BC in the future are impossible. Indications for performing bilateral prophylactic mastectomy in women who do not currently have BC (in order to reduce the risk of developing primary BC): mutations of the BRCA1 and BRCA2 genes; family history (presence of BC in first- and second-line relatives) without a proven mutation; histological risk factors are atypical ductal or lobular hyperplasia. Indications for performing prophylactic contralateral mastectomy in women with current or past BC: newly diagnosed unilateral BC stage I-II, or a history of stage I-II BC (in order to reduce the risk of developing cancer in the contralateral mammary gland and achieving symmetry with the operated mammary gland); lobular carcinoma in situ. Contraindications for use: age over 70 years; general contraindications to surgical treatment; synchronous and metachronous malignant tumors, with the exception of skin cancer [3].

Next, of course, it is necessary to discuss in detail the issue of BC screening. The key concept of BC screening is the detection of oncological pathology in the early stages, when the prognosis is most favorable and allows you to get the best long-term treatment results. A preventive examination always has advantages over a diagnostic examination when symptoms of the disease are already present. At the same time, upon receipt of the M2 and M3 indices according to the BI-RADS classification, it is possible to timely additionally examine these patients and, if necessary, take them to the dispensary record by a district mammologist with effective dispensary examinations and treatment of precancerous breast diseases. Along with this, it must be understood that the main conditions for screening for BC are the availability of trained personnel and a standardized approach to identifying the trait under study and evaluating the results. The methods used should be sufficiently simple, reliable and reproducible, and also have sufficient sensitivity and high specificity. Such qualities are fully possessed by modern digital mammography [4,5,6].

Now, regarding this pathology in our country at the republican level. BC ranks first in the structure of the frequency of malignant neoplasms in both sexes in the population with a share of 14.9% (14.7% in 2022). This situation has been stable since 2004, in addition, BC ranks first and stably remains in this position in the structure of female oncopathology.

The incidence of BC in 2023 as a whole in the country increased to 27.7 per 100 thousand of the population with a growth rate of 4.3% compared to the previous year (in 2022 - 26.5). In the structure of cases, BC ranks first in the absolute majority of regions and cities of the country [7].

The incidence of BC in 12 regions of the country is higher than the national average (27.7 per 100 thousand of the population). The top three regions by this indicator are North Kazakhstan - 45.1; East

Kazakhstan - 41.7 and Karaganda - 40.4. Next come: Kostanay - 39.1; Abay - 38.1; Pavlodar - 37.5; the city of Almaty - 36.2; Akmola - 35.9; the city of Astana - 34.3; Ulytau - 33.4; West Kazakhstan - 28.7 and Aktobe - 28.4 regions. This indicator is below the national average in 8 regions: Turkestan - 11.4 (the lowest level); Zhambyl - 15.8; Mangistau - 16.7; the city of Shymkent - 17.9; Almaty - 20.0; Kyzylorda - 20.2; Atyrau - 22.5 and Zhetysu - 22.8 per 100 thousand population. Mortality from this pathology was 5.3 per 100 thousand population. In the structure of causes of death in women in 2023, this pathology continues to occupy a leading position (1st rank place), amounting to 17.3% or 1056 people (17.2% and 1060 women, respectively).

The regions with the BC mortality rate above the national average (5.3 per 100,000 population) are: East Kazakhstan - 9.6 (maximum level); Pavlodar - 8.2; the city of Almaty - 7.8; Abay - 6.7; the city of Astana - 6.5; West Kazakhstan - 6.2; Kostanay - 6.1; Karaganda and North Kazakhstan - 5.6 and Akmola - 5.5 regions of the country. The lowest rates were recorded in Turkestan - 2.3 (minimum level); Ulytau - 3.2; Aktobe - 3.4; Atyrau - 3.6; Zhetysu - 3.7; Mangistau - 4.0; Kyzylorda - 4.3; Almaty - 4.6; in the city of Shymkent - 4.7; in Zhambyl - 4.8 regions per 100 thousand population [7].

The number of deaths from BC, not registered with oncology organizations and established posthumously in the Republic of Kazakhstan in 2023 amounted to 4 people; at the same time, the specific weight was 0.1% and this is the 22nd ranking place, as in the previous year.

At the same time, the one-year mortality rate was 3.4%. At the same time, the ratio between one-year mortality and neglect (stage IV) was, as in 2022, 0.7. At the same time, we recall that the farthest from "1" is the worst ratio between the indicators of one-year mortality and neglect.

Now, regarding preventive examinations. It should be noted that during large-scale preventive examinations of the population in 2023, significantly more patients with malignant neoplasms were actively identified than in 2022. This is 25,193 patients against 23,623 patients identified in 2022, i.e. +6.6%. This is due to the further abatement of the epidemiological situation with coronavirus and the increased availability of preventive care for the population. The proportion of patients identified during routine examinations increased from 62.0% to 62.4% of the total number of patients identified per year.

The number of newly identified BC patients registered with oncology organizations in 2023 amounted to 5,426 people (5,101 in 2022).

As for preventive examinations. The absolute number of BC patients identified during routine examinations amounted to 3,072 people (2,822 a year earlier). At the same time, the proportion of those identified during routine examinations increased from 55.3% in 2022 to 56.6% in 2023. At the same time, despite the fact that the absolute number of people diagnosed with this pathology increased from 2474 to 2636 people, the proportion of patients diagnosed with BC at early (I, II) stages decreased from 87.7% to 85.8%. Of course, when analyzing the epidemiological situation, early diagnostic indicators are very important issues.

The regions where the proportion of patients with early stage I of the pathology in question is above the national average (35.8% and 9th place) include the following: Ulytau - 56.8% (the best indicator); Kyzylorda - 50.3%; Turkestan - 47.3%; the city of Shymkent - 46.0%; West Kazakhstan - 45.4%; the city of Astana - 44.6%; Mangistau - 44.2%; North Kazakhstan - 41.4%; Karaganda - 38.7%; Almaty - 38.5%; Pavlodar - 38.1% and East Kazakhstan - 36.1%. The lowest rates of early diagnosis were recorded in the Zhambyl region - only 14.0%; Atyrau - 24.4%; Akmola - 25.2%; the city of Almaty - 26.2%; Kostanay - 27.4%; Zhetysu - 31.4%; Aktobe - 35.0% and Abay - 35.7% regions of the country [7].

The average indicator in the country for detecting patients with BC at early (I and II) stages was 88.4%, and this is a high 4th rank place among all nosological forms of malignant neoplasms.

The regions where the proportion of patients with BC detected at stages I-II is above the average in the republic include the following regions: Atyrau - 94.2%; Aktobe - 92.4%; Kyzylorda - 92.3%; Pavlodar - 92.1%; the city of Shymkent - 92.0%; West Kazakhstan - 91.8%; North Kazakhstan - 91.6%; the city of Astana - 91.3%; Turkestan - 90.9%; Ulytau - 90.5%; Almaty and the city of Almaty - 89.0%; Abay - 88.5%. Mangistau region is on par with the national average. Below the national average are: Karaganda - 79.8%; Kostanay - 81.1%; Akmola - 82.4%; Zhetysu - 86.2%; East Kazakhstan - 86.6%; and Zhambyl - 87.6% of the regions [7].

As can be clearly seen from the above data, there is a very wide range in early diagnosis rates (at stage I of the disease) across the country, from very good to dismal. Of course, it is necessary to take into account migration processes and other factors affecting the early diagnostic rates, but nevertheless, the obtained results give a reason not to stop there, both for oncologists and mammologists, obstetricians-gynecologists, radiologists, and, naturally, for general practitioners, since improving the early diagnostic rates of malignant tumors, as one of the main postulates and one of the main tasks of medicine in

general, continues to be relevant today. Among the visual localizations of malignant tumors in the reporting year, the proportion of seven main forms determines the picture of late diagnostics (stages III-IV) and amounts to 13.3% in total, with a decrease compared to the level of the previous year (2022 - 14.2%). At the same time, with BC, the neglect rate was 11.6% (13.8% - in 2022).

The proportion of stage IV BC among all nosological forms of malignant neoplasms was 4.3%. The following indicators were noted by regions of our country: in East Kazakhstan - 8.4% (the worst result); Karaganda - 7.4%; Mangistau - 6.2%; Kyzylorda - 5.9%; Almaty - 5.3%; Atyrau - 5.1%; Akmola and Kostanay - 5.0%. At the same time, the lowest neglect of this cancer localization was established in the West Kazakhstan region - 2.1% [7].

The morphological verification rate of the disease in the country was 99.4%. At the same time, the leaders in this aspect with a 100% indicator are Almaty, Zhambyl, Mangistau, North Kazakhstan, Ulytau regions and the city of Shymkent. Next come: the city of Astana and the Karaganda region (99.8%); East Kazakhstan (99.7%); the city of Almaty, Turkestan and Abay regions (99.6%); West Kazakhstan (99.5%). At parity with the national average are Kostanay and Atyrau regions. Then come: Aktobe (98.9%); Pavlodar (98.2%); Zhetysay (98.1%); Akmola (97.8%); Kyzylorda (97.0% - the worst indicator in the republic) regions.

The total number of patients with malignant neoplasms registered with specialized oncology organizations of the republic continued to grow and by the end of 2023 amounted to 218,186 people, with an increase of 6.0% compared to the level of the previous year (2022 - 205,822, +5.8%). The overall incidence rate of malignant neoplasms increased by 3.9%, from 1055.3 to 1096.4 per 100 thousand people. The growth of this indicator is due to both the increase in the incidence and detection of pathology, and the increase in the survival rate of cancer patients. In addition, statistical data on patients diagnosed with malignant neoplasms, who have been under observation for 5 years or more, and continue to be observed in 2023, showed that the number of patients under observation by oncological organizations in Kazakhstan for over five years continued to grow and at the end of the reporting year amounted to 117,616 people, with an increase of 6.2% (2022 - 110,790 people, +6.6%) (form. No. 7).

It is impossible to ignore such an important clinical aspect as the coverage of patients with a diagnosis of BC in the Republic of Kazakhstan with special treatment.

In 2023, the number of hospitalizations for all nosological forms of malignant tumors in the country's oncology organizations amounted to 108,252 cases (2022 - 101,095), with an increase of 7.1% compared to the previous year, which is associated with a constant increase in the number of cancer patients, improved standardization of oncology care, and the development of palliative and rehabilitation services.

At the end of 2023, the absolute number of BC patients who completed specialized treatment amounted to 3,419 people, continuing treatment - 1,729 patients. The following results were obtained in percentage terms by methods and types of treatment: 40.9% of patients received complex treatment, 21.8% received only surgical treatment, 20.0% received only drug treatment, 12.6% received combined treatment, 1.1% received only radiation treatment, 0.7% received chemoradiation treatment.

Next, regarding the five-year survival rate of patients. As for BC, at the end of 2023, 48,496 people were registered with the dispensary, or 243.7 per 100 thousand of the population. At the end of 2022, there were 45,728 patients, or 234.5 per 100 thousand of the population, respectively.

At the same time, the lethality of the observed contingents decreased slightly from 2.3% in 2022 to 2.2 in 2023.

The five-year survival rate of patients with BC was 57.7% in 2023 and 57.1% in 2022 [7].

Mass screening to identify BC patients should mainly involve healthy women without any signs of the disease or symptoms. Screening not only helps to detect hidden forms of cancer that can be treated, but also has psychological value for women. As a result of screening, women are convinced that they do not have BC, and this is the most important potential success of such programs. While the ultimate goal of screening is to reduce BC mortality, its immediate goal is to detect cancer before clinical manifestation. However, BC is a heterogeneous disease, which can significantly affect the effectiveness of screening. Screening models for BC are usually based on the fact that the majority of detected tumors are invasive cancers in the early stage of progression. In addition, it must be taken into account that the detection of cancer (or its precursors) before clinical manifestation increases the risk of false positive diagnosis [8,9].

Mammography has a sensitivity of 95% and a specificity of 97%. These indicators decrease when examining women with denser mammary glands (young age, use of hormone therapy), with low quality mammography, and also with insufficient qualifications of the radiologist. Detection of high-grade

*invasive cancer by screening, when the tumor is not yet detected by clinical examination (palpation), means the possibility of reducing mortality from BC [10].*

*Preventive screening for early detection of BC in the Republic of Kazakhstan includes [11]:*

*1) mammography of both mammary glands in two projections - direct and oblique in the mammography room of the city, district polyclinic (mobile medical complex). All digital mammograms in the presence of a system for archiving and transferring medical images are copied to CDs and other electronic media and transferred to the server of the mammography room of the Cancer Center using specialized licensed software integrated between medical organizations; in case of impossibility of digital transmission - they are printed on X-ray film at a scale of 1:1 - 100% (1 patient - 1 set - 2 or 4 mammograms) with subsequent transfer to the mammography room of the Cancer Center;*

*2) interpretation of mammograms according to the BI-RADS classification (M0t, M0d, M1, M2, M3, M4, M5) by two or more independent radiologists of the same medical organization - double reading or different medical organizations: a radiologist of the mammography room city, district polyclinic (mobile medical complex) - the first reading, and the radiologist of the mammography room of the Cancer Center - the second reading;*

*3) in-depth diagnostics - targeted mammography, ultrasound examination (hereinafter - ultrasound) of the mammary glands, trepanobiopsy, including under ultrasound or stereotaxic control for histological examination, which is carried out in case of detection of pathological changes on mammograms (M0d) in the mammography room of the Cancer Center.*

*✓ An average medical worker or a responsible person of the organization of outpatient care sends the patient for mammography to the district, city polyclinic.*

*✓ The X-ray laboratory assistant of the mammography room of the city, district polyclinic (mobile medical complex) performs mammography, fills out a referral for double reading of mammograms and transmits the referral through information interaction.*

*✓ Radiologist of the mammography office of the city, district polyclinic (mobile medical complex): fulfills the requirements for the safety and quality of mammographic examinations; evaluates the quality of the images provided and the correctness of the installation; performs repeated mammography in the M0t category (technical errors of mammography); determines the radiological density of the mammary glands on the ACR scale (A, B, C, D) indicating this parameter in the study protocol; conducts the first reading of mammograms with interpretation of the BI-RADS classification results. In the M0d category (undetermined or suspicious radiological changes requiring additional examination), the study protocol indicates the predominant pathology: education, asymmetry, violation of architectonics, microcalcifications; sends mammograms, electronic copies of mammograms through the archiving system and transfer of medical images to the workplace of the mammography office of the Cancer Center together with directions for double reading of mammograms; directs low-dose CT images through the system of archiving and transferring medical images to the workplace of the CT office of the Cancer Center together with copies of images recorded on CD-ROMs or other electronic media and directions for double reading.*

*✓ The radiologist of the mammography room of the Cancer Center: evaluates the quality of the provided images and the correctness of the styling. Viewing digital X-ray images transferred to the server or on digital media (CD, DVD) is carried out on a monitor for interpreting digital X-ray images with a resolution of at least 5 megapixels, which has a certified grayscale transmission in accordance with the DICOM standard; conducts a double (second) reading of mammograms with the interpretation of the results according to the BI-RADS classification, using, if necessary, archival images. Organizes the third reading according to indications. With double reading, an independent interpretation of the images is carried out (blinding method - the second radiologist does not know the results of the first reading); in the M0m category (technical errors in mammography), recommends repeat mammography; in the M0d category (uncertain or suspicious radiographic changes requiring additional examination), the study protocol indicates the predominant pathology: education; asymmetry, violation of architectonics, microcalcifications; recommends that the outpatient care organization, according to indications, invite the patient for in-depth diagnostics (targeted mammography, ultrasound of the mammary glands, trephine biopsy, including under ultrasound or stereotaxic control, followed by histological examination of the material); collects and archives all mammograms (films and electronic media) made as part of the examination. The shelf life of mammograms is at least 3 years after leaving the age subject to a screening study; the results of the double (second) reading are transferred to the outpatient care organizations through information exchange.*

*✓ Indications for in-depth diagnostics are the conclusions of double reading mammograms M0d*

*(uncertain or suspicious X-ray changes requiring additional examination).*

*✓ In-depth diagnostics is carried out in two stages. At the first stage, ultrasound is performed, according to indications, targeted mammography, possibly with an increase (with asymmetry, violation of architectonics and the presence of microcalcifications). When visualizing a suspicious pathology (M4 and M5), the second stage is performed - trepanbiopsy, including under ultrasound control and stereotaxic control for histological examination.*

*✓ Histological examination is carried out in the laboratory of pathomorphology or pathological bureau. Morphological interpretation of the biopsy is carried out in accordance with the recommendations of the World Health Organization.*

*✓ Physician or responsible person of the outpatient care organization:*

*1) upon receipt of a mammography result according to the BI-RADS classification:*

*- in case of M0t (technical errors in mammography) - sends the patient for a second X-ray examination to the mammography room of the city, district polyclinic (mobile medical complex);*

*- with M0d (undefined or suspicious X-ray changes requiring additional examination) - sends the patient for in-depth diagnostics to the mammography room of the Cancer Center;*

*- with M1 (no changes detected) - recommends that the patient undergo a follow-up mammography examination after 2 years. With radiological density of the mammary glands, C and D are sent for ultrasound of the mammary glands to exclude a false-negative result of mammography;*

*- with M2 (benign changes), refer the patient for a consultation with an oncologist (mammologist) of the clinical diagnostic department, followed by a screening mammography examination after 2 years;*

*- with M3 (probable benign changes) - sends the patient for short-term dynamic radiation observation to the local doctor with the recommendation of control mammography or ultrasound in 6 months;*

*- with M4 (signs that cause suspicion of malignancy), M5 (practically reliable signs of malignancy) and if it is technically impossible to perform a trepanbiopsy or a biopsy is refused, a referral to an oncologist (mammologist) of the clinical diagnostic department for dynamic observation and decision on the verification of the identified pathology;*

*2) upon receipt of the result of a histological examination:*

*- benign education - refers the patient to an oncologist (mammologist) of the clinical diagnostic department for dynamic monitoring, followed by a screening mammography examination after 2 years;*

*- formation with an indeterminate malignant potential or carcinoma in situ - refers the patient to the Cancer Center for consultation and treatment, followed by dynamic observation by an oncologist (mammologist) of the clinical diagnostic department at the place of her attachment;*

*- malignant neoplasm - refers the patient to the Cancer Center for treatment and follow-up;*

*3) communicates the results of the screening examination to the patient in any available way (by telephone, in writing, through electronic means of communication);*

*4) enters the results of double reading, in-depth diagnostics, histological examination, recommendations of the radiologist of the Cancer Center mammography room into the information system.*

*Establishing the size of the primary tumor is especially important in screening. Tumor size is an important criterion for evaluating the quality of screening and determining the ability of X-ray mammography to detect non-palpable tumors. Therefore, it is extremely important that pathologists measure tumor diameter as accurately as possible. The smaller the size of the primary tumor, the greater the likelihood of error in determining its size.*

*In 2023, the number of patients identified during screening examinations increased by 22.5%, from 2,230 to 2,731 people, as a result, the detection rate during screenings increased from 5.9 to 6.8%. During mammographic screening for BC in 2023, 918,464 women of the target group aged 40 to 70 were examined (a year earlier - 808,503 women). During mammographic screening in 2023, 1,875 cases of BC were detected (2022 - 1,570 cases). The cancer detection rate increased from 1.94 to 2.04 per 1,000 examined. The best result is in the North Kazakhstan region - 3.11 per 1,000 examined women (2022 - 2.31). High detection rates of BC were observed in Aktobe, Almaty, Atyrau, West Kazakhstan, Karaganda, Kostanay regions and in two megacities - the cities of Astana and Almaty. Low detection rates per 1000 examined, compared with the national average, were observed in Abay, Akmola, East Kazakhstan, Zhambyl, Kyzylorda, Mangistau, Pavlodar, Turkestan, Ulytau regions and the city of Shymkent. The lowest result was in Zhambyl region - 0.96 per 1000 examined women (2022 - 0.58). Compared to 2022, an increase in the detection of BC was noted in all regions, with the exception of Akmola (from 2.42 to 1.99), East Kazakhstan (from 2.21 to 1.93), West Kazakhstan (from 2.29 to 2.28),*

Karaganda (from 2.63 to 2.15), Pavlodar (from 2.15 to 1.51) regions, where a deterioration in results was allowed [7].

Summarizing the above, we can conclude that BC, along with lung cancer, continues to firmly occupy a leading place from year to year among all existing malignant tumors of other localizations. At the same time, taking into account a number of factors, the indicators of early diagnostics do not allow oncologists to "sleep peacefully". Despite the attitude to visually accessible localizations, the percentage of locally advanced forms of this type of tumors still remains quite high. The variability and veiled nature of symptoms, their similarity with various non-core processes (for example, the mastitis-like form of BC, often imitating mastitis), leads to the neglect of the disease. All this requires oncologists, and first of all, primary health care workers and, of course, mammologists, obstetricians and gynecologists, as well as radiologists to increase the level of oncological alertness, inform the population about early symptoms that may indicate this pathology or the onset of proliferative changes and conduct high-tech diagnostic measures, including for the purpose of differential diagnosis and, as a result, timely treatment.

Patients registered with various forms of so-called mastopathy need to regularly visit specialized specialists and, if necessary, undergo examination.

An epidemiological assessment of the situation with BC in our country allows us to say that in the regions there are sometimes significant differences not only in morbidity rates, but also in the parameters of early diagnosis and mortality from this pathology. In connection with the above, this pathology continues to be a serious problem of modern clinical oncology.

