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ECONOMIC SCIENCES

PROSPECTS FOR ECONOMIC DEVELOPMENT OF UZBEKISTAN WITHIN THE WORLD TRADE ORGANIZATION: ANALYSIS OF MULTILATERAL TRADE AGREEMENTS

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Abstract

This article examines the prospects for economic development of Uzbekistan within the framework of the World Trade Organization (WTO) and analyzes the impact of multilateral trade agreements on the national economy. As a country transitioning to a market economy, Uzbekistan's integration into the World Trade System is of great importance for sustainable economic growth. The study analyzes the state of Uzbekistan's trade relations with WTO and EAEU member states over the past five years - imports and exports. The article puts forward proposals to stimulate the country's economic development, increase competitiveness, and address the complexities of global trade dynamics through WTO membership.

Keywords: WTO, Uzbekistan, EAEU, economic growth, export, import

Introduction

The World Trade Organization (WTO) is an influential international organization that coordinates the trading system of world economies. Currently, 166 countries are members of the WTO [12], which account for 98% of global trade [13]. The main task of the WTO is to establish free and transparent trade relations, promote fair competition and strengthen the economic stability of member countries. This task of the WTO fully corresponds to the goal of economic reforms being implemented in Uzbekistan. For developing countries like Uzbekistan, WTO membership is of great importance in bringing trade practices into line with international standards and creating wider access to world markets.

The final result of the country's foreign economic activity, in particular, the reforms being implemented in the field of foreign trade, directly affects the standard of living of the population. As a result of measures taken in recent years to stimulate exports, optimize imports and ensure the balance of foreign trade, the republic's foreign trade turnover in January-September 2024 amounted to 48.2 billion US dollars, which is 3.5 billion US dollars or 7.7% more than in the same period in 2023 [14]. Uzbekistan, through its membership in the WTO, will integrate into the international trading system, and this process will create additional opportunities for promoting exports, expanding the production of import-substituting goods, adapting to international trade standards, and eliminating trade barriers. In turn, WTO membership will give Uzbekistan the opportunity to trade with 166 countries on an equal footing, which will play an important role in strengthening the country's position in the world market. This is a great achievement for Uzbekistan!

Literature review

In their article "On the Impact of GATT/WTO Membership on Trade," Mario Larch, Roberta Piermartini, and V. Yotov state, "In particular, our results show that, on average, accession to GATT and/or WTO increased trade between members by 171 percent and trade between members and non-members by about 88 percent. We also find that, while GATT/WTO has been

effective in promoting trade among members, WTO is more effective in promoting trade with non-members than GATT [1]. M.K. Tang and S.J. Wei noted in their study that "While growth rates typically remain stable for the first five years after accession, WTO membership consistently increases the economy by 20%. Economic growth increases by an average of 2.5 percent for at least five years after a country joins GATT/WTO" [3]. Similarly, according to research by T.L. Allee and J.E. Scalera, "...the more committed a state is to an international organization and the greater the policy change required, the greater the benefits it derives from membership in the organization" [4]. The WTO experience of countries in transition should be considered positive. The agreements significantly improve the stability of market access, they help to eliminate corruption and improve governance without significant losses of state revenues. In addition, Z. Drabek, M. Bacchetta noted that the WTO has also played a positive role in strengthening domestic policies to better manage balance of payments crises [5]. According to G.Felbermayr's research, on average, WTO membership increases bilateral trade by about 40% [6]. T.S.Eicher has argued that WTO membership promotes regional trade integration at the expense of longer-term trade among developing country members [7]. Also, Richard Pomfret, in his study "Uzbekistan and the WTO," noted that "...the answer to the question of whether Uzbekistan should or should not join the WTO depends on its commitment to economic reforms. If the government is serious about replacing its dependence on resource exports and protected manufacturing activities with a more diversified competitive economy, Uzbekistan can achieve and benefit from WTO membership" [8].

Research methodology

This scientific article examines the necessity of Uzbekistan's membership in multilateral agreements for the state economy using a systematic comparative analysis and a systematic approach, expert and comparative analysis, analysis-synthesis, and other modern methods.

Analysis and results

The World Trade Organization (WTO) is an organization that discusses ways to solve trade-related problems of member countries. The basis of the WTO is its agreements, which are signed by the participants of the organization. The WTO was established in 1947 - the successor to GATT. Today, this organization has 166 member states, accounting for 98 percent of the world's gross domestic product. The WTO is an organization aimed at ensuring the primacy of the principle of "non-discrimination" in international trade in goods, services and intellectual property. Based on this principle, member states ensure that discrimination is not allowed among their trading partners, as well as between foreign and domestic manufacturers and service providers. As a result, each member state of the WTO, as an equal subject of international trade, conducts foreign economic and trade relations on the basis of the same opportunities as other members.

For our country, WTO membership will further increase the potential of the country's economy, making Uzbekistan an important link in the global production and value-added chain. Also, the issue of Uzbekistan's full membership in the World Trade Organization is included as one of the most important goals in the "Uzbekistan - 2030" strategy. In a short period of time, in order to harmonize national legislation with WTO agreements, 24 regulatory legal acts were adopted during 2023-2024, and about 40 documents were harmonized. As a result of the intensification of meetings of working groups on accession to the WTO, active bilateral negotiations have been conducted with more than 30 countries today, of which all conditions for market access have been agreed with 11 countries [17].

According to statistical data for 2023, Uzbekistan has established import relations with 129 WTO member states and export relations with 137 countries [11]. In 2023, the foreign trade turnover of our Republic amounted to 62.5 billion US dollars. This figure increased by 12.0 billion US dollars or 23.9% compared to the same period in 2022. The composition of trade turnover is as follows: exports amounted to 24.4 billion US dollars, and imports amounted to 38.1 billion US dollars [9].

Uzbekistan's trade relations with the World Trade Organization (WTO) member states have developed significantly in recent years. In particular, import relations with WTO member states have undergone significant changes. During 2019-2023, Uzbekistan's import volume with WTO member states increased significantly. These changes reflect the need to expand and diversify Uzbekistan's economic relations in global markets. In 2023, Uzbekistan's import volume with WTO member states reached 75.1%, which indicates a high share of these countries in the country's foreign trade. In 2019, imports from WTO member states amounted to 71.5%, and in 2020 this figure increased to 73.6%. In 2021 and 2022, the share of imports was relatively stable, amounting to 73.7% and 74%. In 2023, this share reached 75.1%. This indicator confirms the important role of WTO member states in our country's foreign trade.

From the table below (Table 1), we can see that Uzbekistan's import relations have shown significant changes over the period 2019-2023. The main importing countries are countries such as China, Russia, Kazakhstan, and South Korea, as well as developed and developing economies and economic partners such as Turkey, Germany, Brazil, India, France, and the United States.

In 2023, Uzbekistan's imports from China amounted to \$11.34 billion, from Russia to \$6.66 billion, from Kazakhstan to \$3.07 billion, and from South Korea to \$2.31 billion. Import relations with these countries are of great importance, as they are Uzbekistan's main partners in technology, industrial equipment, energy products, raw materials, and other important resources.

The increase in imports with major economies such as China and Russia is mainly driven by imports of energy, industrial equipment, automobiles, electronics, chemicals, and construction materials. China's share in imports has grown significantly by 2023, reaching \$11.34 billion. This indicates the need to further strengthen Uzbekistan's import policy towards China. Changes in Uzbekistan's import relations are closely related to the country's foreign trade policy updates.

Table 1

Import relations of the Republic of Uzbekistan with WTO member states¹ (in million US dollars)

№	Countries	2019	2020	2021	2022	2023
1	China	5 108,63	4 501,22	4 923,42	6 427,71	11 339,10
2	Russia	4 137,69	4 173,78	5 462,24	6 230,69	6 660,63
3	Kazakhstan	1 942,01	2 097,35	2 742,18	3 243,51	3 068,54
4	South Korea	2 664,82	2 099,37	1 841,06	2 299,78	2 313,47
5	Turkey	1 326,41	1 087,27	1 717,58	1 738,54	1 897,74
6	German	927,53	759,37	693,51	1 071,30	985,50
7	Brazil	115,50	89,17	348,23	553,37	652,28
8	India	330,57	423,03	460,57	655,06	649,11
9	France	140,51	132,51	259,53	271,67	595,00
10	USA	567,24	248,48	365,48	368,73	512,01
As percentage of total imports		71,5	73,6	73,7	74,0	75,1

¹ Analyzed by the author based on data from the Statistical Agency under the President of the Republic of Uzbekistan.

Uzbekistan's main imports from WTO member states:

– Technology and industrial equipment: Technological products, industrial equipment and automotive products imported from China, South Korea, Germany and the United States play an important role in Uzbekistan's industrial sector.

– Energy resources: Oil, gas, coal and other energy resources imported from Russia and Kazakhstan meet Uzbekistan's energy needs.

– Agricultural products: Food and agricultural products imported from Kazakhstan, Turkey and Brazil play an important role in ensuring Uzbekistan's food security.

– Chemicals and industrial materials: Chemical industry products, construction materials, polymers and other industrial materials are used in various industrial sectors of Uzbekistan.

Uzbekistan's export relations with WTO member states have undergone significant changes in 2019-2023. During these years, the volume and composition of Uzbekistan's exports have changed significantly,

new markets have opened, and relations with existing partners have been strengthened.

Looking at the export dynamics of our republic, Uzbekistan's export relations with WTO member states have undergone changes over the years 2019-2023. According to statistics, the main export partners of Uzbekistan remain Russia, China, Kazakhstan and Turkey. In 2023, exports to Russia amounted to 3.5 billion US dollars, while exports to China exceeded 2.5 billion US dollars. Other important export markets of Uzbekistan include Afghanistan, Kyrgyzstan, Tajikistan, France, Pakistan and the United States (Table 2).

We can see that in 2023, the total volume of exports with WTO member states amounted to 48 percent, the change in this indicator for different countries requires diversification of Uzbekistan's foreign trade strategy. The decline in the share of Uzbekistan's exports is associated with the global economic situation, in particular the impact of the pandemic, and changes in demand in its markets. At the same time, there is an increasing need to diversify many sectors of exports, discover new markets, and strengthen existing ties.

Table 2

Export relations of the Republic of Uzbekistan with WTO member states² (in million US dollars)

№	Countries	2019	2020	2021	2022	2023
1	Russia	2 531,87	1 485,76	2 088,24	3 151,10	3 495,68
2	China	2 528,75	1 937,05	2 529,09	2 632,00	2 486,56
3	Kazakhstan	1 392,96	908,42	1 178,38	1 407,55	1 417,05
4	Turkey	1 217,63	1 018,99	1 692,38	1 643,45	1 263,33
5	Afghanistan	616,96	776,74	667,48	756,28	857,24
6	Kyrgyzstan	669,64	760,46	792,04	982,54	634,44
7	Tajikistan	327,56	405,12	501,90	522,12	608,30
8	France	214,74	89,72	21,28	72,62	400,44
9	Pakistan	97,94	98,55	130,07	185,16	269,27
10	USA	36,65	28,50	60,79	124,48	253,12
As percentage of total exports		55,2	49,7	57,8	59,4	48,0

The main components of Uzbekistan's exports are:

– Agricultural products: Uzbekistan's exports are largely based on agricultural products, especially cotton, fruits and vegetables, rice, grains and other food products. Countries such as Russia, China, Kazakhstan, Turkey and Afghanistan are the main markets for Uzbekistan's agricultural exports.

– Textile products: Uzbekistan's textile industry also occupies an important place in terms of export volume. Textile products are exported to China, Turkey, Russia and the United States.

– Industrial products and machinery: Uzbekistan's exports of industrial products, especially construction

materials and machinery, also occupy an important place. Russia, Kazakhstan and Turkey are the markets for Uzbekistan's industrial exports.

Uzbekistan's import relations with the EAEU member states showed significant growth in 2019-2023. In 2023, Uzbekistan's import volume with the EAEU member states amounted to 13.6 billion US dollars. If import relations with the EAEU member states accounted for 26.8% of total imports in 2019, by 2023 this share will be 27.8%. This indicator reflects changes in the country's foreign trade policy, the development of cooperation with the EAEU, and the growth of import needs (Table 3).

² Analyzed by the author based on data from the Statistical Agency under the President of the Republic of Uzbekistan.

Table 3

Import relations of the Republic of Uzbekistan with the EAEU member states³ (in million US dollars)

No	Countries	2019	2020	2021	2022	2023
1	Russia	4 137,7	4 173,8	5 462,2	6 230,7	6 660,6
2	Kazakhstan	1 942,0	2 097,3	2 742,2	3 243,5	3 068,5
3	Belarus	283,9	219,5	319,2	411,6	525,8
4	Kyrgyzstan	150,7	146,7	161,6	280,7	333,8
5	Armenia	2,5	2,9	3,0	5,1	9,5
As percentage of total imports		26,8	31,4	34,1	33,1	27,8

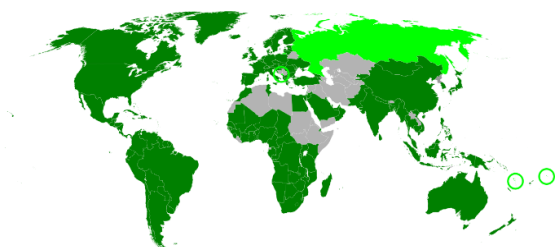
The total volume and share of Uzbekistan's export relations with the EAEU member states showed changes in 2019-2023. In 2023, the share of total exports with the EAEU member states amounted to 23.4%. This is a decrease from 26.6% in 2019, but a decrease in the share of exports compared to 2022 (29.1%). These changes are mainly due to the volume and diversification of Uzbekistan's exports to other regions. In 2019, exports to the EAEU member states

amounted to 26.6%, while in 2020 this figure decreased to 21.2%. In 2021, the share of exports increased to 24.8% and reached 29.1% in 2022. In 2023, this figure was 23.4%. Uzbekistan's export relations with the EAEU member states changed over the period 2019-2023, showing a number of increases and decreases. Russia, Kazakhstan and Kyrgyzstan constitute the main export markets of Uzbekistan (Table 4).

Table 4

Export relations of the Republic of Uzbekistan with the EAEU member states⁴ (in million US dollars)

No	Countries	2019	2020	2021	2022	2023
1	Russia	2 531,9	1 485,8	2 088,2	3 099,1	3 495,7
2	Kazakhstan	1 393,0	908,4	1 178,4	1 393,1	1 417,1
3	Kyrgyzstan	669,6	760,5	792,0	978,4	634,4
4	Belarus	48,9	42,6	59,6	127,9	128,9
5	Armenia	2,8	4,2	10,4	19,9	31,9
As percentage of total exports		26,6	21,2	24,8	29,1	23,4



From the above analysis, we can see that Uzbekistan's trade relations with WTO member states are changing significantly from year to year. In the country, about 75% of imports and an average of 40-45% of exports during the year are accounted for by WTO member states.

The foreign trade turnover of our republic with the countries that are members of the Eurasian Economic Union amounted to 25.4% in 2023. It should be noted that the movement of goods and services, the movement of migrants and the movement of capital are ensured between the member states of the Eurasian Economic Union (Russia, Belarus, Kazakhstan, Armenia and the Kyrgyz Republic), and a common economic territory with a single customs system has been formed.

Conclusion

In conclusion, Uzbekistan's WTO membership creates good opportunities for the development of exports and imports on a global scale. In 2023, the share of imports with WTO member states amounted to 75.1%, which indicates that they constitute the main part of imports. The development of import relations with major economies such as China, Russia, South Korea and Turkey will satisfy Uzbekistan's needs for industrial, technological and consumer products. At the same time, the share of exports with WTO member states amounted to 48%, which will allow us to supply emerging markets with Uzbekistan's export products.

Membership in the EAEU will help Uzbekistan strengthen regional cooperation. The share of imports with EAEU member states will be 27.8% in 2023. Trade relations with countries participating in the Eur-

³ Analyzed by the author based on data from the Statistical Agency under the President of the Republic of Uzbekistan.

⁴ Analyzed by the author based on data from the Statistical Agency under the President of the Republic of Uzbekistan.

asian economic integration process, such as Russia, Kazakhstan and Belarus, are being strengthened. Exports with EAEU member states also amounted to 23.4%, and basic products such as cotton, textiles and fruits and vegetables occupy an important place in the structure of Uzbekistan's exports.

For Uzbekistan, WTO membership plays an important role in ensuring diversification and technological development in world markets. It creates opportunities for strengthening trade relations with China and Russia, exporting highly competitive products in various sectors.

Membership in the EAEU is mainly useful for deepening economic ties in the region and expanding trade with neighboring countries such as Russia and Kazakhstan. It creates stable markets for products such as cotton and fruits and vegetables.

For Uzbekistan, WTO membership is more advantageous in terms of long-term strategic prospects. Because:

- WTO membership increases access to international markets.
- Creates a reliable platform for attracting foreign investment.
- Diversification of products and services allows for an increase in the share of high value-added products.

At the same time, it is advisable to strengthen ties with the EAEU and take advantage of regional economic benefits through effective trade policies. Rather than becoming a full member of the EAEU, maintaining preferential trade agreements with the union may be a more flexible strategy for Uzbekistan. This will help to obtain regional benefits without limiting cooperation with the WTO.

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MATHEMATICAL SCIENCES

THE EXISTENCE OF ASTROPHYSICAL PORTALS REFUTES THE VERSION OF SRT STUDIED IN TEXTBOOKS⁵

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Abstract

The article claims that the version of the special theory of relativity studied in all physics textbooks is incorrect and sets out the main provisions of its corrected version. And from the relativistic formulas of the corrected version of SRT it follows that in nature, in addition to our visible universe, there are mutually invisible universes and anti-universes that are connected to each other by a large number of portals. At the same time, the entrances to the portals are supposedly the so-called anomalous zones, which people avoid visiting, since it is very difficult to get out of them. However, scientific research of portals by unmanned robotic complexes is possible and necessary. Such scientific research will allow solving a number of very important scientific problems - proving the existence of mutually invisible universes adjacent to our visible universe, explaining the Fermi paradox, proving the possibility of traveling not only in the space of the hidden Multiverse, but also in time, etc.

Keywords: imaginary numbers; special theory of relativity, invisible universes and antiuniverses, hidden Multiverse, Hyperverse, portals, anomal zones

1. The version of SRT taught in all physics textbooks is incorrect

Although Albert Einstein became famous as the author of the special and general theories of relativity, who was nominated for the Nobel Prize 66 times, he received it in 1921 not for the theory of relativity, but for the study of the photoelectric effect. And he never received the Nobel Prize for the special theory of relativity (SRT) because SRT had no experimental confirmation. In other words, SRT was actually called a theory incorrectly, since it was only a hypothesis. And therefore, according to the Nobel Committee, sooner or later it could be experimentally refuted.

And the Nobel Committee turned out to be right - now it has already been experimentally refuted.

First, in 1934, it was refuted by the discovery of Cherenkov radiation [1], which was created by the movement of electrically charged particles in a transparent medium with a refractive index $n > 1$ at a speed exceeding the phase velocity of light in this medium. For this discovery, P.A. Cherenkov, I.E. Tamm and I.M. Frank even received the Nobel Prize in 1958. But the SRT was then corrected and survived.

Then, in 2011, the OPERA collaboration tried to disprove it at the Large Hadron Collider, expecting to receive the Nobel Prize for this. And they even published a message about their success [2]. But six months later, in 2012, at the same Large Hadron Collider, the ICARUS collaboration found an error in the OPERA experiment and disproved it [3].

And in the 21st century, the generally accepted version of SRT has already been confidently refuted by the existence of radio technology, the existence of tsunamis, the existence of pianos and other musical instruments, and even the existence of suspended swings on playgrounds, as well as many other experiments [4]-

[15]. But throughout the 20th century, relativistic physicists could not figure this out. And even now, the authors of physics textbooks do not understand this. And therefore, these textbooks still present the incorrect version of SRT created in the 20th century [16]-[45], according to which relativistic formulas have the form (see Fig. 1a, b, c)

$$m = m_0 / \sqrt{1 - (\frac{v}{c})^2} \quad (1)$$

$$\Delta t = \Delta t_0 \sqrt{1 - (\frac{v}{c})^2} \quad (2)$$

$$l = l_0 \sqrt{1 - (\frac{v}{c})^2} \quad (3)$$

in which m_0 – rest mass of a moving body;

m – relativistic mass of a moving body;

Δt_0 – rest time of a moving body;

Δt – relativistic time of a moving body;

l_0 – rest length of a moving body;

l – relativistic length of a moving body;

v – speed of motion of a body;

c – speed of light.

And these formulas in textbooks are explainable only in the range of subluminal speeds $v < c$, in which the quantities m , Δt and l take on values measured by real numbers. But in the range of superluminal speeds $v > c$, these quantities m , Δt and l already take on values measured by imaginary numbers discovered by Scipione Del Ferro, Niccolo Fontana Tartaglia, Gerolamo Cardano, Lodovico Ferrari and Rafael Bombelli [46] 400 years before the creation of the SRT, the physical meaning of which, however, was not explained by them. But, perhaps, even earlier than them, imaginary

⁵ This is reprint of the article "Antonov A. A. Astrophysical portals are sources of new knowledge. German International Journal of Modern Science. № 95.

numbers were discovered by Paolo Valmes [47], who was burned alive at the stake for this by the sentence of the inquisitor Thomas de Torquemada. The creators of the SRT also could not explain this. And the physical meaning of imaginary numbers in physics textbooks has not been explained to this day.

Moreover, the graph of the function $m(v)$ in the range of speeds $v > c$ (see Fig. 1a) corresponds to a physically unstable process, which cannot exist in nature at all. Therefore, all formulas (1)-(3) are completely incorrect. But since such a theory, which even its authors could not explain, was of no use to anyone, a postulate was introduced into it, called the principle of not exceeding the speed of light, the meaning of

which is clear from its name. And the SRT was preserved, since it claimed that in nature processes confirming the physical reality of imaginary numbers allegedly do not exist. And in the 20th century, no one objected to this. And therefore, despite the above-mentioned experiments refuting the SRT, it is sometimes even claimed that Albert Einstein understood that nothing in the Universe can move faster than the speed of light. And that the speed of light is not just a number, but a physical limit. The same as, for example, absolute zero at a temperature of minus 273.15 degrees Celsius.

But the version of SRT that is still studied in all physics textbooks is incorrect [16]-[45], because:

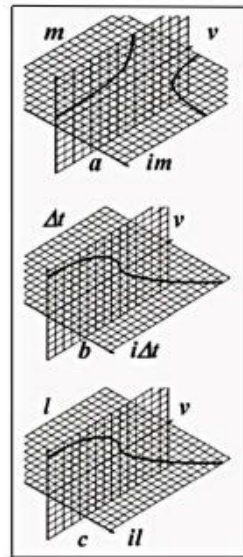


Fig. 1. Graphs of functions $m(v)$, $\Delta t(v)$ and $l(v)$ corresponding to the existing versions of the SRT in the subluminal $v < c$ and superluminal $v > c$ ranges

- the relativistic formulas obtained in it are incorrect;
- the relativistic formulas obtained in it were incorrectly explained using the incorrect principle of not exceeding the speed of light;
- from these incorrect relativistic formulas, incorrect conclusions were made about the physical unreality of imaginary numbers and about the existence in nature of our only visible universe, in which everything is measured only by real numbers.

2. Corrected version of SRT

But not all scientists share the opinion set out in the version of SRT given in physics textbooks that, in accordance with the principle of not exceeding the speed of light, imaginary numbers are physically unreal and that in nature there is only one visible universe, ours, since both of these statements are refuted experimentally.

And the relativistic formulas of the corrected version of SRT have the form [48]-[56]

$$m(q, r, s) = \frac{m_0 i_1^q i_2^r i_3^s}{\sqrt{1 - [v/c - (q + r + s)]^2}} \quad (4)$$

$$\Delta t(q, r, s) = \Delta t_0 i_1^q i_2^r i_3^s \sqrt{1 - [v/c - (q + r + s)]^2} \quad (5)$$

$$l(q, r, s) = l_0 i_1^q i_2^r i_3^s \sqrt{1 - [v/c - (q + r + s)]^2} \quad (6)$$

in which $q(v) = [v/c]$ is the “floor” function of discrete mathematics of the argument

v/c , which is the fourth spatial dimension (Fig. 2);

$r(v) = [v/c]$ is the “floor” function of discrete mathematics of the argument v/c , which is the fifth spatial dimension (Fig. 2);

$s(v) = [v/c]$ is the “floor” function of discrete mathematics of the argument v/c , which is the sixth spatial dimension (Fig. 2).

That is, our Multiverse is six-dimensional – each universe has three dimensions x, y, z and three more dimensions q, r, s have coordinates of these universes in the Multiverse (Fig. 3) – and is described by quaternions $f_{q,r,s}(x, y, z) + i_1 q + i_2 r + i_3 s$, the number of which is equal to the number of universes in the Multiverse. This is exactly what Lisa Randall predicted: “We could be living in a three-dimensional pocket of higher dimensional space.”

In this case, the three imaginary units i_1, i_2, i_3 in quaternions are related by the relations

$$i_1^2 = i_2^2 = i_3^2 = -1 \quad (7)$$

$$i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1 \quad (9)$$

$$i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1 \quad (8)$$

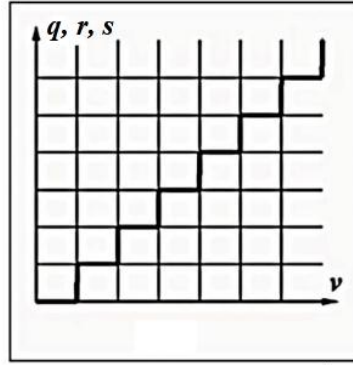


Fig. 2. Graphs of functions $q(v)$, $r(v)$, $s(v)$, illustrating the meaning of the “floor” function of discrete mathematics

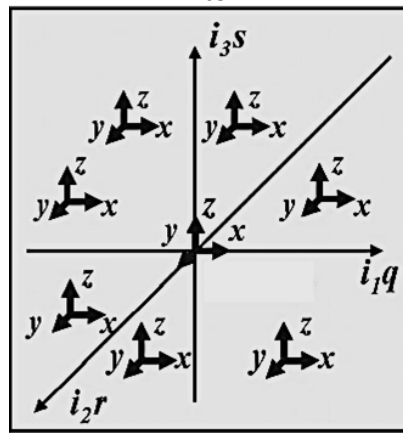


Fig. 3. Six-dimensional space of the hidden Multiverse, where q, r, s are the coordinates of invisible parallel universes, and x, y, z are the coordinates of the matter content in each parallel universe

In the mathematics of hypercomplex numbers, the function $i_1^q i_2^r i_3^s$ can be calculated only for integer values q, r, s , but can take both positive and negative values and both real and imaginary values. But we have already proven that imaginary numbers are physically real and therefore we must also explain them. Therefore, let us now consider the values $m(v)$, $\Delta t(v)$ and $l(v)$ of the quantities, and in the range of velocities $V > C$ for successive values of the argument $q + r + s$ equal to 0, 1, 2, 3, 4, 5, ... Then for our visible universe with coordinates $q=0, r=0, s=0$, i.e. located at the origin, we obtain $i_1^q i_2^r i_3^s = 1$. For definiteness, we will call it the tardyon universe. For the value $q + r + s=1$ in the range of velocities $V > C$, we obtain $i_1^q i_2^r i_3^s = +i$. This situation corresponds to the invisible universe, since it is located beyond the event horizon. For definiteness, we will call it the tachyon universe. For the value $q + r + s=2$ in the velocity range $V > C$ we get $i_1^q i_2^r i_3^s = -1$. This situation also corresponds to an invisible universe, since it is located beyond the

event horizon. We will call it a tardyon antiuniverse. For the value $q + r + s=3$ in the velocity range $V > C$ we get $i_1^q i_2^r i_3^s = -i$. This situation also corresponds to an invisible universe, since it is also located beyond the event horizon. We will call it a tachyon antiuniverse. For the value $q + r + s=4$ in the velocity range $V > C$ we get $i_1^q i_2^r i_3^s = +1$. This situation also corresponds to an invisible tardyon universe (but a different one), since it is also located beyond the event horizon. For the value $q + r + s=5$ in the velocity range $v > c$ we get $i_1^q i_2^r i_3^s = +i$. This situation also corresponds to an invisible tachyon universe (but a different one), since it is also located beyond the event horizon. Thus, all universes except ours are invisible. Therefore, we will call our Multiverse hidden. And the hidden Multiverse has a helical structure.

An example of a possible structure of the hidden Multiverse is shown in Fig. 4. As can be seen, in such a structure of the hidden Multiverse, it is possible to move to the tardion antiuniverse from the tardion universe and to the tachion universe from the tachion antiuniverse in different ways, but not arbitrarily, but only in such a way, in which the value will successively take

the values $+1, +\dot{i}_1 \oplus \dot{i}_2 \oplus \dot{i}_3, -1, -\dot{i}_1 \oplus \dot{i}_2 \oplus \dot{i}_3, +1, \dots$ etc., where $\oplus$ is the symbol of the logical operation of discrete mathematics 'exclusive OR'. In this case, different trajectories of movement from one universe (or antiuniverse) to another can differ only due to substitution of some tachyon universes from $\dot{i}_1, \dot{i}_2, \dot{i}_3$ with others and some tachyon antiuniverses from $\dot{i}_1, \dot{i}_2, \dot{i}_3$ with others. Consequently, the tachyon universes $\dot{i}_1, \dot{i}_2, \dot{i}_3$ in the hidden Multiverse are located parallel to each other. The tachyon antiuniverses $\dot{i}_1, \dot{i}_2, \dot{i}_3$ for the same reasons are also placed parallel to each other. And therefore, in the hidden Multiverse, when moving from any tardyon universe to a tardyon antiuniverse and then to another tardyon universe, parallel universes and antiuniverses must alternate in the following sequence – 'tardyon universe', 'one of the tachyon universes', 'tardyon antiuniverse', 'one of the tachyon antiuniverses', 'tardyon universe', 'one of the tachyon universes', etc.