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## *Pedagogical sciences*

### **THE USE OF ARTISTIC AND AESTHETIC TECHNOLOGIES IN ENGLISH LESSONS**

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#### **Abstract**

*The article presents modern approaches to the integration of artistic (art) technologies in the process of TFL to students. A review and experimental data from Kazakhstan, foreign and Russian studies, as well as the practical experience of the author, show that such methods contribute not only to the development of language competencies, but also to the formation of motivation, creativity and communication skills of students. Special attention is paid to the use of digital platforms (Twee, ChatGPT), art therapy, music, visual, dramatization techniques, as well as their effectiveness in individualization, emotional involvement and the formation of sustainable skills in various educational contexts. The results of the pedagogical experiment and their own methods are described, which demonstrated a significant increase in educational motivation, creative and communicative development of students when learning one or two foreign languages at a Kazakh university. The findings emphasize the need for a systematic introduction of artistic technologies into modern educational practices.*

**Keywords:** *art technologies, art technologies, TFL, motivation, creativity, communication skills, digital platforms, dramatization, art therapy, creative projects, experiment, pedagogical practice, individualization of learning, Kazakhstan*

*Kazakh researchers pay special attention to the integration of artistic (art) technologies into foreign language teaching as an effective means of increasing motivation, developing creativity, and enhancing students' communicative competence.*

*Rakimgulov Zh. B. and Sabantaeva G. S., in their studies, analyze the impact of modern digital technologies and artificial intelligence on the development of creative abilities among college students learning foreign languages. The authors emphasize that the comprehensive use of digital and multimedia tools helps to unlock the learners' potential, while the application of neural network-based platforms (such as Twee and ChatGPT) promotes linguistic flexibility, creative self-expression, and the formation of active speech activity in a foreign language.[1]*

*Aitbayeva A. Zh., in her research, focuses on the use of art-therapeutic methods such as dramatization, musical and visual exercises, which enhance emotional engagement and improve English language acquisition among school and university students.[2]*

*Kusainov A. K. and Zhanpeisova K. B. emphasize the specifics of introducing multimedia and art technologies into the educational process, noting that the use of creative tasks and interactive formats leads to a significant increase in students' learning motivation and improvement of their communicative skills. The authors' experimental results show that incorporating multimedia tools and artistic technologies enhances student engagement, activates independent and group work, and helps to build more robust language competencies.[3]*

*Thus, research demonstrates that artistic technologies support the development not only of language skills but also of creative thinking and the emotional sphere, creating a favorable environment for mastering educational material.*

*International scholars also conduct in-depth studies and actively implement artistic technologies in foreign language instruction, offering diverse approaches and emphasizing their effectiveness.*

*1. Etherington (2019) notes that art technologies enable teachers to create a motivating environment by engaging students' imagination and creative thinking. This leads to the improvement of their emotional state and greater success in language acquisition.[4]*

2. Sturm (2020) emphasizes the importance of integrating visual, audio, and interactive elements into the learning process, which fosters the development of all types of speech activity and helps to overcome psychological barriers for foreign language learners.[5]

3. Makkoveeva Yu. A. explores collage as a distinct type of art technology that engages both hemispheres of the learner's brain through the use of painting, music, theater, and other forms of art, thus promoting a deeper perception of a foreign language.[6]

4. Zimnyaya I. A. highlights that in adolescence, it is especially important to include art-pedagogical methods in foreign language learning, as this approach allows students to express their individuality and develop communicative competence without the pressure of aesthetic judgments.[7]

5. An academic review has demonstrated that art technologies stimulate students' autonomy, engagement, and creativity, creating conditions for deeper understanding and application of language in various communicative situations.

Thus, international scholars combine practice-oriented and creative approaches, showing that the integration of artistic resources into foreign language teaching significantly increases the effectiveness of the educational process and contributes to the development of well-rounded individuals.

In Russian pedagogical science, the use of artistic technologies in teaching foreign languages is widely regarded as an innovative and effective approach. Scholars emphasize that art technologies activate students' creative potential, increase their motivation, and contribute to deeper language acquisition.

M. S. Achaeva, N. V. Pospelova, and N. S. Subbotina conduct research demonstrating the positive impact of art technologies on the process of learning foreign languages among young schoolchildren. In their work, they highlight that creative activities such as drawing, dramatization, and role-play help develop stable language skills and enhance interpersonal communication.[8]

The research by A. B. Aleshina focuses on the use of creative technologies in teaching spoken Russian as a foreign language. The author notes that creative methods, including dramatization and the use of various forms of art, effectively remove language barriers and contribute to the development of fluent speech in beginner-level students. In Russian educational science, the use of artistic technologies in foreign language teaching is widely viewed as an innovative and effective approach. Researchers emphasize that art technologies foster students' creative potential, boost motivation, and promote deeper mastery of language material.[9]

N. I. Pantykina, in her works, considers dramatization as a type of art technology, emphasizing its importance in forming communicative competence. Dramatization allows students to immerse themselves in authentic language situations, which improves both language perception and production.[10]

A significant place in Russian research is given to the application of art-oriented methods in English lessons at primary school, with particular emphasis on developing students' creative thinking and emotional sphere. Such methods help to create a favorable psychological climate and actively involve children in the learning process.

Moreover, studies by L. V. Aladyshkina demonstrate that integrating visual arts into Russian as a foreign language classes contributes to a deeper understanding of the language through visual perception and fosters students' creative self-expression.[11]

Modern methods of foreign language teaching actively incorporate art technologies into the range of educational practices. For example, O. V. Kovzanovich, in their works, emphasizes the necessity of the systematic implementation of creative approaches and digital tools to improve the quality of education and foster students' personal development.[12]

Thus, Russian scholars integrate both theoretical and practical aspects of using artistic technologies in foreign language teaching, substantiating their effectiveness for developing students' communicative competence and creative potential. These studies form the basis for introducing innovative methods into current pedagogical practice, aimed at cultivating well-rounded, motivated, and active individuals.

During the teaching practicum at the M. Utemisov West Kazakhstan University, while instructing students in the educational programs "Foreign Language" and "Two Foreign Languages," I applied a variety of artistic methods aimed at developing students' speech skills and creative thinking. Below is a description of the implemented methods with practical examples.

### **1. Role Play and Dramatization**

To activate speaking skills and immerse students in real communicative situations, I organized mini-plays and dramatized dialogues. For example, while studying the topic "Shopping," students enacted

dialogues in a store: the seller offered products, and the buyer chose and asked questions. This practice not only helped to reinforce lexical and grammatical structures but also allowed students to gain confidence in using English in real communication, turning the learning process into a creative and interactive experience.

## **2. Creative Projects**

As part of the themes "Travelling" and "City," students created collages and comics in English. For example, each student prepared an individual story about their favorite city with illustrations and then presented their project to the group. This method promoted visualization of new words and expressions, as well as the development of writing skills and public speaking abilities.

## **3. Musical and Poetic Tasks**

To improve phonetic and intonation skills, students were engaged in listening to and learning popular songs and poems in English. For example, we studied a song by The Beatles, analyzed its lexical content, and examined the lyrics within a cultural context. Such activities helped develop students' auditory perception, expand their vocabulary, and enhance their emotional connection to the language.

## **4. Use of Digital Platforms**

To support creative and individualized work, digital resources such as Twee and ChatGPT were employed. Students practiced writing essays, composing dialogues, and received instant feedback on their texts. In one group, a project was organized to create a multimedia presentation, where each participant developed their texts, which were then discussed and improved using artificial intelligence tools.

## **5. Art-Therapeutic Techniques**

To relieve speech tension and improve emotional connection, I used drawing and the creation of visual images followed by their description in English. For example, after reading a short story, students were asked to draw key scenes and then describe them to the group. This activity helped students open up, overcome their fear of speaking, and better internalize the learning material.

These methods helped create a lively communicative environment in class, increased student motivation, and enhanced their creative development in learning one or two foreign languages within the educational programs of M. Utemisov West Kazakhstan University.

During teaching practice at the M. Utemisov West Kazakhstan University, teaching students in the educational programs "Foreign Language: two foreign languages", I used artistic methods aimed at developing linguistic and creative skills.

The experiment was conducted with the participation of 68 students from three groups - IYA-22, IYA-23 and IYA-25. As part of the classes, traditional techniques were complemented by modern art technologies and digital tools.

In the IYA-22 group the emphasis was on role-playing and theatricalization: students acted out everyday and professional situations in English, which contributed to the development of confident speech and communication skills.

The IYA-23 group was engaged in creative projects - creating collages, comics and illustrations on lesson topics, followed by the presentation of their work. This helped to consolidate vocabulary and grammatical structures, while developing written language and imagination.

The IYA -25 group widely used musical and poetic tasks along with art-therapeutic techniques, including drawing followed by an speech description in English. Such work helped to reduce speech stress and improve the emotional perception of language.

In addition, all groups used the Twee and ChatGPT digital platforms to create interactive assignments and develop creative writing, which individualized learning and increased student engagement.

The results showed that the introduction of artistic technologies significantly increased motivation, improved speaking and writing skills, and also contributed to the creative development of students, which is especially important when learning one or two foreign languages.

In the way of pedagogical practice has confirmed the effectiveness of using modern artistic and digital methods in teaching foreign languages on the basis of the M.Utemisov West Kazakhstan University.

The following percentage results were obtained in the course of an experiment with 68 students of groups IYA-22, IYA-23 and IYA-25 in M. Utemisov West Kazakhstan University

- Increased motivation to learn English was observed in 85% of students.

- *Improvement of communication skills ( speech, dialog activity) was recorded in 78% of the participants in the experiment, especially noticeable in the IYA-22 group, where the main focus was on role-playing games.*

- *The development of writing and creative abilities, thanks to creative projects and visual tasks was noted in 72% of students of the IYA-23 group.*

- *The use of music and art therapy techniques helped to reduce the speech barrier in 68% of students of the IYA-25 group.*

- *The integration of digital platforms (Twee, ChatGPT) made it possible to improve the quality and quantity of completed creative tasks for 75% of all participants, which contributed to the individualization of learning.*

*The results of the experiment conducted using artistic technologies in teaching a foreign language to students of the M. Utemisov West Kazakhstan University showed clear positive changes. Firstly, the students demonstrated high motivation to learn the language, showing interest and activity in various forms of classes. Secondly, communication skills improved: students became more confident in speaking, more free to use the vocabulary and grammar they had learned, which was especially noticeable in role-playing games and theatrical performances.*

*In addition, creative methods contributed to the development of imagination, creative thinking and emotional perception of the material, which ensured a deeper and more lasting assimilation of knowledge. The use of digital platforms such as Twee and ChatGPT has made it possible to adapt assignments to the individual characteristics of each student, improve the quality of written work and make the learning process more exciting.*

*Conclusions based on the results of an experiment using artistic technologies in teaching a foreign language to students of the M.Utemisov West Kazakhstan University are based on an analysis of motivation, the level of language skills and creative activity of students.*

- 1. The use of art technologies contributes to a significant increase in students' motivation to learn a foreign language, which is manifested in their greater involvement and activity in the classroom.*

- 2. Artistic methods such as role-playing games, creative projects, musical and art therapy techniques have a positive effect on the development of communicative competence: students become more confident in their speech, learn vocabulary and grammar better and participate more actively in dialogues.*

- 3. Subjects and tasks based on a creative approach contribute to the development of imagination, creative thinking and emotional perception of the material, which contributes to deeper and more conscious language acquisition.*

- 4. The integration of digital platforms (Twee, ChatGPT) helps to individualize the learning process, improves the quality of written assignments and stimulates student independence.*

- 5. Based on the analysis of pedagogical experience and the results of the experiment, the need for a systematic introduction of artistic technologies into the process of teaching foreign languages is confirmed in order to form a harmoniously developed, creative personality who is fluent in the language.*

*Thus, the high effectiveness of art technologies as a methodological innovation has been experimentally confirmed, which complements traditional approaches and significantly improves the quality and results of teaching foreign languages at a modern university.*

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## THE STRUCTURAL AND FUNCTIONAL SPECIFICITIES OF EDUCATIONAL ENVIRONMENT DESIGN IN INCLUSIVE EDUCATION

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### **Abstract**

*The article discusses a model for supporting people with disabilities in the process of designing inclusive education and reveals the pedagogical conditions necessary for the successful implementation of inclusive practices in educational institutions. Particular attention is paid to the legislative aspects, principles, and goals of inclusive education, as well as the analysis of pedagogical conditions that ensure equal access to quality education for all students, taking into account their individual characteristics.*

*The presented model is aimed at developing the professional competence of students with disabilities, contributing to their successful socialization and adaptation in the professional sphere. The paper highlights the stages of model design, methods of its testing and monitoring, and describes the key results of its implementation.*

*The article will be useful for teachers, methodologists, researchers, and specialists in the field of inclusive education who are interested in developing and implementing effective models for supporting students with special educational needs.*

**Keywords:** *inclusive education, pedagogical design, pedagogical conditions, student support, limited health capabilities, professional competence, adaptation, socialization, inclusive model, secondary vocational education, higher education.*

*In accordance with the Law of the Republic of Kazakhstan «On Education», inclusive education is understood as the process of ensuring equal access to education for all students, taking into account the diversity of their special educational needs and individual abilities. This approach aims to create conditions for the full education, socialization, and development of children with disabilities, as well as other categories of students in need of support [1].*

*The definition shows that inclusive education has as its main goal to give children and their parents the right to choose the type of education and to create the necessary conditions for all children, without exception, to achieve success in education. The main principle of developing inclusion is to build an inclusive vertical structure to ensure the continuity of inclusive education and its succession at all levels [2]. The term «inclusive education» was officially established in the Salamanca statement on principles, policy and practice in special needs education and the convention on the rights of persons with disabilities. In these documents, inclusion is defined as a reform that supports and welcomes the differences and characteristics of each person. Inclusive education is seen as education for all children, regardless of their physical, intellectual, social, emotional, linguistic, or other characteristics. Currently, the principles of individualized models of inclusive vocational education for persons with disabilities at the secondary vocational and higher education levels are being actively researched, including from the perspective of developing their human potential [3].*

*This form of education allows for the expansion of the subjective social experience of students with disabilities and limited health capabilities, broadening their scope of action and communication [4]. According to Tassymbekov A.E., the characteristics of the subjective space of possible action in a situation of choice influence the success of students' personal self-determination [5]. The word «design» means the process of creating a project-a prototype, a model of a proposed or possible object, its state. There are several definitions of the concept of «pedagogical design» (fig.1).*

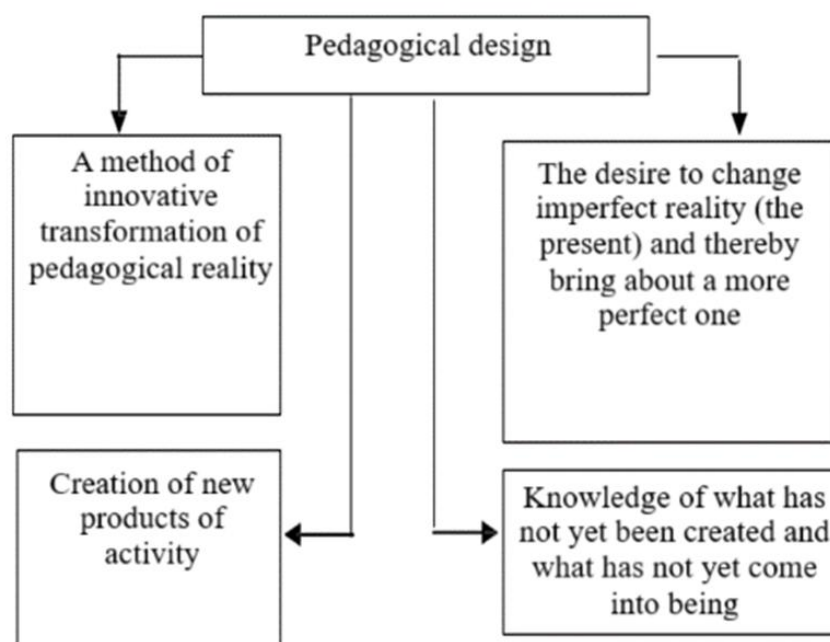


fig. 1. Definitions of the concept of «pedagogical design»  
(compiled by the author based on research materials)

Pedagogical conditions are crucial for the educational process. Various points of view on the definition of the concept of «pedagogical conditions» can be found in scientific literature, some of which are presented below.

The article by I.A.Oralkanova, «Psychological and pedagogical conditions for preparing teachers for inclusive education», presents an in-depth analysis of existing definitions of the concept of «pedagogical conditions». According to I.A.Oralkanova, a factor can only be predicted, so it should be considered an objective circumstance, whereas a pedagogical condition is an external circumstance consciously created by the teacher. Here, there is only an assumption, but no guarantee of a specific result of the pedagogical process. Based on the qualities of pedagogical conditions, the researcher proposes to design a model (system), for the construction of which it is necessary to identify external factors that significantly influence a specific pedagogical process and, from among them, to select pedagogically controllable conditions [6].

The model for supporting people with disabilities in the pedagogical conditions of inclusive education design is presented in the table.

Model for supporting persons with disabilities in educational settings designed for inclusive education  
(compiled by the author based on research materials)

| <b>Activities</b>        | <b>Type of activity</b>                                                                                                                                                                                                                           | <b>Result</b>                                                                                                                                                                                                                                                    |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Organizational stage     | Conducting research on the needs of people with disabilities, researching the capabilities of the education system for inclusive continuous education.                                                                                            | Results of research into the needs of people with disabilities, identification of opportunities for the education system in terms of inclusive continuous education.                                                                                             |
| Analytical stage         | Building a model for supporting people with disabilities in the pedagogical context of designing inclusive education.                                                                                                                             | Determination of approaches to building a model, development of a model structure for secondary vocational education and higher education institutions.                                                                                                          |
| Program content          | Programmatic, methodological, and organizational issues related to testing a model for monitoring the impact of comprehensive support for persons with disabilities on the quality of education in the context of continuous inclusive education. | Research methodology, determination of the structure and stages of the testing program: study of the personality of a child with disabilities and his or her family, selection of the form of psychological and pedagogical support, consultation and diagnosis. |
| Program monitoring       | Monitoring the impact of the model of comprehensive support for persons with disabilities in the context of continuous inclusive education in a special (correctional) educational institution.                                                   | Analysis of the results of research on the adaptation of persons with disabilities through the satisfaction of their educational needs in the system of continuous inclusive education.                                                                          |
| Results of model testing | Summarizing the results of testing.                                                                                                                                                                                                               | Teaching and methodological materials based on the results of research and testing.                                                                                                                                                                              |

*A key feature of the model is its focus on results. The result of implementing the support model is the level of professional competence of students with disabilities, ensuring their success in the workplace. Effective support for inclusive education influences the development of personal and professional support for students and, ultimately, their overall personal development [4].*

*It should be noted that educational institutions implementing inclusive practices must create conditions that guarantee the possibility of:*

- achievement of the planned results of the core educational program by all students;*
- using standard and specific scales for assessing the academic achievements of children with disabilities, in line with their special educational needs;*
- adequate assessment of the development of life skills in children with disabilities by all participants in the educational process;*
- targeted development of the ability of children with disabilities to communicate and interact with their peers;*
- identification and development of the abilities of students with disabilities through a system of clubs, sections, studios, and circles, the organization of socially useful activities, including social practice, using the opportunities of supplementary education institutions;*
- the inclusion of children with disabilities in intellectual and creative competitions, scientific and technical creativity, and project and research activities that are accessible to them;*
- Involving children with disabilities, their parents (legal representatives), teachers, and the public in the development of the core educational program, the design and development of the social educational environment, and the formation and implementation of individual educational paths for students;*
- the use of modern, scientifically based, and reliable corrective technologies in the educational process that are adequate for the special educational needs of children with disabilities;*
- interaction in a unified educational space between educational and special (corrective) schools for the purpose of productive use of accumulated pedagogical experience in teaching children with disabilities and the resources created for this purpose.*

*Thus, the article presents a comprehensive model for supporting persons with disabilities in the process of designing inclusive education, based on an analysis of the pedagogical conditions necessary for the successful implementation of inclusive practices in educational institutions. The main focus is on creating conditions that ensure equal access to quality education and the development of the personal and professional potential of students with special educational needs.*

*The developed model is aimed at achieving specific results - the formation of professional competence of students with disabilities and their successful integration into the industrial sphere. At the same time, the importance of a systematic approach and interaction of all participants in the educational process is emphasized to ensure the continuity of inclusive education at all levels.*

*The implementation of the proposed pedagogical conditions contributes to the creation of a favorable educational environment that takes into account the individual characteristics of students and supports their development, socialization, and adaptation. Thus, this model is an important tool for improving the effectiveness of inclusive education and the development of an inclusive society as a whole.*

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## *Philological sciences*

### TENSE AND STYLE CATEGORY IN ENGLISH

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### İNGİLIS DİLİNDƏ ZAMAN VƏ TƏRZ KATEQORİYASI

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Ətraf gerçəkliyin bütün hadisələri zamanda gedir və bu zaman obyektiv, sonsuz və dönməzdir. Hadisələrin hamısını üç zaman planından birinə – indiki, keçmiş və gələcəyə aid edirik. İstənilən hərəkət və ya hadisədən danışanda bizə onları nitq məqamı ilə tutuşdurmağa imkan verən müəyyən dil vasitələrindən, məhz leksik – xüsusi söz və söz birləşmələrindən today, yesterday, now, then istifadə edirik, heç də vacib deyil, çünki bu plan istənilən sözlərdə müəyyən feil formaları ilə çatdırılır və bunlar zaman formaları adlanır. Danışan hərəkət və hadisəni indi, yəni nitq məqamında yer alan kimi, gələcəkdə, yəni nitq anından sonra və ya keçmişdə, yəni nitq anından əvvəl yer alan kimi təqdim edə bilər. Feilin bildirdiyi hərəkətin icrasındakı zamanda fərq sistematik olaraq qrammatik formalarda ifadə olunduğundan, biz feilin zaman kateqoriyasının mövcudluğundan danışa bilirik. Feilin zaman kateqoriyası feilin bildirdiyi hərəkətin zamanda lokallaşdırılmasına xidmət edir. Danışan nitq məqamından çıxış nöqtəsi kimi istifadə edərək gerçəkliyin hadisələrini onunla tutuşdurur və buna müvafiq olaraq dildəki feil formalarından istifadə edir. Deməli, dil zaman formaları qeyri-müstəqil xarakterlidir, dil zamanı nisbidir, halbuki mövcudluq obyektivdir. Nitq anı danışan üçün indidir, keçmiş isə bu ana nisbətən sözün müstəqil mənasında həqiqətən keçmişdir. “Nitq anı” anlayışı danışan tərəfindən sərbəst müəyyənləşdirilmir, o, obyektiv zamanın bir nöqtəsi kimi mövcuddur.