Moreover, naturally, the movement from our tardion universe to the tardion antiuniverse through some tachyon universe - for example, $\dot{i}_1$ - does not necessarily have to proceed further through the tachyon antiuniverse $\dot{i}_1$. It can proceed further through tachyon antiuniverses $\dot{i}_2$ and $\dot{i}_3$. The same reservation applies to the situation if the movement from the tardion universe to the tardion antiuniverse begins through tachyon universes $\dot{i}_2$ or $\dot{i}_3$.

All these transitions are shown in Fig. 4. Moreover, since all such hidden Multiverses correspond to its open screw structures, united through the corresponding portals with other Multiverses, then all together they form the Hyper-universe. In this case, the invisible universes adjacent to our visible universe give rise to the phenomenon of dark matter, the remaining invisible universes of the hidden Multiverse give rise to the phenomenon of dark energy, and the invisible universes located outside the hidden Multiverse give rise to the phenomenon of dark space.

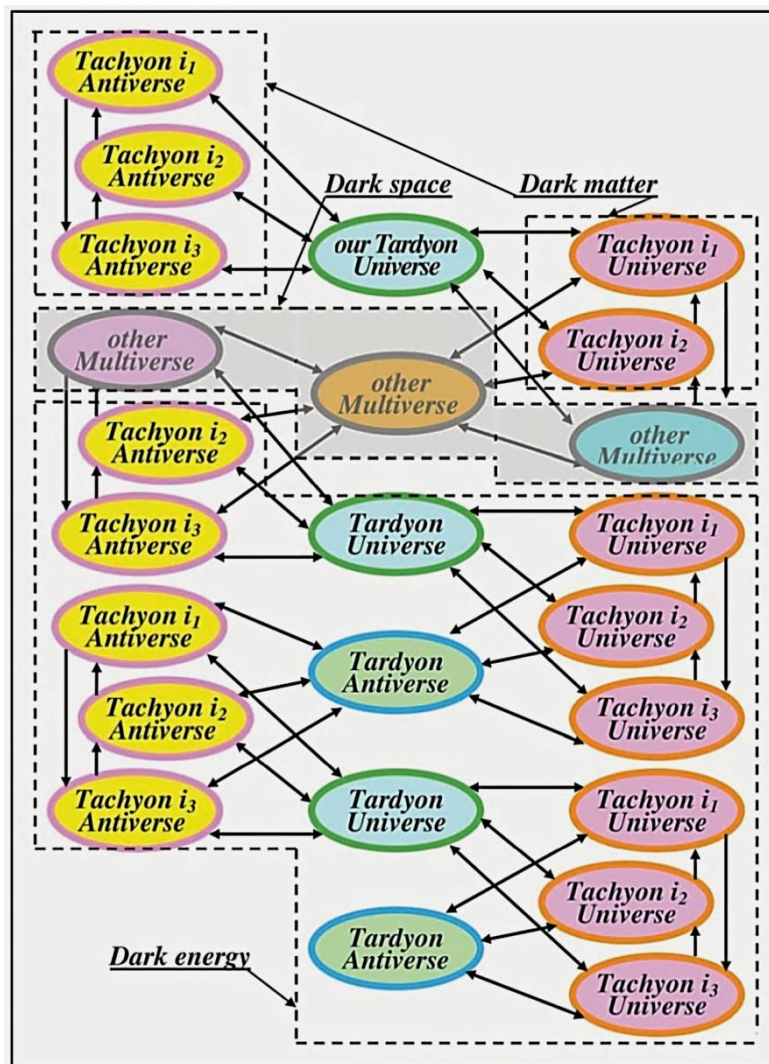


Fig. 4. Possible quaternion structure of the hidden Multiverse containing twenty-two parallel universes, including six invisible universes adjacent to our visible universe

3. Portal research

Numerous universes actually existing in space - if they exist - forming a hidden Multiverse, drift and touch, slightly immersing themselves in each other. And these zones of mutual immersion of neighboring universes, through which it is possible to pass from one universe to another, are called portals [57], [58]. And portals exist (and this still needs to be experimentally proven - see below) only if there exist at least two parallel universes, between which the portals are located.

The entrances and exits to portals are called anomalous zones [59]-[62], since incomprehensible phenomena occur in them. In particular, people disappear in them, since the paths from the entrance to the exit in portals are invisible labyrinths, from which it is almost impossible to escape. Because of this, people avoid visiting anomalous zones. And there are more than two hundred thousand anomalous zones on Earth.

But portals are of great scientific interest. And they can be studied without visiting, using unmanned vehicles.

3.1. How to see invisible universes?

The question of whether mutually invisible universes and portals between them exist in nature is fundamental. The answer to it determines whether the version of SRT presented in textbooks is correct or not. But since scientists, despite long theoretical debates, have not yet come to a consensus, the truth can be revealed by an experiment. Moreover, it is quite simple and clear.

And for this, it is not at all necessary to visit other universes. It is enough to at least look at them. As in order to be convinced that in addition to the room visible to us, in which we are now, there is a neighboring invisible room, it is enough to look from the corridor connecting these rooms into the neighboring room. The corridors connecting neighboring universes are portals [57], [58].

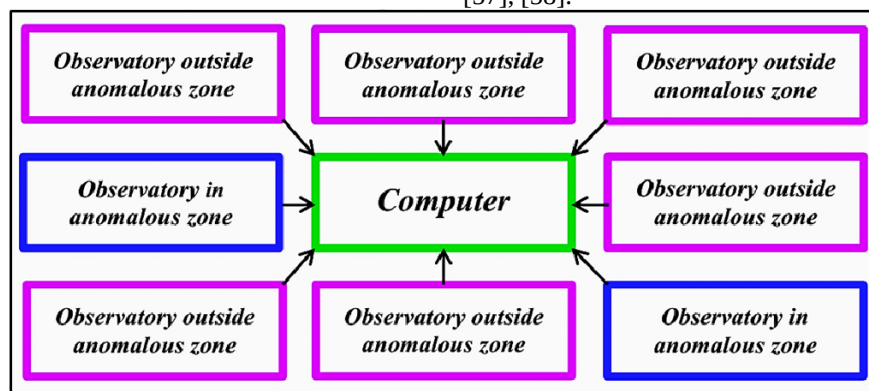


Fig. 5. Scheme of an astronomical experiment to detect invisible universes

And in order to be convinced, while in the portals, that you are no longer in our universe, but on the way to the neighboring universe, you need to look from the portal through a telescope at the starry sky and see other constellations on it [63]-[68]. This is a very reliable experiment, since you can't draw constellations in the sky.

3.2. The Arrow of Time

Here are some quotes on this topic.

"Time is the most frequently used word in English and the third most frequently used word in Russian. It is in every other language, too, because synchronizing actions in time is as important as coordinating them in space. Without knowing the exact time, it is impossible to organize your life and plan it in advance. If in ancient times you could rely on natural cycles and an internal sense of time, then in our days you need to constantly have a watch or a phone with you. Time is the most important of the abstract concepts that we pronounce every day. Every thinking person has thought about the problem of time at least once in their life, and a huge amount of philosophical and scientific literature has been written on this topic. However, no one will say for sure what time is. Or prove that time is irreversible. Or maybe it only seems that way to us?" [70]

Here is what Stephen Hawking writes: *"We can see a cup fall off a table and break into pieces, but we*

never see the cup put back together from those pieces and return to the table. The increase in disorder, or entropy, makes it possible to distinguish the past from the future and thus gives time a definite direction."

This phenomenon, known as the arrow of time, is one of the most amazing mysteries of physics. And the name "arrow of time" for this phenomenon was proposed at the beginning of the 20th century by the British physicist Sir Arthur Stanley Eddington.

And it would seem that one cannot argue with such statements.

3.3. Anti-time

But we will nevertheless try to show that the concept of the arrow of time, used in the generally recognized incorrect version of the SRT, is refutable in its corrected version. To do this, let us return to Fig. 4. And note something unusual in it. A hypothetical journey along the structural diagram of the hidden Multiverse shown in the figure is, according to formulas (4)-(6), a journey not only in space, but also in time. Since the transition from our visible tardion universe to one of the neighboring tachyon universes or antiuniverses is accompanied by their movement not only in space, but also in time, since time in them is different.

And this can be proven using various routes of such movements. Let us cite one of the simplest. Let us assume that we moved through a portal from our visible

tardion universe - using for this purpose some anomalous zone on the surface of the Earth - in a short time (for example, one day) to one of the neighboring tachyon universes or antiuniverses. And at the same time, naturally, we disappeared from the sight of our colleagues who saw us off at the edge of the anomalous zone. But we did not disappear anywhere in this neighboring tachyon universe or antiuniverse and carried out some research on it for a couple of months. Then, having carried out the planned research, we again in a short time (for example, one more day) through the same portal safely returned to Earth. And since on Earth, relative

to the neighboring invisible tachyon universe or antiuniverse, time flows (into the future or into the past) in a direction perpendicular to earthly time, then on Earth it seems to have stopped. Therefore, it seemed to our colleagues who met us on Earth that we had been absent not for two months, but only for two days. But we showed our unshaven beards for two months and thus proved that we had ended up in the past, since our colleagues who saw us off had moved into the future for two months. And in this past, we were beardless two months ago.

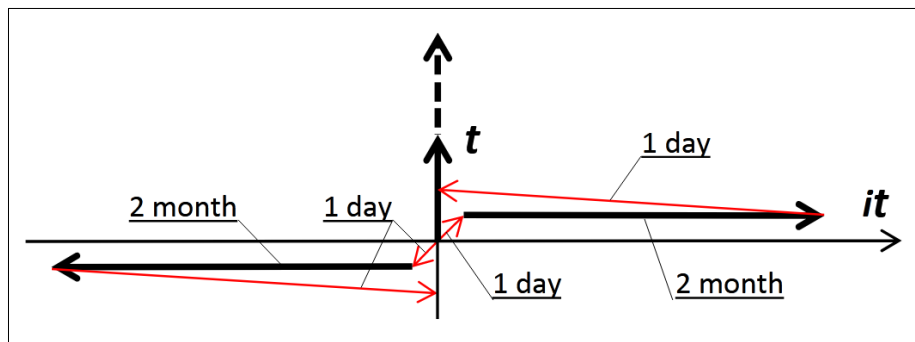


Fig. 6. The vertical solid arrow t is the real time axis (in our visible tardion universe). Horizontal thin arrow it is the axis of imaginary time (in the neighboring invisible tachyon universe and antiuniverse). Vertical dotted arrow - coordinate of the scientists' position 2 months after they, being at the beginning of the coordinates, sent two expeditions through the portals to the tachyon universe and the antiuniverse. Big horizontal arrows correspond to stay of scientists in tachyon universe and antiuniverse. And red arrows show transitions through portals.

Of course, we won't be able to contradict Stephen Hawking with such an experiment and see the process of restoring a broken cup from its fragments. But the fictional travelers from our visible tardion universe to neighboring invisible tachion universes or anti-universes and back, nevertheless made a journey through time. And due to this, having returned to the past, they nevertheless turned the arrow of time by 180° .

And for those who are not convinced by this hypothetical experiment, below

it is explained how to make it really physically feasible.

3.4 Geophysical research of portals

Oddly enough, geophysical studies of portals [71]-[80] can be much more productive in space exploration than astronomical studies of the visible starry sky. Indeed, astronomical observations allow us to study only our visible universe. And geophysical studies of portals, which are transitions to neighboring invisible universes, allow us to study invisible universes neighboring our visible universe. Moreover, as can be seen from Fig. 4, they allow us to study invisible universes, even those located outside the hidden Multiverse. They also allow, since there are more than two hundred thousand anomalous zones on Earth that are supposedly entrances to portals, having studied the portals, to perform the most detailed classification of invisible universes antiuniverses neighboring our visible universe. And to identify, and then even study some characteristics of invisible universes and atheuniverses, even those located outside the boundaries of the hidden Multiverse. Which will allow us to understand why they are not part of the

hidden Multiverse. And it is possible that several other Multiverses neighboring our hidden Multiverse will be discovered.

And with all this, geophysical research of space is much cheaper than astronomical research.

Moreover, geophysical research of portals will allow attempts to create time machines [81], with the help of which the research described in the previous section 4.3 can be transformed from hypothetical into real astrophysical ones.

3.5. Fermi paradox

The Fermi paradox is a statement of a seemingly paradoxical situation in which, on the one hand, it is known that there are many stellar systems in space suitable for life, but on the other hand, despite all the efforts of scientists, no signs of life have been found in this space. And it would seem very strange [82]-[84].

But in fact, there is nothing strange about it [85]-[97]. After all, what are we looking for? What signs of life do we expect to see? The same as now on Earth? For the same radio stations to work as on Earth, which, when transmitting signals, spend most of their energy on transmitting signals to nowhere due to an imperfect radiation pattern? For the inhabitants of supercivilizations to detonate atomic and hydrogen bombs? And so on.

But first of all, these are all defects of our imperfect civilization, which supercivilizations got rid of long ago. And therefore they are invisible. And secondly, why not assume that we do not see their ships in space also because they have different logistics as a result of using their super knowledge. Even on Earth, on

the way to work in large cities, people now often use the subway. And therefore, such their movement from space is also invisible.

And then their activity can be proven by comparing two texts:

1. "Our contemporaries – *people of the Earth* – begin their working day, leaving *their homes*, by visiting the nearest *metro station "A"*. Then, invisible from space, they *travel in the tunnel "Aa"* underground to the transfer point "*ab*" on our planet Earth. After that, they travel through another *underground tunnel "bB"* to another *underground station "B"*, leaving which they rise to the *surface of the Earth* in the place they need."

2. "Our contemporaries – *inhabitants of supercivilizations* – begin their working day, leaving *their invisible home built using superstealth technology*, by visiting the nearest *anomalous zone "A"*. Then, invisible from space, they *move through the portal "Aa"* to the transfer point "*ab*" in the neighboring universe. After which, through *another portal "bB"*, they move to another *neighboring universe "B"* and exit the portal in the *anomalous zone* in the place they need.

As you can see, the same thing happens in both situations – invisible movement in space, with the replacement of terms of our civilization currently existing on Earth with similar terms in supercivilizations:

- "people of the Earth" with "inhabitants of supercivilizations";
- "housing" with "invisible housing built using superstealth technology";
- "metro station "A" with "anomalous zone "A";
- "riding in tunnel "Aa" with "moving through portal "Aa";
- "ab" on our planet Earth" with "ab" in the neighboring universe";
- "underground tunnel "bB" with "portal "bB";
- "underground station "B" with "neighboring universe "B";
- "the surface of the Earth" with "in the anomalous zone".

That is, in order for the movement of inhabitants of supercivilizations in space to become invisible, it is only necessary that they move between universes through portals, and that planets in star systems serve as transfer stations from one portal to another. And therefore, this circumstance will need to be taken into account during geophysical studies of portals.

And the Fermi paradox must be recognized as yet another proof of the existence of portals and mutually invisible parallel universes, and, consequently, the incorrectness of the version of SRT studied in all physics textbooks.

4. Conclusion.

Thus, the article experimentally proves and theoretically explains that the version of SRT, created in the 20th century, which is still studied in all physics textbooks, is incorrect, because:

- the relativistic formulas obtained in it are incorrect;
- these formulas are incorrectly explained using an incorrect postulate called the principle of not exceeding the speed of light;

- incorrect conclusions are made from these formulas about the physical unreality of imaginary numbers and the existence in nature of our only visible universe, in which everything is measured only by real numbers.

But in the corrected version of SRT, from the relativistic formulas obtained in it, it follows that in nature, in addition to our visible universe, there are many other mutually invisible universes and anti-universes. And they, drifting in space, touch each other, even slightly plunging into each other and forming transition zones called portals. Moreover, through portals, neighboring universes and anti-universes exchange their material contents according to the law of communicating vessels.

However, people avoid visiting portals, as they are invisible labyrinths. Therefore, if you accidentally get into them, it is almost impossible to get out of them. At the same time, portals are of significant scientific interest, as as a result of their astro-geophysical research, unlike astronomical research, they allow us to prove the existence of neighboring invisible universes and anti-universes and to obtain some information about them that cannot be obtained otherwise. They also allow us to carry out other interesting research - to prove the possibility of traveling in the Multiverse not only in space, but also in time and thereby prove the existence of anti-time, etc.

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PEDAGOGICAL SCIENCES

ABOUT SOME PSYCHOLOGICAL AND PEDAGOGICAL PROBLEMS OF MODERN EDUCATION IN THE REPUBLIC OF ARMENIA

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О НЕКОТОРЫХ ПСИХОЛОГО-ПЕДАГОГИЧЕСКИХ ПРОБЛЕМАХ СОВРЕМЕННОГО ОБРАЗОВАНИЯ В РА

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Abstract

The article discusses and analyzes the social and psychological problems of education and the issues of the crisis of the educational system of the Republic of Armenia. There are real problems associated with the social contrasts of modern society, contributing to rapid changes in educational paradigms in Armenia, as well as constant changes in educational concepts and various educational reforms. Currently, the main task of education is the formation and development of personality, but not through the accumulation of knowledge, but through cognition, analysis and implementation of independently accumulated experience.

Аннотация

В статье рассматриваются и анализируются социальные-психологические проблемы образования и вопросы кризиса образовательной системы РА. Сделан вывод о наличии реальных проблем, которые связаны с социальными контрастами современного общества, способствующими быстрым сменам образовательных парадигм в Армении, а также постоянным сменам концепций образования, равно как и различным образовательным реформам. В настоящее время основная задача образования состоит в формировании и развитии личности, но не посредством накопления знаний, а посредством познания, анализа и реализации самостоятельно накопленного опыта.

Keywords: the paradigm of education, the crisis of the educational system, educational reforms, social and psychological problems of education, educational reforms, concepts, models.

Ключевые слова: парадигма образования, кризис образовательной системы, образовательные реформы, социальные-психологические проблемы образования, образовательные реформы, концепции, модели.

В настоящее время особенно актуальной, а скорее модной, стала тема уровня образования и образованности, и не только в Республике Армения, но и во всем мире, что явилось, по мнению многих ученых, последствием глобализации как тенденции, обусловленной взаимовлиянием и взаимопроникновением различных культур, мировоззрений, социальных систем и экономик [Саркисян, Таткало 2020].

Однако глобализация принесла миру не только позитивные перемены. Ускорив процесс взаимопроникновения различных культур, она привела мир к многочисленным конфликтам этнокультурного и социокультурного плана, обострила противоречия между центробежными и центростремительными силами, что не могло не отразиться на

национальных образовательных системах и общем уровне образованности населения.

В последние десятилетия наблюдается реальное снижение общеобразовательного уровня выпускников средних школ и даже вузов, что обусловлено однонаправленностью обучения, (имеется в виду ориентация на конкретные специальности), слабое владение академическими общегуманитарными знаниями, снижением коммуникативного и социального порога из-за погружения в виртуальную действительность, а также наличием функциональной неграмотности, что связывается не только с низким уровнем академических знаний, но и с недостаточным уровнем социально-психологических качеств.

Социальные-психологические проблемы образования и вопросы кризиса образовательной системы рассматриваются и анализируются многими отечественными и зарубежными социологами, которые пришли к выводу о наличии реальных проблем в образовании и их непосредственной связи с социальными контрастами современного общества, в связи с чем и происходили быстрые смены образовательных парадигм, смена концепций образования, сменяющие друг друга реформы и модели образования [Isambert-Jamati 1972].

В современной социологии образования наметились два подхода:

- первый подход исследует образование как систему во взаимодействии с другими общественными системами, в частности, с социальной структурой общества.

- второй подход заключается в рассмотрении образования как процесса (социальные аспекты содержания образования, анализ содержания учебных планов, анализ отношений учащихся к образованию в целом и к отдельным дисциплинам, в частности).

На наш взгляд, было бы продуктивнее рассматривать эти два подхода в непосредственной связи друг с другом, поскольку только в неразрывной связи и взаимодействии они могут дать ответы на поставленные социумом вопросы и предложить реальные, а не декларативные пути формирования необходимого для современного общества образовательного и культурного продукта.

Именно конкретное общество в своей конкретной социальной структуре может определять, запрашивать и «заказывать» содержание образования в широком аспекте.

Некоторые специалисты считают [Шелер 1994], что причина современного кризиса образования лежит в разрыве двух видов образования, имеющих в истории цивилизации; первый вид образования характерен для начала человеческой цивилизации, передача знаний носила личностный характер: от учителя – единственного носителя знаний – к ученику. Существовала непосредственная духовная связь между поколениями. Социальная функция образования заключалась в сохранении традиционной социальной и культурной системы определенного общества, регуляции деятельности членов данного общества.

На смену личностной педагогике приходит технократическая педагогика, в которой знание приобретает самостоятельность из различных источников и различными путями и становится единственным приоритетом. Происходит духовное отчуждение: меняются привычные трансляторы знаний, что порождает частичное недопонимание или же односторонность восприятия. Постепенно снижается критичность в отношении источников информации. Социальная функция образования трансформируется в инновационную функцию, смещаются привычные культурные условия, во многом меняется понятие «социального порядка» конкретного лингвокультурного общества.

На наш взгляд, кризис образования связывается с культурным кризисом, который объясняется

сменой доминант в мировой культуре, сменой культурных архетипов.

Естественно, мы не можем отрицать ценность и неизбежность приобщения к мировым источникам информации и не можем противостоять или избежать процессов образовательной стандартизации, но необходимость создавать «мосты» между глобальными образовательными процессами и интересами и образовательными традициями определенного государства должна стать доминантой, так как образование в первую очередь рассматривается как транслятор культуры и имеет функцию формирования личности, познания и формирования мировоззрения и нравственных ценностей в определенных конкретных социально-исторических условиях.

«Современная цивилизация оказалась в патовой ситуации: в рамках существующих общественных механизмов и существующих нравов, т. е. системы нравственных начал, любой шаг, любое действие не могут считаться обнадеживающим. Единственное, что заведомо необходимо, – знания, всеобщая образованность и действия, дающие человеку тайм-аут, время, необходимое людям для познания реальности и для принятия согласованных в планетарном масштабе решений. И прежде всего – в разработке некоего нового нравственного императива» [Моисеев 2001: 22].

Отражение кризиса национальных образовательных систем можно найти и в работах русских авторов, которые отмечают, что главной тенденцией на рубеже XX и XXI века является «осознание кризиса системы образования и педагогического мышления как выражение кризиса духовной ситуации нашего времени» [Огурцов, Платонов, 2004: 225].

Причину кризиса некоторые российские авторы видят в заимствовании западной системы высшего образования. Мы не можем полностью согласиться с данной трактовкой возникновения кризиса, так как основными его (кризиса) причинами является не количество лет и ступеней, а, как нам кажется, формирование нового информационного общества и, как результат, формирование нового мировоззрения и мировосприятия, предполагающего:

- ✓ тотальную информатизацию;
- ✓ девальвацию традиционных культурных ценностей, обусловленную разрушением информационно-культурных границ в результате тотальной информатизации;
- ✓ отсутствие мировоззренческих и духовных приоритетов;
- ✓ отсутствие обоснованной философской базы, отражающей тенденции развития современного трансформирующего социума;
- ✓ отсутствие реальных шагов в процессе гуманизации образования, хотя это декларируется постоянно и в любых документах.

Перечисленные выше причины относятся к социальным факторам, помимо которых существуют и личностные. Тот же период (конец 70-х годов XX

века) знаменуется возникновением кризисных тенденций на личностном уровне. По мере развития «постиндустриального» общества стали наблюдаться изменения психологических характеристик членов данного общества, особенно тех, которые включены в сферы деятельности «человек – человек». Основным противоречием в социальных отношениях в постиндустриальном обществе выявляется противоречие между Я – реальным и Я – отраженным в свете требуемых социально-профессиональных отношений. Требования, предъявляемые современным профессионалам любой области, в корне отличаются от привычных стандартов и форм, принятых в прошлом столетии. Возникает глубокий разрыв между тем, что «Я хочу – Я привык – Я считаю правильным» и «Так требуется». В силу традиционности и отсутствия динамичного реагирования на происходящие процессы может возникнуть стадия профессиональной и личностной стагнации.

Проявление кризиса на личностном уровне обусловлено теми же категориями и причинами, что и возникновение кризиса на уровне социальном. Все это, естественно, отражается на процессе образования.

Еще одной из причин возникновения кризиса образования является так называемый «период полураспада компетенций» [Шафранов-Куцев 2011]. Ускоренные темпы развития информативных технологий и внедрение их в сферу образования приводят, с одной стороны, к увеличению прогрессивных тенденций в этой сфере, к расширению возможностей постижения научной информации, к модернизации методов и подходов в образовании, к возможности самостоятельного образования и повышения профессиональной и культурной компетенции каждой отдельной личности, с другой стороны – к невозможности охватить, понять и использовать в социально-профессиональной сфере весь поток предлагаемой информации.

В связи с увеличивающимся потоком информации увеличивается и объем знаний, которым располагает человечество во всех сферах своей деятельности. В свою очередь, с увеличением потока информации происходит и процесс устаревания определенного пласта знаний. Объем человеческих знаний по некоторым данным удваивается каждые десять лет, таким образом, определенный пласт знаний так же быстро и устаревает.

«По многочисленным оценкам специалистов, в самых различных отраслях профессиональной деятельности в 40-е годы прошлого столетия полураспад компетенций наступал через 12 лет, в 60-е годы – через 8-10 лет, в 70-е годы – через 5 лет. Для выпускников вузов начала XXI века во многих сферах деятельности такое устаревание происходит уже через 2-3 года.

Ежегодно обновляется около 5 процентов теоретических и 20 процентов прикладных знаний. Прогресс в различных отраслях идет неравномерно, следовательно, реальный период полураспада компетенций для современного специалиста постоянно сокращается и будет сокращаться» [Шафранов-Куцев 2011: 10].

Естественно, при такой ситуации многие специалисты переживают психологический шок: растет неуверенность в собственных знаниях, умениях и возможностях, возникает синдром «ненужности», о чем говорилось выше. Может показаться, что подобная ситуация должна привести к общему желанию повышать свой профессиональный уровень, однако в реальности это не так.

Исходя из объективных и субъективных причин, у людей возникает психологический барьер, наблюдается нежелание принимать и использовать новую информацию, нежелание «переучиваться», возникает критическое, иногда и агрессивное отношение к новой информации, так как каждый специалист является уже социально сформировавшейся личностью с определенным набором профессиональных знаний, с индивидуальным жизненным опытом, с моральными и нравственными установками, которые не всегда соответствуют новым концепциям и установкам.

Особенно часто это наблюдается у учителей и преподавателей, которые годами передавали знания и считали эти знания и способы их передачи незыблемыми. Если проанализировать процессы, происходящие в сфере образования в Армении после 90-х годов, принимая во внимание общемировые тенденции кризиса образования, то вывод о наличии «синдрома стгорания» у учителей русского языка становится объективным.

Одним из показателей этого является тот факт, что школьные учителя с многолетним опытом и стабильными академическими знаниями отказываются от работы в школе. Объективно снизилось количество абитуриентов, поступающих на филологические и педагогические факультеты.

Наши наблюдения в процессе работы с учителями, результаты анкетирования и опросов свидетельствуют о том, что те, кто продолжает работать в школе отмечают:

- отсутствие перспективы;
- отсутствие положительной мотивации;
- бесперспективность данной специальности;
- чувство «отторжения» в социуме, чувство «ненужности»;
- неуверенность в собственных возможностях;
- нарушение привычного коммуникационного кода;
- неопределенность позиций в современной «мозаичной» культуре;
- непонимание целей и задач современного образования.

Таким образом, причиной кризиса является, как мы отмечали выше, неопределенность функций образования на современном этапе, отсутствие таких концептуальных понятий, как целостность, преемственность, синтетичность и интегративность подходов, что подразумевает связность различных наук для полноценного и всестороннего восприятия мира.

Кризис профессионального образования проявлялся во всех сферах и направлениях. Это объяс-

няется, на наш взгляд, не только различием концептуальных подходов к содержанию или структуре образования, но и:

- изменением, трансформацией общественных отношений, определяющих социальный заказ на определенные специальности;
- разрывом между социализацией и уровнем образования;
- отсутствием четких и привычных идеологических установок;
- отсутствием концепции педагогического образования, ориентированного на современную образовательную парадигму;
- отсутствием конкретной цели на каждом конкретном этапе;
- отсутствием единой методологической платформы для преемственного непрерывного образования;
- устареванием знаний и в связи с этим возникающим распадом профессиональных компетенций;
- наличием синдрома выгорания у преподавателей и учителей.

Кроме вышеуказанных, необходимо отметить еще несколько причин, способствующих углублению кризиса: проблема несогласованности знаний, неумение быстро адаптироваться и развиваться в вероятностно-неопределенных экономических и политических ситуациях и рассматривать любую профессиональную деятельность с точки зрения многовекторности.

С одной стороны, происходит информационный разрыв, несогласованность знаний, и как результат – недоверие или полное опровержение принятых данным социумом норм и ценностей, с другой стороны – наличествует консерватизм образовательных систем и декларативизм в этих системах.

Приведенные выше причины приводят к необходимости переосмысления таких понятий, как «образование, образованный человек».

Основываясь на данной концепции, деятельность рассматривается с точки зрения социальности и социализации: насколько современное образование может способствовать развитию личности, насколько оно дает возможность учащимся самостоятельно воспринимать знания, их осмысливать и

использовать для дальнейшего своего развития и реализации в профессиональной деятельности.

Целью же образования становится подготовка человека (вне зависимости от возраста) к деятельности не в конкретной социальной среде, а в быстро развивающемся поликультурном обществе [Саркисян 2020]. Исходя из этого, содержанием образования становится освоение общих культурных, гуманитарных и профессиональных компетенций. Социокультурный аспект образования выдвигается на передний план, предполагая включение в деятельность духовные и материальные знания и их перспективы.

Таким образом, как указывалось выше, основная задача образования состоит в формировании и развитии личности, но не посредством накопления знаний, а посредством познания, анализа и реализации самостоятельно накопленного опыта.

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PHILOLOGICAL SCIENCES

THE PSYCHOLOGICAL ASPECTS OF BILINGUALISM AND MULTILINGUALISM: CURRENT ISSUE, CHALLENGES, AND PERSPECTIVES

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Abstract

This paper presents an in-depth exploration of the psychological dimensions of bilingualism and multilingualism, with a particular emphasis on the interplay between the Russian, Kazakh, and English languages. It underscores the crucial role that Kazakh and Kazakh-Russian bilingualism plays in shaping the cultural identities of Kazakh speakers while also enhancing their ability to communicate in foreign languages.