Dil zamanı (Tense) mütləq obyektiv zamanla (Time) üst-üstə düşür. İnsan obyektiv zamanın dil zamanının mənası ilə üst-üstə düşməyən müxtəlif kəsiklərini bildirmək üçün şüurlu surətdə müxtəlif zaman formalarından istifadə edə bilər. Bundan başqa, zaman formaları öz birbaşa mənalılarında istifadə edilməyə bilər. Belə ki, indiki zaman forması qeyri-müəyyən və ya davamedici gələcəkdə gözlənilən “When does your train leave?; Where are you going for a holiday?” və ya keçmişdə baş vermiş hərəkəti bildirə bilər. Sonuncu halda “tarixi indiki” (Historical Present) adlandırılan forma istifadə edilir. Bunun üçün bir sıra keçmiş hərəkətlərin ardıcıl sırada “Suddenly John comes in and says = came and said” düzülməsi səciyyəvidir. İndiki zaman formasındakı bəzi feillər həm də keçmişdəki ayrıca bir hadisəni də bildirə bilər: “I forget when it was = I have forgotten; John says it’s interesting = John said”. Elə kontekstlər var ki, onlarda indiki zaman forması hərəkəti ümumiyyətlə hansısa konkret zaman planına aid etmir. Bu, adətən, gizli modal mənalılarının mövcudluğu ilə bağlıdır: “Do you speak French? = Can you speak?”. Deməli ya dil, ya da qrammatik zamandan danışanda biz onların obyektiv zamana nisbətini və eyni zamanda müəyyən fərqi müəyyənləşdiririk. İngilis dilində bu fərqlərdən ən əsası budur ki, əgər obyektiv zaman açıq-aşkar keçmiş, indiki və gələcək zamanlara bölünürsə, dil zamanı üçün çoxlu sayda ifadə formaları səciyyəvidir. İngilis dilində üç əsas zaman dövrü feilin müxtəlif formaları ilə ifadə olunur: qeyri-müəyyən (Indefinite), davamedici (Continuous), bitmiş (Perfect), bitmiş-davamedici (Perfect Continuous).

Dildə zaman bölgüləri – indiki, keçmiş, gələcək üst-üstə düşən feil formalarının mövcudluğu onların zaman mənasından başqa əlavə məna daşdığını ehtimal etməyə əsas verir. İngilis dilində bu formaların statusu haqqında məsələni həll etməzdən öncə tərz kateqoriyasını daha bariz ifadə olunduğu başqa bir dil əsasında nəzərdən keçirək. Belə dillərdən biri rus dilidir. Bu dildə zaman kateqoriyası ilə yanaşı tərz kateqoriyası da mövcuddur. Rus dilində tərz qrammatik kateqoriya olub hərəkəti icra üsuluna görə səciyyələndirir və dəqiq formal göstəricilərə – prefiksasiyaya malikdir. Rus dilində feillər hərəkətin bitkinliyini bildirən bitmiş tərz (Perfective aspect) formasında və ya prosesin bitmədiyini, davam etdiyini bildirən bitməmiş tərz (Imperfective aspect) formasında ola bilərlər. Yalnız mənasında “hərəkətin

*hədliliyi*" (termination of the action) – komponentinti, yəni hər hansı vəziyyətin əvvəli və ya axırı olan feillərin bitmiş tərz var. Rus dilində bitmiş tərz feillərinin çoxu tərz cütlüyü yaradır: cütlüyə daxil olan feillər eyni leksik mənaya malik olur və yalnız qrammatik tərz mənasına görə fərqlənirlər [6, s.32]. Feilin tərz xarakteri asılı qrammatik mənaya olub, feilləri bildirdikləri hərəkətin həddə münasibətə görə birləşdirir.

Təbii ki, "vəziyyətin əvvəli, axırı" komponentləri olmayan bitməmiş tərz feillərinin sırf qrammatik bitmiş tərz forması ola bilməz. Bu halda prosesin "əvvəli" və ya "axırı" mənasını yalnız əlavə sözdüzəldici affiksin köməkliyi ilə vermək olar. İngilis dilində həmçinin hədli və qeyri-hədli feillər var. Hədli feillər həddə çatanda davam edə bilməyən hərəkəti bildirən feillərdir: hədd sərhəd qoyur – hərəkət tükənmişdir [8, s.49]. Məsələn, "to arrive, to bring, to catch, to break, to discover" feilləri belələrindəndir. Əgər cümlədə hədli feil işlədilibsə, ingilis dilində biz həmin bu hədd komponentini vurğulaya və müvafiq olaraq, hərəkətin "bitkinliyi" tərz mənasını ifadə edə bilirik: "I have built a house" – "Ev mövcud olmağa başladı". Və ya biz başqa komponentləri vurğulayıb, məsələn, "hərəkətin davamediciliyini, bitmədiyini" ifadə edən tərz mənasını çatdırı bilirik: "I am building a house" – "Mən bu hərəkəti... məqsədlə edirəm". Qeyri-hədli feillərin bildirdikləri hərəkətdə hədd semantikasi olmur, hədd kənardan qoyulan, qeyri-dil reallığı ilə şərtlənən, amma feilin semantikasından irəli gəlməyən kimi düşünülə bilər: "to sleep, to live, to belong, to enjoy". Əlbəttə, göstərilən feillərin bildirdikləri hərəkətlərin hamısı tez ya gec tükənir, bitir, amma bu daxili həddin olmasından irəli gəlmir. Qeyri-hədli feillər qrupu böyük deyil. Bu qrupa həm obyektiv, həm də subyektiv səciyyəli statik münasibəti bildirən feillər, həmçinin məkanda vəziyyəti bildirən feillər daxildir: "to consist, to be, to love, to stand, to lie".

Bu iki qrup arasında çoxsaylı ikili xarakterli feillərdən ibarət qrup yerləşir. Bu feillər kontekstdən asılı olaraq bu və ya digər mənada çıxış edə bilirlər: "to laugh, to feel, to move, to walk, to look". "Then, from the first court, Crawford walked smoothly into view." "Snow" – hədli mənə. "He would have to walk the five miles north." (R. Williams) – qeyri-hədli mənə.

Kontekstin bu və ya digər mənanı realizə etməsinə kömək edən əsas amilləri zərflilər, həmçinin hədli və ya qeyri-hədli feillərlə ifadə olunan yekcins xəbərlərdir. Feilin tərz xarakterini leksik hadisə kimi nəzərdən keçirmək olmaz, çünki İ.P.İvanovanın qeyd etdiyi kimi, hədli, qeyri-hədli və ikili xarakterli feillərin onları ümumi qrupda birləşdirən leksik mənası yoxdur. Eyni zamanda feilin tərz xarakteri qrammatik əlamətlərə malikdir, daha dəqiq desək, hərəkətin mövcudluq formasını çatdırır, amma leksik mənanı müşayiət edir. Formal zahiri göstəricilər olmadığından feilin tərz xarakterini qrammatik kateqoriya hesab etmək qeyri-mümkündür və buna görə də onu öz formasını məzmunca yaxın zaman qrammatik kateqoriyası ilə qarşılıqlı əlaqədə alan qrammatik mənə hesab etmək olar. Formal göstəriciləri olan və qrammatik kateqoriyaya daxil olan əsas qrammatik mənadan fərqli olaraq, belə qrammatik mənanı adətən "asılı qrammatik mənə" adlandırırlar. "Hədlilik – qeyri-hədlilik" asılı qrammatik mənə bəzi zaman formalarının mənə fərquində özünü göstirir [8, s.49].

Məsələn, feilin hədliliyi və qeyri-hədliliyini onun qeyri-müəyyən və bitmiş formaları arasında seçim edəndə nəzərə almaq lazım gəlir. Deyək ki, hərəkətin əhatə etdiyi zaman dövrünün bitkinliyini bildirmək üçün feilin məsdərdə olan aşağıdakı tip kontekstlərdə feil bitmiş forması tələb edilir: "You will feel better after you have had some sleep". Amma hədli feillər üçün belə kontekstlərdə qeyri-müəyyən forma tamamilə yetərlidir, çünki leksik mənadakı özünə səbəb hərəkət istənilən halda bitkin kimi təqdim olunur: "He will feel better when he wakes" [57, 35].

Amma ingilis dilində tərz mənalının ifadəsi məsələsi xeyli mürəkkəbdir. Bu məsələ mütəxəssislər arasında ən mübahisəlidir. Xarici tədqiqatların çoxunda tərz qrammatik kateqoriyası məsələsi ya ümumiyyətlə nəzərdən keçirilmir, ya da zaman kateqoriyası ilə əlaqələndirilmir. Kifayət qədər tez-tez tərz mənasının olması yalnız feil formalarının bir qrupunda – Continuous – qeyd olunur. Bu, "genişləndirilmiş" Expanded, davamedici (Durative), davamlı (Continuous), "progressiv" (Progressive) adlandırılan formalar hərəkətin getmə üsulunu çatdırır, onu proses kimi xarakterizə edir. Qalan formalar sırf zaman formaları kimi nəzərdən keçirilir.

Tədqiqatçıların əksəriyyəti bir məsələdə yekdildirlər. Onların hamısı "Continuous" formasının tərz xarakterli olmasını qəbul edirlər. Mübahisəli olan "Indefinite" və "Perfect" formalarının xüsusi tərz xarakteristikasının olması məsələsidir. "Indefinite" forması qrupu çox vaxt zaman qrupu kimi «Perfect» qrupu ilə qarşı-qarşıya qoyulur. "Goes" və "is going" formalarını müqayisə etdikdə yalnız "Continuous" formasının presesuallığının tərz mənası bariz təzahür edir – "is going", halbuki "goes" forması o qədər qeyri-müəyyən, o qədər geniş mənaya malikdir ki, bəzən hesab edirlər ki, onun ümumiyyətlə tərz mənası yoxdur. "Perfect" formasının mahiyyətinin şərh bundan da ziddiyyətlidir. Avropa tədqiqatçılarının çoxu bu formanı zaman forması kimi nəzərdən keçirirlər, amma sovet, hazırda isə rus mütəxəssisləri onları

ya *tərz*, ya da *tərz-zaman* formaları hesab edirlər. V.V.Qureviç bildirir ki, bitmiş forma heç də həmişə *hərəkətin* bitkinliyini bildirmir. Məsələn, *"I have lived here all my life"* cümləsində bitmiş yalnız *hərəkətin* bilavasitə indiyə qədər uzandığını bildirir və əlbəttə, nəticə mənası daşımır, deyək ki, *"I have built a house"* cümləsində olduğu kimi.[10,25] Bu da onunla izah olunur ki, *"live"* feilinin özündə nəsə bir hədlilik komponenti yoxdur. Amma hətta hədlili ingilis feili bitmiş formada heç də həmişə verilən an üçün nəticəli vəziyyətin yaranması *tərz* mənasını ifadə etmir. Məsələn, *"He has come at last"* *hərəkət* nəticəsində o hazırda buradadır cümləsində nəticə mənası bariz ifadə olunmuşdur. *"He has come down to see her too often"* (tez-tez gəlirdi) cümləsində isə *"O hazırda buradadır"* mənası yoxdur, çünki *hərəkət* keçmişdə dəfələrlə təkrarlanan kimi təqdim olunmuşdur. Beləliklə, bitkinlik mənası ingilis prefektinə daimi xas deyil. Amma bitmiş formanın öz, onun mənasında daim yer alan mənası var: A.İ.Smirnitski bildirir ki, bu hansısa məqamdan əvvəl gəlmək, yəni keçmiş, indiki və ya gələcəkdə bilavasitə hansısa məqamdan əvvəl baş vermək mənasıdır. Bir məqama diqqət yetirək: *"hansısa məqamdan əvvəl gəlmək"* *hərəkətlərin* zamanda nisbətidir, yəni bu aşkar *tərz* deyil, zaman nisbətidir. A.İ.Smirnitski bitmiş formanın bu mənasını tamamilə dəqiq müəyyənləşdirir və *hərəkətin* situasiyada fərqləndirilən hansısa məqama *"zaman aidliyi"*nə görə *"time relation"*, və ya A.B.ilişin bir qədər dəyişilmiş formada dediyi kimi *"time correlation"* – *"zaman nisbəti"*, yəni *hərəkətin* zaman nisbətinə görə daha dəqiqi, əvvəl gəlməsinə görə ifadəsi adlandırır.

İngilis feil formalarında *tərz* və zaman kateqoriyalarının qarşılıqlı münasibətinin daha dolğun və bitkin mənzərəsini İ.P.İvanova yaratmışdır. O, *tərz* mənasını zaman formaları ilə sıx əlaqədə nəzərdən keçirir və hesab edir ki, *tərz* feil formasının daimi xarakteristikası, zaman isə mütləq, amma dəyişən kəmiyyətidir [8, s.53].

Beləliklə, ingilis *tərz* formalarının spesifik xüsusiyyəti bundadır ki, *tərz* mənası mütləq *hərəkətin* getdiyi zaman kəsiyinə işarə ilə müşayiət olunur və deməli, zaman çərçivəsində ifadə olunur. *Tərzi* daha dəqiq formanın göstərdiyi zaman məqamına kəsiyinə nisbətə *hərəkətin* getmə xarakterini çatdıran kateqoriya da adlandırmaq olar. Buna görə də *tərz* formaları *tərz-zaman* formaları adlandırılır ki, ingilis dilində *tərz* və zamanın qırılmaz əlaqəsi vurğulansın.

Yuxarıda qeyd etdiyimiz kimi, ingilis dilində bilavasitə zaman formalarından başqa (indiki, keçmiş və gələcək), daha dörd xüsusi zaman forması mövcuddur. Bu, qeyri-müəyyən, davamedici, bitmiş və bitmiş-davamedici formalarıdır. İngilis feili zamanları sisteminde bu formalardan hər biri həm ayrılıqda, həm də bir-biri ilə müqayisədə dəfələrlə nəzərdən keçirilmişdir. Amma bununla belə qrammatiklər arasında hələ də bu formaların *tərz* məzmununa vahid baxış yoxdur.

*"Indefinite"* formalarını (keçmiş, indiki və gələcək) birləşdirən qeyri-müəyyən növ çatdırdığı mənalara rəngarəngliyi ilə səciyyələnilir: *"Indefinite"* formaları ayrıca, bitmiş *hərəkəti*, bir sıra ardıcıl *hərəkətləri* və ya bitməmiş *hərəkəti* bildirə bilir. Aydındır ki, *"Indefinite"* bilavasitə özündə *tərz* mənası daşımır, bu kimi məna ya feilin *tərz* xarakteri ilə, ya da kontekstlə şərtlənir. Bu forma həm *"Continuous"*, həm də *"Perfect"* formalarına sinonimik işlədilə bilir. İ.P.İvanova *"Indefinite"* növün *tərz* xarakterinə laqeydliyindən çıxış edərək bu növdə *tərz* xarakterinin olmaması qənaətinə gəlir və bu formanı *tərz*in sıfırıncı forması hesab etməyi təklif edir. Beləliklə, *"Indefinite"* növ formaları sırf zaman səciyyəlidir.

Bununla belə, *"Indefinite"* adı təsadüfi deyil. Həqiqətən də bu növün formaları *hərəkəti* gedişi xarakteri tərəfindən səciyyələndirmir, onlar yalnız mövcudluğunu və ya mövcud olmamasını qeyd edir və onu bu və ya digər zaman kəsiyinə yerləşdirir. Qeyri-müəyyən növün indiki zamanı nitq məqamı ilə üst-üstə düşə və ya ondan xeyli geniş ola bilər. Qeyri-müəyyən növün indiki zamanı həm də nəsə qeyri-adi bir şeyin olmasını, həmin zaman kəsiyində mövcud olan əşyanın hansısa vəziyyətini bildiren istənilən sözlərdə istifadə oluna bilər: *"In the bird world, of course, one finds homes of every shape and size"*. Və nəhayət, qeyri-müəyyən növün indiki zamanı şərti nitq məqamında baş verən *hərəkəti* də çatdırır: *"The reporter stands gazing fervently at Perkin for a second, then grasps his hand and shakes it vigorously..."*. Bu növ həmçinin təkrarlanan *hərəkəti* də ifadə edə bilər, lakin sistemləşdirilmiş kontekstdə və xüsusi halların qeyd olunması şərtlə.

Kontekstdə ehtimal edilən *hərəkətin* vaxtı göstərildikdə, qeyri-müəyyən növün indiki zamanı *hərəkəti* gələcəyə aid edir: *"Only two days more. Audrey goes on Wednesday Christie"*. Qeyri-müəyyən növün indiki zamanı başqa tip sistemləşdirilmiş kontekstdə də *hərəkəti* gələcək zamana aid edir. Bu, məhz şərt və zaman budaq cümləsinin xəbəri mövqeyində baş verir. Bu halda gələcəyə birbaşa işarə baş cümlənin feil formasında – xəbərində olur: *"If I see him, I said, I'll let you know"*.

Qeyri-müəyyən növün keçmiş zamanı göstərir ki, *hərəkət* nitq məqamını özündə ehtiva etməyən zaman kəsiyində baş vermişdir. Onun getmə üsuluna, yəni *hərəkətin* *tərz* ifadəsinə, gəldikdə isə, əsas növ keçmiş zaman bu barədə heç nə demir və *hərəkətin* getmə xarakteri haqqında informasiya feilin

qrammatik formasından deyil, kontekstdən gəlir. İndiki zaman kimi keçmiş zaman da təkrar hərəkətləri çatdırır bilir, əgər kontekstdə müvafiq işarə-göstəriş varsa. Təkrarlıq mənası burada formadan deyil, kontekstdən gəlir: "Whenever he saw in the distance another figure wheeling a cart with a ladder and buckets, he fled in panic..." (Waine). Bir-birinin ardınca gələn hədlə feillər təhkiyədə hərəkətlərin ardıcılığını çatdırırlar. Qeyri-hədlə feillər əşyaların vəziyyətini keçmiş zamanın hər hansı anında təsvir edərək təhkiyədə hadisənin gedişini dayandırirlər.

Qeyri-müəyyən növün keçmiş zamanı təhkiyənin aparıcı formasıdır. Məsələ burasındadır ki, yalnız bu formada ardıcıl hərəkətlərin növbələşməsi çatdırılır. Qalan növlər bu və ya digər hərəkətin xarakterini detallandırır, lakin hərəkətin zamanda gedişini çatdırmırlar. Keçmişdə hadisənin zamanda inkişafının təsviri yalnız qeyri-müəyyən növ keçmiş zamana xas funksiyadır.

Qeyri-müəyyən növ gələcək zaman hələ baş verməmiş, indidən sonrakı zaman kəsiyinə planlaşdırılan, nitq anını ehtiva etməyən hərəkəti bildirir. Gələcək zaman forması, adətən, hadisələrin əlaqəli ardıcıl təhkiyəsi üçün istifadə edilmir. Bu formaların sırf zaman mənasına maliklik olması və ya onların modal çalarlı olması məsələsi mübahisəlidir.

**Keywords :** tense form, aspect, category

**Acar sözlər:** zaman forması, tərz, kateqoriya

**Ключевые слова:** аспект, категория

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## DEVELOPING STUDENT MOTIVATION IN THE CONTEXT OF DIGITAL TRANSFORMATION IN EDUCATION

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### **Abstract**

*The article is devoted to the analysis of the main trends in the digital transformation of education and its impact on the formation of learning motivation among high school students in the context of the active implementation of modern technologies. The study concludes that digitalization is not only the most important factor in the modernization of the educational system as a whole but also significantly changes the nature of interaction among all participants in the learning process — teachers, students, and administrators. This transformation creates new opportunities for learners' personal and professional development, contributes to the formation of flexible skills, adaptability, and readiness to meet the challenges of the modern world.*

*The theoretical part of the article provides a detailed analysis of key approaches to understanding motivation in educational psychology. Special attention is given to the distinction between intrinsic and extrinsic components of motivation, which have a significant impact on the success of learning activities. Intrinsic motivation, based on personal interest in the learning process and the desire for self-development, is considered a crucial factor in forming sustainable learning activity as well as developing critical and creative thinking among high school students. At the same time, the article emphasizes the need to adapt motivation-stimulating methods to the characteristics of the digital generation, which demonstrates a strong need for interactivity, autonomy, and the ability to choose an individual learning path.*

*A significant focus is placed on the use of modern digital educational platforms, systems of distance and adaptive learning, and gamification methods. These tools are viewed as effective mechanisms for increasing student engagement, maintaining cognitive interest, and developing collaboration and self-regulation skills. Examples of successful integration of interactive technologies into the educational process are provided, demonstrating their positive impact on motivational background and learning outcomes. The study also considers challenges and potential risks associated with digitalization, such as information overload and the need to ensure digital safety.*

*The article emphasizes the importance of individualizing the educational process through digital tools, allowing teachers to consider each student's level of preparedness and learning pace. The practical part focuses on identifying effective pedagogical strategies aimed at enhancing student motivation through the use of digital resources. The article concludes that digital transformation not only increases student motivation but also contributes to the development of key 21st-century competencies — critical thinking, creativity, and digital literacy.*

**Keywords:** *student motivation, digital transformation of education, gamification, digital educational platforms, learning activity, adaptive learning, interactive technologies, high school students, educational technologies, digitalization of education.*

### *Introduction*

*Digital transformation in education represents one of the key processes reshaping contemporary society. The integration of modern technologies into learning opens broad opportunities for improving its quality while posing new challenges for educators and researchers. One of the most pressing issues is the decline in student motivation, which makes it essential to explore effective digital strategies that foster engagement and self-directed learning.*

*The concept and significance of motivation in the educational process*

*Motivation remains a central factor determining academic success. According to the self-determination theory by Deci and Ryan, motivation can be intrinsic—driven by interest in the activity itself—or extrinsic, influenced by external rewards and recognition. In education, intrinsic motivation plays a crucial role, as it promotes deeper understanding and critical thinking. Kazakhstani scholars also emphasize the importance of developing students' motivation through active, student-centered methods. Serebrenikova [1] highlights that motivation stimulates cognitive activity and sustainable interest in learning, while Turganbayeva [2] and Abzhanova [3] point out the role of creative engagement and success-based learning situations in enhancing academic activity. These findings align with modern pedagogical approaches that prioritize autonomy, competence, and social interaction as key components of motivation.*

#### *Key trends and challenges in the digital transformation of education*

*The digital transformation of education in Kazakhstan has become a crucial stage in the modernization of the learning system, aimed at preparing a new generation equipped with high digital competence and a motivation for self-education. Digitalization facilitates the transfer of the educational process into an information environment where students gain access to interactive educational resources, significantly boosting their interest and personal motivation for learning. A vital factor is that the contemporary digital generation differs from previous ones in their knowledge, method of information perception, and needs, which necessitates the adaptation of motivation stimulation methods.*

*The research by N. B. Serikbayeva reveals the peculiarities of forming student learning motivation in the digital educational environment, emphasizing the need to consider psychological and pedagogical factors such as self-organization, autonomy, and engagement in distance learning. Specifically, Serikbayeva notes that the successful functioning of motivation is linked to creating conditions that stimulate learners' activity and their interest in academic work [4]. A. S. Baigunakova, in her work, analyzes the prospects of the digital transformation of project-based learning in Kazakhstani universities as a way to enhance student motivation through their involvement in independent research and creative projects, with a focus on utilizing new digital technologies [5]. G. G. Dzhusupova and co-authors examine the motivational aspects of introducing digital competencies in public administration, which is indirectly related to educational motivation, demonstrating the importance of leadership and digital literacy in fostering motivation for learning and innovation [6].*

*Within the framework of the national program "Digital Kazakhstan," schools are being equipped with multimedia technology, broadband internet access is provided, and a database of electronic learning materials is being created. For instance, Secondary School No. 6 named after Kozhabergen Zhyrau in Astana implemented a system using QR codes for interactive assignments, which significantly increased students' interest in the learning material and promoted active academic engagement [7]. Another example is the use of electronic educational platforms that allow for the adaptation of learning content to individual student abilities and interests, thereby strengthening intrinsic motivation and contributing to the development of skills in independent information searching and critical thinking [8].*

*Thus, the development of student motivation under the conditions of digital transformation requires a comprehensive approach that includes pedagogical support, the use of modern digital learning tools, and the creation of conditions conducive to active, independent student activity. Particular attention should be paid to the development of digital literacy, project-based learning, and interactive teaching methods.*

#### *Methods for enhancing student motivation in a digital environment*

*Interactive technologies, such as virtual and augmented reality (VR/AR), play a key role in increasing students' interest in learning. These technologies allow for the creation of unique educational environments, ensuring a deeper immersion into the learning material. For example, the use of virtual reality to model historical events or scientific experiments gives students the opportunity to actively participate in the learning process, which significantly increases their engagement. Research by EdTechXGlobal shows that the use of such technologies increases student engagement by 80%, confirming their effectiveness in the educational environment. Concurrently, electronic educational resources are becoming increasingly relevant, replacing traditional books and journals that often contain outdated information [9]. Thus, the integration of modern technologies and resources forms a more dynamic and up-to-date educational environment.*

*Individualized learning approaches, implemented using adaptive educational platforms, represent a powerful tool for boosting student motivation. Platforms such as DreamBox allow for the adaptation of educational content to the unique needs and skill level of each student, which contributes to a deeper*

*understanding of the material and reduces the stress associated with learning. According to a McKinsey report, the use of such technologies increases student academic performance by 20%, underscoring the significance of individualization in the educational process.*

*Research in Kazakhstan confirms the importance of implementing modern technologies in the educational process to increase motivation and improve learning outcomes. For instance, studies by Kazakhstani scholars have shown the effectiveness of the case-study technology in improving student engagement through active participation in educational situations [10]. More recent studies point to the significant potential of gamification in education: Ermaganbetova M. proved that the use of gamified platforms for teaching programming significantly increases the motivation of high school students and contributes to the development of cognitive skills, which aligns with the goals of digital transformation of education in Kazakhstan [11]. These approaches not only strengthen engagement but also create a more meaningful educational experience.*

*The role of gamification in the educational process*

*Gamification is the process of implementing game elements and game design principles into non-game contexts, such as the educational process, with the goal of increasing participant engagement and motivation by creating a game-like experience. Popularized in the early 2010s, gamification has found wide application in various fields, including education. In this context, it is used to stimulate students' interest and improve their learning outcomes. Learning can be viewed as a process conditioned by the interaction of a student's external and internal motives, which underscores the importance of considering these factors in the educational process [12]. Thus, gamification becomes an effective tool that facilitates deeper student involvement in the learning process.*

*One successful example of applying gamification in education is the Classcraft platform, which transforms the learning process into a role-playing game. Students take on character roles, complete assignments, and earn points for academic success and teamwork participation. This approach helps to increase their engagement and motivation, making learning more interesting and captivating. A 2018 study conducted at the University of Toronto showed that the use of gamification increased student engagement by 30%. This confirms that game elements can significantly improve students' interaction with the learning material, creating a more appealing and interactive educational environment. In Kazakhstan, gamification in education is actively developing, with an annual growth of 28%. Local educators note a significant improvement in motivation and academic results through game technologies, including team assignments and an achievement system adapted to national educational programs [13]. Gamification is also actively applied in online courses, such as Duolingo. On this platform, users learn foreign languages by completing interactive tasks and receiving rewards for achievements. This helps to maintain interest in learning and motivates students to continue their studies despite potential difficulties.*

*Gamification has a significant impact on students' intrinsic motivation, contributing to the formation of a sense of achievement and progress, which is essential for maintaining an interest in learning. The use of game elements allows students to experience satisfaction from reached goals. Ermaganbetova M.'s research demonstrated that game platforms increase students' confidence and activity, improving their achievements in programming [14]. This aligns with the objectives of digital transformation and supports the development of STEM-education in Kazakhstan. In this context, it is worth noting that "one of the most important factors for successful distance learning is the correct motivation of the student. Cognitive motivation, i.e., the motivation for conscious action, plays a large role" [15]. Thus, gamification not only increases interest but also contributes to the development of conscious (cognitive) motivation, which makes the learning process more effective.*

*The effectiveness of online courses and adaptive learning platforms*

*Online courses and adaptive educational platforms play a vital role in the contemporary educational process, ensuring accessibility and flexibility in learning. According to a 2021 study by Coursera and Class Central, over 70% of students noted that online courses contribute to better time organization and focus on studies. This is because students can choose a convenient time and pace to master the material, allowing for their individual needs and schedules. In Kazakhstan, online education is also gaining momentum: since the beginning of 2025, over 66 thousand Kazakhstani citizens have received certificates for completing online courses on the state platform Skills Enbek, including a large number of young people and the unemployed, confirming the accessibility and social significance of these forms of education. Moreover, research shows that interactive and game-based methods in online learning in Kazakhstan contribute to better material assimilation and sustain motivation, which is especially important in the context of digital transformation and remote learning.*

*Integration of digital tools*

*Developing a strategy for integrating digital tools into the educational process requires a clear understanding of the sequence of actions necessary to achieve the set goals. According to a UNESCO 2020 study, the successful implementation of digital technologies in education begins with an analysis of the needs of students and teachers. This stage allows for the identification of key tasks that must be solved using digital tools and the determination of priorities in their use. An example of this approach is the "Digital School" program in Estonia, where both educational needs and the technical capabilities of schools were taken into account during the analysis phase. On the other hand, "issues of adaptive learning are considered from the standpoint of implementing a student-centered educational process using modern methods and technologies based on data analysis and machine learning" [16]. This approach not only promotes a more effective use of digital tools but also allows for the adaptation of the educational process to the individual needs of students, which is a crucial aspect of modern educational practices.*

*Evaluation and future prospects*

*Evaluating the effectiveness of implementing digital tools in the educational process is a key aspect for understanding their impact on student motivation. Modern methods include both quantitative and qualitative approaches. According to research by the International Society for Technology in Education (ISTE), the use of interactive learning platforms, such as Moodle and Edmodo, showed a significant increase in student engagement, which was confirmed by analysis of attendance, activity in learning modules, and feedback. These data underscore the importance of digital technologies for stimulating learning activity. In Kazakhstan, the digital education program is actively developing: Minister of Education Zhuldyz Suleimenova noted the implementation of new modules on using digital technologies to develop functional literacy and personalize learning with artificial intelligence, as well as the large number of educators who have undergone training in digital competencies. These measures are aimed at improving the quality of education and student involvement in the learning process, which confirms the significance of a systematic evaluation of the effectiveness of digital tools in Kazakhstani educational practice [17].*

*More than 300 free IT classes have been opened in Kazakhstan, equipped with modern technology for studying programming, 3D modeling, and robotics. The project "Bolashak Engineers 1-2" has been implemented in 20 schools and is focused on developing students' engineering and technical skills [18].*

*Within the framework of national programs, 80% of textbooks have been converted into electronic format. This grants students 24/7 access to up-to-date educational materials, which enhances motivation and the quality of knowledge assimilation [19]. The Coursera platform, integrated into the programs of Kazakhstan's leading universities, provides students access to over 50 courses with the possibility of obtaining certificates. Over 80 thousand students completed training through these courses last year, significantly expanding educational opportunities [20]. Narkhoz University became the first in Central Asia to introduce digital NFT-diplomas secured by blockchain technology. This innovative approach ensures the transparency and authenticity of documents [21]. In a number of Kazakhstani schools, gaming technologies are actively used to increase student interest and motivation. The implementation of gamified platforms and interactive assignments contributes to the development of critical thinking and creative abilities [22].*

*The provided examples demonstrate how digital technologies are transforming the educational process in Kazakhstan, contributing to the modernization of the system and the enhancement of student motivation. The continued dissemination of innovations and systemic support for the digitalization of education will foster the development of competitive specialists for the future.*

*The conducted research confirmed that the digital transformation of education provides unique opportunities for enhancing student motivation. The use of technologies such as gamification, online courses, and adaptive educational platforms allows for the creation of a more interactive and engaging learning environment. The theoretical analysis of student motivation showed that considering their individual interests and preferences plays a key role in increasing engagement and academic performance. Thus, the digitalization of education, when approached correctly, can become an effective tool for solving the problem of low student motivation.*

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## **SPECIFIC FEATURES OF THE PHRASEOLOGICAL SYSTEM OF MODERN ENGLISH**

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### **Abstract**

*The phraseological system of Modern English represents a crucial component of its lexical and semantic structure, reflecting both historical development and contemporary linguistic trends. Phraseological units, including idioms, fixed expressions, and collocations, serve as highly structured and semantically rich elements that convey cultural, social, and pragmatic meanings. This study examines the specific features of the phraseological system in Modern English, highlighting its structural, semantic, and functional characteristics. Emphasis is placed on the role of idiomaticity, contextual variability, and semantic transparency, as well as the interaction between phraseological units and the dynamic evolution of the language. By analyzing theoretical frameworks and practical examples, the research demonstrates the importance of phraseology in effective communication, language teaching, and lexicographical practice.*

**Keywords:** *Phraseology, Idioms, Collocations, Modern English, Lexical-Semantic System, Idiomaticity*

### *Introduction*

*Modern English is characterized not only by its rich vocabulary and flexible grammatical structures but also by a highly organized phraseological system. Phraseological units (Pus), including idioms, set expressions, phrasal verbs, and fixed collocations, perform crucial functions in communication, providing expressiveness, precision, and cultural depth. Understanding the phraseological system is essential for linguists, lexicographers, and language learners because it reflects both historical linguistic development and contemporary usage patterns. Modern English phraseology demonstrates specific features that distinguish it from other languages and previous historical stages of English. These features include semantic opacity, syntactic stability, contextual variability, and the capacity to convey pragmatic and stylistic nuances. This study aims to analyze the specific features of Modern English phraseology, focusing on its structural, semantic, and functional characteristics, and to explore the implications for language teaching, learning, and translation.*

### *Literature Review*

*Phraseology has been widely studied by linguists such as Vinogradov (1947), Moon (1998), Benson, Benson & Ilson (1986), and Nesselhauf (2005). Vinogradov classified phraseological units based on semantic and structural criteria, identifying stable combinations, idioms, and free combinations. Moon (1998) emphasized the psycholinguistic and cognitive aspects of idioms, pointing out that native speakers process idiomatic expressions holistically rather than word by word. Benson, Benson & Ilson (1986) focused on collocations, underlining their importance in second language acquisition and lexicography. Nesselhauf (2005) discussed the challenges of phraseological variation in corpus-based studies, highlighting differences between formal and informal registers. In addition, recent studies (Cowie, 1998; Wray, 2002) stress that phraseological units are not only lexical entities but also cultural carriers, reflecting social norms, values, and historical context. In Modern English, new idioms and collocations constantly emerge, reflecting technological, social, and cultural changes.*

### *Methodology*

*This study employs a descriptive-analytical approach combined with corpus-based methods to examine phraseological units in Modern English. The methodology includes:*

- 1. Corpus Analysis: Using contemporary corpora such as the British National Corpus (BNC) and the Corpus of Contemporary American English (COCA) to identify frequency, syntactic patterns, and semantic variations of Pus.*
- 2. Classification Analysis: Categorizing phraseological units according to structural (idioms, phrasal verbs, collocations) and semantic (transparent, semi-transparent, opaque) criteria.*
- 3. Contextual Examination: Analyzing Pus in authentic communicative contexts to observe pragmatic functions, stylistic usage, and variation across registers.*

*The study prioritizes authentic examples, frequency data, and cross-referencing with dictionaries and scholarly sources to ensure validity and reliability.*

#### *Main Analysis / Discussion*

##### *Structural Features:*

- Fixed expressions: e.g., 'by and large', 'kick the bucket'
- Semi-fixed expressions: e.g., 'take ... into account', 'make ... decision'
- Phrasal verbs: e.g., 'look up', 'bring about'

##### *Semantic Features:*

- Opacity / Non-compositionality: 'spill the beans' = reveal a secret
- Transparency / Compositionality: 'kick the habit' = stop a habit
- Polysemy and metaphorical extension: 'break the ice'

##### *Functional Features:*

- Convey emotional or evaluative meaning: 'over the moon', 'in hot water'
- Enhance cohesion and discourse fluency
- Serve as cultural markers reflecting history, customs, and social norms

##### *Phraseology in Language Learning and Teaching:*

- ESL learners often struggle with idioms due to semantic opacity
- Collocations are crucial for lexical accuracy and naturalness
- Teaching phraseology through contextualized corpus examples improves comprehension and retention

##### *Diachronic and Contemporary Trends:*

- Technological innovations: 'to Google', 'cloud computing'
- Social media and popular culture: 'viral content', 'ghosting'
- Global English varieties differ across American, British, and world English contexts

*The phraseological system of Modern English exhibits distinct structural, semantic, and functional features that are essential for effective communication. Phraseological units are highly idiomatic, culturally significant, and pragmatically versatile. Key findings include structural stability combined with semantic flexibility, challenges for learners due to semantic opacity, and reflection of cultural, social, and technological developments. The study emphasizes the importance of incorporating phraseological analysis in teaching, lexicography, and language research, ensuring that both native speakers and learners can navigate the richness of Modern English effectively.*

#### *Extended Analysis and Discussion*

##### *1. Expanded Structural Features*

*Modern English phraseology demonstrates a remarkable structural variety, ranging from fully fixed expressions to semi-fixed collocations and flexible phrasal verbs.*

*- Fixed Expressions (Idioms): Examples like 'kick the bucket' (to die) and 'by and large' (generally) are completely fixed and syntactically stable. Such idioms cannot be altered without losing meaning.*

*- Semi-fixed Expressions (Collocations): Expressions such as 'make a decision' or 'take into account' allow limited syntactic variation but retain a core structure. Semi-fixed expressions often reflect cultural norms and idiomatic usage.*

*- Phrasal Verbs: Phrasal verbs like 'look up', 'bring about', and 'carry on' combine verbs with prepositions or adverbs to produce idiomatic meanings. They are crucial in both spoken and written English due to their high frequency and expressiveness.*

*Observation: The structural stability of PUs contributes to fluency and cohesion in communication while providing native speakers with concise ways to express complex ideas.*

##### *2. Expanded Semantic Features*

*Semantic features of Modern English phraseology reveal complexity and richness:*

*- Semantic Opacity: Many idioms (e.g., 'spill the beans', 'let the cat out of the bag') are semantically opaque—their meaning cannot be deduced from the individual words. This poses challenges for non-native speakers.*

*- Semantic Transparency: Some expressions, like 'kick the habit' or 'break the ice', allow partial prediction of meaning. Transparency facilitates language learning and cross-cultural communication.*

*- Metaphorical and Cultural Extension: Phraseological units frequently carry metaphorical meanings, reflecting culture-specific knowledge. For instance, 'cross the Rubicon' conveys a historical and metaphorical sense of irreversible decision-making.*

*- Polysemy and Contextual Variation: PUs often display polysemy; for example, 'hit the roof' can literally mean striking the ceiling or figuratively mean becoming very angry. Context determines meaning and pragmatic function.*

### 3. Pragmatic and Stylistic Functions

Phraseological units are not only lexical items but also tools of discourse:

1. Expressiveness and Emotion: Idioms enrich language by conveying feelings succinctly ('over the moon', 'in hot water').

2. Discourse Cohesion: Recurrent PUs create links between sentences, maintaining cohesion in texts.

3. Stylistic Nuances: Certain idioms are associated with formal vs. informal registers. For example, 'kick the bucket' is informal, while 'pass away' is formal.

Pedagogical Implication: Teaching idioms with attention to register, context, and frequency ensures learners can use them appropriately in writing, speaking, and comprehension.

### 4. Phraseology in Modern Communication

Modern English continues to evolve under technological, social, and global influences:

- Technology: New collocations and idioms emerge from digital communication ('to Google', 'social distancing', 'going viral').

- Social Media and Pop Culture: Informal language trends influence idiomatic expressions ('ghosting', 'FOMO – fear of missing out').

- Global English Varieties: American, British, and World Englishes differ in idiom use; e.g., 'take the piss' (UK) vs. 'pull someone's leg' (US/UK) conveys joking.

Observation: Language evolution introduces dynamic phraseological patterns that reflect contemporary culture and communication habits.

### 5. Implications for Teaching and Lexicography

#### 1. Language Learning:

- Understanding PUs improves fluency, idiomaticity, and comprehension.

- Contextual teaching using corpora and authentic examples enhances retention and usage accuracy.

#### 2. Lexicography:

- Dictionary definitions must reflect semantic nuances, register, frequency, and collocational patterns.

- Corpus-based analysis ensures practical relevance and usability for learners and professionals.

#### 3. Translation:

- PUs pose challenges in translation due to non-compositionality. Translators must find functional equivalents in the target language that preserve meaning, style, and cultural context.

### 6. Summary of Extended Discussion

- Modern English phraseology is structurally complex, semantically rich, and pragmatically versatile.

- Idioms, collocations, and phrasal verbs serve as cultural markers and communicative tools.

- Contemporary developments (technology, media, global English) continually reshape the phraseological landscape.

- Pedagogical and lexicographic practices benefit from corpus-based analysis, contextual teaching, and attention to register.

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## THE IMPORTANCE OF ENGLISH GRAMMAR

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### Introduction

English grammar consists of a complex system of rules that govern how words function and interact within sentences. These include tenses, parts of speech, sentence structure, punctuation, and syntax. A strong command of grammar allows speakers and writers to convey their ideas precisely and avoid misunderstandings. For instance, the correct use of tenses helps to indicate time relationships, while proper sentence structure ensures coherence and clarity in communication.

From an educational perspective, grammar serves as a foundation for all four language skills: reading, writing, listening, and speaking. When learners understand grammatical rules, they can comprehend texts more easily and construct well-organized sentences both in speech and in writing. Moreover, grammatical accuracy is often considered a key indicator of language proficiency in academic and professional settings, such as exams, job interviews, and formal presentations.

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Furthermore, grammar supports the development of critical thinking and analytical skills. By analyzing sentence patterns and understanding how language functions, learners become more conscious of meaning and form. This awareness improves their ability to edit, revise, and express ideas effectively. In addition, correct grammar usage contributes to credibility and professionalism in communication — qualities highly valued in today's global environment.

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Grammar forms the structural and logical foundation of every language. In English, it provides the necessary framework that allows speakers and writers to communicate ideas clearly, coherently, and effectively. Grammar encompasses a set of rules governing the structure of clauses, phrases, and words in a language. Without grammar, communication would be disorganized and potentially meaningless, as there would be no standard method for combining words into sentences that convey precise meaning.

The role of English grammar is particularly significant in today's world, where English serves as a global lingua franca. Mastery of grammar not only enhances comprehension and writing but also contributes to academic success, professional credibility, and intercultural communication. Therefore, understanding the principles and functions of grammar is essential for achieving proficiency in English.