The authors take a detailed psychological approach to investigate how these linguistic capabilities affect the process of language acquisition. They posit that achieving proficiency in a language demands a nuanced understanding of the distinct ways individuals absorb and learn multiple languages. By examining each concept in isolation, they offer a thorough perspective that incorporates both cognitive processes and the emotional experiences linked to language learning.

The foundation of their analysis rests on established psychological principles of human language development, showcasing how cognitive growth, cultural identity, and linguistic behavior interact within diverse social environments. Gaining insight into these intricate dynamics is vital for the effective development of linguistic skills, paving the way for improved intercultural communication in our increasingly interconnected global landscape.

Keywords: bilingualism, multilingualism, psychological aspect, perspectives and challenges

Introduction

From a psychological standpoint, bilingualism and multilingualism hold particular interest in understanding the processes of speech perception and production. Based on ongoing discussions, it has been agreed that the core of bilingualism and multilingualism resides in the brain of the individual. Therefore, research into the brain as the site of linguistic interaction between bilinguals and multilinguals should receive significant attention.

However, the brain is not only responsible for bilingualism but also for multilingualism and indeed, monolingualism. Moreover, the brain acts as the central hub for an individual's overall physical, mathematical, linguistic and other forms of knowledge. This does not mean that psychological research into the bearer of this knowledge in these fields should take precedence over research in physics, mathematics or linguistics. The same can be said for bilingualism and multilingualism without neglecting the significance of the psychological dimension in their study.

The acquisition and mastery of a native or non-native language are directly related to the process of perception and generation of speech. A detailed study of the mechanisms of speech and their functioning is just beginning. Future researchers of speech problems are monolingual, bilingual, and polylingual (in their research, they will probably be related to the complex of

studying neuroscience, the theory of artificial intelligence, computing, computer technology, new technologies of experimental psychology and linguistics, etc.

Literature review

Currently, the most comprehensive and objective approach to exploring the intricacies of bilingual and multilingual speech is derived from the esteemed Russian neuro-linguistic Vygotsky-Luria school. This perspective allows researchers to delve into the inner workings of language production by examining the influential models proposed by prominent figures such as A. A. Leontiev [1], P.F Kan., et al. [2], I. A. Zimnaya [3], R. Filippi et al. [4], A. A. Zalevskaya [5], E. Sharpe., & A. Perovic [6], P.K. Sah., & G. Li [7], E. Yaş [8]. A careful analysis of their frameworks reveals striking fundamental similarities that enrich our understanding of speech processes.

Among the newer contributions to this field are Raitskaya, L., & Tikhonova [9], K. Koptleuova et al. [10], Antoniou, M et al. [11]. For example, Akhutina's [12] model, which takes a fresh look at how individuals construct the semantic structure of statements. This structure acts as a crucial intermediary, guiding the transition from abstract meaning to concrete verbal expression, and it serves as a strategic blueprint for further development of ideas. Furthermore, Akhutina's model introduces a vital planning component that resonates

with Vygotsky's theories on speech. This component illustrates how established linguistic tools can transform into dynamic instruments that allow individuals to express their unique thoughts more effectively. Notably, this transformation also involves mechanisms that account for various contextual elements, situational nuances, and the orientation of the listener, ultimately enriching the communicative experience.

Methodology

Research design

This investigation delves into the psychological dimensions of bilingualism and multilingualism, providing a comprehensive overview of these intricate subjects.

Research methods:

In this study, we employ a combination of analysis and synthesis as our primary methods. Analysis serves to dissect a linguistic phenomenon into its constituent elements, while synthesis integrates these parts to form a holistic understanding. Induction, a method of reasoning, moves from specific observations to broad generalizations, while deduction proceeds in the opposite direction, from general principles to particular instances. We apply linguistic rules to specific examples or derive novel rules from observations of language use. Additionally, abstraction aids in identifying the essential features of linguistic phenomena, a crucial step in developing linguistic theories.

Theoretical framework

The model of speech production can be summarized as follows: Human activity is motivated by a certain intention, and individuals act based on this intention. This action aims to achieve a specific goal, which involves carrying out various micro-level and macro-level operations. These components of activity are organized hierarchically. There are different levels of activity, with the highest level being directly responsible for the achievement of the goal. Activities at this level are usually recognized, while activities at lower levels, such as subordinate activities or operations, are often performed unconsciously and are associated with automated skills.

For speech production, the level of significance is likely to be the most important factor: conscious control is only exercised over the semantic accuracy of the utterance, while all other necessary processes can be performed and managed automatically without conscious involvement. This may be one of the reasons why automaticity allows for a relatively wide range of phonetic variations in different pronunciations, both in the native language and in situations of bilingualism or multilingualism, that is, when deviating from the norm and making it noticeable and attracting attention.

The main stages of speech production, whether in a monolingual, bilingual or multilingual context, can be broadly categorized as follows:

1. Motivation - This is the initial stage of the process when the speaker initiates communication by generating the intention to convey a message.

2. Meaning formation - At this stage, the speaker forms their interpretation of what they want to say, using a unique combination of concepts and ideas to create an intended meaning.

3. Syntax/deep structure - Here, the speaker chooses specific words and phrases to accurately convey their message, deciding on the order and placement of these elements in sentences or utterances. Internal speech is a type of communication that takes place within an individual's mind, whether it's in a monologue, dialogue, or polylogue. It refers to thinking and forming ideas before expressing them outwardly.

The surface syntactic layer of language processing takes lexical and grammatical elements from deeper levels of the language system and combines them to create a coherent sentence. This ensures that correct word forms and word orders are used to convey the intended meaning. Phonological and phonetic aspects also play a crucial role in speech production, ensuring that sounds are correctly produced and combined to create intended utterances.

The layered process appears to be structured in such a manner that each layer builds upon the previous one, providing the subsequent layer with the resources necessary to accomplish the task. For instance, the level of articulation or "phonological" aspects contribute to the grammatical construction of speech [12, 174].

The multi-level process of speech production applies to speakers who are monolingual, bilingual, or polylingual. It seems that there may be one, two, or three systems within the layered organization of speech production. At the motivational and deeper semantic levels of an individual, a basic conceptual system may exist, as neuro-linguistic research has yet to provide data on the specific role of neurons in bilingual or multilingual individuals.

The brain is structured such that it does not contain separate neurons for storing information about specific languages, but rather, all languages are represented through complex interactions between neurons. As an individual acquires more languages, their neural interactions become more extensive and intricate.

Perhaps, at the deepest level of syntactic structure, where the fundamental "building blocks" are located, we can begin to discuss the immediate origin of two systems within an individual's mind. This level corresponds to code-switching, or the interchange between different linguistic systems. An individual speaker may be viewed as someone who chooses between various codes, such as different styles, dialects, sociolects, or even separate languages.

Discussion and results

In terms of the mechanisms of code-switching, intra-language and inter-language switching may not significantly differ. Therefore, bilingualism and multilingualism may be seen as the result of this switching, influenced by social, linguistic, and other factors.

It is reasonable to assume that the process of speech production in any language involves the use of memory mechanisms. As is well known, without regular practice, newly acquired language skills can become forgotten. Conversely, consistent practice or regular communication can help to strengthen these skills.

Therefore, a level-based approach to the organization of speech production allows us to understand both supporters of the "monolithic" view of language and those who see it as a collection of individual linguistic repertoires, if we consider pre-verbal or pre-lingual levels of speech production.

It can be argued, apparently, that bilinguals and multilinguals may share a common underlying conceptual system when considering the level of nouns and subsequent levels. However, scientific research has not yet produced sufficient data to fully describe this underlying system. Linguistically speaking, it also appears that it may be impossible to talk about a unified system of bilingualism or multilingualism in general.

Speech production is directly linked to the understanding of a message. The connection between producing speech and comprehending messages in a second language is a significant issue. Production and comprehension of speech in the native language context are closely related. For instance, concerning phonetics, establishing a system of functional units facilitates automating speech production mechanisms and maximizing use of probabilistic features in comprehension. Under conditions of interference, neither aspect of speech activity is completely automated, so the nature of the interaction between sound systems significantly limits errors that may occur. In other words, poor-quality speech in a foreign language does not preclude understanding, and difficulty distinguishing foreign sounds does not always lead to pronunciation mistakes.

Perspectives of studies

With regard to the perceptual capabilities of individuals, there are two distinct viewpoints when it comes to phonetic linguistic phenomena. The first perspective is that the perceptual space corresponds to the phonological space, implying that an individual is capable of distinguishing as many sounds as there are in their language, and other differences between sounds are not consciously recognized by the speaker.

The second perspective is based on studies into the psychophysiological abilities of humans to process sound. This perspective suggests that the ability to differentiate between specific classes of sounds is universal, meaning that the perceptual capacity is independent of a particular phonetic system. All individuals can approximately distinguish similar types of vowels and utilize similar symbols to represent them.

Experimental phonetic studies have led to the proposal of a third perspective on human auditory abilities: individuals may be able to distinguish a greater number of sounds than the number of phonemes in their native language, although this ability is still affected by phonological patterns [13, 129].

Bilingualism in Kazakh-Russian and trilingualism in Kazakh, Russian, and English require sufficient data on the perception of sounds in the native and non-native languages to fully understand native speakers' auditory systems. Research on auditory perception based on bilingualism in Kazakh and Russian can be beneficial for understanding the phonological hearing characteristics, which are crucial not only for the development of theories on bilingualism, multilingualism, and language interference, but also for educational practices.

Challenges of the study

The questions we have raised regarding the psychological aspects of bilingualism and multilingualism highlight several important areas for further research. These inquiries are particularly relevant in understanding how individuals from different linguistic backgrounds navigate their languages—specifically, examining Kazakh, Russian, and English speakers can provide unique insights into language perception, cognition, and social dynamics. Here is a breakdown of the issues identified, along with the implications they bear for future research. 1. Understanding how bilingual and multilingual individuals acquire and utilize additional languages involves looking at cognitive, social, and contextual factors.

2. Investigating how motivation, exposure, and instructional methods impact language proficiency will deepen our understanding.

3. Identifying the stages or milestones in speech production for bilinguals could reveal how these individuals integrate sounds and structures from multiple languages, including any unique challenges they face. 4. Research should explore the cognitive mechanisms involved in language switching, including the role of executive functions such as inhibition, cognitive flexibility, and working memory. This could uncover how bilinguals manage competing linguistic demands in real-time communication.

4. Understanding how a strong foundation in a native language affects the acquisition of additional languages is vital. This includes examining transfer phenomena, where skills or knowledge from the native language positively or negatively influence the learning process of the non-native language.

The effects of learning a non-native language on the native language's retention and usage remain significant. Research could focus on whether multilingualism causes a language shift or attrition in the native language among speakers.

Thus, the exploration of these questions opens avenues for comprehensive studies into the cognitive, psychological, and sociolinguistic facets of bilingualism and multilingualism in contexts involving Kazakh, Russian, and English. Such research can contribute to a broader understanding of language acquisition and its intersections with culture, identity, and cognitive development. Future inquiries should also consider the methodologies employed in studying sound perception across different languages, as this could ensure a nuanced understanding of how linguistic features are processed in the brain. Collaborations across linguistics, psychology, neuroscience, and education will be essential to address these complex questions effectively. By investigating these themes, researchers can contribute to a richer comprehension of the multifaceted nature of language knowledge and usage in a globally connected world.

Conclusion

From a psychological standpoint, the significance of Kazakh-Russian bilingualism and trilingualism is particularly pronounced in its ability to cultivate a Ka-

zakh-Russian identity while also enhancing foreign language capabilities. This in-depth examination of language proficiency explores the intricate processes through which individuals learn and utilize different languages. Each concept—bilingualism, trilingualism, and multilingualism—is dissected with care, enabling a thorough understanding that takes into account the various cognitive and emotional factors that can impact language acquisition.

Furthermore, these linguistic concepts are deeply entrenched in the psychological mechanisms that shape an individual's potential for learning languages. They highlight the complex interactions between cognitive development, the formation of cultural identity, and the use of language in a range of social settings. By unpacking these dynamics, we can better appreciate how they contribute to the promotion of language skills and the enhancement of cross-cultural communication in an increasingly interconnected global landscape. Understanding these relationships is crucial for fostering effective language learning strategies that embrace and celebrate multiculturalism.

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[DOI: 10.5281/zenodo.14726296](https://doi.org/10.5281/zenodo.14726296)**Abstract**

Military discourse plays a crucial role in communication during conflicts as it addresses not only technical aspects of warfare but also emotional and moral contexts. One notable feature of this genre is the phenomenon of thought in thought, which reveals the multilayered meanings of spoken words. In this article, we will analyze how this phenomenon is manifested in the speeches of leaders from various countries.

Thought in thought is a term that denotes the presence of multiple layers of meaning within communication. In military rhetoric, this is particularly important as speakers not only present facts but also aim to influence the emotional state of their audience, convince them of the importance of actions, and create a positive image. Such communicative maneuvers help sustain morale and national unity during difficult times.

Keywords: military discourse, thought in thought, stylistic devices, wartime speeches.

Military discourse has been the subject of study by various scholars across multiple disciplines, including linguistics, communication studies, sociology, political science, and cultural studies.

Prominent scholars in discourse analysis, explored how language and context shape identities, knowledge, and social dynamics, including in military settings (G. Genette [1]), examined military discourse in the context of gender, analyzing how language reinforces certain power dynamics and cultural narratives within military institutions (H. P. Abbot [2]), studied the language used in military discourse, particularly the framing of military actions and the impact of language on public perception (Bortolussi M., Dixon P. [3]), examined the relationship between military discourse and public policy, focusing on how military language shapes political narratives (G. Genette [1]), explored how military discourse reflects and shapes societal values and political beliefs (O'Neill P. [4]), studied how information is disseminated in society, which includes military communication and propaganda (Potter J., Wetherell M. [5]). The study of military discourse is multidisciplinary, involving insights from various fields to understand its complexities, implications, and functions in society.

1. The phenomenon of thought in thought is not a widely recognized term in linguistics, but similar ideas and theories are explored in various fields related to rhetoric, discourse analysis, and communication studies. Scholars and researchers who delve into the complexities of layered meanings, subtext, and implications in communication can provide insights relevant to this concept. Scholars like S. Marnette [6], L. Vandelanotte [7], W. Peer and H. P. Maat [8], J. Sanders and G. Redeker [9] and later linguistic theorists explore how language can highlight certain meanings while obscuring others, akin to the idea of layered thoughts. Researchers in rhetorical studies often analyze the persuasive techniques used in speeches and texts, examining how speakers embed deeper meanings within their rhetoric. Scholars like Norman Fairclough and Teun A. van Dijk [10], [11] investigate how language constructs social meaning and power dynamics, addressing subtleties within discourse that can relate to thought in thought. Cognitive Linguistics examines how language

and thought are interconnected, exploring how meanings are constructed in the mind and how layers of understanding can arise in communication (A. Palmar [12], R. M. Sainsbury [13]). Psycholinguistics in its turn examines how cognitive processes influence language comprehension and production, which can shed light on how people interpret layered meanings in communication. Scholar like D. Schiffrin [14] and M. Jahn [15] might not have explicitly studied thought in thought, but their critical frameworks can be applied to analyze the complexities of meaning in social and political discourse.

In his speeches former Chief of the General Staff of the Armed Forces of Ukraine Valeriy Zaluzhnyi often discusses military strategy, operational plans, and the overall defense posture of Ukraine in response to aggression, particularly focusing on the Russian invasion and frequently using thought in thought emphasizes the importance of national unity and resilience among both the military and the civilian population, encouraging a collective effort in defending the country. For example, in his article "Positional War" for The Economist he claims: *"Whether your arms manufacturers want this or not, the war has unfortunately changed. The wars of 1953 are no longer valid. They ended in the summer of 2023 in Ukraine. It was at the moment when robots came to the battlefield, and the Western press and NATO generals were laughing at me. Already in 2024, technologies have entered the fight. They were brought by artificial intelligence. No one is laughing at me anymore. Even here in Britain, the national security strategy is already being reconsidered."* [16]

In the contextualized extract we can observe that by using thought in thought V. Zaluzhnyi highlights the significance of international military and humanitarian aid, addressing allies and partners to garner support for Ukraine, reports on the progress and achievements of the Ukrainian Armed Forces, showcasing their capabilities and successes against adversarial forces and stresses the need for readiness and adaptation of Ukrainian forces to face current and future challenges in the conflict. Moreover, by using repetition in connection with thought in thought V. Zaluzhnyi draws attention to specific words, phrases, and mainly the very

thought in thought, making them stand out. This helps him underline their significance and ensure that they resonate with the audience. By repeating crucial points, V. Zaluzhnyi conveys a sense of urgency or importance, encouraging the audience/readers to pay closer attention and evoke emotions by reinforcing particular sentiments or themes. This creates a powerful connection between him and the audience/readers as it allows them to internalize the significance of the message messages.

The President of Ukraine also tends to frequently use the stylistic device of thought in thought in his speeches. In combination with another stylistic devices he enhances the emotional resonance, bolsters persuasion, fosters unity, and clarifies objectives. By skillfully employing these devices, he manages to effectively mobilize public sentiment, rally support, and shape the national narrative during the time of war. For example:

"The border between Ukraine and captivity, between life and death. The border between an independent European state and the number one terrorist organization in the world. 913 days ago, particularly through Sumy region, Russia launched a war against us. It violated not only sovereign borders but also the limits of cruelty and common sense. Boundlessly seeking one thing: to destroy us. Instead, today we celebrate the 33rd Independence Day of Ukraine. What the enemy brought to our land has now returned to his home. And those who wanted to turn our lands into a buffer zone must now think about how their country does not become a buffer federation. That is how independence responds. It avenges our peaceful citizens, who are bombarded with KABs and Kh-47s, our grayed parents, and our children who are forced to learn underground. For all our people who would prefer to have never known the names of these cursed places: "Savasleyka," "Olenya," "Engels." But, unfortunately, Ukrainians know them. And so our enemy will know what revenge means in Ukrainian: worthy, symmetrical, long-range. They will know that in every point of the Russian Federation, which poses a threat to the life of our state and our people, sooner or later, a Ukrainian response will arrive." [17]

Stylistic devices like metaphors ("Russia launched a war against us. It violated not only sovereign borders but also the limits of cruelty and common sense."), imagery ("so our enemy will know what revenge means in Ukrainian: worthy, symmetrical, long-range"), the rule of three ("And so our enemy will know what revenge means in Ukrainian: worthy, symmetrical, long-range.") and repetition ("The border between Ukraine and captivity, between life and death. The border between an independent European state and the number one terrorist organization in the world") comprised in thought in thought evoke emotions such as pride, hope, and resilience, which can motivate listeners and foster a sense of unity. By using the very stylistic devices the President connects with his audience's feelings, fostering a sense of shared struggle and loss. He also manages to foster unity among the nation and its allies by creating a communal effect of thought in thought inclusive language and collective pronouns ("us", "we", "Ukrainians", "Ukrainian citi-

zens", "peaceful citizens", "our children") build solidarity and a sense of shared identity among citizens, encouraging them to come together in difficult times. By using thought in thought in his speech V. Zelenskyi articulates the objectives of warfare and military actions, making clear what is at stake and why the fight is necessary, he reframes adverse situations to align with the narrative of resilience and strength, shaping public perception and focus.

By giving references to facts ("bombarded with KABs and Kh-47s"), proper names ("cursed places: "Savasleyka," "Olenya," "Engels.""), dates ("913 days ago," "the 33rd Independence Day"), and places ("Sumy region") the President reinforces collective identity and national pride and by invoking in the aspect of thought in thought the key national values such as freedom, justice, and solidarity he manages to reinforce the moral justification for the actions that are going to be undertaken.

While implementing uplifting language amidst turmoil in his speech serves to uplift spirits, assuring citizens of eventual victory and peace and invoking themes of perseverance through hardship can strengthen resolve, reminding the Ukrainians of their strength and capacity to endure ("They will know that in every point of the Russian Federation, which poses a threat to the life of our state and our people, sooner or later, a Ukrainian response will arrive.").

Thought in thought in combination with stylistic devices play a pivotal role in wartime speeches by enhancing the effectiveness of communication, influencing emotions, and rallying support.

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[DOI: 10.5281/zenodo.14726317](https://doi.org/10.5281/zenodo.14726317)**КОНЦЕПЦИЯ ПАДЕЖА В ДВУХ ГРАММАТИКАХ Н. И. ГРЕЧА****Энчо Тилев***Главный ассистент, доктор филологии**Пловдивский университет им. Паисия Хилендарского*

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Abstract

The subject of research in this article is the category of case in two grammars by the Russian philologist Nikolai Ivanovich Grech – in “Prostrannaya russkaya grammatika” and in “Prakticheskaya russkaya grammatika”, published in 1827. The scientist probably formed his ideas under the influence of comparative-historical linguistics that arose in Germany, and they are very reminiscent of the later ideas of F. de Saussure on the systemic nature of language, on diachrony and synchrony in linguistic research. N. I. Grech made a significant contribution to the case studies and laid the foundation for a more in-depth theoretical understanding of linguistic facts.

Аннотация

Настоящее исследование посвящено вопросу описания категории падежа в двух трудах российского филолога Николая Ивановича Греча – в «Пространной русской грамматике» и в «Практической русской грамматике», изданных в 1827 г. Свои идеи ученый сформировал, вероятно, под влиянием сравнительно-исторического языкознания, возникшего в Германии, и очень напоминают поздние идеи Ф. де Соссюра о системной природе языка, о диахронии и синхронии в лингвистических исследованиях. Н. И. Греч внес значительный вклад в изучение рассматриваемой абстракции и положил начало линии более углубленного теоретического осмысления языковых фактов.

Keywords: Nikolay Ivanovich Grech, grammar, case, Russian language, theoretical linguistics, history of linguistics.

Ключевые слова: Николай Иванович Греч, грамматика, падеж, русский язык, теоретическая лингвистика, история лингвистики.

Девятнадцатое столетие в истории лингвистики занимает особое место, поскольку именно тогда, как хорошо известно, сформировалась лингвистика как отдельная наука. Во всей Европе этому предшествовала активная работа по созданию грамматик, учебников и учебных пособий, что естественным образом привело к накоплению большого количества данных о языках различного строя. В первой половине XIX века в России было создано множество работ по грамматике, значительно повлиявших на дальнейшее описание русского языка.

Объектом настоящего исследования является категория падежа и ее описание в русском языкознании постлюмоновского периода. Предмет изучения – две грамматики Николая Ивановича Греча, где автор подробно представил свой взгляд на рассматриваемую абстракцию.

Среди многочисленных работ по русской грамматике первой половины XIX века заслуживает внимания «Пространная русская грамматика» Николая Ивановича Греча, изданная в 1827 году в Петербурге. Книга является одной из первых работ, предлагающих более широкое рассмотрение языка

как явления на индивидуального и наднационального характера, и именно этой проблеме посвящены первые две темы введения – «О языкѣ вообще» и «О происхождении и образовании языка вообще». Пожалуй, впервые в русском языкознании более комплексно был поставлен вопрос о сущности языка, о его роли в формировании общественной жизни (ср.: «Средство, служащее ему [человеку – мое примечание, Е. Т.] для выражения чувствований и мыслей, именуется *языкомъ*, въ обширномъ смыслѣ сего слова» (Греч 1827а : 1). Как известно, эти проблемы теоретического языкознания в дальнейшем будут более детально описаны и систематизированы. Однако и здесь Н. И. Греч говорит об всеобщей и частной грамматиках, выделяет философский аспект в изучении языка, с одной стороны, когда язык понимается как «связная система, въ коей опредѣляются соотношенія между изображеніемъ мыслей и чувствованій, и орудіемъ онаго, т. е. звуками голоса», с другой стороны, и исторический аспект, где «надлежитъ, во-вторыхъ, разсмотрѣть происхожденіе и постепенное образованіе языка до извѣстнаго времени» (Греч 1827а : 3).

Эти идеи, принятые автором, вероятно, под влиянием сравнительно-исторического языкознания, возникшего в Германии, очень напоминают поздние идеи Ф. де Соссюра и структуралистов о системной природе языка, о диахронии и синхронии в лингвистических исследованиях. По обсуждаемым здесь вопросам Н. И. Греч вывел русское языкознание на уровень мировой лингвистики того периода.

Из вышеизложенного очевиден широкий спектр взглядов автора на различные аспекты языка как продукта человеческого разума, но очевидно и превосходное знание трудов современников и предшественников со стороны Греча. Впервые в этой работе по русскому языку появляется хронологический обзор литературы, посвященной русской грамматике (см. Греч 1827а: 40 – 54). При этом автор не ограничивается простым упоминанием различных работ, а критически оценивает вклад своих предшественников в описание и кодификацию языка. Например, в лице М. В. Ломоносов Н. И. Греч видит гения, вдыхающего душу в свои произведения и увлекающего за собой современников и будущие поколения «даже въ ошибкахъ своихъ» (Греч 1827а: 45 – 46). Н. И. Греч высоко оценивает труд учёного энциклопедиста, называя его *преобразителем* русского языка и творцом русской грамматики. Это мнение разделяют все, кто досконально изучил «Россійскую грамматику». Свидетельства сильных и слабых сторон отдельных лингвистических трудов особенно важны, поскольку Н. И. Греч был либо современником их авторов, либо их преемником, что придает большую достоверность его оценке.

Прежде чем рассмотреть, как Н. И. Греч определяет падеж, следует отметить некоторые термины, употребляемые в его грамматике. Греч дает следующее определение слову *понятие*: «Понятіе есть изображеніе какого либо предмета вещественнаго или невещественнаго въ умѣ человѣческомъ: всякій такой предметъ называется *существомъ*; напримѣръ: *дерево, птица, душа*» (Греч 1827а: 100). Так, по мнению Н. И. Греча, существа могут находиться в некотором отношении друг к другу, и отношения эти заключаются в независимости одного существа или в зависимости другого от местоположения или в соответствии с какими-то особыми обстоятельствами. Так, в некоторых языках – английском и французском, например, – отмечает Н. И. Греч, – зависимость одного предмета от другого или их соотношение выражается с помощью предлогов, тогда как в других языках это делается с помощью слогов (по терминологии автора). Таким образом делается вывод, что падежи представляют собой «сиі перемѣны окончаній, означающія различныя отношенія предметовъ, и независимость или зависимость оныхъ» (Греч 1827а: 122). Здесь также подчеркивается связь предлогов с падежными флексиями, что хорошо описано в последующие десятилетия.

Также стоит отметить деление склонений, проведенное в «Пространной русской грамматике». Н. И. Греч демонстрирует новаторство и в этой части, дифференцируя три склонения на основе их родовых различий. В первое склонение входят слова с окончанием мужского рода, во второе – с окончанием среднего рода, а в третье склонение – с окончанием женского рода.

П Е Р В О Е.			В Т О Р О Е.			Т Р Е Т Ё Е.			
Оконч. мужескаго.			Оконч. средняго.			Оконч. женскаго.			
Е д и н с т в е н н о е ч и с л о.									
Оконч. ия.	твёрдое мягкія			твёрдое мягкія			твёрдое мягкія		
	Примѣры:								
	(1.4)	(2.5)	(3.6)	(7)	(8)	(9)	(10)	(11)	(12)
И.	ъ	й	ь	о	е	мя	а	я	ь
Р.	а	я	я	а	я	мени	ы	и	и
Д.	у	ю	ю	у	ю	мени	ѣ	ѣ	и
В.	сх. съ И. или Р.			о	е	мя	у	ю	ь
Т.	омъ	емъ	емъ	омъ	емъ	менемъ	ою	ею	ію
П.	ѣ	ѣ	ѣ	ѣ	ѣ	мени	ѣ	ѣ	и
М н о ж е с т в е н н о е ч и с л о.									
И.	ы	и	и	а	я	мена	ы	и	и
Р.	овъ	евъ	ей	ъ	ей	мень	ъ	ь	ей
Д.	амъ	ямъ	ямъ	амъ	ямъ	менамя	амъ	ямъ	ямъ
В.	сход. съ И. или Р.			или Родительнымъ			надежель.		
Т.	ами	ями	ями	ами	ями	менамя	ами	ями	ями
П.	ахъ	яхъ	яхъ	ахъ	яхъ	менахъ	ахъ	яхъ	яхъ

Рис. 1. Классификация существительных по Н. И. Гречу (Греч 1827а: 165)

На первый взгляд, это классификация по роду, но выражение «оканчивающиеся на» м. р., напри-

мер, вызывает определенное несогласие. Как известно, в русском языке довольно много существительных мужского или общего рода, имеющих

флексию как у слов женского рода (например, *дедушка, владыка, юноша; плакса, грязнуля*). Выражение «оканчивающиеся на» предполагает смешение слов по формальному признаку, а не объединение их по роду, но Н. И. Греч не обращает на это внимания. В образцах склонения различных существительных (см. с. 169 – 176) указывается только одно существительное этого типа – *дядя*⁶, которое изменяется по парадигме слов женского рода (ср. Греч 1827а: 172). Так предложенная Н. И. Гречем классификация типов склонения оказывается не особенно удачной, поскольку распределение по родам не может охватить все случаи словоизменения лексем. Поэтому более правильной представляется принятая сегодня классификация, при которой слова разного рода объединяются в один тип склонения.

Н. И. Греч также обращает внимание на место ударения для дифференциации форм в таких словах, как *рука, море, поле*, где формы родительного падежа единственного числа и именительно-винительные формы во множественном числе формально совпадают, но различаются акцентологически. Кроме того, автор использует также понятие *одушевленные предметы*, с помощью которого он придает терминологическое значение слову *предмет* и тем самым предвосхищает более широкое понимание этого термина, принятое сегодня в лингвистике.

В седьмой главе, посвященной предлогам, Н. И. Греч говорит о них как об одном из элементов выражения различных отношений. Автор подчеркивает, что соотношения выражаются двояко – «*падежами*, т. е. придаточными корнями последующими, присовокупляемыми къ окончанию слова» (Греч 1827а: 372), а также предлогами, предшествующими слову. И здесь, как и у некоторых других авторов грамматик того времени, наблюдается ошибочное, с сегодняшней точки зрения, совпадение понятий *префикс* и *предлог*, при этом Греч допускает и наличие слитных предлогов (*вступать, заплатить*). В этой части отмечена связь между данной приставкой и последующим предлогом в словосочетаниях типа *доехать до реки, пришел к другу, вошел на гору*.