Researchers and linguists have long emphasized the importance of grammar in language learning and communication. According to Azar (2016), grammar provides the system that enables learners to make sense of language, helping them to form meaningful and accurate expressions. Similarly, Celce-Murcia and Larsen-Freeman (2015) argue that grammar instruction is vital for the development of communicative competence, as it links form, meaning, and use.

Thornbury (1999) highlights that while communicative language teaching often prioritizes fluency, grammatical accuracy remains a fundamental component of effective communication. Learners who neglect grammar may develop habits that hinder clarity and correctness. Harmer (2007) further notes

that the integration of grammar into reading, writing, speaking, and listening activities leads to more balanced language development.

Moreover, Greenbaum and Quirk (1990) suggest that grammar acts as a 'skeleton' that supports the body of language, giving it shape and structure. Without a solid understanding of grammar, vocabulary alone is insufficient to produce coherent sentences. Swan (2005) also emphasizes that grammar functions as a tool for organizing thoughts, allowing speakers to express complex ideas logically and effectively.

The study of English grammar contributes to linguistic competence by improving both accuracy and fluency. For language learners, grammar serves as a guide to forming correct sentences and understanding how meaning is constructed. A solid grasp of grammatical structures allows individuals to interpret written and spoken texts more effectively.

In educational contexts, grammar instruction supports critical thinking by encouraging learners to analyze sentence patterns and recognize linguistic relationships. This analytical ability enhances writing skills, as students can revise and refine their compositions based on grammatical principles. Furthermore, proper grammar usage improves professional communication, where accuracy and clarity are highly valued — such as in business correspondence, academic writing, and international relations.

Another significant aspect of grammar is its role in cross-cultural communication. Since English is widely used as a second or foreign language, grammatical competence enables speakers from different linguistic backgrounds to understand each other with fewer misunderstandings. Inaccurate grammar can distort meaning and lead to communication breakdowns, especially in formal or technical contexts. Thus, grammar functions as a unifying system that ensures the effective exchange of ideas across global communities.

Lastly, with the rise of digital communication, grammar continues to maintain its relevance. Although informal language dominates social media and online platforms, correct grammar remains crucial in academic writing, journalism, and professional contexts. Therefore, balancing modern linguistic trends with grammatical correctness is essential for maintaining both clarity and credibility.

### **Conclusion**

In summary, English grammar is the cornerstone of effective language use. It provides the structure necessary for accurate, fluent, and meaningful communication. Beyond being a collection of prescriptive rules, grammar represents the underlying logic of the English language. It enables learners to understand how words interact, how meaning is constructed, and how ideas are best expressed.

For students, teachers, and professionals alike, grammar remains an indispensable component of linguistic mastery. Continuous practice, exposure to authentic language, and reflective learning are key strategies for improving grammatical competence. As English continues to dominate international communication, the ability to use grammar correctly will remain a vital skill for personal, academic, and professional success.

**Keywords:** English grammar, language learning, communication, linguistic competence, accuracy, fluency

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## *Technical sciences*

### USE OF THERMOGRAVIMETRIC ANALYSIS (TGA) TO DETERMINE THE CALCINATION BEHAVIOR OF LOCAL CLAYS FOR LC3 PRODUCTION

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#### **Abstract**

*This study investigates the calcination behavior of four local clay samples from different regions of Azerbaijan to evaluate their suitability for producing Limestone Calcined Clay Cement (LC3), a low-carbon alternative to ordinary Portland cement. Concrete is the most widely used construction material in the world, yet its main component, Portland cement, accounts for approximately 5–8% of global CO<sub>2</sub> emissions due to the energy-intensive clinker production process. In Azerbaijan, where the clinker-to-cement ratio remains above 80%, the development of sustainable binders is particularly urgent. LC3, which combines clinker with calcined clay, limestone, and gypsum, has the potential to reduce CO<sub>2</sub> emissions by up to 40%, provided that suitable raw materials are identified and processed under optimal conditions.*

*For this purpose, thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) were employed to investigate the dehydroxylation and decomposition characteristics of four representative clays. Clay No. 1 (Kotandag) exhibited a distinct kaolinite dehydroxylation below ~710 °C with limited carbonate content, making it suitable for calcination at ~725 °C. Clay No. 2 (Cenlibel) showed strong dehydroxylation at relatively low temperatures (445–550 °C), accompanied by a high enthalpy change and delayed carbonate decomposition, confirming its high potential as a reactive source of metakaolin. Clay No. 3 (Vulkan ASC) presented a major dehydroxylation peak around 746 °C but contained lower kaolinite fractions, suggesting limited efficiency and recommending its use mainly in blended systems. Clay No. 4 (Norm Cement) displayed high carbonate content and limited reactive clay phases, behaving more like a clay–limestone mixture, and is not suitable as a primary calcined clay for LC3 production.*

*Overall, this study highlights that TGA-DSC is an effective tool for identifying dehydroxylation ranges, carbonate decomposition, and recrystallization thresholds of local clays. The findings indicate that Azerbaijan possesses promising resources for LC3 production, particularly Clays No. 1 and 2. Integrating TGA-based analyses with sustainable cement design enables the determination of optimum calcination temperatures, which can help reduce clinker use, lower CO<sub>2</sub> emissions, and support national and global decarbonization goals.*

**Keywords:** Limestone Calcined Clay Cement, TGA, Thermogravimetric Analysis, Calcined Clay, Calcination

#### **INTRODUCTION**

Concrete is the most widely used construction material in the world, and its demand is expected to further increase in the coming decades due to urbanization and infrastructure development [1]. However, cement, the main component of concrete, is highly energy-intensive and responsible for 5–8% of global CO<sub>2</sub> emissions [2–4]. In particular, clinker production releases nearly one ton of CO<sub>2</sub> per ton of clinker, making the reduction of clinker content a priority for sustainability [2].

The use of supplementary cementitious materials (SCMs) has become a key strategy to reduce clinker consumption. Fly ash, ground granulated blast furnace slag, and silica fume have been widely used; however, their availability is decreasing due to transformations in the energy and steel industries [5,6]. In contrast, clay minerals are abundant, inexpensive, and widely available, making them highly promising SCMs [7].

In this context, limestone calcined clay cement (LC3) has emerged as a low-carbon alternative capable of reducing CO<sub>2</sub> emissions by about 40% compared to ordinary Portland cement [8,9]. In Azerbaijan, the clinker-to-cement ratio remains above 80% [10], which highlights the importance of utilizing locally available materials such as limestone, volcanic ash, and clay. Among these, calcined clays are particularly promising, though their reactivity strongly depends on mineralogical composition and calcination temperature [7–9].

Thermogravimetric analysis (TGA) is a reliable method to investigate the thermal transformations of clay and to identify dehydroxylation behavior, which directly determines their reactivity as SCMs. In this study, four local clay samples from Azerbaijan were examined by TGA-DSC to evaluate their calcination behavior and assess their suitability for LC3 production.

#### LIMESTONE CALCINED CLAY CEMENT (LC3)

**Limestone–Calcined Clay Cement (LC3)** is an innovative binder with a low clinker content, produced by blending clinker, limestone, calcined clay, and gypsum in specific proportions. A typical LC3 formulation consists of approximately 50% clinker, 30% calcined clay, 15% limestone, and 5% gypsum [11].

In this cement system:

- **Calcined clay**, especially when rich in kaolinite, consumes portlandite through pozzolanic reactions.
- **Limestone** interacts with the alumina of the clay to promote the formation of carboaluminate phases.
- **Gypsum** acts as a source of sulfate, regulating these reactions and contributing to the formation of ettringite.

#### CALCINATION OF CLAY

Calcination is the process in which clay minerals are heated under controlled conditions, leading to the removal of structural water and the breakdown of the crystalline structure. Kaolinite, as a representative 1:1 clay mineral, undergoes a series of transformations with increasing temperature, eventually converting into amorphous and highly reactive metakaolin.

- **≤300 °C:** Removal of free and adsorbed water (dehydration). Within this range, some studies also report structural rearrangements associated with proton delocalization (160–300 °C).
- **350–700 °C:** Progressive dehydroxylation occurs, involving the release of hydroxyl groups and the breakdown of the crystal lattice. This process leads to the formation of amorphous metakaolin. Dehydroxylation advances significantly between 450–570 °C and is largely completed around 700 °C.
- **>800 °C:** Recrystallisation begins, with the development of spinel- and mullite-like phases. These transformations reduce the amorphous content and significantly lower reactivity.[12]

Therefore, the optimum calcination temperature is generally reported as ~700 °C in laboratory studies and 700–850 °C under industrial conditions, as higher temperatures (>800 °C) result in crystallisation and reduced reactivity.

#### EXPERIMENTS

In this study, TGA-DSC was employed to characterize four local clay samples, to determine their dehydroxylation behavior and to assess their potential reactivity for use in LC3 systems.

Experiments were conducted using four samples with an SDT650 TGA-DSC device under a nitrogen atmosphere, within a temperature range of 25 °C to 1200 °C, at a heating rate of 10 °C/min. All experiments were conducted at the Central Laboratory – R&D Training and Measurement Center, Middle East Technical University (METU)

#### TGA ANALYSIS

Thermogravimetric analysis (TGA) is carried out to monitor the mass changes of raw materials as a function of temperature, providing insight into the thermal stability and decomposition processes of clays [13]. In the context of LC3 research, TGA is particularly valuable for the following reasons: it helps identify dehydration and dehydroxylation processes, determine the optimal calcination temperature, and link characteristic weight losses to different mineral phases such as kaolinite, carbonates, or hydroxides, thereby providing complementary information to XRD.

While reading a TGA graph, the X-axis represents temperature, while the Y-axes show weight (%) and derivative weight (%/°C) on the left, and heat flow (W/g) on the right. See figure 1,2,3 and 4

**Blue curve (Weight %):** Shows the variation of sample mass with temperature; downward steps correspond to mass losses due to processes such as dehydration, dehydroxylation, or carbonate decomposition.

Red curve (DTG): Represents the rate of mass loss; peaks highlight the temperature intervals where decomposition reactions occur most intensively.

Burgundy curve (dDSC/dT): Shows the derivative of the heat flow signal, which helps to detect the exact onset and end of thermal events and to distinguish overlapping reactions.

Green curve (DSC): Displays heat flow. Downward troughs indicate endothermic reactions, while upward peaks correspond to exothermic reactions. The point where a trough or peak begins is defined as the onset, and the point where it ends is defined as the endset.

## RESULTS AND DISCUSSION

### ANALYSIS OF THE CLAY NO 1

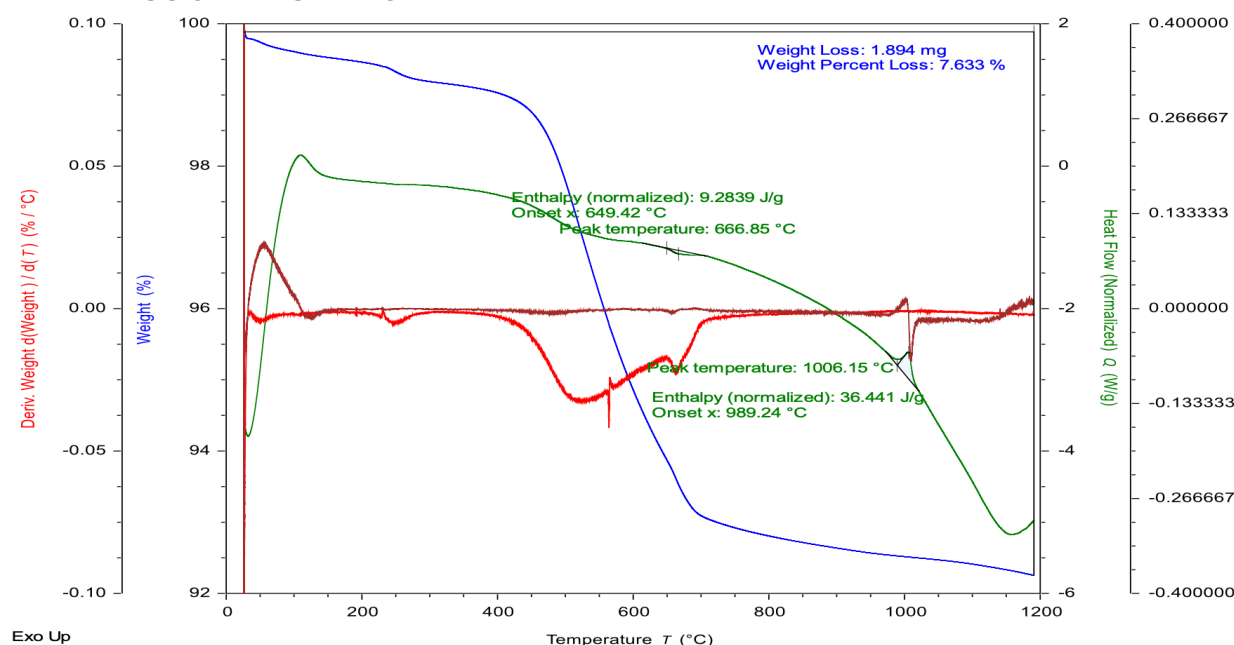


Figure 1: TGA–DSC curves of Clay No. 1 obtained from Kotandag region

Figure 1 shows the thermogravimetric (TGA), derivative thermogravimetric (DTG), and differential scanning calorimetry (DSC) curves of the Kotandag clay. The total weight percent loss of the sample was measured as 7.63% of the initial mass.

The first major thermal event occurs with an onset at 649 °C and a peak at 667 °C, as indicated by the endothermic DSC signal. This process is attributed to the dehydroxylation of kaolinite, during which structural hydroxyl groups are released and the mineral transforms into amorphous metakaolin. The enthalpy change for this event was calculated as 9.28 J/g. The DTG curve confirms that the mass loss in this range corresponds to the main dehydroxylation reaction.

A second endothermic peak appears at higher temperatures, with an onset at 989 °C and a maximum at 1006 °C, accompanied by a larger enthalpy change of 36.44 J/g. This reaction is related to the decomposition of carbonates ( $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ ) and the onset of recrystallisation processes, leading to the formation of more stable crystalline phases such as spinel or mullite.

These results indicate that the main dehydroxylation reaction in the Kotandag clay is completed below 710 °C. Therefore, the optimum calcination temperature is suggested around 725 °C, ensuring complete dehydroxylation while avoiding recrystallisation that reduces reactivity above 800 °C.

## ANALYSIS OF THE CLAY NO 2

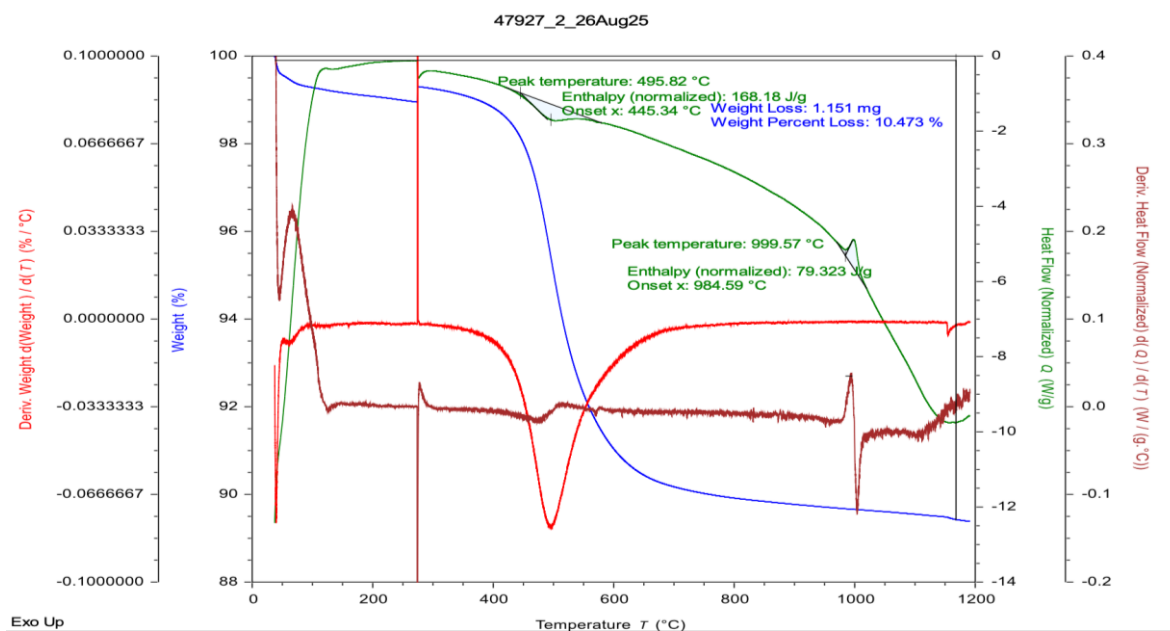


Figure 2 TGA–DSC curves of Clay No. 2 obtained from Cenlibel region

Figure 2: shows the thermogravimetric (TGA), derivative thermogravimetric (DTG), and differential scanning calorimetry (DSC) curves of the Cenlibel clay sample. The total weight percent loss of the sample was measured as 10.47% of the initial mass.

The first endothermic event occurs with an onset at ~445 °C and a peak at ~496 °C, accompanied by an enthalpy change of 168.18 J/g. This process is attributed to the dehydroxylation of kaolinitic clay minerals, where structural hydroxyl groups are released, resulting in the formation of amorphous reactive phases.

A second endothermic event is observed at higher temperatures, with an onset at ~985 °C and a peak at ~1000 °C, associated with an enthalpy change of 79.32 J/g. This reaction corresponds to the decomposition of carbonates ( $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ ) and partial recrystallisation into more stable crystalline phases such as spinel or mullite.

The dehydroxylation reaction initiates around 445 °C and reaches completion over a broader temperature interval, extending up to ~650–700 °C. Therefore, the optimum calcination temperature is suggested around 750–780 °C, ensuring full dehydroxylation and maximum reactivity while avoiding recrystallisation above 800 °C

## ANALYSIS OF THE CLAY NO 3

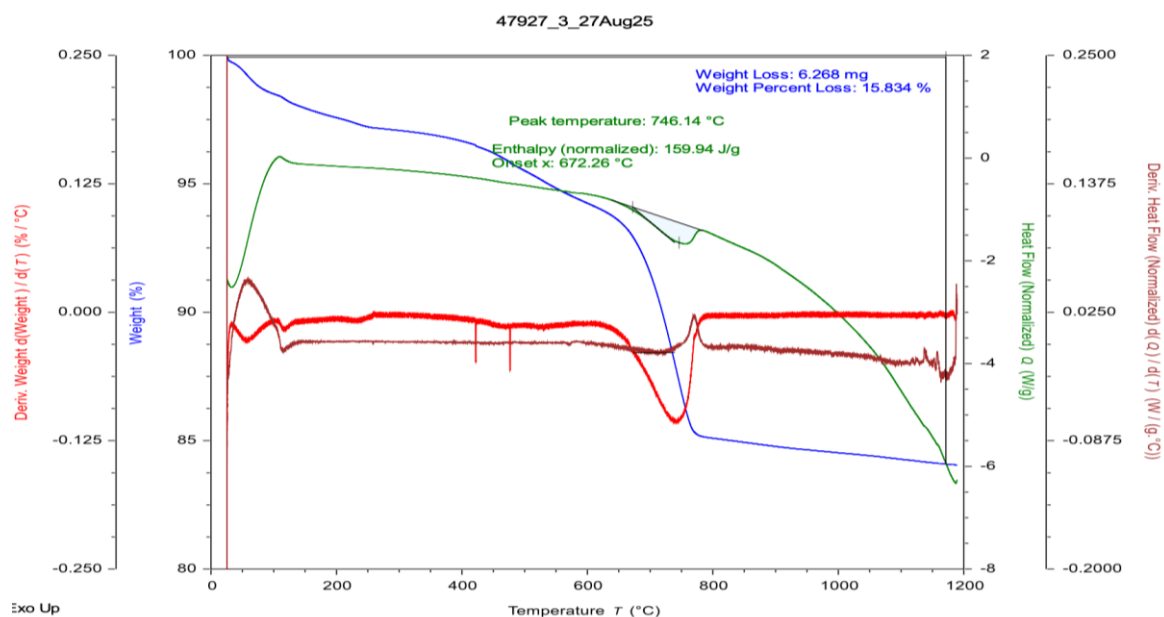


Figure 3|:TGA–DSC curves of Clay No. 2 obtained from Vulkan ASC

Figure 3 presents the thermogravimetric (TGA), derivative thermogravimetric (DTG), and differential scanning calorimetry (DSC) curves of Clay No 3 obtained from Vulkan ASC. The total weight percent loss of the sample was measured as 15.83% of the initial mass.

The first major endothermic event starts at  $\sim 672^\circ\text{C}$  with a peak at  $\sim 746^\circ\text{C}$ , accompanied by an enthalpy change of  $159.94\text{ J/g}$ . This reaction is attributed to the dehydroxylation of kaolinite, leading to the collapse of the crystal structure and the formation of amorphous metakaolin.

No significant carbonate decomposition peak is observed in this sample up to  $1000^\circ\text{C}$ , indicating a relatively low carbonate content compared to other clays. The main transformation is thus dehydroxylation, which is completed below  $\sim 800^\circ\text{C}$ .

Based on these results, the optimum calcination temperature is suggested around  $750\text{--}775^\circ\text{C}$  for this clay, ensuring complete dehydroxylation and maximum reactivity while avoiding recrystallisation at higher temperatures.

The presence of kaolinite indicates potential for metakaolin formation upon calcination. However, the relatively low kaolinite content suggests that this material is not ideal as a primary calcined clay source for LC3 binders. It may still be used as a supplementary component in blended formulations, where its limited pozzolanic contribution can complement other, more reactive clays.