С чисто практической направленностью – факт, зафиксированный в названии пособия, в том же 1827 году Н. И. Греч издает также «Практическую русскую грамматику» (ср. Греч 1827б). Но она, как отмечает автор в предисловии, не содержит подробной теоретической части с историческими экскурсами, как есть в «Пространной грамматике». Очевидно, что автор рассматривает эту свою работу скорее как дополнение к своей теоретической грамматике, и основные его взгляды на систему русского языка изложены здесь в весьма сжатой форме. Здесь также делается акцент на реляционной природе падежа, и можно предположить, что для осмысления категории таким образом Н. И. Греч находился под влиянием новейших лингвистических работ, изданных в Германии и Франции, о чем говорится в предисловии.

В заключение можно сделать вывод, что «Пространная русская грамматика» действительно оказывается качественно новым трудом, имевшим значительный теоретический вклад в изучение рассматриваемых явлений. Эта грамматика положила начало линии более теоретического осмысления языковых фактов, которая развивалась на протяжении всего XIX века и достигла своего апогея в работах ученых XX века. Основываясь на работах более раннего периода – прежде всего на «Российской грамматике» М. В. Ломоносова, Н. И. Греч описывает современный русский язык на начальном этапе его становления, что служит базисом для диахронического изучения эволюции грамматической системы.

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⁶ Это существительное было выбрано из-за его особой формы род. п. мн. ч. – *дядей* (см. стр. 163).

PHYSICAL SCIENCES

ON GENERALIZATION OF THE EIGENVALUE PROBLEM IN QUANTUM MEASUREMENT: A MEASUREMENT THAT WOULD BE BETTER NOT TO EXIST

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Abstract

In his work "Against 'measurement'" [Physics World, August, 33-40 (1990)], J. Bell mentioned Dirac as the most distinguished of 'why bother?'ers since P. Dirac in his paper 'The Evolution of the Physicist's Picture of Nature' [Sci. Amer. **208**(5), 45-53 (1963)] considered the difficulties (or 'misunderstandings', according to N. Bohr) of quantum mechanics and divided them into two classes. Into the first class he particularly referred the problems of 'observer' and 'measurement'. Dirac suggested that these problems should be left for later.

This work is an attempt to review the above problems, both based on our own point of view and on the analysis of the works of our predecessors (mainly in footnotes to avoid casting a shadow on the former). This attempt results in a new analytical model of the measuring experiment, the conclusions of which are also discussed.

Keywords: Measurement, Observation, Observable, von Neumann Measurement Postulate, Interaction Energy Operator.

A brief analysis of the processes of measurement common to any science reveal paradox. This paradox is encountered when one tries to make clear formal statements are related to experience in such a way that factual statements, such as statements about measurements, result. I believe that this paradox bears an analogy to the "fallacy of the third man" which disturbed Plato.

E.G. Ballard [1]

1. Preamble

With its reticence, its understatement and under-visibility (or under-observability, if the readers like) that quantum mechanics challenges for more than a hundred years [2,3]⁷, it reminds me the well-known Zen Ryoanji Temple Garden in Kyoto which is a small rectangular area, 30 m long from east to west, and 10 m from south to north, covered with white gravel, and composed of 15 black unprocessed stones gathered in five groups. Let us name it as the *Garden reality*.

2. Portrait of Observer: Observable⁸

⁷ I presume that the period between 1900, when Planck put forward the hypothesis of quanta (his son Erwin Planck recalls that once, walking in Grunewald near Berlin with his father, the latter said: "Today I have made a discovery as important as that of Newton" ([4, 5]), and 1925-26, the birth of the aforementioned works, was determined by the impossibility of proposing a quantum theory that would be free from the concepts of classical mechanics. Despite the significant success of Bohr's theory in understanding the physical and chemical properties of atoms and molecules, it and the resulted Copenhagen interpretation were not logically closed: it contradictorily combined the laws of classical mechanics and quantum postulates.

⁸ G. Jaeger ([6], p. 62) notes: "Bell (see [7], p. 170) argued that the use of the term observable can be misleading, much

The problem of a measurement on the object is thereby transformed into the problem of an observation on the apparatus.

E.P. Wigner (p.9, [24])

No matter from which point the garden visitor, - define him the Observer - views, observes or watches this reality, the fifteenth stone is always out of sight, obscured by other stones. Sometimes, however, it seems as if 15 stones are visible, since individual stones, due to their irregular shape, are perceived as two. It is only possible to fully observe all the stones by floating in the air above that *Garden reality* and looking down on it from above. I suggest that the observer does only observe of what lies before his eyes, without thereby violating the properties, structure of the observed object or objects. On one hand, it is type of the "detached observer"⁹. On the other, it excludes a so-called effect of observer. Let explain the latter.

Everything around us is an object (a thing, a phenomenon). They compose the nature ("*physis*",

as Bethe argued that the term uncertainty can be: "There is indeed much talk of 'observables' in quantum theory books. And from some popular presentations the general public could get the impression that the very existence of the cosmos depends on our being here to observe the observables. I do not know that this is wrong. I am inclined to hope that we are indeed that important.

But I see no evidence that this is so in the success of contemporary quantum theory."

⁹ This term was used by A. Einstein in his dialogue with N. Bohr at the Fifth Solvay Congress in 1927 on the principles of the Copenhagen interpretation of quantum mechanics, which, however, did not yet have such a name, introduced only in the 1950s [8-12].

"φύσις", in the ancient Greek¹⁰), the *reality* that is studied by *physics* as the science of 'physis', the nature of things or phenomena. This study of reality on a so called scientific method, i.e. the empirical method for acquiring a knowledge that is based on the postulate (or assumption) that reality exists independently of observer as an objective reality (tautology, in some sense). The observation is the basis of describing this objective reality that manifests itself in physical phenomena. Let us remember this statement.

Under the action of observation, an observer observes the thing(s) around him by means of his senses and/or (macroscopic) instrument(s) (or apparatus). The effect of observer assumes that these senses can influence thing(s) so significantly that they can change them – actually this is a disturbance of an observed system by the act of observation: often it is the result of the instrument(s) that an observer utilizes by necessity and less often by his senses. Although, it is worth remembering that these senses themselves may have a limited use.

The act of observation is always related with the observer's memory, or the capacity of brain: with necessity he memorizes the observed thing(s) as a result of observation. The capabilities of human's memory (of brain) are not unlimited [19], and therefore a given observer can remember (photograph) only a certain segment in the act of observation. Definitely, this segment is not a whole picture of the nature or reality. To form a complete picture of reality from these pieces, segments, a given observer should communicate with another observer, and the latter with the other, and so on. This requires a next step in the procedure of observation. Note that these are applicable in a macroscopic world.

A microscopic, sub-atomic, or quantum world is essentially different¹¹. As Feynman noted: "If I say they [the electrons and light – E.S.K.] behave like particles I give the wrong impression; also if I say they behave like waves. They behave on their own inimitable way, which technically could be called a quantum mechanical way. They behave in a way that is like nothing that you have ever seen before, Your experience with things that you have seen before is incomplete. The behaviour of things on a very tiny scale is simply different. An

atom does not behave like a weight hanging on a spring and oscillating. Nor does it behave like a miniature representation of the solar system with little planets going around in orbits. Nor does it appear to be somewhat like a cloud or fog of some sort surrounding the nucleus. It behaves like nothing you have ever seen before." ([20], p.128).

And this is true: it is impossible to look at, touch, poke a typical quantum object, since the spectrum of visible radiation, lying in the range from 380 to 720 nanometers, is approximately 2000 times larger than the size (diameter) of an atom, which is 10-8 cm (and the nucleus is about 10-13 cm) ([20], p. 2-4, 2-2. Physics before 1920)¹².

The act of observation turns into the act of being observable. It turns out that the quantum, subatomic world, which is supposedly described by quantum mechanics, itself needs observers (and, looking ahead, measuring equipment (see [21] for references). Let now introduce the term 'observable' as the observer who has an ability to observe, or as the observer who equipped by the method of observation, the scientific method, that determine the properties of what is observed¹³. Kant defines this transition from observation to observable as follows: "There is no doubt whatever that all our cognition begins with experience, for how else should the cognitive faculty be awakened into exercise if not through objects that stimulate our senses and in part themselves produce representations, in part bring the activity of our understanding into motion to compare these, to connect or separate them, and thus in work up the raw material of sensible impressions into a cognition of objects that is called experience? As far as time is concerned, then, no cognition in us precedes experience, and with experience every cognition begins." ([23], p.136¹⁴), whereas Feynman introduces the intermediate phase: "Observation, reason, and experi-

¹⁰ Note the consonance of the words 'physis' and 'physics'. Let us remember the following words of Aristotle from his "Metaphysics" ([13], Book I (A); first sentence): "ALL men by nature desire to know" (compare with Descartes in his "Meditation 2": "cogito ergo sum"). The definition "to know", according to Merriam-Webster (since 1828), is "1. to perceive directly: have direct *cognition* of; 2. to have *understanding* of; 3. to recognize as *being* the same as something previously known". So, for example, the word "science" (scientia) means in Latin "knowledge" (see in English "knowledge": recall the above definition of fundamental science). This desire, applied to physis, prompted Aristotle to introduce a discipline whose purpose is to gain knowledge about physis as "physics" (in Greek: φυσική ἀκρόασις *Phusike akroasis*; in ancient Greek: τὰ φυσικά, that means "the [writings] on nature" or "*natural philosophy*". In Latin: *Physica*, or *Naturales Auscultationes*, possibly meaning "*lectures on nature*"). (Part 2, Book II [14]; see also [15]) (see ([16], p.85 и Part 2, Book II [14]). It is perhaps also worth mentioning here the recent discussion on "What is Physics" on the pages of Physics Today [17,18].

¹¹ It seems that the etymology of some of these words is rather similar: 'atom' from the ancient Greek *ἄτομος* meaning 'indivisible', 'incut'; 'quantum' from the Latin *quantus* meaning 'how much', that is 'elementary discrete indivisible fraction'. Generally speaking, these two words stress the idea of a discreteness in nature.

¹² For this reason, I think the legend of Democritus (460 B.C. ~370 B.C.) supposedly sitting on a rock by the sea and cutting an apple into an indivisible particle of apple matter (atom) is definitely a myth. A myth is defined as a statement that is accepted without proper grounds and does not, in principle, admit of experimental demonstration. On the contrary, the atomic fission was discovered by O.Hahn, F. Strassmann and L. Meitner, and O.R. Frisch in 1938-39.

¹³ Dirac echoes (p. 34, [22]): "When we make an observation we measure some dynamical variable."

¹⁴ On p.716 [23], Kant defines experience as "perception with rules". Later, he defines experience as "the agreement of perceptions (of empirical representations) to the cognition of an object".

ment”¹⁵ ([24], p. 2-2)¹⁶ (the second phase refers to what Wiener on p. 307 [29] noted as ‘psychology’¹⁷).

3. Measurement

... Any theory that has certain properties has a measurement problem.

N. Ormrod, V. Vilasini, and J. Barrett [30]

3.1. Introduction

This is how we approach the key topic of this work – the measurement [1,31,32]. The paradigm of measurement is inherent to the whole building of physics. permeates the entire essence of quantum mechanics [23-59], and links it to classical mechanics since, generally speaking, the concept of observer does not only include human sense organs rather devices or measuring apparatuses¹⁸. Fock [61] (see also [62]) notes that “there is no fundamental difference between the two. For example, glasses correct defects of the eye lens, microscopes and telescopes greatly expand the possibilities of observation.” However, the applications of apparatus are based on certain abstractions: One is the absolutization of physical processes: that is, the assumption that they occur “by themselves” and are not disturbed by the act of observation, and therefore do not require further instructions on the methods of observation. As quantum mechanics proves, this assumption is fulfilled only approximately.

So, the measuring apparatuses expand the known limited capabilities of human sense organs. It is assumed that they consist of a large number of particles composing some classical ensembles which are described by coherent quantum superpositions of sufficiently many and macroscopically distinct states [45,46,63]. All this results in the following [32]:

Quantum Measurement Problem: *Given a specific basis (or context), quantum mechanics describes mathematically a quantum state in terms of a superposition of, in general, multiple states. Since the evolution described by quantum mechanics allows us to predict*

that the quantum system will get entangled with the apparatus and thus its pointer positions will also become a superposition, the question is why do we observe a single outcome instead of a superposition of them?

It is absolutely clear that the quantum measurement problem disappears if the measuring apparatus is microscopic. There are several examples [57] of this.

3.2. Measuring Experiment¹⁹

Under a measuring experiment which Fock [64] claims as a phenomenon (an experience), the above (in Section 2.) order of cognition is simply reversed: performing a measurement, an observer observes its outcome(s) or property(ies). As part of the controversy with Bohr over his article [65] in *Dialectica*²⁰, Fock [66] defined three stages of a measuring experiment in quantum mechanics in which the actual measurement constitutes only its last stage. It is preceded by the following two stages: **i.** The stage of preparation of the observed (unperturbed) phenomenon itself²¹ and **ii.** The stage of the behavior of an object under fixed external conditions, which alone is the subject of description by quantum mechanics.

Therefore, considering a measurement as a phenomenon, the former is described quantum mechanically. Speaking generally, say within the Copenhagen interpretation, a quantum system is characterized by a state vector. The latter – according to Wigner [34], ‘this is an almost verbatim quotation of von Neumann’ [67] – changes in two ways. One is with time, obeys Schrodinger time-dependent equation of motion of quantum mechanics and change occurs continuously. The other one is a discontinuous and is often called the ‘reduction’ or ‘collapse’ of a state vector [67,68]²².

Let us end this Subsection with the concept of “contextuality” [69]. We have already met the word “context” in formulation of the **Quantum Measurement Problem**. By definition, *context* is a complex of conditions under which the measurement is performed

¹⁵ Within quantum mechanics, this refers to a measuring experiment.

¹⁶ The difference between the observer and the observable is demonstrated, as I believe, in the famous story about Einstein and the moon told by Pais [25] (also [26-28]): “It must have been around 1950. I was accompanying Einstein on a walk from The Institute for Advanced Study to his home, when he suddenly stopped, turned to me, and asked me if I really believed that the moon exists only if I look at it.” Rigorously, there are actually two acts: Act 1 – the observer’s observation of the moon; Act 2 – If I do not look at the object, is it the moon? To answer this question, it is necessary to know the properties of the moon that fully identify it. This is achieved by experience, an experiment that determines, or “measures” its properties (identifications). With the readers’ permission, I equate the words ‘experiment’ and ‘measurement’.

¹⁷ “The distinction between psychology, logic, and epistemology is a commonplace. The first treats of experience as an act, experience in its relation to the individual observer. The second concerns itself with the internal marks by which truth may be distinguished from error, and in so far as it deals with experience, has to do with some sort of validity of the experience as evidence of a truth. The third discusses in a general way all the elements-observer, object, immediate presentation-which enter into the experience.”

¹⁸ Interestingly, the authors of the famous EPR paper [60] restricted to human experience only: “The correctness of the theory is judged by the degree of agreement between the conclusions of the theory and human experience” (p. 777).

¹⁹ I choose some consensus on Bell’s point of view (p.34 [44], see also [6]): “Even in a low-brow practical account, I think it would be good to replace the word ‘measurement’, in the formulation, by the word ‘experiment’.”

²⁰ The history of this article is as follows. In 1948, on the pages of this journal, then published in Switzerland, a discussion took place on the fundamental problems of quantum mechanics, in which N. Bohr, W. Pauli, A. Einstein, W. Heisenberg, L. de Broglie, H. Reichenbach and others took part.

²¹ Here Fock argues with Bohr’s assertion [66]: “As a more appropriate way of expression, one may strongly advocate limitation of the use of the word *phenomenon* to refer exclusively to observations obtained under specified circumstances, including an account of the whole experiment.” (Compare with Kant’s [23] thesis on the existence of *phenomenon* and *nomenon*). Fock [69] also notes that “Bohr repeatedly emphasized that measurement is associated with “uncontrolled interaction” between the object and the device.

²² The attempts to obtain the second kind of the state-vector change from the first one by v. Neumann [67] and Wigner [34] were failed (see also p. 110 of [68]).

(p. ix, [69])²³. It is clear that this notion is related to the stage **i** of preparation of quantum measuring experiment.

3.3. Modeling of Measuring Experiment

Quantum Phenomena do not occur in a Hilbert space.

They occur in a laboratory. –

Asher Peres [77]

All I'm concerned with is that the theory should predict

the results of measurements.

Stephen Hawking (1994)²⁴

The starting point in a model scenario of a measuring experiment is to partition the complete experimental system **S** into a quantum subsystem **Q**, which is undertaken for performing an experiment by an observable **O**, and a measuring apparatus (instrumental subsystem naturally equipped with a pointer) **A**: $\mathbf{S} = \mathbf{Q} \cup \mathbf{A}$. It is traditionally asserted the macroscopic nature of the latter²⁵. Next, we prepare the state Ψ_i of **Q** for measuring is conducted by the apparatus **A** that interacts with **Q** via the interaction potential $\hat{O}$.

In order to logically proceed, we present the following statements:

Postulate 1 ([68], p. 6; see also [66] and §§ 10,77 of [22]): A physical observable **A** is represented by a self-adjoint operator $\hat{\mathbf{A}}$ in complex Hilbert space **H**.

Postulate 2 ([68], p. 6): Any self-adjoint operator $\hat{\mathbf{a}}$ represents a physical observable **a**.

In the other words, the terms ‘measurement’ and ‘mutual interaction’ are equivalent, in some sense. The outcome of a given measuring experiment, described by $\hat{O}$, on the initial state Ψ_i is the product state Ψ_f , i.e., explicitly,

$$\hat{O} \Psi_i = \Psi_f. \quad (1)$$

This is the general scheme of considering (or interpreting) any measuring experiment. In mathematical terms, Eq.(1) is, in some sense, a generalized eigenvalue problem. At this point the logical model of the measuring experiment ends and is usually formulated

in terms of a series of statements, considered by some as theorems [39] (see also p.39 of [44] and [59]), by others as axioms [35], and by others as postulates [68]. To the last refers the well-known von Neumann measurement postulate [66,68] and [47] which is formulated as follows (according to [68], Projection Postulate): “

Postulate 3: “Let **a** be a physical observable represented by a self-adjoint operator $\hat{\mathbf{a}}$ having a purely discrete non-degenerate spectrum. Any measurement of **a** on the quantum state wave function $\Psi(\tau)$ at the time $t = \tau$ induces transition from this state Ψ into one of the eigenfunctions $\chi_k^{\mathbf{a}}$ of the operator $\hat{\mathbf{a}}$: $\hat{\mathbf{a}}\chi_k^{\mathbf{a}} = \lambda_k\chi_k^{\mathbf{a}}$. The probability for finding λ_k in this transition is equal to (Eq. (1). [39]):

$$P = |\langle \chi_k^{\mathbf{a}} | \Psi(\tau) \rangle|^2. \quad (2)$$

If a given measurement’s outcome is λ_k , this implies that the wave function abruptly changes from $\Psi(\tau)$ into $\chi_k^{\mathbf{a}}$.

The Projection Postulate, often referred to the “reduction” or “collapse” one, corresponds to such time-evolution process that differs from the one, typical in quantum mechanics which is described by the time-dependent Schrödinger equation. As van Kampen [39] emphasizes, all this adds ‘a new postulate to the Schrödinger quantum mechanics’ and ‘the collapse can be used to prepare a system in a certain state $\chi_k^{\mathbf{a}}$ ’. This Postulate is limited by that a self-adjoint operator $\hat{\mathbf{a}}$ which represents a physical observable **a** has a non-degenerate spectrum. This constraint is overcome by Lüders Projection Postulate which Lüders proposed in 1951 (see also p.14 of [68]).

Let us make a pause to rethink these Postulates. The Projective one interprets a measurement of a physical observable **a** on a given quantum system as that projects the latter into one of the eigenstates of the measuring operator $\hat{\mathbf{a}}$. This is a so called projective measurement whose concept is actually a central paradigm of physics [38]. I suggest that the concept of measurement in quantum mechanics should necessarily include the following immutable truths:

* The observation and measurement of a quantum system perturbs its state.²⁶

²³ In classical physical theories, measuring experiments that are performed simultaneously to a given one are called the latter’s context [70]. In the other words, the context of a given measuring experiment is independent on the other, simultaneously measured experiments. Due to Kochen-Specker theorem, precisely, Bell-Kochen-Specker theorem [71,72] (see also [73]) stating that there exists a contradiction between two basic assumptions of the hidden variable theories which are intended to reproduce the results of quantum mechanics: that all hidden variables corresponding to quantum-mechanical observables have definite values at any given time, and that the values of those variables are intrinsic and independent of the device used to measure them.” (see also wiki), this independence is no longer valid in quantum theory. This is called quantum contextuality [74]. Interestingly, the experiment recently described in [75] does not allow to make conclusions

about contextuality that is concluded from that the measurement of the observables as well as the preparation of the state manifestly depend on the chosen context [76].

²⁴ During a debate with Roger Penrose in 1994 at the Isaac Newton Institute for Mathematical Sciences at the University of Cambridge, transcribed in The Nature of Space and Time (1996) by Stephen Hawking and Roger Penrose, p. 121: https://en.wikiquote.org/wiki/Stephen_Hawking . .

²⁵ [90], p. 2; [44], p. 40. The construction of the entire system that can be viewed as a tensor product ‘quantum system’ $\otimes$ ‘measuring instrument’ is discussed in [79].

²⁶ It is difficult to say who first made this statement. Though, for the first time, I read it in Fock [61], von Neumann [66], and de Broglie [80].

* “In quantum theory, every measurement entails a choice. If we choose to measure one observable (physical variable), we choose *not* to measure some other observable” (p.25, [51]).

* Partial measurement, where full wave function collapse is not the only outcome, provides a detailed test of the measurement process. As demonstrated in experiments on superconducting phase qubits, the effect of such measurements can be *undone* and the initial state can be recovered. [52,53]. In the other words, the projective measurement is an irreversible process.

* The measurement and its effect enter the theory as a fundamental notion through one of its axioms [54]. Measurement can be modelled as a physical *interaction* between two systems, “*object*” and “*apparatus*” (see also [35]). Thus, we have measurement-as-axiom and measurement-as-interaction. Quantum mechanics should make them equivalent and mutually compatible [54]. However, quantum mechanics “does not seem to grant” this, since the former axiom tells us that the post-measurement quantum state of the system will be an eigenstate of the operator corresponding to the measured observable”, whereas the latter leads to an entangled quantum state for the composite system-plus-apparatus. Then, “the system has been sucked into a vortex of entanglement and no longer has its own quantum state. On top of that, the entangled state fails to indicate any particular measurement outcome” (p. 142 [54]).

We add that these Postulates form the basis of the usual quantum mechanics viewpoint on the measuring process (experiment) which Ludwig [50] calls “Registration Procedures and Preparation Procedures” and considers as ‘too one-sided’. This onesidedness Ludwig relates “to the philosophical meaning and interpretation of quantum mechanics, where the measurement process is, of course, a central issue in the problem of meaning” (p. 303. [50]). Let explain the latter. Above we note that the problem of measurement is the problem of measuring one or another, or more unknown properties of a given object. Equivalently, the problem of measurement is to determine whether or not a given object has a given property. This means that a given object under consideration have these properties, at least at the time measurement. These properties can be obviously changed shortly after the measurement due to perturbation of the object by the measurement apparatus. The ideal measurement is that, by definition, this perturbation does not occur.

3.4. Model of Disturbing Measurement

The all discussed in 3.3 depends on the angle from which we look at these statements. Let us look at them from the following another angle and start thinking.

Let a system $S = S_{\text{apparatus}} \cup S_{\text{quantum}}$ be given. $S_{\text{apparatus}}(X)$ is the apparatus subsystem that includes the pointer, and X is subsystem’s generalized coordinate. $S_{\text{quantum}}(x)$ is a quantum subsystem under a measurement performed by the former one, and x is the corresponding generalized coordinate. Let $\Pi(X; x)$ be an arbitrary self-adjoint interaction operator corresponding, according to **Postulate 2** to the observable π . Hence, we may consider Π as the measuring operator. Let $\Psi_i(x)$ be the initial (normalized to unity) state wave function of S_{quantum} belonging to the Hilbert space H . The outcome of a given measurement is $\Psi_m \equiv \Psi_{m(\text{measured})}$, as assumed is also normalized. In the other words, Π maps Ψ_i onto Ψ_m , i. e.,

$$\Pi \Psi_i = \Psi_m \pi, \Psi_i, \Psi_m \in H. \quad (3)$$

(3) is some type of the generalized eigenvalue problem for the operator Π [81-84]. It is assumed that Ψ_i and Ψ_m both belong to the same Hilbert space H which is partitioned as

$$H = H_i \oplus H_i^\perp \quad (4)$$

where H_i is one-dimensional Hilbert sub-space spanned on Ψ_i over the field $\mathbb{C}$ of complex numbers: $H_i = \mathbb{C}\{\Psi_i\}$, and $H_i^\perp$ is the corresponding orthogonal complement. Therefore, one obtains the decomposition of Ψ_m as follows:

$$\Psi_m \pi = \lambda \Psi_i + u_m \pi, \quad (5)$$

where $u_m \pi \in H_i^\perp$ is defined as an error (bug-)state, and $\langle u_m \pi | \Psi_i \rangle = 0$. It can be proven by contradiction that if $u_m \pi = 0$, Ψ_i is the eigenfunction of Π , that is impossible due to the latter arbitrariness²⁷. Hence, $u_m \pi \neq 0$. ■ (= Q.E.D.). Then, the matrix element of the measuring operator Π in the state Ψ_i , or the expectation value of Π in the state Ψ_i , is equal to²⁸

$$\langle \Psi_i | \Pi | \Psi_i \rangle = \lambda. \quad (6)$$

Under the repeated measurement, one obtains

$$\begin{aligned} \Pi^2 \Psi_i &= \Pi (\lambda \Psi_i + u_m \pi) = \lambda (\lambda \Psi_i + u_m \pi) + \Pi u_m \pi (7') \\ &= \lambda^2 \Psi_i + \lambda u_m \pi + (\mu u_m \pi + u_m'), \end{aligned} \quad (7)$$

where the last expression on the r.h.s. of (7') is represented by that in the last r.h.s. brackets in (7), by analogy with (3) and (5)²⁹. From the latter equations it follows that $u_m \pi \in H_i^\perp$ and $u_m' \in (H_i^\perp)^\perp$. Due to the latter belonging, one can represent

$$u_m' = \gamma_m \pi \Psi_i + \Psi_i', \quad (8)$$

²⁷ The case that is referred to **Postulate 3** is excluded from consideration.

²⁸ Margenau (p.469 [35]) treats this as ‘another version’ of the Born rule (see also [85]). Let us recall that the Born rule, or postulate [86-88,35] “introduces a probability concept into

the otherwise deterministic theory and relates it mathematically to the Hilbert space formalism” (p. 197 [86]), under the assumption that the interaction operator Π has a spectrum and the corresponding eigenstates.

²⁹ Actually, Eq. (7) contrasts to the repeatability hypothesis of von Neumann (p. 335 [66]) (see e.g. also [55]).

where the latter is orthogonal to Ψ_i . By analogy with the above proof by contradiction, one can prove that if u_m' in Eq. (7) is equal to 0, then u_m^π in (7) becomes the eigenfunction of Π . The latter conflicts with Eq. (5) (see also footnote²¹). ■ Hence, γ_m^π in Eq.(8) is not equal to 0.

Therefore,

$$\langle \Psi_i | \Pi^2 | \Psi_i \rangle - (\langle \Psi_i | \Pi | \Psi_i \rangle)^2 = \gamma_m^\pi \equiv \gamma_i^\pi, \quad (9)$$

(9) is the expression of variance [89]. Since $\gamma_m^\pi \neq 0$, this is the case, on the one hand. Let denote this variance as $\Delta\pi(\Psi_i) \neq 0$. On the other, due to that in the probability theory and statistics, the variance is the expected value of the squared deviation from the mean of a random variable, $X_m^\pi = \Pi\Psi_i$ or, equivalently, u_m' , or a bug state u_m^π is treated as a random variable [89-91]³⁰. Therefore, there exists the uncertainty of measuring of the observable π in the state Ψ_i , due to that the latter behaves under the measurement of the observable π as the modest measurement (5). We formulate this as the following statement:

Proposal 1: If a given state Ψ_i obeys the equations (3) and (5) under the measurement of the observable π that corresponds to the measuring operator Π and if it is not the latter's eigenfunction, then this measurement admits the non-zero uncertainty $\Delta\pi(\Psi_i) = \gamma_i^\pi \neq 0$ in terms of the appropriate variance (9).

Extending Proposal 1 on the momentum, $\mathbf{p}$, and position, $\mathbf{r}$, observables, one obtains:

Proposal 2: If a given state Ψ_i obeys the equations (3) and (5) under the measurement of the observable $\mathbf{p}$ that corresponds to the measuring operator $\mathbf{P}$ and if it is not the latter's eigenfunction, then this measurement admits the non-zero uncertainty $\Delta\mathbf{p}(\Psi_i) = \gamma_i^{\mathbf{p}} \neq 0$ in terms of the appropriate variance (9).

and

Proposal 3: If a given state Ψ_i obeys the equations (3) and (5) under the measurement of the observable $\mathbf{r}$ that corresponds to the measuring operator $\mathbf{R}$ and if it is not the latter's eigenfunction, then this measurement admits the non-zero uncertainty $\Delta\mathbf{r}(\Psi_i) = \gamma_i^{\mathbf{r}} \neq 0$ in terms of the appropriate variance (9).

In some sense, **Proposals 2 and 3** remind the Heisenberg's uncertainty principle if these **Proposals** are

valid together. However, they can work separately, either the second or the third, if their corresponding conditions take places. This implies the uncertainty in the measurement either in the momentum or (not and) in position.

4. Afterwords

Whether or not you can observe a thing depends upon the theory you use. It is the theory which decides what can be observed.