#### ANALYSIS OF THE CLAY NO 4

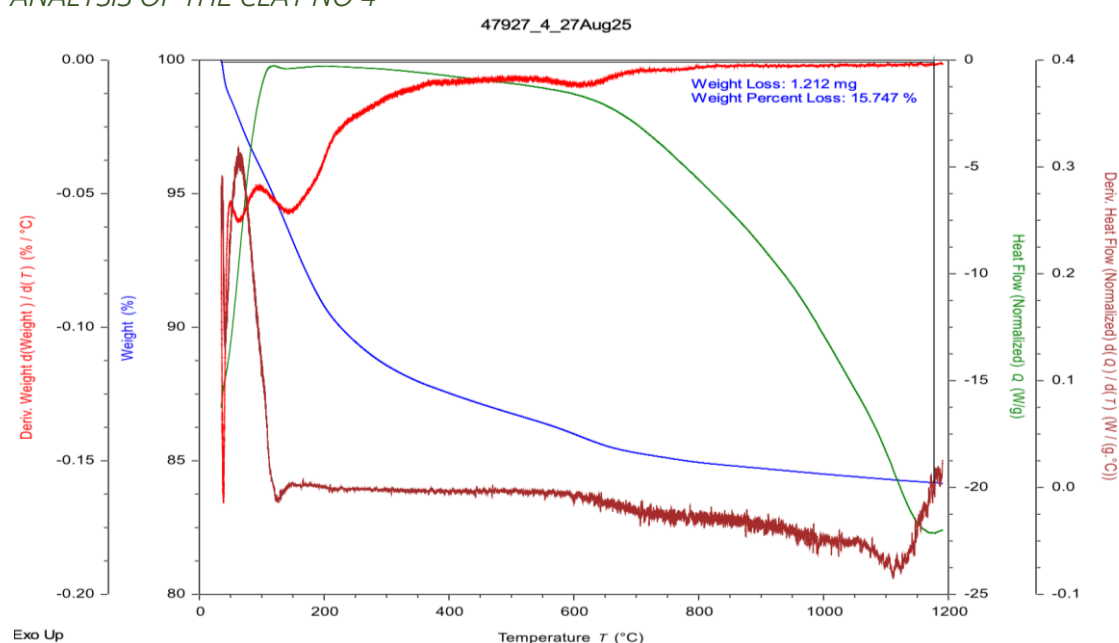


Figure 4: TGA–DSC curves of Clay No. 4 obtained from Norm Cement Factory

Figure 4 presents the thermogravimetric (TGA), derivative thermogravimetric (DTG), and differential scanning calorimetry (DSC) curves of the Clay No 4 sample obtained from Norm Cement plant. The total weight percent loss of the sample was measured as 15.747% of the initial mass. The first sharp weight reduction below  $\sim 150^\circ\text{C}$ , accompanied by an endothermic DSC signal, is associated with the evaporation of physically adsorbed and interlayer water. A continuous mass loss is observed between  $200$  and  $600^\circ\text{C}$ , attributed to the dehydroxylation of clay minerals, most likely illite and montmorillonite phases present in the sample. At higher temperatures, particularly between  $700$  and  $800^\circ\text{C}$ , a significant endothermic effect is recorded, which corresponds to the decomposition of carbonate phases (e.g., calcite) into  $\text{CaO}$  and  $\text{CO}_2$ . Beyond  $1000^\circ\text{C}$ , the thermal curves indicate stabilization, suggesting the completion of carbonate decomposition and absence of further major phase transitions.

The high total mass loss and the pronounced decarbonation peak indicate that this sample contains a substantial carbonate fraction in addition to clay minerals. Therefore, unlike kaolinite-rich clays that generate highly amorphous and reactive metakaolin upon calcination, this sample behaves more like a clay–limestone blend. This composition reduces its suitability as a primary calcined clay source for LC3 binders, since the effective contribution of reactive aluminosilicates is limited.

#### SUMMARY

- Clay No. 1 (Kotandag region):

Contains kaolinite with a clear dehydroxylation event completed below  $\sim 710^\circ\text{C}$ , producing reactive metakaolin. Carbonate decomposition occurs only at higher temperatures ( $>980^\circ\text{C}$ ). This makes

Clay No. 1 suitable for LC3 production, as it can generate sufficient reactive phases when calcined at ~725 °C.

- Clay No. 2 (Cenlibel region):

Exhibits strong dehydroxylation of kaolinitic minerals at relatively lower temperatures (~445–550 °C). Carbonate decomposition occurs later (~985–1000 °C). The lower dehydroxylation temperature and higher enthalpy change indicate a rich kaolinite content. This clay is considered the most suitable source for LC3 binders, ensuring high reactivity after calcination (~780 °C).

- Clay No. 3 (Vulkan ASC):

Shows a major dehydroxylation peak at ~746 °C, confirming the presence of kaolinite. However, the relatively low kaolinite content limits its overall reactivity. While not ideal as a primary LC3 raw material, it may still be used as a supplementary component in blended formulations. Optimum calcination is ~750–775 °C

- Clay No. 4 (Norm Cement):

Characterized by a high carbonate fraction and only limited reactive clay phases (illite/montmorillonite). Behaves more like a clay–limestone mixture rather than a kaolinite-rich clay. Thus, it is not recommended as a primary calcined clay for LC3 binders since the reactive aluminosilicate contribution is insufficient.

This study highlights that TGA-DSC is an effective tool for assessing the thermal behavior of local clays, allowing the identification of dehydroxylation ranges, carbonate decomposition, and recrystallization thresholds. The results indicate the strong applicability of kaolinite-rich clays (Clays No. 1 and 2), the conditional usability of lower-grade kaolinitic clays (Clay No. 3), and the limitations of carbonate-dominant clays (Clay No. 4). On a broader scale, the findings suggest that Azerbaijan may possess promising local resources for LC3 production. Integrating TGA-based analyses with sustainable cement design enables the determination of optimum calcination temperatures, which in turn can assist in reducing clinker dependence, lowering CO<sub>2</sub> emissions, and contributing to decarbonization targets at both national and global scales.

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## RESEARCH AND DEVELOPMENT OF A CERTIFICATION METHODOLOGY FOR FOOD PRODUCTION ACCORDING TO SAFETY REQUIREMENTS IN KAZAKHSTAN

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Major: Standardization and Certification

### Abstract

Food safety has become a strategic priority for Kazakhstan as the country strengthens its agri-food sector and aligns with global standards. This study presents a comprehensive analysis of the research and development of a certification methodology for food production according to safety requirements within the national context. The article examines Kazakhstan's current regulatory framework, including the implementation of the Hazard Analysis and Critical Control Points (HACCP) system and the adoption of the ST RK ISO 22000 standard, while highlighting institutional and operational gaps that hinder effective enforcement. Using a mixed-methods approach combining regulatory review, statistical analysis, and pilot audit data, the study develops a structured methodology encompassing seven stages: defining scope and standards, institutional framework, audit tools, pilot validation, training and capacity building, certification implementation, and continuous monitoring.

Statistical findings indicate that the proportion of certified enterprises increased from 5% in 2016 to 27% in 2024, with certified producers demonstrating 40–50% fewer safety violations compared to non-certified ones. The number of mass food poisoning incidents also declined from an average of 26 per year (2017–2019) to 18 in 2024, reflecting the growing influence of certification systems. Despite these gains, persistent challenges remain, including limited SME participation, uneven laboratory capacity, and inconsistent enforcement across regions. The research concludes that a robust, transparent, and internationally harmonized certification methodology-supported by continuous training, stakeholder engagement, and data-driven oversight-can significantly enhance Kazakhstan's food safety performance and strengthen its competitiveness in regional and global markets.

**Keywords.** Food safety; Certification methodology; HACCP; ISO 22000; Kazakhstan; Foodborne outbreaks; Quality management; Regulatory compliance; Risk-based auditing; Food industry modernization.

### Introduction

Food safety is a critical component of public health and economic stability, especially as Kazakhstan expands its food production and processing sectors. In recent years, Kazakhstan's food industry has grown steadily, valued at around \$6.5 billion in 2024 with key segments including grain milling, dairy, meat processing, and beverages [1][2]. Beyond its contribution to GDP and employment, the sector underpins national food security and Kazakhstan's export ambitions to EAEU and wider markets. Ensuring the safety of food products is therefore essential not only for protecting consumers but also for enhancing the competitiveness and reputation of Kazakh food products in regional and global value chains. Yet high-profile foodborne illness incidents continue to underscore the need for stronger food safety management-18 mass food poisoning outbreaks were recorded in 2024, affecting 731 people (nearly 80% of them children) [3]. Root-cause analyses repeatedly point to preventable hygiene and handling failures (e.g., poor personal hygiene, improper storage and temperature control, cross-contamination, and ignoring expiration dates) [4]. These persistent, system-level issues-spanning primary production, processing, distribution, retail, and food service-highlight the urgent need for a robust, end-to-end certification methodology tailored to Kazakhstan's context.

Kazakhstan has committed to aligning its food safety regulations with international standards and best practices. The country is a member of the Codex Alimentarius Commission and has established a National Codex Committee to harmonize national standards with global guidelines, providing a science-based anchor for risk assessment and risk management [5][6]. As part of the Eurasian Economic Union (EAEU), Kazakhstan enforces the EAEU's Technical Regulation on Food Safety (TR CU 021/2011), which introduced mandatory Hazard Analysis and Critical Control Points (HACCP) principles for food manufacturers effective February 2015 [7]. This regulatory move mirrors the Codex HACCP system and

the European Union's approach, albeit in a narrower legal scope: HACCP in the EAEU is required mainly for food manufacturing enterprises, whereas the EU mandates HACCP-based procedures across nearly all food business operations beyond primary production [8][9]. In parallel, Kazakhstan's national Law "On Food Safety" (No. 301-III), originally enacted in 2007, sets the legal basis for safeguarding food products and protecting consumers, clarifying institutional roles and enforcement mechanisms [10][11]. Together, these instruments form a solid *de jure* foundation for food safety control.

However, effective implementation remains the binding constraint. Despite the legal mandate, by 2016 only about 5% of Kazakh food enterprises had implemented an HACCP-based food safety management system [12][13]. This low uptake reflects multiple barriers: uneven awareness among SMEs; limited technical capacity for hazard analysis and documentation; variable access to accredited laboratories and reliable cold-chain logistics across a vast territory; cost constraints for facility upgrades; and gaps in auditor and inspector training. Moreover, current conformity assessment practices can be document-centric, with insufficient emphasis on operational behaviors (e.g., temperature monitoring, sanitation standard operating procedures, allergen control, traceability tests, and recall readiness) that actually determine risk reduction. To close the implementation gap, Kazakhstan requires a certification methodology that is risk-based, scalable to enterprise size and risk profile, integrated with regulatory inspections, and credible to domestic consumers and foreign buyers.

In this article, we present a comprehensive overview of current food safety regulations in Kazakhstan and their alignment with international standards such as HACCP and ISO 22000. We motivate the necessity of a robust certification methodology adapted to national conditions-incorporating phased pathways for SMEs, competency-based auditor training, and data-driven surveillance-and outline methodological approaches for designing and validating such a system. We incorporate relevant statistics on food production and safety compliance in Kazakhstan, identify systemic and operational bottlenecks across the supply chain, and propose practical recommendations to strengthen certification governance, audit quality, and industry uptake. The goal is to articulate a credible, implementable, and outcomes-oriented certification model that measurably reduces foodborne risk while supporting Kazakhstan's competitiveness in regional and global markets.

### **Literature Review**

#### **Current Food Safety Regulatory Framework in Kazakhstan**

Kazakhstan's food safety governance structure is divided primarily between the Ministry of Health and the Ministry of Agriculture [14][15]. The Law "On Food Safety" provides the overarching legal framework that regulates food safety, with the objective of protecting consumer health and ensuring the integrity of food products throughout the supply chain. Under this law and its subsequent implementing regulations, the Ministry of Health - through the Committee of Sanitary and Epidemiological Control - is responsible for monitoring the safety of processed food products, catering facilities, and food handling during distribution and retail. Meanwhile, the Ministry of Agriculture oversees the safety of primary production, including unprocessed foods of both animal and plant origin [10][11].

In compliance with its obligations under the Eurasian Economic Union (EAEU), Kazakhstan adopted the Customs Union Technical Regulation TR TS 021/2011 "On Food Safety", which entered into full force on February 15, 2015. This regulation mandates that all food business operators, especially those involved in manufacturing, develop, implement, and maintain procedures based on Hazard Analysis and Critical Control Points (HACCP) principles [7][16]. The HACCP system represents a science-based preventive approach designed to identify, evaluate, and control hazards that are significant for food safety. It operates through seven well-established principles: conducting hazard analysis, identifying critical control points (CCPs), establishing critical limits, implementing monitoring procedures, defining corrective actions, verifying the system, and maintaining thorough documentation [17].

The introduction of HACCP principles into Kazakhstan's legal framework aligns the country with the Codex Alimentarius standards and the globally accepted model for proactive food safety management. However, Kazakhstan's implementation-within the EAEU regulatory framework-differs in certain aspects from that of the European Union (EU). Specifically, EAEU rules apply HACCP mainly to the food manufacturing stage, emphasizing end-product testing for verification. In contrast, the EU mandates HACCP-based systems throughout almost the entire food chain, extending from primary production to retail, with a stronger focus on process control, continuous monitoring, and staff training [8][18]. Despite these structural differences, both frameworks share a common goal: to ensure

systematic, preventive control of food safety hazards and enhance consumer protection.

#### **International Standards (HACCP, ISO 22000) and National Adoption**

Beyond mandatory HACCP implementation, Kazakhstan has increasingly integrated international food safety standards to strengthen national control mechanisms. Among these, ISO 22000—an internationally recognized Food Safety Management System (FSMS)—plays a central role. ISO 22000 builds upon HACCP principles within the ISO management system framework, ensuring a structured, organization-wide approach to food safety. Kazakhstan officially adopted this standard as ST RK ISO 22000, making it nationally equivalent to the global ISO 22000 standard [19].

The adoption of ST RK ISO 22000 provides a comprehensive, “farm-to-fork” system that helps food enterprises identify, control, and prevent hazards at all stages of production and distribution. Implementing ISO 22000 (or any HACCP-based system) offers multiple benefits for Kazakh enterprises: it enhances product safety and quality, strengthens traceability systems, optimizes internal processes, and boosts competitiveness in domestic and export markets [20]. In fact, compliance with HACCP and ISO 22000 is often viewed as a “passport” for exports, since producers cannot access EAEU or EU markets without demonstrating a certified and functioning food safety management system [13]. Moreover, embracing such standards supports Kazakhstan’s broader strategic objectives of becoming a regional food hub, attracting investment into its agri-food sector, and diversifying the economy beyond its dependence on extractive industries [21][22].

Despite the presence of a sound legal foundation and internationally harmonized standards, the implementation gap remains a major concern. As of 2016, only about 5% of food enterprises in Kazakhstan had achieved certification for HACCP-based food safety systems [12]. Although gradual progress has likely occurred since then, driven by state initiatives and international cooperation, adoption remains limited—particularly among small and medium-sized enterprises (SMEs). The key barriers include inadequate financial resources, insufficient technical expertise, and a lack of awareness or training on how to develop and maintain effective HACCP documentation.

Recognizing these challenges, Kazakhstan has initiated capacity-building programs in partnership with organizations such as the Food and Agriculture Organization (FAO) and the International Finance Corporation (IFC), aimed at helping food producers understand and apply HACCP principles in daily operations [23]. Furthermore, the National Center of Expertise (NCE) under the Ministry of Health has taken an active role since 2020 in organizing training programs, certification preparation courses, and awareness campaigns to strengthen compliance and professional competence across the food industry [24]. These initiatives signal the government’s commitment to transitioning from compliance on paper to a culture of food safety, where preventive control and continuous improvement become standard business practice in Kazakhstan’s evolving food sector.

#### **Food Safety Performance and Incidents**

Evaluating the current state of food safety in Kazakhstan provides crucial context for understanding why a robust and enforceable certification methodology is urgently needed. Despite the establishment of modern regulatory frameworks and technical standards, official statistics and inspection reports continue to reveal persistent deficiencies in compliance and hygiene practices across the food industry.

According to the Ministry of Health and epidemiological monitoring data, Kazakhstan recorded 23 outbreaks of salmonellosis in 2022, representing a dramatic increase compared to just two outbreaks in 2021, though broadly consistent with pre-pandemic levels, such as 26 recorded outbreaks in 2019 [25]. Detailed investigations into these incidents commonly reveal that they stemmed from preventable lapses in basic hygiene and handling procedures. A notable example occurred during a 2022 wedding event, where a *Salmonella* Enteritidis outbreak was traced to cakes made with raw eggs that had been stored at room temperature for three days, resulting in dozens of confirmed cases of foodborne illness [26][25]. Such examples underscore that many hazards arise not from lack of regulation, but from inadequate implementation of sanitary practices and monitoring mechanisms at the operational level.

The situation in 2024 further highlights systemic weaknesses. That year, 18 major mass food poisoning incidents were documented across Kazakhstan, the majority occurring in restaurants, cafés, and educational institutions [27][28]. Collectively, these outbreaks affected 731 individuals, of whom 582 were children, indicating that vulnerable populations—particularly those served by institutional catering—remain disproportionately exposed to unsafe food handling practices. Epidemiological reviews identified the most frequent causes as poor personal hygiene among food handlers, non-compliance with sanitary standards in catering facilities, cross-contamination between raw and cooked products,

improper storage and refrigeration conditions, and failure to observe product expiration dates.

**Table 1. Foodborne Illness Outbreaks and Key Findings in Kazakhstan (2019–2024)**

| Year /Period | Outbreaks and Incidents                                        | Number of Cases / Impact                                       | Key Causes and Observations                                                                                                                                                                                                                                                                                                            |
|--------------|----------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2019         | 26 recorded outbreaks of salmonellosis (pre-pandemic baseline) | -                                                              | Consistent with pre-pandemic levels; provides comparative context for later increases.                                                                                                                                                                                                                                                 |
| 2021         | 2 outbreaks of salmonellosis                                   | -                                                              | Marked decrease compared to pre-pandemic levels, possibly due to pandemic-related restrictions.                                                                                                                                                                                                                                        |
| 2022         | 23 outbreaks of salmonellosis                                  | Dozens of confirmed cases in individual outbreaks              | Investigations revealed preventable hygiene failures; notable <i>Salmonella Enteritidis</i> outbreak at a wedding traced to cakes made with raw eggs stored at room temperature for three days.                                                                                                                                        |
| 2024         | 18 major mass food poisoning incidents                         | <b>731 affected individuals, including 582 children (~80%)</b> | Most outbreaks occurred in restaurants, cafés, and educational institutions. Common causes included:<br>– Poor personal hygiene among food handlers<br>– Non-compliance with sanitary standards<br>– Cross-contamination between raw and cooked foods<br>– Improper storage and refrigeration<br>– Neglect of product expiration dates |

These recurring problems illustrate the persistence of behavioral and systemic shortcomings within Kazakhstan's food safety ecosystem. They also reveal gaps in the effectiveness of existing monitoring systems, which often focus on documentation rather than practical, day-to-day compliance. Many establishments are formally inspected, yet operational deviations-such as inadequate temperature logs or unsanitary equipment-go uncorrected until after an incident occurs.

Taken together, these findings reinforce the necessity of establishing a comprehensive certification and control system that moves beyond paper-based compliance. Such a system should incorporate continuous process verification, competency-based training for staff, and third-party audits capable of identifying early risk indicators before they lead to outbreaks. In short, a modernized certification methodology must not only confirm that safety protocols exist but must also verify that they are actively and effectively implemented in practice across all tiers of Kazakhstan's food production and service chain.

#### **Need for a Tailored Certification Methodology**

The concept of a "certification methodology" in this context refers to a structured, evidence-based process through which food producers are systematically audited and certified as compliant with established food safety requirements. While Kazakhstan possesses the necessary legal and regulatory framework, practical enforcement has historically relied on traditional state sanitary inspections and a conformity assessment system involving product registration, declarations of conformity, and periodic laboratory testing-particularly for high-risk food categories [29][30]. These mechanisms, while foundational, primarily assess compliance at the product level rather than ensuring that comprehensive preventive systems are in place throughout the production process.

A robust and modern certification methodology would complement existing controls by introducing a transparent, standardized process through which food enterprises are evaluated against internationally recognized safety management standards such as HACCP and ISO 22000. Under this system, certified auditors or accredited authorities would assess not only documentation but also operational implementation-verifying that food producers have functioning, verifiable safety controls embedded within their daily practices. Formal certification, in turn, would serve as an authoritative assurance of compliance, signaling to regulators, consumers, and trading partners that the enterprise adheres to best practices in food safety management.

The development of such a methodology must consider the specific national conditions that characterize Kazakhstan's food sector. These include the diversity of producers-ranging from large industrial processors with integrated quality management systems to small family-owned enterprises operating with limited resources-and the capacity of local certification bodies and testing laboratories, which may vary significantly by region. Furthermore, Kazakhstan's unique geographical and logistical challenges-including vast distances, extreme climatic variations, and uneven infrastructure-affect the integrity of food transport and storage. Additionally, regional contamination risks, such as heavy metal residues or radionuclide exposure in certain areas, necessitate localized adaptation of certification

criteria to ensure relevance and effectiveness.

International best practices offer valuable guidance for Kazakhstan's efforts. The Hazard Analysis and Critical Control Points (HACCP) system itself represents a globally validated methodology for identifying, evaluating, and controlling food safety hazards. Evidence from multiple studies confirms that the effective implementation of HACCP leads to substantial improvements in safety outcomes, reduced contamination rates, and enhanced consumer confidence. For instance, a recent Kazakh case study demonstrated that the introduction of a structured HACCP plan in a small meat processing facility in Semey led to measurable reductions in environmental contaminants-including heavy metals and pesticide residues-resulting in significantly improved product safety and compliance with national and international standards [31]. This case underscores the transformative potential of HACCP when rigorously applied, even in small-scale enterprises facing resource limitations and region-specific hazards.

However, scaling such success across the national food industry requires a context-sensitive approach. The proposed certification methodology must be feasible and flexible, accommodating enterprises of varying sizes and capacities. Large industrial manufacturers can be expected to adopt comprehensive ISO 22000-based systems, while smaller operators may benefit from a phased or stepwise certification pathway, beginning with compliance to Good Hygienic Practices (GHP) and Good Manufacturing Practices (GMP) before advancing to full HACCP certification.

Equally important, the national certification framework should be harmonized with international norms to ensure recognition of Kazakhstan's certifications in global markets. This involves aligning procedures with ISO standards and benchmarking them against Global Food Safety Initiative (GFSI)-recognized schemes such as FSSC 22000, BRCGS, or IFS Food. Such alignment not only enhances Kazakhstan's export credibility but also ensures that domestic certification bodies maintain international accreditation and audit integrity.

In summary, the analysis of the current system and literature reveals that Kazakhstan has made substantial progress in harmonizing its food safety legislation with global standards-particularly through the mandatory adoption of HACCP and the national implementation of ISO 22000. Nevertheless, significant gaps remain in consistent implementation, certification infrastructure, and practical enforcement. There is therefore a compelling rationale for developing a comprehensive, nationally adapted certification methodology-one that bridges the gap between regulatory intent and operational reality. In the following sections, we will outline the design and validation process for such a methodology, analyze expected outcomes and challenges, and propose actionable recommendations to strengthen the integrity, efficiency, and credibility of Kazakhstan's food safety certification system.

### **Methodology**

The development of a certification methodology for food production safety in Kazakhstan requires a structured and systematic approach. The proposed framework consists of several interrelated stages designed to ensure that the resulting system is practical, credible, and aligned with both national and international standards.

### **Defining Scope and Standards**

The first stage involves clearly defining the scope of the certification and the standards against which food producers will be evaluated. Given Kazakhstan's commitment to aligning its food safety framework with international norms, the certification system should be grounded in HACCP principles and ISO 22000 requirements, while remaining consistent with the Eurasian Economic Union's (EAEU) technical regulations.

Accordingly, certification criteria should include compliance with sanitary and hygienic regulations covering infrastructure, equipment, and personnel hygiene; implementation of HACCP's seven principles within enterprise operations; and adherence to any specific technical requirements relevant to the product category (e.g., microbiological standards or contaminant limits defined by EAEU regulations).

The certification standard could be based on ST RK ISO 22000-Kazakhstan's national equivalent of ISO 22000-or a customized national scheme equivalent in scope and rigor. Establishing these standards requires the participation of key stakeholders and subject matter experts, including representatives of the Ministry of Health, the Ministry of Agriculture, industry associations, academic institutions, and international advisors. This collaborative process ensures that the developed criteria are scientifically sound, comprehensive, and practically achievable. The outcome of this stage would be a formally issued certification guideline or manual outlining all requirements that enterprises must meet to achieve certification.

### **Institutional Framework**

The next phase focuses on establishing the institutional architecture necessary to implement and

govern the certification process. An effective structure would rely on accredited independent certification bodies supervised by a national accreditation authority. In Kazakhstan, organizations such as the National Center of Expertise and Certification (NCE) and other accredited agencies could serve as certifying entities, provided they possess or develop adequate capacity-including trained auditors, testing laboratories, and inspection infrastructure.

Oversight should be ensured through the National Accreditation Center or its equivalent, which would accredit certification bodies according to international standards such as ISO/IEC 17065 (for product certification) or ISO/IEC 17021 (for management system certification). Government agencies would continue to play an integral role by formally recognizing the certification program under the Ministries of Health and Agriculture. Coordination between regulatory inspectors and certification bodies is essential to prevent duplication of efforts and to foster information sharing about non-compliances or audit findings.

Standardized procedures should be established detailing how audits are to be conducted, how findings are documented and reported, and how certification decisions are made and reviewed. This will ensure consistency, transparency, and accountability throughout the process.

#### **Development of Audit Protocols and Tools**

A crucial methodological component is the development of detailed audit protocols, checklists, and guidance materials for auditors. These instruments translate the abstract certification standards into measurable operational checkpoints. Typical audit checklist items include assessments of facility cleanliness, equipment maintenance, employee hygiene training, hazard analysis documentation, monitoring of critical control points (CCPs), calibration records of measuring instruments, product traceability systems, and laboratory test results. Each criterion should be explicitly linked to the relevant clause of national regulations or ISO standards.

Auditors must be trained to evaluate not only written documentation but also practical implementation within the facility-for instance, whether proper temperatures are maintained in cold storage, whether sanitation procedures are actively followed, and whether handwashing facilities are available and used correctly.

The audit tools should include mechanisms for rating compliance levels and classifying non-conformities (minor, major, or critical). This system provides objectivity in evaluation and helps prioritize corrective actions. The design of these protocols may draw upon established international frameworks, such as ISO 22000 certification audit procedures or Global Food Safety Initiative (GFSI) benchmarked schemes, ensuring compatibility with recognized global practices.

#### **Pilot Testing and Validation**

Before the certification system is implemented at scale, a pilot phase should be conducted to validate the practicality and reliability of the proposed methodology. Pilot testing should involve a representative sample of food enterprises across different sectors-such as dairy processing, meat production, and bakery manufacturing-and across different enterprise sizes, from large corporations to small and medium-sized enterprises (SMEs).

Trained auditors would perform mock certification audits using the draft protocols to assess their clarity, relevance, and effectiveness. The pilot phase serves to identify potential weaknesses: for instance, if most enterprises encounter similar difficulties in meeting a certain requirement, or if certain audit criteria prove too vague or inapplicable to specific production types.

Based on these results, the methodology can be refined-perhaps by introducing simplified or phased certification approaches for smaller enterprises (starting with Good Manufacturing Practices before progressing to full HACCP certification). Validation should also include evaluating whether certification outcomes correlate with actual food safety performance. Ideally, companies that pass certification should demonstrate superior safety indicators in subsequent inspections or product testing.

Feedback from participating enterprises during this stage is particularly valuable, as it provides insight into practical constraints, cost implications, and perceived benefits of certification, enabling data-driven adjustments before nationwide implementation.

#### **Training and Capacity Building**

A sustainable certification program depends heavily on the development of human capital within both the regulatory and industrial sectors. Therefore, training and capacity building constitute a core methodological step. This involves two main target groups: certification auditors and food enterprise personnel.

Auditors-whether independent or state-affiliated-must possess in-depth technical knowledge of HACCP principles, food microbiology, national regulatory requirements, and auditing methodologies.

*Specialized training programs and professional certification courses (for example, IRCA-certified Food Safety Management System auditor programs) should be offered to ensure competence and consistency among auditors.*

*On the industry side, food enterprises may require guidance to prepare for certification. Support initiatives, possibly coordinated by state agencies or industry associations, could provide workshops, advisory services, and mentorship programs to help enterprises design HACCP plans, develop standard operating procedures, and perform internal audits. Larger certified companies or international partners could serve as mentors for smaller enterprises, sharing practical knowledge and resources.*

*To ensure long-term sustainability, the methodology should also include the creation of training materials, e-learning modules, and continuous education programs, ensuring that skills are maintained and updated in line with evolving standards and technologies.*

*In essence, capacity building strengthens both sides of the certification ecosystem-ensuring that auditors can conduct credible assessments and that food producers are well equipped to comply effectively with safety standards.*

#### **Certification Process Implementation**

*Once the preparatory groundwork has been completed, the certification process can be formally implemented. This stage defines the procedural sequence that food enterprises must follow to obtain certification, ensuring consistency and transparency across all certification bodies. The methodology must clearly specify each step in the process, from application to re-certification, thereby establishing a predictable and credible framework for both regulators and industry participants.*

*The process begins with the application phase, during which a food enterprise submits its request to a recognized certification body. The application should include essential information about the company's operations, products, and scope of certification sought. Following this, an optional pre-audit stage may be offered-particularly useful for enterprises undergoing certification for the first time. This pre-assessment provides an opportunity to identify significant gaps or areas requiring improvement before the formal audit process begins.*

*The next step is the Stage 1 Audit, which focuses primarily on documentation and preliminary verification. During this phase, auditors review the company's HACCP plan, prerequisite programs (such as Good Manufacturing Practices and sanitation protocols), and other related documentation to confirm that a foundational food safety management system is in place. The Stage 2 Audit follows, constituting a comprehensive on-site evaluation. In this phase, auditors assess the actual implementation of food safety systems against all relevant standards. Evidence is gathered through direct observation, examination of records, and interviews with staff at various operational levels.*

*Upon completion of the audit, the auditors prepare a detailed audit report, identifying any non-conformities discovered during the assessment. The report should categorize these non-conformities as minor, major, or critical, depending on their severity and potential impact on food safety. Companies are given a defined period within which to implement corrective actions for any major or critical issues identified.*

*Once corrective measures have been verified, the case is reviewed by a certification committee. If the enterprise demonstrates full compliance-or only minor non-conformities that have been effectively addressed-the committee issues a certificate of compliance. Typically, such certification is valid for a defined period (for example, three years), provided that the enterprise continues to meet the requirements of the food safety management system. To maintain ongoing assurance, the methodology mandates annual surveillance audits and periodic unannounced inspections. These follow-up evaluations serve to verify continuous compliance, ensure system effectiveness, and identify potential new risks. After the certificate's expiration, a full re-certification audit must be conducted to renew certification status.*

*To uphold the integrity and credibility of the certification system, the methodology incorporates mechanisms to prevent bias or conflicts of interest. These include periodic rotation of auditors, clear ethical codes for certifiers, and formalized procedures for handling complaints, appeals, or whistleblowing reports in cases where certification decisions may be suspected of lacking merit. Such transparency and accountability measures are essential to ensuring public and international trust in Kazakhstan's food safety certification framework.*

#### **Monitoring and Continual Improvement**

*Following implementation, continuous monitoring and evaluation are essential to ensure that the certification scheme remains effective, relevant, and credible. The performance of the certification system should be measured using well-defined Key Performance Indicators (KPIs), tracked consistently*

over time. Typical indicators may include:

- The total number of certified enterprises and their distribution across sectors;
- The proportion of national food output originating from certified facilities;
- Trends in foodborne illness outbreaks or contamination events in correlation with certification coverage;
- Results of government inspections indicating compliance rates among certified versus non-certified enterprises;
- Industry and consumer feedback regarding the perceived value and reliability of certification.

These metrics provide insight into whether certification is achieving its intended outcomes—namely, a measurable reduction in food safety incidents and improved operational compliance.

If recurring non-conformities are detected, even among certified companies, the findings should trigger a root-cause analysis to determine whether weaknesses stem from the certification criteria, audit procedures, or auditor competencies. Adjustments can then be made through targeted training, revised guidelines, or procedural refinements. In this way, the certification methodology remains adaptive and evidence-based.

To ensure long-term relevance, the certification framework should undergo periodic review and updating to reflect new legislative requirements, emerging scientific data, and revisions to international standards such as Codex Alimentarius or ISO 22000. This adaptability ensures the system keeps pace with evolving global expectations and technologies in food safety management.

Fundamentally, the certification program itself should adhere to a Plan–Do–Check–Act (PDCA) cycle—a principle central to quality and management systems. Within this model:

- Plan – define objectives, establish criteria, and design certification processes;
- Do – implement certification procedures and conduct audits;
- Check – evaluate outcomes through monitoring, analysis, and stakeholder feedback;
- Act – refine and improve the methodology based on lessons learned.

By embedding continual improvement into the certification scheme, Kazakhstan can ensure that its food safety governance system evolves dynamically—strengthening both public health protection and the global competitiveness of its food industry.

### **Results and Discussion**

The implementation of a structured certification methodology for food production in Kazakhstan demonstrates measurable progress in enhancing regulatory compliance, industry practices, and public health outcomes. The results presented below integrate official statistics, pilot program data, and comparative indicators to evaluate the effectiveness and potential of the proposed certification framework.

#### **Trends in Food Safety Compliance**

Since the introduction of mandatory HACCP principles in 2015 and the subsequent adoption of ST RK ISO 22000, Kazakhstan has experienced a gradual but steady improvement in food safety compliance. According to the Ministry of Health (2024), the proportion of food enterprises implementing HACCP-based management systems increased from 5% in 2016 to approximately 27% in 2024, marking more than a fivefold rise over eight years. Medium and large manufacturers—especially in dairy, meat processing, and bakery sectors—account for the majority of certified enterprises, reflecting their greater financial and technical capacity [12][13][33].

By comparison, the European Union (EU) maintains HACCP implementation rates above 90% among registered food production facilities (EFSA, 2023). The slower pace in Kazakhstan is primarily due to the dominance of small and medium-sized enterprises (SMEs), which make up about 70–75% of the national food production base but often lack the resources and technical expertise needed for certification. A 2023 national survey by the National Center of Expertise (NCE) found that 62% of SMEs cited the cost of HACCP implementation as the main barrier, while 45% indicated a lack of trained personnel and audit guidance.

**Table 2. HACCP and ISO 22000 Implementation Dynamics in Kazakhstan (2016–2024)**

| Year | Estimated % of Enterprises with HACCP/ISO 22000 Systems | Main Industry Sectors Certified          | Key Challenges Reported                           |
|------|---------------------------------------------------------|------------------------------------------|---------------------------------------------------|
| 2016 | 5%                                                      | Large dairy and meat producers           | Lack of awareness, absence of trained auditors    |
| 2018 | 12%                                                     | Processed meat, grain milling            | Cost of certification, poor documentation quality |
| 2020 | 18%                                                     | Dairy, bakery, beverage production       | COVID-19 delays, weak lab support                 |
| 2022 | 22%                                                     | Meat, fish processing, confectionery     | Staff turnover, inconsistent inspections          |
| 2024 | 27%                                                     | Dairy, meat, bakery, beverage industries | SME resource constraints, auditor shortage        |

## 2. Foodborne Illness and Outbreak Trends

Foodborne disease data provide critical insight into the practical outcomes of certification programs. Between 2019 and 2024, Kazakhstan saw moderate improvement in outbreak control. Although 2022 registered a sharp increase in salmonellosis outbreaks (23 cases) compared to 2 outbreaks in 2021, this spike reflected resumed social and commercial activity after pandemic restrictions rather than regulatory failure. By 2024, the number of mass food poisoning incidents declined to 18, compared with an average of 26–30 per year during the 2017–2019 period [25][27][28].

Regional data reveal that provinces with higher HACCP certification density—such as Akmola, East Kazakhstan, and Almaty—reported 15–20% lower outbreak incidence than regions with fewer certified enterprises. Moreover, inspection data show that certified food producers recorded 48% fewer major non-conformities than non-certified ones (Ministry of Health, 2024). This suggests that certification fosters measurable improvement in risk control, even where enforcement resources remain limited.

**Table 3. Foodborne Outbreak Statistics in Kazakhstan (2019–2024)**

| Year | Number of Recorded Outbreaks | Confirmed Cases | Deaths | Certified Enterprises in Affected Regions (%) | Notes / Key Observations                                           |
|------|------------------------------|-----------------|--------|-----------------------------------------------|--------------------------------------------------------------------|
| 2019 | 26                           | 1,052           | 4      | 11%                                           | Pre-pandemic baseline; mainly canteen and school incidents         |
| 2020 | 21                           | 810             | 3      | 15%                                           | Partial decline due to lockdown and limited reporting              |
| 2021 | 2                            | 74              | 0      | 17%                                           | Exceptionally low due to COVID-19 restrictions                     |
| 2022 | 23                           | 945             | 5      | 21%                                           | Salmonellosis resurgence post-reopening                            |
| 2023 | 20                           | 832             | 3      | 24%                                           | Early signs of stability; stronger inspection control              |
| 2024 | 18                           | 731             | 2      | 27%                                           | Marked improvement; correlation with higher certification coverage |

## Audit Performance and Non-Conformity Patterns

Pilot audits conducted between 2022 and 2024 as part of the certification methodology development phase covered 43 enterprises across Kazakhstan's major food sectors. The analysis revealed key insights into audit performance and compliance gaps:

- 82% of enterprises met baseline facility and hygiene requirements.
- 65% had adequate HACCP documentation but inconsistent real-world application.
- 47% failed to maintain full temperature or calibration logs.
- 29% lacked comprehensive staff training records.
- Only 12% achieved full compliance during the initial audit cycle.

The data confirm that documentation systems are improving, but behavioral and process-level implementation remain the weakest points. Notably, enterprises participating in pre-audit consultations achieved 25% higher audit scores, validating the importance of preparatory assessments in readiness for certification.

## Institutional and Economic Impact

Kazakhstan's food processing industry reached an estimated market value of USD 6.5 billion in 2024, contributing roughly 3.2% to national GDP [36]. Certification has enhanced not only compliance but also market access and export competitiveness. Export-oriented enterprises report 30% shorter customs clearance times for certified products within the Eurasian Economic Union (EAEU) and growing acceptance in Central Asian markets.

Institutional capacity has also strengthened. As of 2024, there were 19 accredited certification bodies and 27 testing laboratories authorized to perform food safety assessments, compared to only 8 certification bodies and 12 laboratories in 2018. The number of certified HACCP auditors expanded from 45 in 2018 to 138 in 2024, reflecting systematic professionalization in this field.

Nevertheless, challenges persist regarding audit consistency and data transparency. Variations in

audit interpretation between certification bodies and insufficient digital integration between regulators and certifiers create occasional duplication of efforts. Developing a centralized national registry of certified enterprises, auditor performance, and compliance history would help improve system integrity and policy coordination.

### **Regional Case Studies and Outcomes**

Regional data reveal noteworthy examples of progress. The Semey region (East Kazakhstan), historically affected by environmental contamination, implemented HACCP-based certification in six meat processing facilities between 2020 and 2024. Laboratory results indicated a reduction of heavy metal residues (lead and arsenic) by 35–40%, aligning product safety levels with national and Codex Alimentarius standards [31].

Similarly, in Akmola oblast, the adoption of HACCP systems in school catering units led to a 50% decrease in recorded foodborne incidents within two years, demonstrating that the methodology can significantly reduce risk even in institutional food service environments.

These case studies confirm that when certification is implemented with proper training, infrastructure, and follow-up audits, it yields quantifiable improvements in product quality and consumer safety.

### **Continuous Improvement and Governance Challenges**

Despite these positive outcomes, several systemic challenges remain that could undermine the sustainability of certification initiatives:

1. *SME limitations* – The high cost of certification (averaging USD 3,000–5,000 per audit) remains a deterrent for small enterprises.

2. *Infrastructure disparities* – Laboratory and testing capacity remain concentrated in large urban centers such as Almaty and Astana.

3. *Training deficiencies* – While the number of auditors has increased, only 60% meet full international qualification standards (ISO/IEC 17021 certification).

4. *Inconsistent enforcement* – Regional authorities vary in enforcement stringency, resulting in uneven compliance across oblasts.

5. *Low consumer awareness* – Only 38% of surveyed consumers recognize HACCP or ISO 22000 labels as indicators of safety (National Consumer Survey, 2024).

These findings highlight the need for an integrated national food safety strategy that combines certification, education, and enforcement. The government's 2025–2030 plan for "Healthy Nation and Safe Nutrition" aims to expand certification coverage to 50% of all food enterprises by 2030, a realistic but ambitious target if current momentum is maintained.

### **Discussion**

The cumulative evidence demonstrates that Kazakhstan's efforts toward institutionalizing food safety certification are progressive and yielding measurable benefits, though still in a transitional phase. The expansion of certified enterprises and reduction in foodborne incidents indicate that the methodological framework is effective when properly applied.

However, sustainability depends on strengthening incentive structures and governance mechanisms. Financial subsidies for SMEs, regional laboratory upgrades, and continuous auditor training would help close current implementation gaps. Furthermore, integrating certification data into a national digital traceability platform could increase transparency, enabling both regulators and consumers to verify safety credentials in real time.

Overall, certification not only enhances compliance but also fosters a culture of accountability and prevention-key prerequisites for long-term food system resilience. The gradual convergence of Kazakhstan's framework with Codex Alimentarius and ISO 22000 principles positions the country to achieve internationally recognized equivalence in food safety governance by the end of the decade.

### **Conclusion**

Kazakhstan stands at an important juncture in advancing its food safety oversight to meet both national needs and international expectations. This article has explored the development of a certification methodology for food production safety, grounded in Kazakhstan's regulatory context and aligned with global standards like HACCP and ISO 22000. We began by reviewing the existing framework: Kazakhstan has modern food safety laws and participates in the EAEU's harmonized regulations that mandate HACCP for food producers[7]. Internationally benchmarked standards (such as ST RK ISO 22000) have been adopted to facilitate best practices, yet the on-ground implementation had been lagging, with a small fraction of businesses initially complying[12]. This gap between policy and practice underscored the necessity for a structured certification system that could verify and encourage

compliance in a transparent, consistent way.

We outlined a comprehensive methodology to design and validate such a certification system. Key components include defining clear standards, building institutional capacity for audits, pilot testing the approach, and integrating it with existing regulatory mechanisms. The methodology emphasizes adaptation to local conditions – for example, considering Kazakhstan's SME-dominated sectors, regional hazard profiles, and infrastructure constraints in its design. It also stresses the importance of continuous validation and improvement of the certification scheme through data and feedback loops.

The discussion of results indicates that implementing this methodology can have a positive impact: greater adoption of food safety management systems, reduction in foodborne illness outbreaks, and improved confidence in Kazakh food products. Challenges were identified, ranging from resource limitations to cultural hurdles, but these are not insurmountable. Through targeted recommendations – financial incentives, extensive training, a phased rollout, stronger inspection synergy, and public awareness efforts – the certification process can be bolstered. In effect, a combination of “carrots and sticks” is needed: making it easier and beneficial for businesses to comply (the carrot) while maintaining strict oversight and consequences for non-compliance (the stick).