Albert Einstein³¹

Actually, there are three Afterwords. The first one.

Mermin [58] defined three types of quantum physicists. I don't think I belong to any of them. Although, I am closer to the first type: "(1) those who think quantum mechanics is defaced by a so-called measurement problem", but not quite, I would say, with some bias towards Weinberg, who believed that 'quantum mechanics might need an overhaul' [95].

An example of this is the present work, aimed at a new, *modest interpretation* of the quantum measurement experiment. This is the second Afterword. Within the proposed approach of a measuring experiment, randomness (probability) enters in quantum mechanics throughout a measuring experiment. This fact is rather known (see e.g., [92,93,57]). However, it is distinguished from the traditional viewpoint based on the Projection **Postulate 3**.

The existence of randomness in the experimental measurement event stems from non-zero variance. The measurement experiment is so complex that we refer everything related to the bug-state, Eq.(5), as the random. Although it is just an event with a presumably low, precisely calculated, probability of existence. For this, it is necessary to determine the probability distribution function [89]. Note that randomness is usually interpreted as a poorly calculated probability, where there is not enough data. In this connection - and this is already the third Prologue - I view a quantum object not as phenomenon, but as, according to Kant [23], '*noumenon*', or '*thing-in-itself*' ("Ding an sich" in German, or in English: "thing per se"), which reveal its properties during its observational measuring experiment. Everyone knows Einstein's famous saying "...[t]he theory produces a good deal but hardly brings us closer to the secret of the Old One. I am at all events convinced that *He* does not play dice"³². In view of the present

³⁰ According to the Stanford Encyclopedia of Philosophy (<https://plato.stanford.edu/entries/chance-randomness/>), 'Randomness ... exists when some outcomes occur haphazardly, unpredictably, or by chance (This is reminiscent of the standard phrase: "All coincidences of names, surnames and events are accidental." [or random – ESK]). These latter three notions are all distinct, but all have some kind of close connection to probability. Notoriously, there are many kinds of probability: subjective probabilities ('degrees of belief'), evidential probabilities, and objective chances, to name a few ([94] - ESK), and we might enquire into the connections between randomness and any of these species of probability. In this entry, we focus on the potential connections between randomness and chance, or physical probability... As mentioned in the introduction, some philosophers deliberately use 'random' to mean 'chancy'. A random process, in their view, is

one governed by chance in the sense of the previous section... Chance from a physical point of view implies an event that may or may not happen.'

³¹ Featured in: Albert Einstein Quotes.

³² By these words in his letter to Max Born (December 1926), Einstein expressed his reaction to Born's probabilistic interpretation of quantum mechanics. Once Einstein said this phrase to Bohr to indicate his refusal to accept quantum probabilities. Bohr then argued: "Einstein, stop telling God what to do." Some decades later, Hawking said: "Not only does God play dice, but he sometimes throws them where they cannot be seen." (From The Colour of Time with Marina Amaral, <https://marinaamaral.substack.com/p/einstein-stop-telling-god-what-to>).

modest interpretation of the measurement experiment in quantum mechanics, we may conclude that is exactly the man who creates the experimental apparatus that manifest a random (probabilistic) appearance of a quantum *noumenon*.³³

Acknowledgements

I am pleased to dedicate this article to the 100th anniversary of quantum mechanics [96], in the 'blossoming'³⁴ development of which Italian physicists played a major role: it suffices to recall the names of E. Fermi, E. Majorana, I. Accardi, E. Agazzi, G. C. Ghirardi, F. Barone, V. Aquilanti, U. Fano, A. Bassi, and many many others [97-100]. I thank Ugo Fano and Enzo Aquilanti for their talks on these events. I take this opportunity to thank Enrico Clementi and Gina Corongiu for their long-term support.

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³³ (Private remark) I have the impression that the *noumenon* of the "thing-in-itself" consists precisely in the concealment

of the measurable property, which entails its indefiniteness, uncertainty.

³⁴ Borrowed from the title of Ref. [98].

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³⁶ Excerpt: "The thing that amazes me is that quantum mechanics is only 100 years old," the physicist Angelo Bassi said. We were in conversation across a picnic table on a drab Soviet-era campus in Zagreb, an early-autumn breeze swishing through the yellowing leaves of some nearby trees. "It's a

baby, it's nothing — 100 years in the history of science. How can you just stop there? It doesn't make sense any way you look at it." We sat in the shadow of a rust-stained beige building where Bassi was about to speak at a workshop for physicists who specialize in the century-old subject."

PSYCHOLOGICAL SCIENCES

PSYCHOLOGICAL CHARACTERISTICS CONTRIBUTE TO THE SENSITIVITY TO THE RISK OF DECISION-MAKING IN THE PROCESS OF PROFESSIONAL ACTIVITY OF SPECIALISTS FROM THE MARITIME INDUSTRY

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Abstract

The article indicates that in current minds in the development of the sea-gospodarsky galusa, the problem of complexity to the risk and solution is of particular importance in connection with the shift in the level of diversity and complexity of work specialists with specific minds for the activities they perform. Working on a ship in an isolated space and the need to make quick and accurate decisions in the minds of the unknown require practitioners of a high level of professional and psychological training durability.

A theoretical analysis of scientific literature was carried out. Scientific approaches to the examination of the observed phenomenon have been refined.

The stages of our empirical research are described.

An analysis of the results of our scientific research work was carried out.

The prospects for further development of this problem have been identified.

An alternative version of the problem has been proposed.

Methodological recommendations are given for changing the influx of sensitivity to the risk of making a decision in the professional activity of specialists in the Maritime Region.

Keywords: psychological characteristics; risk propensity; decision-making; professional activity; specialists in the maritime industry.

Problem statement. Modern research shows that risk-taking is an important factor that influences the decision-making process. A high level of risk-taking can contribute to quick decision-making, but at the same time increases the likelihood of errors.

Given the importance of reliability and safety in the maritime industry, it is necessary to investigate the psychological characteristics of the influence of risk-taking on decision-making by specialists in this field of professional activity. Risk-taking, which includes the willingness to make decisions under stress, can help specialists maintain efficiency and rationality in their actions. Understanding these aspects will contribute to improving the process of selection and training of personnel, as well as the development of psychodiagnostic methods that will help to recognize and take into account the psychological characteristics of employees in the process of their professional activity.

In conditions of increased risks that accompany maritime activities, the ability of specialists to make effective decisions is of great importance. Insufficient level of training and disregard for risk-taking can lead to wrong decisions and reduced work efficiency. Therefore, the relevance of the study is determined by the need for scientific understanding of the influence of risk-taking on decision-making, which will contribute to increasing the level of professional training and safety in the maritime industry.

The pressure exerted on people by modern society is formed by dynamic transformational processes and makes the study of the issue of risk extremely important. The mental state, behavior and adaptation process of a person depend on these changes, which permeate all aspects of his psyche. Such a situation not only increases interest in a person as a subject of his life, but also emphasizes the importance of studying his individual characteristics, in particular, risk-taking,

which can be one of the factors of a person's adaptive capabilities [1; 2; 5; 7].

Analysis of recent research and publications.

Based on the analysis of scientific and scientific-methodological literature conducted by us, we can state the following.

We consider it necessary to draw attention to the fact that in different historical eras, educators of their time approached the interpretation and understanding of risk in different ways. At the same time, they found justification for their conceptual views on the phenomenological essence of this phenomenon in religious and philosophical dogmas characteristic of mass culture, which are the fundamental basis of the worldview of people of a particular epochal period.

Thus, with the development of the cultural and scientific potential of humanity, views on the nature of this phenomenon changed in geometric progression.

As is known, the term "risk" itself has an ancient origin and translated from Italian means "to dare". It is also worth noting that the history of the construction of the concept of risk is closely related to a person's view of the future.

In ancient Greece, the mythological worldview was based on the belief that the future was entirely determined by the will and desires of the gods, and thus depended on the behavior of man himself.

The rise of world religions, primarily Christianity, led to uncertainty about the future. It was clear that a person's actions determine his chances for a "different" future both here on Earth and in the afterlife. As a result, responsibility for the results of his actions appeared.

Later, when it became clear that only God could not determine the future, a careful and impartial analysis of the problems associated with risk began. Luca, an Italian professor of mathematics and monk, was one of the first.

Ultimately, predictions of the future became possible with the advent of gambling. In this sense, probability theory was developed in 1654 as a result of collaboration between the French mathematician P. Fermat and the inventor, philosopher and mathematician B. Pascal during the study of gambling. This led to a significant paradigm shift and technological progress, which allowed quantitative predictions of the future to be created. Since then, various predictions, fortune-telling, and other unscientific practices have been replaced by scientific prediction systems.

At the beginning of the 18th century, the German mathematician G. Leibniz proposed an idea that had previously been substantiated by the Swiss mathematician J. Bernoulli, who formulated the law of large numbers and developed the foundations of statistics. Later, the French mathematician A. Moivre introduced the concept of normal distribution and the degree of risk - standard deviation. D. Bernoulli formulated the concept of expected utility, on which the modern understanding of investment theory is based. Bayes' theorem (hypothesis theorem) demonstrated how the degree of awareness of the object of management affects decision-making.

That is, the 17th-18th centuries are attributed to the development of science, the definition of fundamental laws and almost all modern risk management tools.

According to Vishnyakov, risk is part of any human activity and depends on various circumstances and elements that can have a good or bad effect on the choice made. The scientist argues that the competitive nature of political actors and the generality of socio-political ties highlight the possibility of not achieving the desired results.

Risk studies are usually divided into three main groups:

1. studies focused on the study of external risk factors, that is, on situations that carry a threat and create risk.

2. works that analyze a person's attitude to these situations and his behavior in conditions of risk.

3. studies that study the psychological traits of an individual that determine unique reactions, actions and behavior in risky situations, as well as those traits that can contribute to the emergence or increase of risk [11].

It is obvious that this kind of schematic and conditional study of the problem of risk is part of a larger work; in fact, some of the proposed directions even "overlap" and enhance the content of risk, since both internal and external factors, as well as their combinations, are facets of the same phenomenon. Nevertheless, studies, as a rule, focus on one of the main points of view that each author chooses to study the problem of risk, and not on another.

Accordingly, more attention is paid to:

- or an objective, situational approach to the study of external variables and risk circumstances;

- or a subjective method of studying the activities, behavior and conduct of an individual in dangerous scenarios;

- or research into hybrids (subjective-objective approach) of the first two methods.

In addition, it is important to draw attention to the class of studies that focus primarily on internal risk factors, that is, on the unique psychological features of the individual that accompany or contribute to or do not contribute to risk.

Even the definition of the term "risk" includes all of the above directions.

The position of the first direction, situational or objective, is that risk is considered from the point of view of its objective nature. In this context, risk acts as an objective phenomenon that is associated with uncertainty. It is perceived as a normal, natural state of affairs, and not as something exceptional. Risk is a constant component of reality, one of the ways of its assessment and development. It is also considered an external factor that may pose a threat or potentially lead to dangerous consequences.

The situation of risk (certainty of probability) is highlighted in many works that focus on the problem of decision-making, along with situations of certainty (reliability) and uncertainty (unreliability) as the main conditions (situations) on which the outcome of these decisions is based.

The fact that the main emphasis is on the objective nature of danger indicates the predominance of the first

direction - situational or objective. Below are some definitions of risk in this context: an objective phenomenon, a type of uncertainty; a stable state of the world, one of the ways of its measurement and development; an external factor, a threat and a potential danger.

Many works devoted to the topic of risk (certainty of probability) emphasize the ability to make decisions, along with situations of certainty (reliability) and uncertainty (unreliability), as the primary circumstances (situations) on which the results of decisions are based.

The concept of "situation" is often used in everyday life, which is understandable, since the analysis of a specific situation is usually the starting point for making a decision. Many researchers believe that the closest term to the word "circumstance" is "situation". So, T. V. Kornilova in her works notes that a situation is a set of various circumstances and conditions that form the environment for a certain activity. Moreover, this situation can both contribute to and hinder the implementation of a specific action. According to the author, a risk scenario can take the following forms:

- 1) a subject who has several options has objective chances of achieving the desired result;
- 2) only subjective assessments can be used to determine the probability of the desired result;
- 3) a person has access to both objective and subjective probability when choosing and using an option [8].

A dangerous situation is a form of uncertainty that arises due to various subjective reasons, the main of which are the capabilities and limitations of a person in the perception, assessment and analysis of the situation, which affect decision-making. Some authors propose to define risk and uncertainty as "measurable" and "immeasurable" quantities, respectively, since risk assessment serves as a theoretical basis for decision-making in modern circumstances [3].

When decisions are made without knowing the outcome, but knowing the probability of the attributes of each outcome, there is a risk. V.M. Kolpakov defined risk as a high probability of adverse outcomes and losses.

This is a scenario between two extremes: certainty and uncertainty. This allows us to determine the probability of each potential outcome, as well as its possible consequences. In addition, the author lists the lack of clarity regarding the circumstances surrounding the decision-making process, potential consequences and the role of the decision-maker as one of the main sources of uncertainty [8].

Within the framework of this psychological approach, attempts are made to systematize the factors that expose an individual to risk. This is reflected in numerical risk classifications that divide risk into groups based on the achievement of predetermined goals, and in the search for risk functions that, for example, are found in economics (innovative, regulatory, protective, and analytical).

From the above (situational) positions, various types of risk are identified and described. These include extraordinary risk (loss of life or health); regulatory and everyday risk (risk of material losses, unsuccessful choice of profession and other risks); economic risk; administrative risk; risk of being subject to legal and

administrative sanctions; risk of losing authority in a subjectively significant group.

Different risk characteristics are assessed based on the circumstances. The following types of risk are recognized and distinguished: professional and non-professional; episodic and systematic; foreseen and unexpected; justified and unjustified; risk for the sake of the cause and risk for the sake of oneself; forced risk and arbitrary risk; biological risk and social risk, etc.

It should be emphasized that the pressure exerted on a person by situational (objective) dangers varies both in nature and in content. For this reason, in modern psychology they are considered as external factors that influence a person's tendency to act in dangerous situations.

Among external factors, the concept of "danger" is particularly emphasized. In this context, risk is considered as a characteristic of an event or situation that is accompanied by the presence of danger or uncertainty and requires a choice between several possible options, at least one of which may have negative consequences. The terms "risk", "danger" and "uncertainty" are inter-related and are often used together, but there are certain differences between them. V.V. Kochetkov notes that the difference is that the circumstances of risk include knowledge of the probability of outcomes, while the conditions of uncertainty do not allow determining the probability of certain consequences.

In turn, as L. Yakakovyt'ska states, the research question always remains to identify all conditions (situational and dispositional) that contribute to or hinder risk-taking in human actions. Therefore, we see the consideration of the processes of accepting and overcoming uncertainty and risk in the context of studying the holistic functioning of a person's intellectual and personal potential, after which ultimately the realization of the willingness to take a risk or the decision to refuse it remains as the main connecting link of multi-directional research on choice. [3, p. 2]. [7, p. 6], [1; 3; 5; 7].

Purpose of the article: To focus attention on the special theoretical and practical relevance and importance of studying the problem of "Psychological features of the influence of risk-taking on decision-making in the process of professional activity of specialists in the maritime industry". To describe the stages of the scientific research work we conducted. To familiarize ourselves with the results of the research we conducted.

Presentation of the main material.

Numerous domestic and foreign scientists study the neurobiological and psychophysiological foundations of decision-making (Gold and Shadlen, Kiani and Shadlen, Lieberman, Pennycook, Fugelsang and Koehler, Bogut'ska), the characteristics of decision-making under risk and/or uncertainty (Evans, Gardner and Steinberg, Kornilova, Reshet'lo and Fedotova), the role of emotions and intuition, as well as biases during decision-making (Arily, Naqvi, Shiv and Bechara, Kahneman and Tversky, Maksud, Finnegan and Walker), cognitive decision-making styles (Gustavo, Kahneman, Katsenelinboigen), individual factors of decision-making (Briggs and Myers, Kornilova and

Kerimova), age-related features of decision-making (Reyna, Steinberg, Pomytkina), etc.

Due to the fact that decision-making takes place in a time dimension, the concept of the “decision-making process” was developed. This process begins when a problem scenario arises and ends when the optimal course of action is chosen to resolve the problem situation [2].

The need for choice (“we are faced with a problem situation and the need for a choice”), analysis of options (“we analyze alternative options”), choice (“we make a choice”), anticipation (“we live with the choice made”) are the four main stages of the psychological concept of decision-making based on the WRAP model of Chip and Dan Hees. When making a decision, it is very important to take into account each of these phases.

From the authors’ point of view, the most important stage of the decision-making process is the last one: “living with the choice made”. Since anxiety and fear of unknown possibilities directly affect decision-making, one important aspect of the decision-making process that most scientists ignore is the consequences of our judgments. As a result, it is very important to take into account the general level of intelligence, tolerance for risk, tolerance for ambiguity, and other psychological characteristics when making judgments.

According to scientists, at each of the defined stages of decision-making, four different types of thought traps “await” us:

1. “confirmation bias” refers to the process of seeking evidence that only confirms our beliefs or assumptions;
2. “narrow vision/narrow frame” refers to an unjustified restriction of the possibilities being evaluated, causing us to overlook some of them;
3. “short-term/momentary emotions” that impair our ability to think rationally and cause us to make bad decisions;
4. “overconfidence” refers to having too much faith in our own predictions of the future [12].

To maximize decision-making and prevent these problems, the authors recommend using the WRAP model, a four-step approach aimed at optimal choices. The phases of the procedure are: “expanding possibilities”, “reality checking assumptions”, “achieving distance before making a decision” together with “preparing for possible error”. The first letters of the names of the stages of the process are combined to form the acronym WRAP. “WRAP” can be translated from English as “wrapping”, “cloaking”. The WRAP model is perceived as a way of “wrapping” the traditional approach to decision-making in order to protect against typical mistakes, biases and traps.

When making a choice, people often choose only one option. In about 65% of situations, a yes-or-no decision is made; that is, only one alternative is considered, and a vote is taken based on these options. This indicates that other options that may be available are not considered, and the choice is made within a “narrow framework” [12].

One solution to avoid falling into the “narrow framework” trap is to use the “disappearing options”

approach. What other options do you have in this situation? When our options “disappear”, our responsibility is to switch our “spotlights” to search for other options or solutions that are not immediately obvious or “highlighted”; multitasking, or the simultaneous evaluation of multiple options, allows us to create a “general contour” of the problem and a more accurate picture of the work by combining elements of successful first options and eliminating unsuccessful ones; we can also go beyond the company and look at the experience of competitors, acquaintances, or best practices; we can also use the ladder to search for distant analogies in an attempt to find people who have already completed our task.

Painful decisions often indicate a conflict between our key priorities. What exactly drives you? Who do you aspire to become? What option do you think is best for yourself and your loved ones? Since different people may give different answers to these questions, the WRAP process will not be able to provide a universally correct answer. Two people may make the same decision, but each person’s choice may be radically different and yet justified for each individual. Therefore, by identifying and fixing your basic life priorities, you can greatly simplify the decision-making process.

To avoid the trap of overconfidence according to the WRAP model, several techniques can be used. One of them is the creation of future options, which includes methods such as “pre-mortem analysis” (evaluating the possible consequences of failure) and “preparation” (providing alternative strategies for difficult situations). These techniques help to imagine possible negative scenarios and better prepare for them. Another important technique is the establishment of “minefields”, such as time limits or artificial selection, which allows you to avoid overconfidence and provide additional verification of decisions. Both techniques contribute to a more realistic assessment of the situation and help prevent excessive self-confidence in decision-making.

John von Neumann developed the theory of utility maximization, according to which decisions are made in order to achieve maximum benefits. It emphasizes that in the process of choice, a person seeks to choose the most advantageous option. An interesting concept is the concept of constrained optimality, which involves choosing the best action given the available constraints.

Further development of these ideas was reflected in the theory of bounded rationality, which states that a person makes decisions by searching for an alternative that meets certain criteria. Within the rationalist paradigm, much attention is paid to the development of models that help solve complex problems under conditions of conflicting goals. It is also important to analyze the factors that influence the selection of the necessary information and mental operations to achieve the optimal solution [12].

In order to implement the goal and objectives of the study, an empirical study of the influence of risk-taking on decision-making in the professional activities of specialists in the maritime industry was conducted.

The purpose of the study is to determine and study the indicators of risk-taking that affect decision-making in the professional activities of specialists in the maritime industry.

The purpose of the study determines the need to set and solve the following tasks:

- 1) to conduct an analysis of the psychological and methodological literature on the problem of studying risk-taking and the decision-making process in professional activities;

- 2) to select reliable and valid psychodiagnostic methods for assessing risk-taking and decision-making that meet the goal and objectives of the study;

- 3) to conduct a research-experimental study to determine the influence of risk-taking on decision-making in the professional activities of specialists in the maritime industry;

- 4) to develop methodological recommendations for reducing the influence of risk-taking on decision-making in the professional activities of specialists in the maritime industry.

After conducting a theoretical and methodological analysis of the concepts of "risk", "risk appetite" and "decision-making in professional activities", a group of respondents was selected. The empirical study involved 60 men aged 28 to 46, who are specialists in the maritime industry and regularly go on ship voyages.

When conducting the research experiment, the following methods were used: testing to identify risk propensity and decision-making, as well as the correlation method to establish the influence of risk propensity on decision-making in the professional activities of a specialist in the maritime industry.

There were three stages to conduct an empirical study of the influence of risk propensity on decision-making in the professional activities of specialists in the maritime industry.

At the first stage of the study, theoretical information on this issue was studied and analyzed, research methods were selected, a sample was formed, and method forms were prepared. The second stage is an empirical study of risk propensity on decision-making in the professional activities of specialists in the maritime industry. The third stage is the interpretation and analysis of the data obtained during the study.

Decision-making under risk is an important aspect of the professional activities of maritime specialists. In such conditions, decisions are often made taking into account available, but incomplete or uncertain data, which creates risky situations. The main challenge for specialists is the need to quickly and effectively assess the probability of possible outcomes, taking into account potential threats and benefits.

Risk in the decision-making process can be associated with various aspects: technical, economic, environmental, social and other factors affecting maritime operations. For example, decisions regarding the vessel's route, loading or unloading cargo, or conducting rescue operations can have serious consequences for both people and the environment.

Professional activities in the maritime sector require specialists to have a high ability to make decisions under uncertainty. Here, such qualities as risk tolerance, stress resistance, analytical skills, the ability to predict the consequences of decisions and responsiveness to changing circumstances come to the fore.

Risk-taking can be both an advantage and a disadvantage in professional activities. On the one hand, it

allows specialists to act decisively in situations requiring quick decision-making. On the other hand, excessive risk-taking can lead to underestimation of potential dangers and, as a result, to making wrong decisions [3].

Understanding the mechanisms of decision-making under risk and the impact of risk appetite on them is critical to ensuring the effectiveness and safety of professional activities in the maritime industry.

Decision-making under risk is a complex process that includes several key mechanisms. These mechanisms determine how maritime industry specialists assess the situation, choose possible actions and make a final decision under conditions of uncertainty. Since the decisions they make can have significant consequences for the safety of people, ships and the environment, understanding these mechanisms is critical.

The first stage in decision-making is risk assessment, where the probability and possible consequences of different scenarios are determined. Specialists analyze the situation, taking into account available information, historical data, forecasts and their own experience. In the maritime industry, this process may include the analysis of weather conditions, technical condition of ships, navigational conditions, etc. The main task at this stage is to identify potential threats and opportunities in order to form a clear idea of the level of risk [9].

After risk assessment, specialists use different approaches to decision-making. This can be an intuitive approach, when the decision is made based on experience and knowledge, or a more formal approach, where mathematical models and algorithms are used. Depending on the level of uncertainty and available information, decisions can be made quickly or after a detailed analysis of all possible options. For example, in conditions of acute risk (storm, technical accident), decisions are often made instantly, while strategic decisions (route planning, fleet management) require more in-depth analysis.

Psychological factors such as risk appetite, fear and self-confidence play an important role in decision-making. Specialists with a high risk appetite may be more willing to make unconventional decisions or risky actions. However, overconfidence or, conversely, fear can lead to unfounded or overly cautious decisions. In the maritime industry, this can manifest itself in decisions related to routing in dangerous conditions or managing cargo operations in unstable situations.

Another important mechanism is the development of possible alternative solutions and their evaluation. Specialists must clearly understand all available options and the possible consequences of each of them, including both positive and negative scenarios. In the maritime industry, for example, this may be a choice between different routes through dangerous areas, where each route has its own advantages and risks.

After analyzing all possible options and assessing the risks, specialists make a final decision, which is the result of a balanced approach that takes into account all the collected data, possible consequences and personal experience. It is also important to take into account the specialist's ability to act under stress and his willingness to take responsibility for the decision made.

The final stage is monitoring and adjusting the decision. After making a decision, it is important to constantly monitor its implementation and, if necessary, adjust actions during implementation. This allows you to respond to changing conditions in a timely manner and minimize negative consequences. In the maritime industry, where situations can change very quickly, effective monitoring and the ability to adapt to new conditions are key to successfully completing the tasks set.

Thus, decision-making mechanisms under risk conditions are a complex process that takes into account various factors and affects the efficiency and safety of professional activities in the maritime industry.

Based on the analysis of existing methods for studying risk propensity and decision-making, we selected the following:

1. Test "Diagnosis of the degree of readiness for risk" by G. Schubert [20];
2. Questionnaire "Risk propensity" by O. Shmelyov [20];
3. Melbourne questionnaire "Decision-making" (MOPR) by Mann, Barnett, Redford, Ford (adapted by T. Kornilov) [29].
4. Scale for assessing the features of systemic decision-making by T. V. Ryabova (SHOOSPR).

As a result of our empirical research, we obtained the following results.

High risk appetite in 20% of respondents. This means that every fifth respondent demonstrates a significant tendency to take risky actions. In the context of a seafarer's work, such a high level of risk means the ability to make decisions even in very dangerous or uncertain situations without significant hesitation. These seafarers are usually ready to act immediately in crisis situations, such as severe storms, ship emergencies, collisions with other ships or even threats to life. Their determination allows them to make decisions quickly, which can be vital in conditions such as explosions or fires on board, where every second is important.

Such a level of risk can be due to several factors. First of all, it can be a consequence of extensive experience working at sea in extreme conditions. The more time a seafarer spends in high-risk situations, the more he adapts to such conditions, building confidence in his decisions. It is important to note that people with a high risk appetite may have adventurous personality traits, including a desire to test themselves in difficult conditions or to prove their skills in critical situations. While such a risk appetite allows them to react quickly to dangers, it also increases the likelihood of mistakes due to overconfidence and underestimation of the threat. High levels of risk in such cases can lead to impulsive decisions or disregard for safety rules, which in the seafaring profession can have disastrous consequences. In order to reduce the possible negative consequences of a high risk appetite, it is important to develop training that improves the skills of analyzing risky situations and directs the impulsiveness of seafarers in a constructive direction. Such training can help professionals with a high risk appetite better understand when it is advisable to make risky decisions and when it is better to act more cautiously.

Average risk appetite in 63.3% of respondents.

This is the largest group of respondents demonstrating moderate risk appetite. In the professional activities of seafarers, an average risk appetite means that these specialists are able to analyze the situation and make informed decisions where the risk is present but controlled. They do not shy away from complex and potentially dangerous tasks, but make decisions based on preliminary analysis, weighing the possible consequences. In the practice of a seafarer, such behavior is optimal, as it allows you to avoid both excessive adventure and paralysis due to fear of danger.

Seafarers with an average risk appetite usually demonstrate good stress tolerance and the ability to work in a team, where their decisions may be criticized by colleagues or management. For example, when navigating in difficult conditions (such as narrow straits or areas with high shipping traffic), they will act strictly according to protocol, but will not be afraid to take a risky decision if it helps to avoid danger. At the same time, their level of risk-taking allows them to work effectively even in difficult conditions, when time for reflection is limited, but it is important not to cross the safety line.

The reasons for this result may be related to professional training and work experience. Maritime specialists receive training in risk management, where special attention is paid to the development of skills in predicting and analyzing hazards. This balanced approach ensures the safety of the crew, ship and cargo, but at the same time allows them to act quickly and confidently in situations where risk cannot be avoided. A medium level of risk-taking is most desirable for seafarers, as it combines caution with the ability to act in difficult conditions. Such specialists are likely to have a positive impact on the work environment, as they maintain discipline and do not shirk responsibility.

Low risk aversion in 16.7% of respondents.

This group of respondents demonstrates high caution and a tendency to avoid risky situations. In the seafaring profession, this means that such professionals prefer not to participate in making decisions related to risk, or do so with a long delay. They may choose safer options, even if this slows down work or limits the crew's ability to react to danger. In everyday work, this may manifest itself in excessive caution when performing routine operations or when making decisions in conditions of deteriorating weather conditions.

Low risk aversion can be both a positive and a negative trait. On the one hand, such seafarers can avoid unnecessary risks and ensure greater safety on board. For example, they are not inclined to violate protocols or ignore safety regulations. This can be useful in stable conditions where it is important to follow standard procedures, especially when working with hazardous materials or complex equipment, where any mistake can lead to serious consequences. On the other hand, excessive caution can be a hindrance in critical situations where speed of reaction is key. For example, in accidents or during the evacuation of a ship, it is important to make decisions quickly and with a certain amount of risk to avoid greater losses. A low level of risk tolerance can slow down the decision-making process, which increases the risk for the entire crew. The reasons for such

caution may be related to the individual psychological characteristics of the seafarers or insufficient confidence in their own abilities. It may also be a consequence of insufficient experience in critical situations or working in conditions where the risk was minimal.

Analysis of the results shows that most seafarers have an average level of risk tolerance, which is optimal for work in the maritime industry. Such a balanced approach allows them to act confidently and thoughtfully in conditions of uncertainty. At the same time, a significant part of seafarers demonstrates either a high level of risk tolerance (20%), which can be useful in extreme situations, or a low level (16.7%), which indicates their caution and desire for stability, but can slow down decision-making in critical situations.

We have compared the indicators based on the results of the test "Diagnostics of the degree of readiness for risk" by G. Schubert and the questionnaire "Risk tolerance" by O. Shmelev.