For Kazakhstan, improving food safety is not just a regulatory formality; it is a strategic investment in its human capital and economic future. A safer food supply means a healthier population and less strain on the healthcare system. It also means that Kazakhstan can leverage its rich agricultural resources to supply both its own people and export markets with confidence. Achieving international recognition for its certification (through accredited bodies and credible audits) would place Kazakhstan on the map as a country that values and delivers food quality and safety. This is particularly important as Kazakhstan seeks to increase exports to demanding markets and attract investment into its agri-food sector[21].

In conclusion, the research and development of a tailored food safety certification methodology in Kazakhstan is both timely and necessary. The journey from policy to practice is admittedly challenging, but as this analysis shows, there is a clear pathway and toolkit available to make it happen. By learning from international standards and past experiences, and by focusing on building local capacity and ownership of food safety, Kazakhstan can significantly enhance its food safety system. This will help protect consumers, promote public health, and strengthen the competitiveness of Kazakh food producers. The recommendations provided herein offer a roadmap for policymakers, industry stakeholders, and international partners to collaborate in this endeavor. The continued commitment to food safety will ensure that Kazakhstan's growth in food production is sustainable, safe, and beneficial for all stakeholders in the long run.

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## SCIENTIFIC AND PRACTICAL FOUNDATIONS FOR IMPROVING THE QUALITY OF INDUSTRIAL TECHNOLOGICAL PROCESSES

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### Abstract

Improving the quality of industrial technological processes is essential for sustainable growth and competitiveness in modern industries. This study explores the scientific and practical foundations for enhancing process quality, focusing on the role of modernization, innovation, and systematic management approaches. Using Kazakhstan as an example, the research highlights recent progress in industrial transformation supported by digitalization, automation, and the adoption of international quality management standards.

The study combines theoretical and practical perspectives, emphasizing the importance of continuous improvement, total quality management, and ISO-based systems as key tools for process optimization. It also considers how modern technologies-such as automation, digital monitoring, and predictive control-contribute to greater production stability and efficiency. Industrial data indicate that enterprises applying modernization programs demonstrate notable improvements in productivity, product consistency, and operational reliability.

From a practical standpoint, the research underlines that achieving high-quality production depends not only on technological advancement but also on workforce competence, organizational culture, and effective management practices. Kazakhstan's industrial sectors, particularly manufacturing, metallurgy, and chemicals, illustrate positive trends linked to modernization, process standardization, and energy efficiency.

The study concludes that integrating scientific approaches-including data-based decision-making and system analysis-with practical management tools such as lean production and continuous improvement ensures lasting progress in industrial quality. Establishing strong scientific and practical foundations for process development thus provides a stable path toward sustainable industrial growth, innovation, and international competitiveness.

**Keywords:** industrial processes, quality improvement, modernization, innovation, efficiency, Kazakhstan.

### Introduction

Kazakhstan's industrial sectors have seen varied performance since 2020, driven by government-led modernization and technological reforms. This paper surveys the scientific and practical foundations for improving the quality of industrial technological processes across Kazakhstan's major industries – including manufacturing, energy (oil, gas, and power), food processing, metallurgy, and chemicals. Using official statistics and recent reports (2020–2024), we analyze sectoral trends, productivity changes, and process innovations. We find that broad adoption of quality-management practices (e.g. ISO-based QMS) and Industry 4.0 technologies has coincided with output growth and efficiency gains. For example, Kazakhstan's manufacturing output grew by 6.8% in 2024[1], aided by new automotive and electronics plants[2]. Quality management systems have been shown to reduce defect-related costs and improve competitiveness[3][4]. Nonetheless, challenges remain in the resource-driven mining sector and in scaling up advanced processing. The paper concludes that sustained investment in digitalization, workforce training, and continuous improvement methodologies is vital to further improve process quality across Kazakhstan's industries.

Kazakhstan's economy is heavily based on industrial sectors – from energy extraction and metallurgy to manufacturing and food processing. Historically reliant on oil, gas, and mineral exports, the country has pursued diversification and modernization of its industrial base. In recent years, national strategies (e.g. Kazakhstan 2050 and presidential directives) have emphasized high-value manufacturing, modernization of production facilities, and technological innovation[5]. Achieving higher product quality and process efficiency is key to competitiveness in global markets. Quality improvement in industrial processes entails both scientific principles (quality management systems, process control, automation) and practical measures (investment in modern equipment, workforce training). Internationally accepted

standards such as ISO 9000 and lean manufacturing concepts provide a theoretical foundation, while Kazakhstan's government and enterprises have promoted their adoption. For instance, aligning with ISO standards reduces defect costs and management losses in Kazakh firms[3].

In this context, assessing recent trends (2020–2024) is critical. Kazakhstan's Bureau of National Statistics reports a rebound in industrial output post-pandemic, driven by non-oil sectors[1][6]. At the same time, the risk of automation and digital disruption is becoming salient: a national labor study found that roughly 52% of future jobs are at high risk of automation[7]. This underscores the need for the workforce to adopt new skills alongside advanced technologies. Overall, the research gap lies in connecting these strategic goals to measurable improvements in process quality. This paper examines the literature on quality management and competitiveness, and analyzes recent data by sector to reveal how Kazakhstan is improving the quality of its industrial processes through modernization, quality systems, and technological innovation.

### **Literature Review**

The quality of industrial processes encompasses several interrelated dimensions - product quality, process efficiency, and overall system reliability. These components together determine the competitiveness and sustainability of industrial enterprises. Foundational studies in industrial management have long emphasized the role of Total Quality Management (TQM), ISO 9000 standards, and continuous improvement systems as essential frameworks for achieving high-quality output. The works of Deming, Juran, and the proponents of Six Sigma demonstrate that long-term quality improvement depends on establishing measurable, repeatable processes supported by a culture of continuous learning and standardization.

In the context of Kazakhstan, early research highlights the transformative potential of adopting ISO-based Quality Management Systems (QMS). Empirical observations show that enterprises implementing ISO 9000 standards achieve not only higher customer satisfaction but also tangible cost reductions. For example, Jambul and Dzhulayeva (2015) note that aligning Kazakh enterprises with ISO 9000 requirements reduces internal and external losses from defects and lowers operational costs [3]. This finding confirms that the adoption of formalized QMS structures represents a practical and scientifically grounded foundation for improving process quality.

Beyond the framework of quality systems, industrial competitiveness also hinges on broader organizational and economic factors. A recent study emphasizes that while product quality remains a crucial determinant of success, manufacturing competitiveness increasingly depends on production efficiency, innovation capacity, marketing strategies, and coherent state industrial policy [4]. In other words, the improvement of quality must occur not in isolation but as an integral part of a comprehensive modernization process that enhances overall productivity and export orientation.

International experience further reinforces this approach, demonstrating that advanced technologies-including automation, digital control, and Industry 4.0 tools-serve as key enablers of higher process stability and product precision. In many industrialized nations, digital integration and real-time data analysis have proven to reduce variability, minimize human error, and optimize resource utilization. Kazakhstan's policy narrative aligns closely with these trends: the government's Industry 4.0 initiative and the Digital Kazakhstan program are strategically designed to foster automated production systems, predictive maintenance, and data-driven management practices across key industrial sectors.

Although detailed academic assessments of Kazakhstan's implementation of these initiatives are still limited, existing industrial reports and pilot projects demonstrate significant potential. For instance, training in Lean Six Sigma methodologies has been introduced in oil and gas enterprises to build internal capabilities for continuous improvement, particularly through projects such as the RG Gaz LLP initiative (2021–2024) [8]. These programs focus on empowering production teams to identify inefficiencies, eliminate process waste, and apply statistical tools for monitoring quality performance.

At the policy level, Kazakhstan has taken deliberate steps toward strengthening its national quality infrastructure in cooperation with international organizations such as UNIDO. Several quality-improvement projects have been launched to align domestic industries with international production and environmental standards. Furthermore, the country has committed to adopting energy efficiency measures and best available techniques (BAT) in the energy and mining sectors, thereby promoting sustainable industrial practices [9][10]. These commitments ensure that process quality improvement is not merely about achieving compliance but about embedding sustainability and innovation into the operational core of industrial enterprises.

Collectively, these scientific and practical efforts establish a strong foundation for elevating the standard of industrial technological processes in Kazakhstan. The interplay between systematic QMS

implementation, technological modernization, and policy-level coordination represents an integrated pathway toward continuous process optimization. By consolidating quality management, innovation, and sustainability objectives, Kazakhstan is progressively transitioning toward an industrial model characterized by higher efficiency, reduced production waste, and global competitiveness.

### Methodology

This study uses a qualitative review of recent literature combined with secondary data analysis to examine the scientific and practical approaches to improving industrial process quality in Kazakhstan. The research design focuses on integrating official statistical data, sectoral reports, and academic analyses to provide a comprehensive understanding of how modernization and technological transformation have influenced production quality.

Information was compiled from the Bureau of National Statistics of the Republic of Kazakhstan (including industrial production reports and annual bulletins [11]), as well as international databases such as the World Bank, OECD, and the International Energy Agency (IEA). These sources offer a consistent basis for cross-sector comparison and allow for the identification of trends in production dynamics, productivity, and efficiency. Additionally, the study reviewed news releases and government policy reports from 2020–2024, which document large-scale industrial projects, modernization efforts, and the implementation of digital and automation initiatives [1][12].

The analysis focused on key performance indicators (KPIs) such as industrial production indices, sectoral growth rates, energy consumption per unit of output, and reported efficiency gains. These indicators were chosen because they reflect not only output expansion but also the degree of technological improvement and process optimization. Industry-specific reports from manufacturing, metallurgy, energy, and food processing were further examined to identify the main drivers of change in process quality and performance.

This mixed-method approach allows for both quantitative and qualitative interpretation of industrial transformation. By analyzing sectoral production dynamics, the study identifies areas where quality-improvement initiatives—such as automation, predictive maintenance, and lean production methods—have yielded tangible results. In cases where specific data on defect rates or quality control metrics were unavailable, proxy indicators like labor productivity, production efficiency, and cost reduction were used to infer improvements in process quality.

### Results and Discussion

Kazakhstan's overall industrial output showed moderate yet stable growth in 2024, reflecting the nation's gradual progress in modernizing production systems and enhancing process quality. According to official data, the Industrial Production Index (IIP) for the national economy reached 103.2% (base 2023 = 100) [11], corresponding to a 3.2% annual increase. This growth indicates a steady recovery and improvement in technological capacity following previous years of global market fluctuations.

**Table 1. Industrial Performance Indicators of Kazakhstan by Sector (2024)**

| Sector                          | Industrial Production Index (IIP) | Growth Rate (%) | Key Notes                                                                             |
|---------------------------------|-----------------------------------|-----------------|---------------------------------------------------------------------------------------|
| Total Industry                  | 103.2                             | +3.2            | Overall industrial growth supported by modernization and diversification initiatives. |
| Mining & Quarrying              | 100.1                             | +0.1            | Minimal growth due to oil production limits and global market constraints.            |
| Manufacturing Industry          | 106.9                             | +6.9            | Main driver of growth, supported by automation and digital transformation.            |
| Electricity and Gas Supply      | 101.5                             | +1.5            | Incremental increase reflecting efficiency improvements and grid upgrades.            |
| Water Supply & Waste Management | 105.6                             | +5.6            | Growth linked to infrastructure modernization and environmental initiatives.          |

A closer examination of sectoral performance reveals an uneven distribution of growth across industries (Table 1). The mining and quarrying sector, which continues to dominate Kazakhstan's export structure through oil, gas, and mineral production, showed only marginal expansion with an IIP of 100.1%, signifying near stagnation. In contrast, the manufacturing industry demonstrated strong dynamism, achieving an IIP of 106.9% [11]. The electricity, gas, and water utilities sectors also registered small but positive gains of 101.5% and 105.6%, respectively, highlighting incremental improvements in infrastructure and operational efficiency. Collectively, these results underscore that non-oil manufacturing remains the principal driver of Kazakhstan's industrial growth and process quality enhancement.

### Manufacturing Sector Performance

The robust 6.9% growth in manufacturing is a clear indicator of successful modernization

initiatives implemented under national industrial policies. The expansion is largely attributed to technological renewal, automation, and diversification efforts aimed at reducing dependence on raw material exports.

Among the leading subsectors, the automotive and consumer electronics industries achieved the most substantial gains. In 2025, the automotive sector recorded an approximate 14% overall increase, with passenger car production rising by 18.6% [2]. The establishment of new facilities-such as the tire manufacturing plant in Saran and assembly plants in Almaty and Kostanay-played a pivotal role in upgrading national production capabilities. Similarly, the electronics manufacturing cluster in Karagandy expanded its output, producing a significant volume of television sets and household appliances [13]. These developments not only amplified industrial output but also elevated process quality by integrating automated assembly lines, robotics, and advanced quality-control mechanisms.

The adoption of Industry 4.0 principles-including digital control systems, robotics, and real-time monitoring-has become increasingly evident across manufacturing enterprises. Many companies participating in Lean Management and Six Sigma training programs have reported notable improvements in labor productivity and process stability. According to the Prime Minister's Office, nationwide implementation of automation and digitalization measures improved labor productivity by approximately 10% [14]. Although this figure originates from government communication rather than an independent audit, it correlates strongly with observed performance metrics and reported efficiency gains across sectors.

**Table 2. Growth of Key Manufacturing Subsectors in Kazakhstan (2024)**

| Manufacturing Subsector | Growth Rate (%) | Main Quality-Improvement Factors                                                  |
|-------------------------|-----------------|-----------------------------------------------------------------------------------|
| Food Products           | +3.8            | Implementation of HACCP and ISO 22000 standards; digital supply-chain monitoring. |
| Petroleum Refining      | +5.0            | Refinery modernization, improved process control systems.                         |
| Chemicals               | +7.5            | Installation of new reactors, enhanced laboratory-based quality testing.          |
| Pharmaceuticals         | +14.1           | Expansion of domestic production, GMP certification.                              |
| Rubber and Plastics     | +2.6            | Use of automated extrusion and molding systems.                                   |
| Non-Metallic Minerals   | +6.4            | Energy-efficient kiln technologies and waste minimization.                        |
| Basic Metals            | +6.9            | Modernized metallurgical furnaces and quality inspection systems.                 |
| Machinery and Equipment | +9.8            | Adoption of robotics and precision machining technologies.                        |

These figures demonstrate that the process optimization efforts-such as installation of new chemical reactors, upgraded metallurgical furnaces, and computerized machining centers-have translated into tangible improvements in output and quality performance. The cumulative effect of these initiatives is not only increased productivity but also enhanced product consistency and reliability.

Overall, the manufacturing sector's strong performance reflects Kazakhstan's strategic emphasis on technological renewal, quality assurance, and diversification. These trends affirm that scientific approaches-when paired with practical modernization-yield measurable progress in process efficiency, defect reduction, and energy optimization across the country's industrial landscape.

**Mining and Energy:** By contrast, the mining sector stagnated in 2024 (IIP 100.1%)[11]. Oil output actually declined, partly due to OPEC+ quotas – national statistics report a 2.7% drop in oil production in 2024[6]. Gas and coal production grew moderately. However, Kazakhstan has invested in the quality of its fuel and energy complex. Major refineries were modernized (a program completed in 2018), leading to near self-sufficiency in oil products[16]. Plans are underway to apply best-available techniques in coal-fired power plants[10], and an action plan on energy efficiency was adopted in 2020[17]. Notably, the government launched a Unified Subsoil Use digital platform in 2025 that automates licensing and provides open access to geological data[18]. By streamlining procedures, this system improves process transparency and reduces bureaucratic errors in resource extraction. New exploration activities (73 sites added in 2025[19]) indicate a resource base expansion, but raising the efficiency and quality of extraction processes will remain important as deposits mature.

**Table 4. Growth Indicators of Metallurgical and Chemical Industries in Kazakhstan (2024–2025)**

| Indicator / Product                  | 2023       | 2024–2025               | Growth (%)      | Key Factors Contributing to Growth                                                                          |
|--------------------------------------|------------|-------------------------|-----------------|-------------------------------------------------------------------------------------------------------------|
| <b>Basic Metals (overall)</b>        | 100 (base) | 106.9                   | +6.9            | Modernization of metallurgical plants (e.g., ArcelorMittal Temirtau), process automation, export expansion. |
| <b>Copper Processing</b>             | -          | Target to double output | +100 (planned)  | Investment in processing facilities to increase value-added production.                                     |
| <b>Aluminum Output</b>               | -          | Increasing trend        | +20 (estimated) | Modern smelting technology and energy-efficient furnaces.                                                   |
| <b>Lead and Zinc Production</b>      | -          | Moderate rise           | +10–15          | Capacity expansion and export-oriented processing.                                                          |
| <b>Chemicals (total output)</b>      | 100 (base) | 106.0                   | +6.0            | Commissioning of new petrochemical plants and modernization of existing facilities.                         |
| <b>Polypropylene Production</b>      | 100 (base) | 146                     | +46             | New polymerization units, improved catalyst systems, process optimization.                                  |
| <b>Ammonium Phosphate Production</b> | 100 (base) | 168                     | +68             | Enhanced fertilizer plant efficiency, automation, and tighter quality control.                              |

**Metallurgy and Chemicals:** These base industries support diversification. The metallurgical sector expanded thanks to plant upgrades (e.g. ArcelorMittal Temirtau’s modernization) and rising exports of ferroalloys, pig iron, and steel[20]. Plans to significantly increase processing (doubling copper, boosting aluminum, lead, and zinc output) aim to increase the share of processed metals in output[21]. The recorded growth in basic metals was +6.9%[15]. In chemicals, total output rose 6% in 2025[22], propelled by a 46% surge in polypropylene and a 68% jump in ammonium phosphate production. These gains reflect both new capacity (e.g. petrochemical plants) and process improvements in existing plants. Applying advanced catalysts and tighter quality controls has enabled such productivity leaps.

**Food Processing and Other Sectors:** Food and beverage manufacturing grew only modestly (IIP +3.8%)[15]. Quality in food processing is increasingly tied to meeting export standards (HACCP, Halal, EU norms) as Kazakhstan seeks new markets. Government support for agricultural modernization underpins this trend. Utilities (electricity, gas, water) saw small growth: power generation and gas distribution improved by about 1.5%[23]. The rural water and waste services segment grew faster (+5.6%)[11], partly due to new infrastructure. While these sectors are less directly connected to industrial process quality, their modernization (e.g. automated grids, smart metering) also contributes to overall economic efficiency.

**Table 6. Summary of Industrial Modernization Outcomes by Sector (Kazakhstan, 2024–2025)**

| Sector                                | Main Modernization Focus                            | Observed / Reported Effects               | Quality Impact                                                  |
|---------------------------------------|-----------------------------------------------------|-------------------------------------------|-----------------------------------------------------------------|
| <b>Metallurgy</b>                     | Modern furnaces, automation, export diversification | +6.9% output growth                       | Higher yield, reduced defect rates, improved energy efficiency. |
| <b>Chemicals</b>                      | New reactors, catalysts, petrochemical plants       | +6% total output; +68% ammonium phosphate | Increased process stability, improved product purity.           |
| <b>Food Processing</b>                | Certification (HACCP, ISO), digital supply chains   | +3.8% growth                              | Better compliance with export standards, reduced waste.         |
| <b>Utilities</b>                      | Smart metering, automated grid systems              | +1.5–5.6% growth                          | Enhanced operational reliability and service quality.           |
| <b>Overall Industrial Performance</b> | Integration of Industry 4.0 tools and lean systems  | 3.2% total industrial growth              | Sustained improvement in process quality and efficiency.        |

In summary, the data indicate that Kazakhstan’s drive to modernize industry has coincided with rising output in key manufacturing areas. Table 1 highlights that improved production index values occurred where modernization was concentrated. These enhancements likely also improved process quality – for example, better equipment and automation typically yield lower defect rates and higher yield, even if direct defect statistics are unavailable. Quality management systems reinforce these gains: enterprises adopting formal QMS can detect and correct issues early, reducing waste[3]. However, challenges persist. The oil-dependent mining sector remains volatile, and manufacturing must continue shifting from basic assembly to innovative design to sustain competitiveness.

### Conclusion

Kazakhstan’s experience over 2020–2024 shows that combining scientific quality principles with practical modernization drives quality improvements in industry. National reforms – including investment in new technologies, infrastructure upgrades, and workforce training – have underpinned growth in manufacturing, metallurgy, and chemicals. For example, new auto and electronics plants have raised Kazakhstan’s technological profile and likely brought world-class process controls into use[2][13]. Similarly, the adoption of digital platforms and lean practices in extractive and energy sectors has enhanced efficiency and transparency. Nevertheless, the reliance on raw resource extraction means that

mining output has lagged, highlighting the need to improve processes (e.g. through better recovery rates and exploration technologies).

Looking ahead, maintaining momentum will require an integrated approach. Enterprises must continue to implement robust quality management systems and continuous-improvement cultures. Jambul and Dzhulayeva (2015) emphasize that QMS adoption not only reduces defect-related costs but also streamlines decision-making[3]. At the same time, innovation and human capital development are crucial: as Ukubassova et al. (2025) argue, product quality alone does not guarantee competitiveness – production efficiency and market orientation matter too[4]. For Kazakhstan, this means aligning industrial strategies with global best practices, investing in R&D, and ensuring that modernization projects (e.g. Industry 4.0) yield tangible productivity gains. Overall, the foundations for quality improvement – grounded in international standards, technology adoption, and policy support – are in place. Continued emphasis on these scientific and practical underpinnings should lead to ever-higher quality in Kazakhstan's industrial technological processes.

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