High risk-taking (21.7%) and risk-taking (20%) levels. These results show that approximately 20% of respondents are both risk-taking and risk-prone. This means that these professionals are not only able to make quick decisions under uncertainty (risk-taking), but also have an intrinsic tendency to seek risk (risk-taking). It is important for these 20% of professionals to assess situations correctly, as their risk-taking may in some cases lead to excessive risk-taking when it is not justified. For example, in situations where reasonable caution would be more appropriate, they may make too quick and bold decisions, which increases the likelihood of errors. This is critical for maritime activities, where risky decisions can have major consequences.

Average risk-taking (63.3%) and risk-taking (63.3%) levels. Most respondents show a congruence between average risk-taking and risk-taking. This means that these professionals have a balanced attitude towards risk: they are not too eager for risky situations, but they do not shy away from them either. Their decisions are usually well thought out, and they are able to control risk. Such a balanced group can be the most effective in the maritime sector. They approach risky situations with caution, but can make quick decisions when necessary. This indicates an optimal approach to work, where it is necessary to combine speed of response with prudence. This approach allows you to function effectively in the high-risk conditions characteristic of the industry.

Low level of readiness (15%) and inclination (16.7%) to risk. These respondents' readiness and inclination to risk are also correlated: they not only do not seek risky situations, but they are also not ready to act quickly in such conditions. These specialists are characterized by caution, which can be a positive aspect in stable or predictable conditions. However, in the maritime industry, where decisions often have to be made under conditions of uncertainty, such caution can become an obstacle. Their indecision or excessive caution can delay making important decisions, which in critical situations can have negative consequences. This is a group of specialists who may need additional training to improve their ability to make decisions under risk.

The coincidence of the levels of readiness and inclination to risk (approximately 63% of respondents

have an average level of both indicators) indicates a strong relationship between these categories. This means that risk-taking, as a personality trait, influences how maritime professionals respond to risk in real-world situations. Those who are risk-averse tend to be more willing to act in risky situations, and vice versa.

A high level of risk-taking and risk-taking can contribute to effective response to crisis situations, but in the absence of sufficient analysis, it can increase the likelihood of errors.

A medium level is the most desirable in most professional situations, as it provides sufficient caution without sacrificing speed of decision-making.

A low level indicates the need for increased training to better adapt to risky situations in maritime activities.

The results of the tables demonstrate that most maritime professionals have an average risk tolerance and willingness to take risks, which is optimal for making informed decisions in their professional activities. However, groups with high and low risk levels may need additional training and attention, as their behavior in extreme conditions may be less effective.

The methodological recommendations include a training program aimed at reducing the impact of risk tolerance on decision-making in the professional activities of maritime professionals. The program contains four main modules, each of which develops specific competencies necessary to reduce the impact of risk on decision-making.

Module 1. Managing risk appetite through self-regulation.

The purpose of the module is to reduce the impact of risk appetite on decision-making by developing self-regulation skills, controlling emotions and stress. This module aims to help maritime professionals develop the ability to maintain a cool head and rationality when making decisions in complex, risky situations.

Relevance. Maritime professionals often work in conditions of high uncertainty and risk, which can cause emotional stress, anxiety, and even panic. During such situations, personal risk appetite can provoke rash or impulsive decisions, which increases the likelihood of errors. Therefore, it is important to teach professionals to correctly assess their emotions and manage them in order to minimize the impact of risk appetite on the decision-making process.

The main objectives of the module:

1. Familiarization with the concept of risk appetite and its impact on decision-making. Training participants will receive theoretical information about the nature of risk and personal risk-taking behavior. It will explain how emotional states such as anxiety, fear, or overconfidence can increase or decrease risk in decision-making;

2. Developing self-observation. Participants will learn to recognize emotional states that arise in situations of increased risk and identify moments when risk-taking begins to influence their decisions. This self-observation will allow professionals to better understand their own reactions and regulate them;

3. Training in stress management and self-regulation techniques. Professionals will learn practical methods for managing emotions and reducing stress levels. Such methods will include:

- breathing techniques. Exercises that help reduce anxiety and calm the nervous system (for example, the “deep breathing” technique, which allows you to quickly restore calm in a stressful situation);
- progressive muscle relaxation. This technique allows you to reduce physical tension that occurs as a result of emotional stress and helps restore relaxation of the body;
- cognitive restructuring methods. A technique that helps you rethink negative thoughts and emotions that can lead to impulsive decisions. Participants will learn to question their own emotional reactions and review them through the prism of rational thinking;

4. Studying mindfulness techniques. These practices help increase the level of conscious control over their own reactions in stressful situations. Mindfulness consists in participants learning to focus on the present moment, accept their emotions without judgment and thus reduce their level of anxiety;

5. Recognizing signs of impulsive behavior. Participants will learn how to recognize signs of impulsive decisions and take steps to control them. This includes recognizing physiological (e.g., rapid heartbeat) and cognitive (e.g., the urge to act quickly without careful analysis) signs.

Module methods and techniques:

1. Theoretical part. Lecture presentation with visualization on the impact of risk-taking on decision-making. Participants will learn about the psychophysiological mechanisms that are activated in stressful situations and will receive explanations about practical tools for managing these reactions;

2. Practical part:

- breathing exercises - participants will learn simple and effective breathing techniques for quick calming. One example is the “4-7-8” technique, which helps reduce anxiety, stabilize the heartbeat and calm the nervous system. This technique consists of inhaling through the nose for 4 seconds, holding the breath for 7 seconds and exhaling through the mouth for 8 seconds;
- progressive muscle relaxation - the trainer will guide participants through sequential muscle relaxation exercises, where they will learn to tense and relax different muscle groups to reduce physiological tension;
- Mindfulness exercises - participants will try a few simple exercises to increase conscious awareness, such as focusing on their breathing or focusing on physical sensations in their body. This will help them learn to quickly return to a state of calm and remain rational.

3. Cognitive self-reflection exercises. Participants will work on exploring their own cognitive models in risky situations. They will analyze how their emotions and thoughts affect their tendency to make risky decisions, and learn to apply cognitive restructuring to prevent impulsive actions;

4. Group discussions and reflection. Participants will discuss their own experiences and learning with other group members, which will help them to understand the importance of self-regulation. The discussion will allow them to analyze personal cases where risk-

taking influenced decisions and identify strategies to better manage their reactions in the future.

Expected outcomes of the module:

- participants will gain a clear understanding of how risk-taking affects decision-making under stressful conditions;
- develop self-monitoring and self-control skills that will help them recognize and avoid impulsive decisions;
- learn effective stress management techniques that can be used to maintain calm during critical situations;
- improve self-regulation skills that will allow them to make more informed and informed decisions, minimizing the negative impact of emotions and stress on their professional activities.

This module is the foundation for the following stages of the training, as it helps participants lay the foundation for further development of team risk management skills and decision-making under uncertainty.

Module 2: Communication and Interaction in Risk Environments.

The aim of the module is to teach maritime professionals to communicate and interact effectively in high-risk and stressful environments. Since work at sea is often associated with critical situations where it is important to quickly exchange information and make collective decisions, this module aims to improve team communication skills, which will help reduce the impact of personal risk tolerance on the overall work outcome.

Relevance. In complex and risky environments, communication plays a crucial role in coordinating actions and making decisions. Maritime professionals often deal with uncertain situations where clear and rapid communication of information is key to successful problem solving. Communication deficiencies can lead to incorrect decisions or delays, which increases the risk to the crew and the vessel. It is especially important to consider that in stressful situations, risk tolerance can increase, which increases the need for clear information exchange and collective decision-making.

The main objectives of the module:

1. Familiarization with the principles of effective communication in risk conditions. Participants will learn about the features of communication in critical situations and how stress and risk-taking can affect team interaction. This will allow them to recognize when their own emotions or risk-taking affect communication and decision-making;

2. Development of active listening skills and clear information transfer. One of the key problems in complex situations is incomplete or incorrectly perceived information transfer. Participants will learn active listening methods, which will help to better understand colleagues and reduce the risk of errors due to misunderstanding;

3. Practice feedback techniques. Participants will learn how to provide constructive feedback in stressful conditions to improve team interaction. This will help to ensure correct perception and transfer of information, even under pressure;

4. Training in team conflict resolution. Different approaches to risk can become a source of conflict in

the team. Participants will learn conflict resolution techniques, including assertive communication, which allows them to express their thoughts constructively and prevent conflicts that can escalate under stressful conditions;

5. Developing leadership skills in high-risk situations. In addition to communication skills, this module will help participants learn how to take a leadership role in complex situations when it is necessary to organize and coordinate the work of a team, directing it to make informed decisions.

Module methods and techniques:

1. Theoretical part:

- familiarization with the basic principles of communication under stress. Participants will learn how emotional states and stress affect the ability to perceive and transmit information. The basic rules of effective communication will be considered: clarity, conciseness, attentiveness to non-verbal signals;

- consideration of the features of risky situations in the professional activities of maritime specialists, when fast and accurate communication is a key factor in successfully overcoming the problem. Participants will be shown how a tendency to take risks can lead to making overly bold decisions due to lack of information or incorrect perception of the situation;

2. Practical part:

- active listening exercises. Participants will work in pairs or small groups, practicing the ability to listen carefully to each other and paraphrase the information received to confirm it. These exercises will help improve the ability to accurately perceive and transmit information even in stressful conditions;

- role-playing games on effective communication under stressful conditions. Using risk scenarios, such as sudden equipment failure or changing weather conditions, participants will practice communication where it is important to convey information quickly and accurately. In such exercises, each team member will have their own role, and their ability to communicate will determine the success of solving the problem;

- simulation of real-life work situations. Conditions similar to those encountered in maritime activities (for example, shipboard emergencies) will be created, where participants will work as a team to solve a problem. This will help them understand how risk-taking can affect their perception of information and how coordinated communication can reduce the risk of wrong decisions;

- practicing feedback techniques. Participants will learn how to provide feedback correctly to improve the effectiveness of interaction under stressful conditions. They will learn how to identify and correct communication errors without increasing the level of tension in the team;

3. Cognitive-behavioral exercises for conflict resolution:

- participants will study different types of conflicts that can arise due to different approaches to risky situations. They will practice assertive communication exercises, which allow you to express your position constructively, reducing the risk of conflict escalation in critical situations. Special attention will be paid to the

techniques of "I-messages", which help to avoid accusations and focus on solving the problem;

4. Leadership development exercises:

- participants will practice team management in risky conditions. These can be simulations of emergency situations on a ship, where one of the participants will act as a leader who will coordinate the team's actions, make decisions and transmit appropriate instructions. This approach will help develop the skills of making informed decisions under pressure and stress;

5. Group discussions and feedback:

- Participants will discuss the difficulties they encountered during the exercises and analyze their communication mistakes and successes. This will allow them to gain a deeper understanding of their own strengths and weaknesses in interacting with others in risky situations.

Expected results of the module:

- participants will develop active listening skills and learn to convey information clearly and quickly under stress;

- effective communication and team interaction skills will improve, which will reduce the risk of wrong decisions due to communication errors;

- participants will learn to provide constructive feedback, which will contribute to the coordinated work of the team in conditions of increased risk;

- develop conflict resolution skills and will be able to avoid the escalation of conflicts in stressful situations;

- improve their leadership qualities, which will allow them to take responsibility for the team in critical conditions and coordinate its actions in order to reduce the overall risk.

This module is an important part of the training, since the success of many decisions in the maritime industry depends on high-quality communication. Coordinated team interaction and effective exchange of information will help minimize risks and improve the overall efficiency of specialists.

Module 3: Developing Risk Analysis and Decision-Making Skills

The aim is to teach maritime professionals methods of risk analysis and making informed decisions under uncertainty. This module aims to develop critical thinking and the ability to weigh different options for action, taking into account possible consequences, which will reduce the negative impact of risk aversion on the decision-making process.

Relevance. In the professional activities of maritime professionals, situations often arise when decisions need to be made under conditions of limited or incomplete information, high time pressure and significant risk. Risk aversion can lead to impulsive or excessively risky decisions, which can have serious consequences for the safety of the crew and the vessel. Therefore, it is important to teach specialists methods of effective risk analysis and decision-making, which will reduce the likelihood of errors.

The main objectives of the module:

1. Familiarization with the basic principles of risk analysis. Participants will learn about methods for assessing risk situations, which include an analysis of potential threats, the likelihood of negative consequences

and strategies for minimizing risks. This will allow them to better understand when it is necessary to resort to risky decisions and when it is worth avoiding risk;

2. Learning to evaluate decision options in risky situations. Participants will learn how to analyze different options for action, taking into account their potential consequences, benefits and risks. They will learn to determine the most rational option with a minimum level of risk and maximum benefits;

3. Developing the ability to make decisions quickly under stress and pressure. In complex and fast-paced situations, decisions must be made quickly. Participants will learn to work under limited time and pressure, while maintaining the ability to rationally assess the situation;

4. Recognizing cognitive biases and avoiding errors. Participants will learn cognitive errors that can occur in the process of making decisions under the influence of stress or a tendency to risk. This will allow them to avoid such mistakes as overconfidence or overestimation of the probability of success;

5. Developing decision-making strategies in teams. Participants will learn to make effective decisions not only individually but also as a team, using collective knowledge and experience to make the most informed decisions;

Module methods and techniques:

1. Theoretical part:

- participants will get acquainted with the main models of risk analysis, such as the "scenario method" (assessment of possible scenarios of development of events), the "decision tree method" (determination of the probabilities of each of the decision options and their consequences), as well as "benefit-risk analysis" (assessment of the balance between risk and expected benefits from the adopted decision);

- the main cognitive biases will be considered, such as the "fog of war" effect (perception of a situation in stressful conditions as riskier than it actually is), the "overconfidence effect" (overestimation of one's capabilities) and the "availability bias" (tendency to make decisions based on the latest information, rather than objective analysis);

2. Practical part:

- analysis of cases of real risk situations. Participants will consider real situations that maritime industry specialists face, analyze possible risks and consequences of different options for action. Each case will be examined from the perspective of making optimal decisions in a situation of uncertainty;

- exercises for rapid decision-making under pressure. Conditions will be created where participants will have limited time to make decisions in simulated risky situations. These may be ship accidents, unexpected weather changes or other critical events. Participants will have to quickly assess the situation, analyze options for action and make decisions. After each simulation, an analysis will be conducted of how the decision made affected the situation;

- simulation of decision-making in a team. Participants will work in groups to make collective decisions in complex situations. This will help them learn to use the knowledge and experience of each team member, combining them to make the most informed decision.

During the simulations, the roles of the leader and team members will be practiced so that each participant has the opportunity to try out different approaches to solving problems;

3. Cognitive exercises to eliminate biases:

- participants will perform exercises to identify and correct cognitive biases that arise when making decisions. For example, the "long-term thinking exercise". Participants will be forced to imagine the consequences of each decision option for the long term, which will help them avoid making decisions with only short-term benefits;

- the "Devil's Advocate" technique. During a collective decision-making process, the participant who acts as the "devil's advocate" should find possible flaws in the chosen solution or suggest risks that may have been ignored by other team members. This will help avoid "groupthink", when the group tends to follow the general opinion without critical analysis;

4. Exercises to balance risk and benefit:

- participants will perform exercises aimed at assessing the benefits and risks of each solution option. They will learn to weigh the pros and cons of each choice, reducing the tendency to be too risky or too cautious;

5. Group discussions and decision analysis:

- After each exercise, participants will analyze the decisions made in the group. This will allow them to better understand how others approach risk assessment and what factors influence decision-making. Participants will be able to receive feedback from their peers and the trainer, which will help them improve their decision-making skills.

Expected outcomes of the module:

- participants will learn to effectively analyze risks, assess different options for action and their consequences;

- improve the ability to make informed decisions under time constraints and stress;

- gain knowledge about cognitive biases and skills to recognize and correct them;

- develop the ability to work in a team to make collective decisions, using the knowledge and experience of other team members;

- learn strategies to reduce the impact of personal risk tolerance on the decision-making process.

This module is one of the key ones in the training, as it focuses on developing critical skills necessary for effective risk management in the professional activities of maritime professionals. It aims to provide participants with the tools to make informed and rational decisions even in the most difficult conditions.

Module 4: Managing Teamwork in Risk Environments

The goal is to develop in participants the skills of effective team interaction, coordination and support in conditions of increased risk and uncertainty. The module is aimed at strengthening team cohesion, which is critical for minimizing errors in complex situations and ensuring safe and rational decision-making in risk environments.

Relevance. In the maritime industry, coordinated team work is a key factor in successfully resolving any critical situations. With a high level of risk, when every

second counts, the interaction between crew members must be as effective as possible. At the same time, the risk-taking tendency of individual team members can negatively affect the collective decision, which increases the likelihood of errors and threats to the safety of the vessel. Therefore, it is important to teach specialists to effectively interact in a team, support each other and make coordinated decisions, reducing the impact of individual risk-taking tendencies.

The main objectives of the module:

1. Development of team interaction skills in conditions of stress and risk. Participants will learn to work as a single, cohesive team, even in stressful situations where the presence of risk can increase tension. This will reduce the risk of wrong decisions due to lack of team coordination;

2. Strengthening trust in the team. Participants will learn to trust each other, which will improve team performance in high-risk environments. Trust between team members is key to ensuring reliable interaction and quick decision-making;

3. Development of leadership qualities in crisis situations. Participants will gain knowledge and skills that will help them take a leadership role in critical situations. This will allow them to more effectively coordinate team actions and make informed decisions in stressful conditions;

4. Learning strategies for resolving conflicts in a team. In stressful conditions, conflicts can arise due to different approaches to risky decisions or personal ambitions. Participants will learn to avoid conflicts and find compromises to maintain team cohesion;

5. Practicing techniques for mutual support and assistance in risky situations. Participants will learn to effectively support each other in difficult situations, which will help reduce stress levels and increase the effectiveness of teamwork.

Module methods and techniques:

1. Theoretical part:

- participants will gain knowledge about the basic principles of teamwork in risk conditions, as well as how stress and risk-taking can affect team dynamics. Special emphasis will be placed on the importance of coordination and the role of the leader in a team during crisis situations;

- models of leadership in risk conditions will be considered, in particular "situational leadership", where the leader adapts his management style depending on the specific situation and the level of risk. Participants will learn about different approaches to leadership in stress conditions and how to choose the right tactics for interacting with the team;

2. Practical part:

- simulation of emergency situations. Participants will participate in simulation exercises that simulate real emergency situations on a ship, for example, technical malfunctions or adverse weather conditions. Participants must coordinate their actions, maintain communication and make joint decisions in conditions of limited time and high risk. After each simulation, an analysis of teamwork will be conducted, identifying how coherence was achieved and what needs to be improved;

- exercises to strengthen trust in the team. Participants will perform exercises aimed at increasing the level of trust between team members. One such exercise may be the "blind guide", where one participant, blindfolded, must perform tasks according to the instructions of other team members. This will help participants learn to trust each other and rely on information from colleagues, even in stressful conditions;

- role-playing games on leadership in crisis situations. Participants will play the role of a leader in risky situations, where they will have to organize a team to respond quickly to a problem. They will learn to distribute tasks, maintain communication and make informed decisions. This exercise will allow each participant to test themselves as a leader and understand which approaches to leadership are most effective in risky conditions;

- resolving conflicts in the team. Participants will learn to resolve conflicts that may arise during decision-making under stressful conditions. The techniques of "assertive communication" will be used, which allow you to express your thoughts and positions without violating the rights of others, as well as find compromises in conflict situations. The exercise involves analyzing conflict scenarios, where participants must offer strategies for solving problems without resorting to aggression or passivity;

- mutual support techniques. Participants will practice providing psychological support to each other under stress, which will help maintain team cohesion. This exercise will be based on real situations when crew members must support each other in difficult moments.

3. Group discussions and reflection:

- after each exercise, participants will have the opportunity to discuss their actions and the behavior of the team as a whole. They will analyze what helped to achieve success in teamwork and what could be improved. The discussion will provide a better understanding of how team dynamics work during stressful situations and how to reduce the risk of making bad decisions due to ineffective communication or lack of coordination.

Expected results of the module:

- participants will learn to work in a team under stressful conditions, coordinating each other's actions to make rational decisions;

- improve leadership skills and develop the ability to effectively manage a team during critical situations;

- develop trust between team members, which will increase the level of interaction and coordination in difficult conditions;

- learn to resolve conflicts under risk and stress, maintaining a positive microclimate in the team;

- master techniques for mutual support under risk, which will help reduce the level of stress in the team and increase the efficiency of the team as a whole.

This module will help participants not only improve their own efficiency under stressful conditions, but will also teach them to coordinate the actions of the entire team, which will reduce the risk of errors and ensure coordinated work during critical situations at sea.

The final part of the training. Effectiveness assessment

To assess the effectiveness of these methodological recommendations, participants will undergo a series of tests aimed at determining the level of risk tolerance before and after the training. The assessment will also include an analysis of participants' behavior during simulations and a survey to determine the level of satisfaction with the training and changes in the approach to decision-making.

Assessment methods:

- questionnaires and questionnaires. Assessment of the level of risk tolerance, stress tolerance, and decision-making skills;
- observation. Assessment of participants' behavior during simulations and their interaction in a team;
- feedback. Participants will provide feedback on changes in their professional activities after the training.

Expected results of the training:

- reduction of the influence of risk tolerance on decision-making;
- improvement of skills in analyzing risk situations and making informed decisions;
- increase in the effectiveness of teamwork and communication;
- increase in the level of stress tolerance and self-regulation, which will help reduce the risk of making wrong decisions in difficult conditions.

These methodological recommendations are aimed at developing the necessary skills in maritime specialists to reduce the negative impact of risk tolerance on their professional activities, which will contribute to increasing work efficiency and reducing the level of professional risks.

Conclusions

Thus, the goal of identifying and studying risk-proneness indicators that affect decision-making in the professional activities of maritime industry specialists was achieved.

In the course of the work, the object of the study was studied - risk-proneness and the decision-making process of maritime industry specialists, as well as the subject of the study - experimental research on the influence of risk-proneness on decision-making in the professional activities of maritime industry specialists.

Using the selected theoretical methods: analysis, systematization of scientific, theoretical and methodological approaches, etc.; empirical methods, the following research tasks were implemented.

Regarding decision-making, we found that this process is multi-component and depends on a number of psychological, cognitive and emotional factors. Decision-making in the professional activities of maritime industry specialists is characterized by a high degree of responsibility and often occurs in conditions of time shortage and incomplete information. Effective decision-making depends not only on the analytical abilities of the specialist, but also on his ability to quickly adapt to new conditions, assess risks and make decisions based on intuition and experience. Risk appetite directly affects the decision-making process, as professionals with a high level of risk appetite are more likely to make quick but less well-founded decisions, which can both improve efficiency and increase the likelihood of errors.

To solve the second problem, reliable and valid psychodiagnostic methods adequate to the goals and objectives of the study were selected. Subjective-evaluative research methods are effective and more common methods in psychology. Therefore, the study was carried out using a psychodiagnostic block, which included the following methods: the test "Diagnosis of the degree of readiness for risk" by G. Schubert; the questionnaire "Risk Propensity" by O. Shmelev; the Melbourne questionnaire "Decision Making" (MOPR) by Mann, Barnett, Redford, Ford (adapted by T. Kornilov); the scale for assessing the features of systemic decision-making by T. V. Ryabova (SHOOSPR).

To solve the third problem, an experimental study was conducted to determine the influence of risk propensity on decision-making in the process of professional activity of specialists in the maritime industry. The study was conducted on 60 specialists in the maritime industry. The relationship was determined using Spearman's rank correlation. The critical value of Spearman's correlation for a sample of 60 people at a level of $p=0.10$ is 0.214, and for a level of $p=0.05$ it is 0.254.

The results of the study showed a negative correlation between vigilance and risk-taking, the correlation coefficient is -0.325. This indicates that the higher the risk-taking, the less often respondents use vigilance as a decision-making strategy. Vigilance was least used among those who are more prone to risk, which confirms their tendency to make faster, less detailed decisions.

Avoidance strategy also has a negative correlation with risk-taking willingness (-0.220), which means that respondents who are willing to take risks are less likely to use avoidance. However, the correlation with risk-taking tendency (-0.087) is not significant, indicating no relationship between these indicators.

Procrastination demonstrates a lack of correlation with both risk-taking willingness (-0.190) and risk-taking tendency (0.087).

The strongest negative correlation was found between hypervigilance and risk-taking willingness (-0.392). With risk-taking tendency, the correlation is also negative, although less pronounced (-0.220), but strong enough to indicate a decrease in the use of hypervigilance among more risky respondents.

Also, during the correlation study, a correlation was found between risk propensity and the information scale (-0.315), emotional-volitional to risk. This means that the level of risk propensity does not affect the ability of respondents to effectively interact with other people and to think and analyze the situation.

When solving the fourth task, methodological recommendations were developed for optimizing the decision-making process taking into account the risk propensity of specialists in the maritime industry. The recommendations are aimed at increasing the efficiency of professional activities and reducing the likelihood of erroneous decisions in situations of increased risk.

The main elements of the recommendations are the development of the following skills: risk analysis, which will allow specialists to better assess potential threats and possible consequences; development of

stress resistance, which will help maintain psychological stability in stressful conditions; decision-making techniques aimed at increasing accuracy and reducing impulsiveness in risky situations; action planning, which allows balancing the speed of decision-making and their validity. Regular training in critical thinking is also recommended, which will contribute to a more objective assessment of situations and the adoption of balanced decisions.

These skills are important for development, since the maritime industry is characterized by a high level of risk of situations in which quick and balanced decisions can be critical for the safety and success of operations. Risk analysis makes it possible to reduce the number of erroneous decisions, helping to predict consequences and avoid unforeseen losses. Stress resistance helps specialists maintain concentration and efficiency even in the most difficult conditions, which is especially important in conditions of long voyages and unpredictable maritime operations. Decision-making and planning techniques contribute to the rationalization of actions, ensuring the optimal ratio between the speed of reaction and the quality of the decision, which minimizes the risk of incorrect actions.

The development of these skills is key to successful professional activity in the maritime industry, where specialists face challenges every day that require a high level of responsibility and the ability to make decisions under risk.

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ASSESSMENT OF SEISMIC AND ENVIRONMENTAL SAFETY OF ORE RESERVES DEVELOPMENT BY GEOMECHANICAL AND GEOPHYSICAL METHODS

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Abstract

Introduction. Today, the development of complex-structure ore deposits in energy-disturbed massifs is characterized by a reduction in ore areas, a decrease in the metal content in the ore, deterioration of mining and geological and mining-technical conditions and an increase in environmental factors, increasing requirements for the safety of human life in the zone of influence of mining objects.

Purpose of the work. Justification of mining-technical, seismic and environmental safety of underground development of complex-structure ore deposits taking into account the geomechanical state of energy-disturbed massifs and seismic impact on protected objects. Based on the graph-analytical methods for calculating the justified parameters of drilling and blasting operations, an assessment is made of the stability of the parameters of outcrops of host rocks and filling material during their processing.

Scientific novelty. An empirical dependence for predicting the oscillation velocity from the reduced charge mass per deceleration stage for field conditions of the type $y=a \cdot b$ (a and b are coefficients depending on the seismoacoustic properties of the rock mass and blasting conditions) is recommended. An increase in the scale of mass explosions is substantiated, which is possible due to an increase in the number of deceleration stages with a reduced charge mass per deceleration stage by borehole initiation (one borehole charge per deceleration stage).

Research methods. A systematic approach was used, which contains an analysis of the results of research and development work on the development of new technologies and technical means to ensure rational use, protection of mineral resources, the environment and the population, taking into account new instrumentation, geological surveying, geomechanical and seismic support using standard and new methods.

Result. Mining, seismic and environmental safety of ore deposit development is achieved by preserving the earth's surface from destruction, complex methods for assessing the stress state of host rocks and pillars of various purposes for their condition (geomechanical monitoring), as well as taking into account the degree of impact of seismic vibrations in the massif, their impact on underground and surface protected objects (seismic monitoring). This will improve the mining, seismic and environmental safety of work at deposits in the Republic of Kazakhstan, Ukraine, Australia, Canada and other developed mining countries of the world.

Keywords: ore deposits, underground mining, protected objects, mining, seismic and environmental safety.

1. Introduction

The studies of seismic action of explosion were carried out, in particular: in Kryvbas, Ukraine; OJSC "Poltava GOK", Ukraine; PJSC "Zaporizhzhya Iron Ore Plant" (PJSC ZZhRK), Ukraine; State Enterprise "Ukrainian Research and Design and Survey Institute of Industrial Technology" (SE "UkrNIPIpromtekhologii") and State Enterprise "Eastern Mining and Processing Plant" (SE "VostGOK"), Zhovti Vody, Ukraine; State Enterprise "Kirovgeologiya", Kyiv, Ukraine; National Technical Univer-

sity "Dnipro Polytechnic" and the Institute of Geotechnical Mechanics named after N.S. Polyakov of the National Academy of Sciences of Ukraine (IGTM NASU), Dnipro, Ukraine; State Higher Educational Institution "Kryvyi Rih National University", Kryvyi Rih, Ukraine; Joint-Stock Companies "VNIPIpromtekhologii" and "VNIMI", St. Petersburg, Russia and others, where mining operations are carried out using blasting operations. The following were involved in the management of seismic action of blasts: Institute of Physics of the Earth of the USSR Academy of Sciences, JSC "UNIIPROMED", JSC

"VNIITSVET", JSC "VNIIPromtekhologii", JSC "NIKMA" and others. Abroad, these studies were conducted in the USA, Germany, France, Chile, Australia and other developed mining countries of the world [1, 2].

The safety of surface buildings and structures in the zone of influence of mining operations largely depends on the intensity and nature of the passage of wave processes during blasts in elastic rock massifs, which form patterns corresponding to their geomechanical and geotechnical conditions [3, 4]. In addition, the safety of structures is determined by the state of loose deposits on the surface of the crystalline foundation, the presence of waterlogging, landslides, etc. [5, 6]. These tasks can be accomplished through ongoing research into the patterns of propagation of seismic waves and the use of technological methods that reduce the volume of explosives per deceleration (intra-fan deceleration, reduction in the height of the sub-level, counter blasting with separation of the seismic wave front, screening, etc.) [7, 8].

Therefore, geophysical support for seismically safe technology for developing ore deposits in energy-disturbed massifs of complex structure using geophysical methods, taking into account mining operations schemes, rational methods for controlling rock pressure, strength and composition of the hardening backfill mixture, the order of mining ore deposits that ensure the stability of outcrops in energy-disturbed rock massifs and the preservation of the earth's surface, water bodies and residential buildings in the zone of influence of mining operations, is an important scientific, practical and social task that requires an urgent solution [9, 10]. This ensures a rational method for controlling rock pressure by using chamber systems with backfill of hardening mixtures of different compositions and strengths. This work is a continuation of research, the main scientific and practical results of which are most fully presented in [11, 12].

Research methods and terms used. The authors analyzed previously conducted studies and control observations, instrumental measurements of the seismic action of the explosion with devices and equipment, mathematical analysis and statistical processing of the results, establishment of dependencies, calculations and justifications using standard and new methods with the participation of the authors of the article under consideration.

Permissible velocity of seismic ground vibrations is the velocity at which the preservation of buildings and structures is completely guaranteed, and probable local deformations do not exceed the predicted ones.

Short-delay blasting is the sequential blasting of individual charges or individual groups of charges with predetermined time intervals measured in milliseconds.

Explosive substance (ES) is a chemical compound or mixture that is capable, under certain conditions, of a very rapid self-expanding chemical transformation with the release of heat and a large amount of gaseous products.

Blasting operations are a set of organizational and technical measures related to the preparation and implementation of blasts.

The object of the study is the technology and technical means for underground ore mining in energy-disturbed massifs of complex structure. One of the most problematic areas is the formation of man-made voids that affect the occurrence and redistribution of the stress-strain state (SSS) of the rock mass. Their existence in the earth's crust, especially during the development of near-surface reserves of rock deposits, provokes the influence of geomechanical and seismic phenomena, up to the level of earthquakes [13, 14].

The purpose of the study is geophysical support for seismically safe technology for the development of ore deposits in energy-disturbed massifs of complex structure using geophysical methods, taking into account mining operations schemes, rational methods for managing rock pressure, strength and composition of the hardening backfill mixture, and the order of ore deposit development. This will ensure the stability of outcrops in energy-disturbed mountain ranges and the preservation of the earth's surface, water bodies and residential buildings in the zone of influence of mining operations. It will also ensure the vital activity of the population living in the zone of influence of the mining region.

To achieve the stated goal, it is necessary to solve the following tasks:

1. *To assess* the seismically safe displacement velocity, ensuring the safety of dilapidated residential buildings and reducing the negative impact of seismic explosive tremors on the population, taking into account the social factor.

2. *To develop* a graph-analytical method for determining seismically safe parameters when mining ore deposits of complex structure using chambers with backfill of different composition and strength.

3. *To establish* the mass of explosive charges with uniform distribution by deceleration stages.

4. *To recommend* empirical dependencies for predicting the oscillation velocity from the reduced mass of the explosive charge per deceleration stage for the conditions of a deposit of complex structure.

2. Material and research methods

The near-surface reserves of the Michurinskoye deposit of the State Enterprise VostGOK (Ukraine), a significant part of which lies under the Ingul River, are represented by steeply dipping ore bodies of varying thickness, along with industrial and civil buildings and structures. The length of the ore bodies is from 600 to 700 m along the strike (mainly 100–250 m), along the dip from 150 to 400 m. The ores and host rocks are strong: the hardness coefficient according to the scale of prof. M. M. Protodyakonov ($f=14-18$), massive, have a non-layered structure. Towards the surface, there is a significant deterioration in the quantitative and qualitative characteristics of fracturing both for individual deposits and for the deposit as a whole. At the upper horizons the rocks are weathered, the f coefficient decreases to 6. The deposit is developed by a chamber mining system with backfilling of the mined-out space with a hardening mixture (Fig. 1).

Mining operations are carried out at a depth of 40–50 m to 350 m. The chambers are developed in sub-floors 10–15 m high. Ore is broken by borehole charges with diameters of 57 and 65 mm, drilled by NT-2 and

PK-75 rigs. Parallel downward boreholes with diameters of 85 and 105 mm for the formation of cut-off slots are drilled by NKR-100 M rigs. The efficiency of drilling operations in mines is increased by using high-performance new-generation drilling equipment developed by industry specialists, as well as leading research centers (developed by NPK A and M and manufactured jointly with RMZ GP VostGOK, Ukraine), etc. [15, 16].

2.1. Assessment of the seismic effect of an explosion on surface objects. The complexity of blasting

operations during when conducting a clearing excavation under a city is associated with the seismic effect of an explosion on various objects, the integrity of which must be maintained throughout the entire period of deposit development. The technology of ore mining requires the preparation of large volumes of broken rock mass and improvement of the quality of blasting operations (the charge mass for the blast varies from 250 to 1050 kg, and for the delay interval – from 90 to 370 kg).

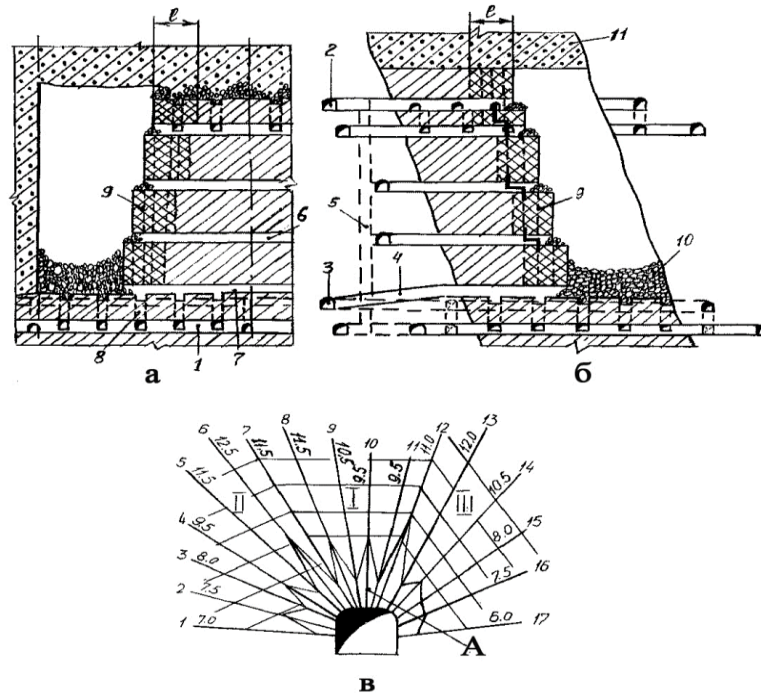


Fig. 1. The development system with sublevel drifts (a) crosscuts (b) with backfilling of the mined-out space with a hardening mixture: 1 – haulage drift; 2 – ventilation drift; 3 – collector; 4 – exit; 5 – block raiser; 6 – sublevel drift; 7 – undercut drift; 8 – hole; 9 – blasthole; 10 – broken ore; 11 – hardening backfill; c – fan of blastholes: 1...17 – numbers of blastholes; 6.0...12.5 – depth of blastholes, m; I, II, III – sequence of section blasting in the fan; l – size of the screening zone, m; A – zone of undercharging of boreholes.

Reduction of seismic impacts of explosions to acceptable levels for various city objects is achieved by limiting the mass of the simultaneously detonated explosive charge. This significantly complicates the breaking of rock mass and the organization of mining operations. Rational technology for conducting blasting operations in the specified conditions is ensured by organizing seismic monitoring of the safety of residential buildings above the mined deposit [17, 18].

3. Theory and practice of the issue

Graphic-analytical method for calculating the stability of outcrops of host rocks and the backfill mass. The geometric parameters of the system for developing sublevel drifts for ore deposits with a horizontal thickness of up to 15 m, when the length of the chamber along strike is 2 - 3 times or more greater than the width

(thickness), are given below. For operational monitoring of the stress-strain state (SSS) of the rock massif, sound measuring instruments were used, in particular, portable ones as the simplest means and methods of observation (developed by the scientific and production complex of automation and mechanics (NPK "A and M"), manufactured jointly with the mechanical repair plant (RMZ) of the State Enterprise "VostGOK" , Ukraine) and others (Fig. 2).

Based on the results of full-scale tests of rock mass elements carried out at uranium deposits of Ukraine, the dependences of the frequency of elastic sounds of destruction on the magnitude of stresses σ were constructed, taking into account the safety factor (K_z), which is expressed as the ratio of the maximum (destructive) load $[\sigma]$ acting on the structural element σ , or as the ratio of the ultimate strength of the material to the design stress, according to the formulas:

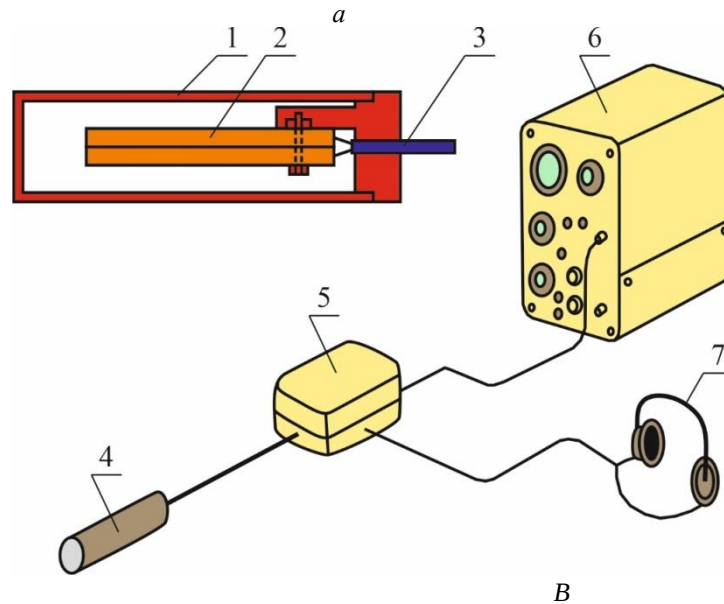


Fig. 2. Scheme of the sound-metric method for probing rock masses: *a* – sensor design; *b* – working diagram: 1 – sensor housing; 2 – crystal of Rochelle salt; 3 – cable; 4 – sensor; 5 – amplifier; 6 – oscilloscope; 7 – headphones

$$\sigma = a \cdot N_u^b; \quad (1)$$

$$K_3 = [\sigma] / \sigma, \quad (2)$$

where N_i – is the number of pulses per minute; a and b are, respectively, coefficients characterizing the structural and strength properties of the rock mass.

The current "Uniform Safety Rules for Blasting Operations" provide dependencies for determining seismically safe charges and distances for relatively simple conditions of charge blasting and design features of buildings constructed with a standard safety margin. For more complex blasting conditions (with repeated blasts in operational blocks), determining seismically safe charges and distances for preserving residential buildings, especially those constructed without the necessary safety margin, is only possible through special studies [19, 20]. The final result of the complex

of seismic studies is the creation of conditions for mining operations with guaranteed safety of objects during the development of the deposit, for example, by chamber systems with hardening backfill and breaking of the ore mass with fans of blast holes with a diameter of 67 mm.

With short-delay blasting, the charges in the delays are distributed evenly, except for the first and last stages, where the charges are reduced by 25-30% with a total blast mass of 612 kg and 7 delays, the mass of the charge of the first delay was 59.8 kg, and the last - 131.2 kg., with a total charge mass of 428.0 kg and four delay stages, the mass of the charge of the first delay was 201 kg, and the last - 20.6 kg. Analysis of the delay time used in short-delay blasting at the Central field (Ukraine) showed that the delay time between stages does not meet standard requirements (Fig. 3).

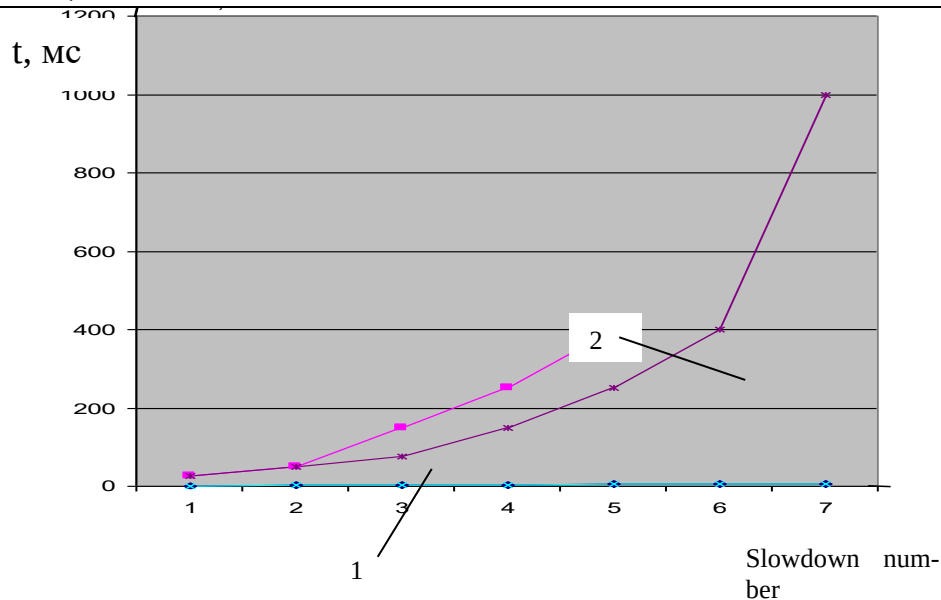


Fig. 3. Graph of decelerations by stages during short-delay blasting of explosives: 1, 2 - frequency of ground vibrations at the base of the protected building, Hz

The frequency of ground vibrations at the base of the protected building (curve 1) is $f_1 = 31$ Hz, i.e. the period of ground vibrations is 32 ms. The recommended deceleration between stage explosions should be $16 \text{ ms} < t_3 < 32 \text{ ms}$. For curve 2, the frequency of ground vibrations is $f_2 = 32$ Hz. The period of ground vibrations will be 32 ms, i.e. $15.5 \text{ ms} > t_3 < 31 \text{ ms}$. The recommended deceleration should be 20 - 25 ms. [21]. The actually established decelerations differ from the recommended ones by several times, or even tens of times. During the monitoring period of the seismic action of mass explosions, 23 events (explosions) were registered. Based on these measurements, the dependence of the vibration speed on the main parameters of the explosion and the hypocentral distance (the distance from the observation point under consideration to the focus) was found. To predict the speed of seismic vibrations, the authors used and refined the well-known formula of Professor M.A. Sadovsky [22]:

$$V = K \cdot \left(\frac{\sqrt[3]{Q}}{R} \right)^n, \quad (3)$$

where V is the velocity of soil displacement, cm/s; n is the attenuation index of the surface vibration depending on the distance between the protected object

and the geometric center of the detonated charge (varies from 1 to 3); K is the index of the specific intensity of shaking, characterizing the seismicity of a given geological region and the technology of blasting operations, units; Q is the mass of the explosive charge per deceleration, kg; R – distance from the epicenter of the explosion to the point of placement of the sensor on the earth's surface, m.

Taking into account the obtained results of studies for specific mining-geological and mining-technical conditions of rock deposits in Ukraine, the authors have refined the dependence (3) of the type:

$$V = 52,434 \left(\frac{R}{\sqrt{Q}} \right)^{-1.6416}, \text{ cm/s} \quad (4)$$

Substituting into formula (2) the value of the permissible vibration speed for the least earthquake-resistant buildings in the development area - 0.7 cm/s, the authors have obtained a dependence between the permissible value of the charge in the slowdown stage and the seismic safety distance to the protected object:

$$R_{c,\delta} \geq 13,864 \sqrt{Q_{c,\delta}}. \quad (5)$$

This dependence for the rock deposit of the State Enterprise "VostGOK" is shown in graphic form in Fig. 4.

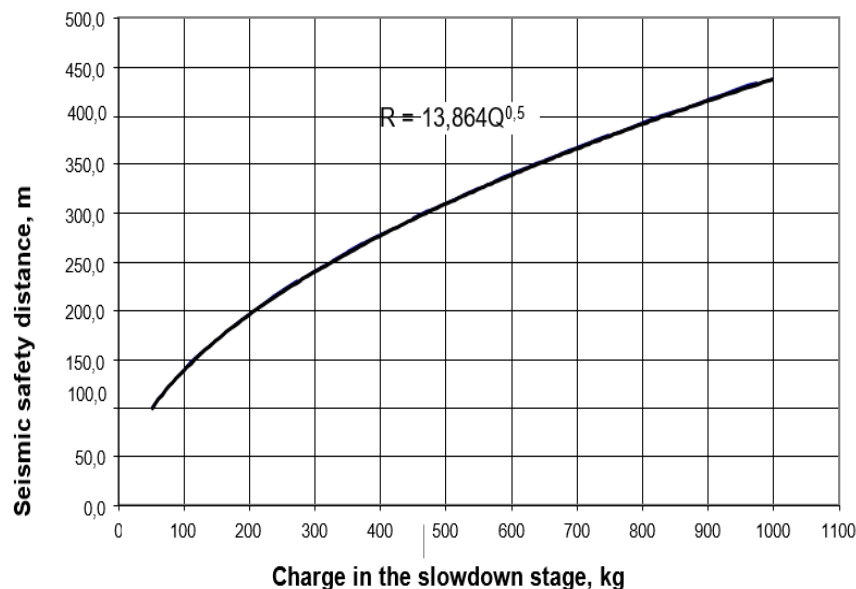


Fig. 4. Dependence of seismic-safe distance on charge mass in the slowdown stage for a deposit

Depending on the strength and the distance (r) to the nearest chamber operating simultaneously in the floor, the seismically safe mass of the charge per one deceleration (Q) is determined by the following formula:

$$Q = \left(\frac{2\sigma_{p.3.} \cdot g \cdot 1000}{85 \cdot \gamma \cdot C_p} \right)^{2,34} \cdot r^3, \text{ kg, (6)}$$

where $\sigma_{p.3.} = 0.1 \sigma_{сж}$ – temporary tensile strength of the fill kg/cm²; g – acceleration due to gravity; $\gamma = 2.3 \text{ g/cm}^3$ – fill density; C_p – propagation velocity of longitudinal waves in the fill mass, cm/sec. At = 30; 60

and 85 kg/cm²; $C_p = 22 \cdot 10^4$; $25 \cdot 10^4$ and $26 \cdot 10^4$ cm/sec, respectively.

Seismic-safe charge mass in fan-shaped boreholes located parallel to the boundary of the backfill massif in the sublevel drift mining system is determined by the formula

$$Q = \left(\frac{\sigma_{сж} \cdot g}{0,290 \cdot \gamma \cdot C_p} \right)^{1,44} \cdot r^3, \text{ kg, (7)}$$

Depending on the backfill hardening time, the distances from the last fan to the outcrop of the artificial massif are given in Table 1.

Table 1

Distance from the last fan on the block boundary to the backfill	
<i>Backfill hardening period, months.</i>	<i>Distance from the last fan on the block boundary to the backfill in borehole diameters</i>
3	14–22
6	10–17
12	8–14

Based on the results of many years of research and development work in underground mining of complex structure deposits in energy-disturbed massifs, the authors propose mathematical models to substantiate seismic safety of charge mass per one deceleration. Calculations of the parameters were performed based on the following conditions: ore and host rocks are stable with medium fracturing, strength according to the prof. Protodyakonov scale is 12–18, the dip angle of deposits is greater than 50°; with an ore body thickness of 3–15 m, a sublevel drift development system is used, and with an ore body thickness greater than 15 m, sublevel orts are used. The floor height is 60 and 70 m, sublevels are 15–18 m; the order of sublevel development is bench-like, drilling of boreholes with diameters of 57 and 65 mm with ascending fans; the voids are filled with a hardening backfill with a strength of 1.5 to 6.0 MPa [22, 23].

The conducted analysis of seismic measuring devices showed that it is advisable to organize seismic monitoring in mines using a modern digital seismograph such as the Blast Mate Series III (manufactured by Instanetel, Canada) [24, 25]. It meets all the requirements for devices for long-term monitoring of the seismic effect of mass explosions and the requirements of international seismic safety standards (Fig. 4).

The objects of study were residential buildings in the village of Bolshaya Balka, Kropyvnytskyi, Ukraine, at 28 Krynychevata Street, and a building at 3 Matrosov Lane. These buildings are structurally “typical” for individual houses built in the 1950-60s of the last century. Seismic vibrations were recorded simultaneously both in the foundation soil of the building and in the building itself. Three-component seismic receivers were installed in the ground at a distance of 5 m from the wall opposite the explosion site and on the building ceiling.

As can be seen from the seismograms, the resulting movements are complex (Fig. 5).



Fig. 5. BlastMate Series III seismograph. General view

The form of recording oscillations for each of the X, Y and Z components corresponds to the first periods. However, these oscillations quickly fade and become unnoticeable after 0.5-1 s. The velocities of ground oscillations reach their maximum values earlier than in the building. The form of the building's movement largely repeats the movement of the ground. The difference lies in the intensity of oscillations. The horizontal components of the ground oscillation velocity are more

than 2 times higher than the corresponding oscillation velocities of the building at the ceiling level, which indicates good shock-absorbing properties of the foundations. The value of the vertical component of the ground oscillation velocity is also higher than the corresponding oscillation velocity of the building. However, this difference is smaller. Permissible values of oscillation velocities according to the standards of countries of the world are given in Table 2.

Table 2

Permissible values of vibration speeds according to world standards

Name	Permissible vibration speed, cm/s		Frequency of ground vibrations, Hz	
	minimum	maximum	minimum	maximum
Germany	0,3	5,0	<10	>50
USA	1,25	5,0	<40	>40
Italy	0,3	5,0	<10	100
Spain	0,4	10,0	<15	>75
France	0,25	7,5	<10	>10
Portugal	0,25	6,0	<10	>40
Sweden	1,8	7,0	<40	>40
England	1,5	5,0	4	>40
Australia	0,2	2,5	<40	>40
India	0,2	2,5	<24	>24
Brazil	-	1,5	-	>40
Ukraine	0,2	5,2	<5	>20
Average	0,55	5,2	<17	>43

This device is reliable, easy to operate and has shown positive results in instrumental measurements at the Ingul mine of the State Enterprise VostGOK, Ukraine, in the zone of influence of blasting operations on residential buildings (Bolshaya Balka settlement,

Kropyvnytskyi city, Ukraine) and water bodies (the Ingul River) [30, 31]. The diagram of the installation of BlastMate Series III seismograph sensors on the surface during the development of ore deposits is shown in Fig. 6.

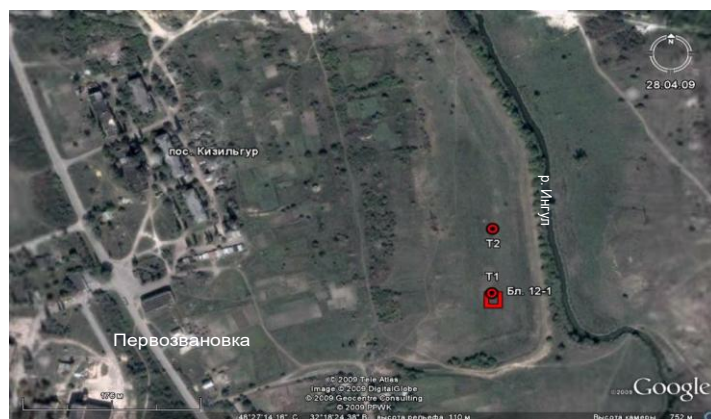


Fig. 6. Installation diagram of BlastMate Series III seismograph sensors on the surface during mining of ore deposits: T1, T2 – measurement points; Bl.12-1 – production block

The characteristics of the explosions and the results of instrumental measurements of seismic ground vibrations at the base of the protected objects are given in Table 3. BlastMate Series III seismic devices make it possible to obtain complete information on the parameters of the seismic action of the explosion immediately after the completion of the explosion and to have a supporting document in the form of a protocol printed by a computer. The influence of the human factor, errors in processing and presenting information is excluded. During the period of monitoring the seismic action of mass explosions, 23 events (explosions) were registered. Based on these measurements, the dependence of the vibration speed on the main parameters of the explosion and the hypocentral distance (the distance from the observation point under consideration to the focus) was found [26, 27]. The dynamics of seismic vibrations of the ground at the base of the structure of private buildings along the longitudinal axis (28 Krinichevataya St.) is shown in Fig. 7.

4. Results and analysis

Environmental and seismic safety of underground mining of ore deposits is characterized by the state of the surrounding natural environment, which excludes deterioration of the ecological situation, occurrence of danger to human health. One of the sources of man-made danger is underground mining of ore deposits under protected objects, especially water and residential buildings. To assess the seismic resistance of buildings, information is needed on the material of the supporting structures of the walls and the presence of deformations in them. Assessment of the technical condition of the housing stock in the area of seismic action of explosions was first carried out in 452 residential private buildings with stove heating and 27 buildings of housing and communal services. It was established that they do not have anti-seismic reinforcements, since they are located in a zone with seismicity below 5 points.

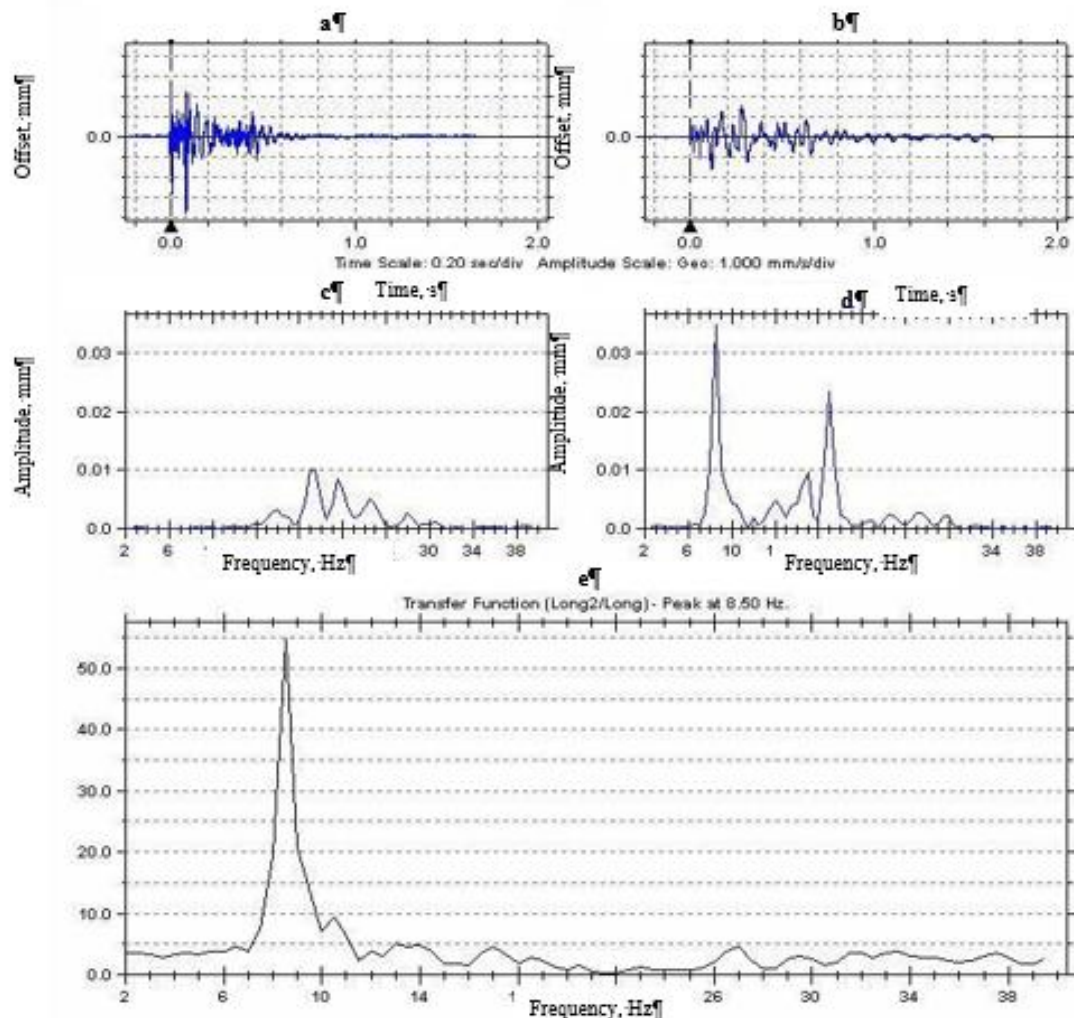


Fig. 7. Analysis of seismic ground vibrations at the base of a building along the longitudinal axis (28 Krinichevataya St.): a – longitudinal component of the maximum ground vibration velocity 0.376 cm/s; b – longitudinal component of the maximum structure vibration velocity 0.157 cm/s; c – spectral density of the longitudinal component of the ground vibration velocity (max. at 19.5 Hz); g – spectral density of the longitudinal component of the structure vibration velocity (max. at 8.5 Hz); d – frequency response of the structure (max. at 8.5 Hz).

Table 3

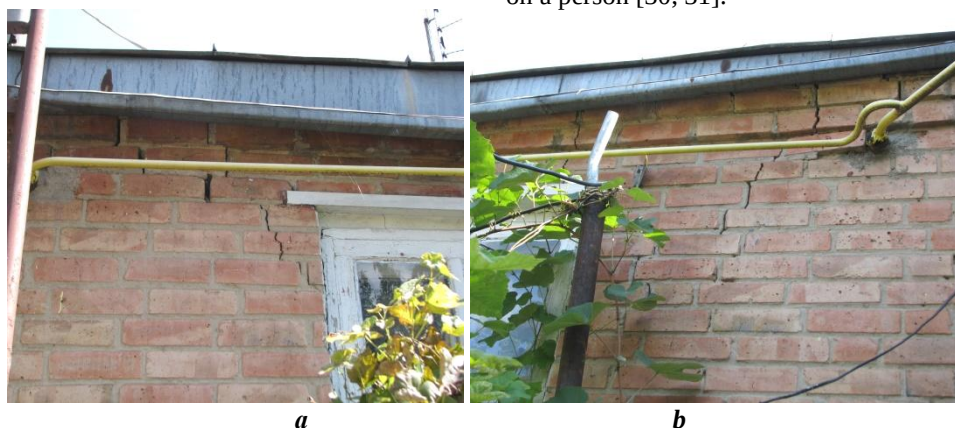
Characteristics of explosions and results of instrumental measurements of seismic vibrations

Operation block number	Charge weight, kg,		Length of blasted holes per deceleration, m			Deceleration interval, ms	Bore diameter, mm	Distance to the epicenter of the explosion from the measurement point, m*			Soil displacement velocity, cm/s*	Oscillation frequency, Hz*
	Total	Per deceleration interval	Total	Charged	Undercharged			Vertical	Horizontal	Resulting		
1a-2-7τ	522,0	83,2	22,5	18	4,5	25	67	290,0	236,0	374,0	0,218	30,0
16-1-1τ	308,0	61,6	20,0	13,2	6,8	0	67	327,0	188,0	377,0	0,054	35,0
16-1-1τ	462,0	96,4	30,0	21,0	9,0	25	67	327,0	188,0	377,0	0,054	40,0
1a-2-1τ	612,0	59,8	39,0	9,0	30,0	25	85	275,0	156,0	316,0	0,164	26,0
1a-2-7τ	398,0	129,4	27,0	19,5	7,5	25	85	300,0	250,0	390,0	0,2	37,0
1a-1-1τ	676,0	163,6	84,5	34,0	50,5	25	85	327,0	71,0	334,0	0,26	21,0
1a-2-1τ	428,0	201,4	50,0	42,5	7,5	25	85	285,0	155,0	324,0	0,215	25,0

According to the three-point system of assessing the condition of buildings (good, satisfactory, dilapidated), about 77% of private buildings were in good and satisfactory condition and 23% were in dilapidated, deformed condition, i.e. had cracks in adobe and clay walls, gaps in load-bearing walls between window openings and had no foundations. Cracks in the upper zone of the brick cladding of the outer wall of the house at 27 Adzhamsky Lane, (Bolshaya Balka settlement, Ukraine) are shown in Fig. 8.

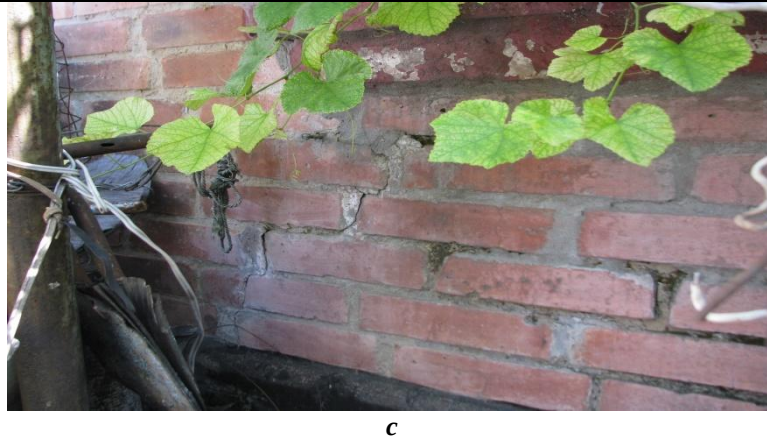
The state-owned buildings were in satisfactory condition. Inspection of the structures of 15 buildings in which deformations and cracks were detected showed that no increase in deformations of the inspected residential buildings was detected, and the existing deformations do not pose a danger to the buildings, provided that current repairs are carried out [28, 29].

For damaged buildings with significant cracks in the load-bearing structural elements, the permissible displacement rate is taken to be no higher than 1 cm/s, and taking into account the social factor 0.4–0.8 cm/s. Experience confirms that with a displacement rate not exceeding 1 cm/s, the population practically does not experience negative reactions to the seismic action of blasting operations carried out near residential buildings. Sometimes the psychological impact of the seismic effect depends on the state of the person. While resting, a person feels the same vibrations as more impressive than while being active. The psychological impact also increases with an increase in the period of vibrations of buildings. Therefore, when determining the permissible speed of soil displacement at the base of a protected object, it is necessary to take into account the psychological impact of seismic explosive vibrations on a person [30, 31].



a

b



c

Fig. 8. Cracks in the upper zone of the brick cladding of the outer wall of the house at 27 Adzhamsky Lane: a, b, c – crack opening width up to 4, 8 and 12 mm, respectively

As a result of conducting a set of scientific research works, the authors established a modern technical level of the applied development system, standardized its elements and technological processes, compiled a set of enterprise standards "System of development by sublevel drifts (orths) with backfilling of the mined space with a hardening mixture. Parameters and dimensions", which regulates (depending on mining and geological conditions) the length, width and height of the chambers of the first, second and third stages of extraction, their maximum permissible values, taking into account the change in the strength properties of the backfill during its hardening and the depth of development, the height of the sub-level and the bottom of the block, the distance between the discharge loading and delivery workings (holes) depending on the thickness of the ore body and the height of the level, the shape and dimensions of the cross-sections of the main side workings.

Technological parameters of the development system: the equipment used, the method and mechanization of ore release, the procedure for processing and breaking chamber reserves, the location and diameter of boreholes are also determined depending on the previously standardized parameters and dimensions of the chambers. This set of standards has been implemented in ore mines of Ukraine and is successfully used by specialists of technological and geological surveying services [32, 33].

The main safety criterion for determining the permissible parameters of ground vibrations is the permissible velocity of seismic vibrations and their frequency, at which the preservation of buildings and structures is guaranteed, and the probability of their deformation does not exceed permissible forecasts. Based on instrumental measurements of the seismic effect of an explosion in ore mines in Ukraine on residential buildings and water bodies in the zone of influence of mining operations, the following has been established [34, 35]:

- environmental safety of mineral deposit development is achieved by preserving the earth's surface from destruction, using complex methods for assessing the stress state of enclosing rocks and pillars of various purposes for their condition (geomechanical monitoring), as well as taking into account the degree of impact of

seismic vibrations in the massif and their effect on surface objects (seismic monitoring);

- inspection and assessment of the condition of more than 20 residential buildings, in which various deformations and individual cracks were detected, showed that the cause of the said deformations is insufficient strength and depth of the foundation, as well as subsidence of the structure as a result of wetting of sedimentary soils;

- it was established that the permissible seismically safe mass of the explosive charge for a delay interval of 50 and 75 ms at a distance from the explosion site to the protected object of 230 m is equal to 220 kg, and at a distance of 285 m - 490 kg, which is convincingly confirmed by the practice of developing uranium deposits.

Thus, in case of systematically repeated explosions over a long period of time, in order to preserve buildings located within the mine allotment and in the blast impact zone, the maximum permissible charges of explosives per deceleration stage must be restricted to such limits that the resulting maximum oscillation velocities would be less than those provided for by the safety standard, taking into account the oscillation frequency [36, 37]. In order to obtain comprehensive explanations of the causes of deformation of residential buildings and to control the seismically safe conduct of blasting operations, it is necessary to conduct further seismic monitoring of the intensity of seismic vibrations and deformation in the structures of protected objects in combination with research on mining and geodynamic processes in the massif [38, 39].

4.1. Promising research directions. The obtained results do not exhaust the problem of nature and resource conservation, environmental and human protection. The development of methodological foundations for optimizing mining technology should lead to the creation of an appropriate subsystem for automating the design and planning of mining operations, increasing the technological and ecological safety of the environment, rational use and protection of mineral resources, as well as the safety of human life in the zone of influence of mining operations [40, 41].

5. Conclusion

It is shown that with a seismically safe displacement velocity of 0.4 cm/s, the recommended technology made it possible to ensure the safety of dilapidated residential buildings, reduce the negative impact of seismic explosive tremors on the population, taking into account the social factor.

It is determined that when producing industrial explosions, fan charges should be placed normally to the protected objects, while the seismic impact on the object is reduced by 4 times. The method of preliminary slit formation will make it possible to significantly reduce the degree of seismic blasting effects on protected objects and increase the mass of the explosive charge in one deceleration interval from 2.7 to 5.0 times.

It was established that the mass of charges should be uniformly distributed over the deceleration stages, except for the first and last ones. The mass of the first and last stages should be 25-30% less than in the others. The number of deceleration stages should be at least 3-4.

An empirical dependence for predicting the oscillation velocity from the reduced mass of the charge per deceleration stage for field conditions of the type $y=a \cdot b$ is recommended (a and b are coefficients depending on the seismoacoustic properties of the rock mass and blasting conditions). An increase in the scale of mass explosions is possible due to an increase in the number of deceleration stages with a reduced charge mass per deceleration stage by borehole initiation (one borehole charge per deceleration stage).

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THE ROLE OF SUSTAINABLE PACKAGING SOLUTIONS IN IMPLEMENTING CORPORATE SOCIAL RESPONSIBILITY: IMPACT ON BUSINESS SUSTAINABILITY

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Abstract

This article explores the impact of sustainable packaging solutions on corporate social responsibility and business sustainability. Key aspects of implementing eco-friendly packaging, such as the use of recyclable and biodegradable materials, are discussed along with their influence on company image, financial performance, and consumer satisfaction. Special attention is given to long-term benefits for business, including reduced operational costs, improved competitiveness, and risk reduction related to environmental regulations. The article emphasizes the importance of sustainable solutions for companies' successful adaptation to modern sustainability requirements.

Keywords: sustainable packaging, corporate social responsibility, business sustainability, recycling, biodegradable materials, financial performance

Introduction

During recent decades, increasing attention has been drawn to issues of sustainability and ecological responsibility in the context of business. In light of the challenges surrounding single-use packaging, pollution, and increasing volumes of waste, companies are faced with developing effective solutions to mitigate the negative impacts on nature. Among these, one of the most discussed aspects refers to the role of packaging, turning it into a very relevant element in Corporate Social Responsibility strategies. Modern consumers are increasingly focused on environmental standards and expect companies to take active measures in this area.

Ecologically clean packaging solutions, which presuppose the use of recyclable and biodegradable materials, waste minimization technologies, become more popular in world practice. It is important to point out that these solutions are closely related to the concept of sustainable business development, where economic, environmental, and social issues merge into one strategy.

The aim of this paper is to investigate the influence of eco-friendly packaging solutions on the implementation of corporate social responsibility and sustainable business development, considering key aspects of the mentioned impact and the relationship between sustainable practices and the long-term competitiveness of companies.

Main part. The concept of eco-friendly packaging solutions

The main characteristic of eco-friendly packaging solutions includes the possibility of their recycling, reusing, or complete decomposing in the natural environment. Even more important, however, is the possibility of **using biodegradable material** that does not leave any long-term trace in an ecosystem and does not make soil and water as bad as traditional plastic packaging usually makes [1].

Modern «green» includes materials based on plant fibers, such as potato starch, soy, and bamboo, or recycled plastic materials that save the consumption of new resources. One of the striking examples of such solutions is packaging made from recycled plastic or bioplastics, which can be made from renewable sources.

Their advantages are the low carbon emissions at all stages of packaging life from production to disposal. Simultaneously, the use of such materials requires the elaboration of specific recycling technologies, which can be problematic for the packaging industry, especially in countries with a low level of waste recycling [2].

Besides, the **reduction in packaging volume and optimization of logistics** also become an important part of eco-friendly solutions. More and more companies are reducing the weight of packaging through certain practices to reduce carbon emissions during transportation.

An important part of an eco-friendly approach is also **minimizing the use of toxic substances** in the production of packaging, such as phthalates and bisphenol A, which can have an adverse effect on human health and the ecosystem. The use of safe and non-toxic materials not only contributes to improving the environmental situation, but also helps companies comply with international health standards and requirements [3].

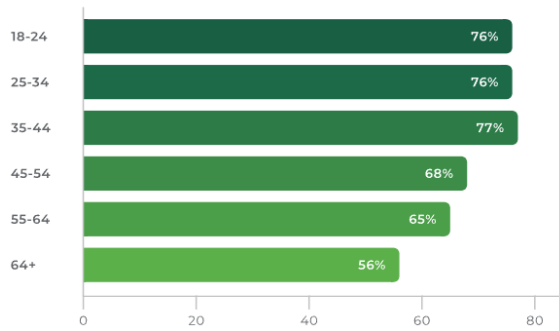
Effects of introducing eco-friendly packaging

The introduction of eco-friendly packaging solutions has a big influence not only on the ecological situation but also on the social and economic aspect of business conduct. One of the main effects of introducing such solutions is the improvement in the **company's image**. In a context of growing consumer attention to ecological aspects, companies using environmentally friendly packaging materials gain a significant competitive advantage. All of the above contributes to increased consumer loyalty, which is increasingly focused on the environmental responsibility of brands. Companies working actively in the field of sustainable development to have a better chance of attracting consumers who are likely to support environmentally oriented business initiatives.

Another important aspect is the influence of green packaging on the **financial and economic indicators of a company**. Although there might be some initial costs for the implementation of new materials and technologies, the long-term benefits of such decisions can significantly exceed the costs. In particular, the use of recycled materials and a reduction in the volume of

packaging can lead to a reduction in raw material and logistic costs. Moreover, the usage of eco-friendly packaging in most cases enables companies to receive tax incentives and other kinds of government support, stimulating further investments in green technologies. Eventually, such measures contribute to operating cost reduction and increase the overall profitability of the company [4].

% of consumers by age choosing to buy a product at least in part due to sustainable packaging



An important aspect is the **impact on the customer base**. Eco-friendly packaging solutions can significantly influence the perception of the brand not only among existing but also potential customers. In addition, according to statistics, purchasing products with eco-friendly packaging is becoming a more conscious and popular choice (fig. 1).

% consumers by income choosing to buy a product at least in part due to sustainable packaging

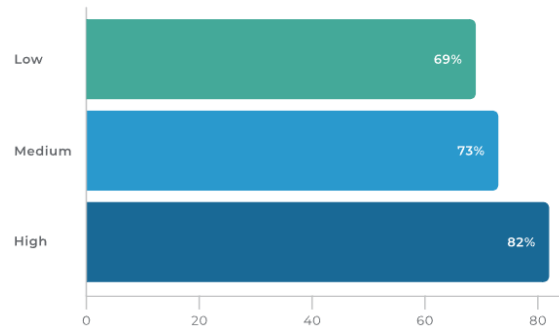


Fig. 1. The ratio of people by age and earnings buying products in ecological packaging, 2023 [5]

Eco-conscious consumers will pay for products that align with their values, and companies that actively promote eco-friendly packaging are able to attract new audiences interested in sustainable and responsible practices. Research shows that companies using eco-friendly packaging see an increase in sales, especially among younger audiences who are most sensitive to environmental issues. This effect is complemented by the increased trend of eco-certification, which verifies a brand for its high standards of sustainability and eco-friendliness [6].

Besides, eco-friendly packaging contributes to the **minimization of risks** in a long-term perspective. Under permanent tightening of environmental regulations and standards, especially within the European Union and other developed countries, compliance with high environmental standards and the introduction of sustainable packaging solutions is among the means to avoid legal and financial implications related to failure to meet regulatory requirements. Therefore, switching to green packaging diminishes the risks that could come with probable fines and restrictions.

In turn, green packaging solutions contribute to good relations with stakeholders. A modern consumer,

investor, and partner want to deal with a company that is open and responsible in its business. The implementation of green packaging and other environmentally friendly initiatives boosts trust in the company and forms solid relationships with key stakeholders in this direction. This effect is especially important for large corporations, for which reputation and compliance with modern standards are turning into the key to success in the globalized market.

Long-term benefits for business

The implementation of sustainable packaging solutions has a profound impact on the long-term development of a business. One of the key factors influencing the sustainability of a company is the reduction of costs throughout the entire life cycle of the packaging. Despite the initial investment in research and implementation of sustainable materials, in the long term they can lead to significant savings. This is due to the optimization of production, processing and transportation processes, as well as the reduction of waste. Given the rising consumer prices around the world, the impact of these factors on business is becoming more significant (table 1).

Table 1

Year over year growth of consumer prices regionally [7]

Period	Europe	South America	North America
2020-2021	3%	28%	5%
2021-2022	9%	41%	8%
2022-2023	7%	44%	4%
2023-2024	3%	29%	3%

In particular, the reduction of all kinds of costs during the whole life cycle is one of the most relevant factors affecting the sustainability of a company. Although initial investment in research and implementation of ecological materials is often required, they can allow relevant savings in the long term because of optimization in production, processing, and transportation phases, and also because of minimization of wastes. Such technologies as plastic recycling and the use of

materials with a low carbon footprint are contributing much to the considerable reduction in operating costs [8].

Other significant long-term benefits include the **company's increased sustainability in the market**. In the context of continuously changing regulations and environmental standards, companies with eco-friendly packaging are better prepared to adapt to new condi-

tions. In this vein, environmental responsibility becomes an important factor in influencing a company's ability to innovate and respond to environmental challenges. This is particularly the case in countries that have a high level of environmental standards, where observance of regulatory requirements becomes crucial for continued business operations. Thus, companies that move toward eco-friendly packaging solutions immediately gain a long-term advantage: increased adaptability to changes in legislation and regulatory bodies.

Another important aspect is **meeting the needs of stakeholders**. Modern consumers, investors, and partners increasingly put forward demands for the company's compliance with environmental standards. Ecological packaging is becoming an important factor that allows increasing trust and loyalty on the part of different stakeholder groups. It is worth noting that, in the long run, such solutions give a company an advantage in attracting investment. Eco-friendly packaging solutions are important in the building of the image of the company as socially and environmentally responsible, which is helpful for its reputation and the attraction of new partnerships.

Besides, green packaging solutions improve **corporate social responsibility** indicators and enhance brand value. In a situation of globalization and growing competition, these factors become decisive for long-term company success. Such corporate values, aimed at sustainable development and environmental responsibility, assist the company in not only surviving the competition but gaining competitive advantages in the long-term prospects of the industry. Hence, the introduction of eco-friendly packaging is not only an ethical issue but also a strategic move as it helps the business to strengthen its position for the long term.

Conclusion

Eco-friendly packaging solutions are a step forward in sustainable business development and significantly influence an economy and a company's reputation. The use of environment-friendly materials and technologies will not only minimize the negative impact on the environment but also provide considerable long-term benefits. These include cost cuts on operating costs, where companies have optimized packaging production and disposal processes. Furthermore, increased flexibility for change in legislative and environmental standards is guaranteed, with regained trust by consumers and investors alike.

Besides, eco-friendly packaging solutions are turning into an important attribute of corporate social responsibility, improving the image of a company and

enhancing its competitive advantages in the market. In the context of growing demand for eco-friendly products and services, companies that actively implement sustainable packaging solutions receive substantial advantages in attracting customers and partners that, in the long-term perspective, influence the growth of financial indicators.

Therefore, green packaging is an important contribution to environmental protection; it is also a strategic tool in developing business sustainability. Implementation of such solutions helps companies to be one step ahead, meeting modern trends and creating added value for all stakeholders. In the future, expect the importance of these solutions to grow for business and society as a whole.

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PRACTICE OF VISUAL DIAGNOSTICS USING ENDOSCOPES**Yuriy Saliy***Assistant**Kharkiv National Automobile and Highway University***Nikita Petrushev***Bachelor student**Kharkiv National Automobile and Highway University***Nalia Penkina***Lecturer at the automotive and mechanical department of**Kharkiv State Automobile and Food Processing University, Kharkiv, Ukraine***Igor Pimonov***Candidate of Technical Sciences, Head of the Department of Operation, Testing,**Service of Construction and Road Machines**Kharkiv National Automobile and Road University*[DOI: 10.5281/zenodo.14726829](https://doi.org/10.5281/zenodo.14726829)**Abstract**

Repair of machinery begins with visual inspection during maintenance of mechanical equipment and ends with visual confirmation of detected defects during repair. The subjectivity of this method of technical diagnostics is compensated by the possibility of training specialists in various directions: in current inspection, in defect analysis, in determining the causes of damage, in non-destructive testing, etc. The peculiarities of human vision should be taken into account. It is necessary to take into account peculiarities of human vision, quality of illumination, used optical devices, disregard illusions and many other things. Visual inspection begins with the development of an algorithm and formulation of signs of damage to the mechanism elements, approaches to the identification of types of mechanical wear. There are peculiarities for visual inspection when used in nondestructive testing methods. The article considers the main provisions of visual diagnostics used in the inspection of mechanical equipment, which leads to an increase in the efficiency of working processes of construction and road machines due to the automation of observation processes.

Keywords: operation, automation, visual inspection, efficiency, construction and road vehicles.

When working with mechanical equipment, it is often necessary to inspect the most remote parts and assemblies closed by the housing without disassembling the mechanism. This occurs when inspecting the mechanism before repair, when performing adjustment operations or after repair to control the completeness of the components, and in other cases. The first stage of endoscopes (endon - inside and skopeo - to examine) was associated with the use of mirrors and portable small-sized light sources. The second stage was associated with the development of fiber-optic technologies and light sources with a high degree of illumination, which was implemented in the designs of boroscopes and fibroscopes. The third stage began with the advent of video endoscopes.

The types of defects that are detected vary depending on the purpose of the machine or assembly: cracks, chipping, scoring, burn-throughs and deposits

on parts, cavities, corrosion, coating defects, adhesions, wear of friction surfaces, correct positioning of parts, integrity of internal fasteners, foreign objects in internal cavities, contaminant deposits, foreign object scratches on internal machine parts, etc. The minimum size of surface defects detected by endoscopes is, in some cases, up to 0.02 mm, and defects as small as 0.15 mm can be measured and documented on digital media. The difficulty of defect detection is associated with the limited field of view, a specialist can see only a part of the defect that needs to be identified and the degree of danger determined. There are no guarantees of inspection of the entire controlled area of the object. Examples of faults recorded during inspection with an endoscope are shown in Figure 1. Inspection of complex technical facilities should be preceded by a methodical study of the sequence of work.



Fig. 1. Examples of images obtained with a video endoscope during the inspection of various inspection objects

Undoubtedly, the high qualification of the endoscopist is essential for determining an objective picture of the technical condition of the product, but the quality of the image generated by the endoscope largely determines the probability of detecting defects, the speed of inspection and the reliability of the diagnostic results. Often, when working with a damaged endoscope, some defects simply "fall out of sight."

The experience of using technical endoscopes has made it possible to formulate the main rule of effective use - the parameters of the endoscope must be appropriate for the task. When using endoscopes, the field of view is narrowed, so you should first answer the question of what you expect to see in the dark and to what smallest detail this object should be examined.

The basis of the endoscope is an optical system consisting of a working part with optical fibers, lenses, or a video camera, through which the image is transmitted from the object to the eyepiece or screen of the device. To make the image visible, the object under study must be illuminated. For this purpose, a lighting system is used - an illuminator with a light source and

a light guide cable for transmitting light from the illuminator to the object or LED light sources.

Rigid endoscopes (boroscopes) are designed for visual inspection of components that can be accessed directly. Boroscopes provide a higher quality image and are used to inspect the cavities of machines and mechanisms, small-diameter channels and pipes, casting cavities, and ground and honed holes. A boroscope consists of an optical and lighting system (Figure 4.29). The optical system consists of lens, rod, or gradient optics enclosed in a metal tube. The illumination system consists of an optical fiber that is located between the outer and inner metal tubes. The light source (mercury or halogen lamp) with a reflective system and ventilation system is located separately at a distance of 1...2 m from the observer. Boroscopes are characterized by the diameter and length of the working part, the angle of observation and the angle of the field of view. Circular view boroscopes allow for 360° viewing without moving the instrument body. Some models have a variable field of view and viewing direction. Viewing eyepiece includes focus and sharpness adjustment

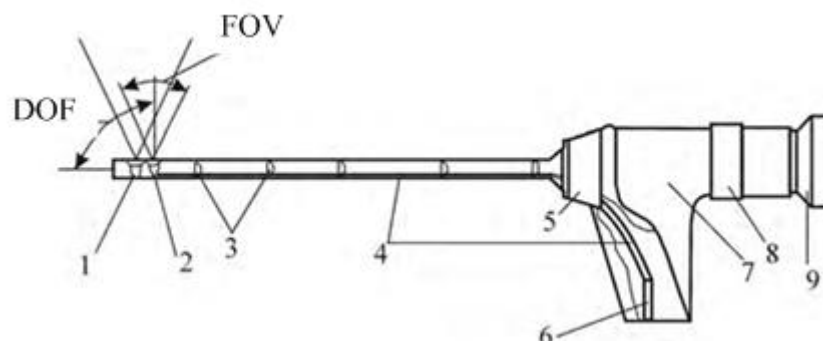


Fig. 2 - Schematic of a boroscope: 1 - illumination lens;

FOV - field of view angle; DOF - direction of view; 2 - objective; 3 - lenses; 4 - light guide; 5 - system of rotation of the observation tube; 6 - connection of the light guide tip; 7 - eyepiece; 8 - focus adjustment ring; 9 - visual acuity adjustment ring

The diameter of the working part is 2...10 mm. The length of the boroscopes is 100...1000 mm. Main angles of observation direction: 0°, 30°, 45°, 75°, 90°, 120°. The viewing angle is fixed by using interchangeable lenses - 30°, 45°, 90°, 120°. There are boroscopes with

a wobbly prism that smoothly change the viewing direction in the range of 55°...115°. Depending on the purpose of the inspection, the field of view can be narrow 35°, medium 60° or wide 90°.

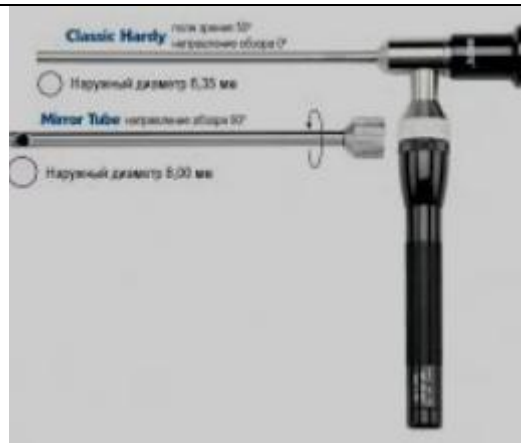


Fig. 3. General view of a boroscope

Flexible endoscopes (fiberscopes, see Figure 3) - are used in cases where direct access to the object is impossible or the object has a complex shape. In fiberscopes, the visual and light transmission systems consist of fiber optics located inside a flexible tube. An optical light guide connects the lens objective and the

eyepiece. The illumination system includes a light-diffusing lens that illuminates the object, a fiber optic harness, and a special tip that connects to the illuminator. Standard light sources with xenon, halogen or ultraviolet lamps are used as illuminators.

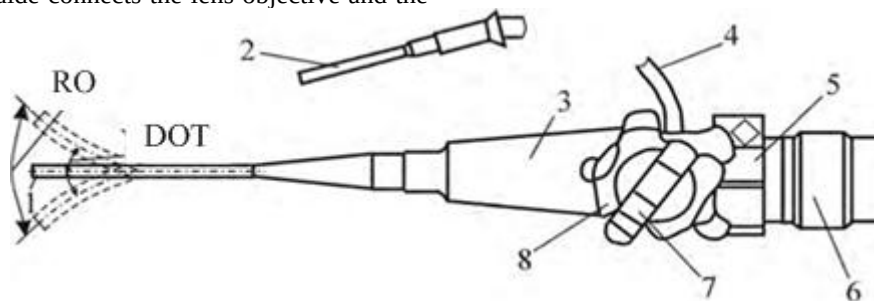


Fig. 3. General structure of the fiberscope:

RO - viewing sector; DOT - angle of rotation of the distal end; 1 - objective lens; 2 - end of the illuminating light guide; 3 - eyepiece; 4 - light guide; 5 - focus adjustment ring; 6 - visual acuity adjustment ring; 7 - control of the distal end rotation to the right and left; 8 - controlling the rotation of the distal end up and down

Typically, a video endoscope has a semi-rigid fiber optic cable, at the end of which there is a video camera that transmits the image to the endoscope monitor and LEDs for illumination. One of the issues is to protect the camera from water and aggressive media (oils, gasoline, antifreeze, etc.).

Improvement of video endoscope designs is aimed at increasing the resolution of cameras, reducing their size, and using special USB extenders that allow to observe the image from a distance of up to 8...10 m.

Multi-zone illumination of the investigated part of the structure with the help of miniature LEDs (their number in modern devices can be 6 or more) ensures the clarity of the color picture (Figure 4). Portable video cameras, a connecting wire, and a plug for connecting to the USB port of a desktop computer, laptop, or telephone are becoming widespread. You can use the tools of the operating system or apply specialized application software.



Fig. 4. Video endoscopes

The advantages of video endoscopes are based on the use of digital technologies: high resolution; increased viewing angle and image scale; image storage and saving, measurement of distance to the object and size of lesions, image editing and analysis, the ability to use expert systems, audio and text comments, image separation and overlay, etc. The use of special programs can significantly improve the quality of the image. As a result of the use of boroscopes and fiberscopes in the inspection of mechanical equipment, two groups have emerged. Professionals - for whom the endoscope is the main element of the inspection process. Specialists - use the endoscope periodically, not systematically.

The use of endoscopy in conjunction with other non-destructive testing methods makes it possible to identify diagnostic results obtained by ultrasonic, eddy current, radiographic, vibroacoustic, acoustic emission, metallographic, thermal imaging and other non-destructive testing methods in case of difficult access to the tested assembly.

"It's better to see once (without special disassembly of the unit) than to hear a hundred times." The high qualification of the endoscopic inspector is crucial for determining an objective picture of the technical condition of the product. It should also be noted that the quality of the image produced by the endoscope largely determines the probability of detecting defects, the speed of inspection, and the reliability of diagnostics in general. Thus, the reliability of defect detection is determined by the characteristics of the device used, selected for the selected object of control.

The smaller the diameter of the endoscope (4.0, 5.0, 6.0, 8.0, 10.0 mm...), the smaller the opening for inserting the device into the object of study, but the outer diameter should be smaller than the diameter of the opening. If the diameter of the endoscope is smaller than the diameter of the working hole, there are additional opportunities for movement and increase of the viewing area when changing the angle of inclination and turning. When using a small diameter endoscope, the effective inspection area is reduced, inspection time is increased, eye fatigue is increased, and the probability of error (missed or false detection of a defect) is increased. For inspections through small,

medium, and large openings, it is best to use two sizes. To obtain a clear image with a video endoscope recorded online to a memory source, it is necessary to use a matrix with a resolution of at least 640×640 pixels.

The length of the endoscope should be appropriate for the size of the object. At maximum immersion, the outer part of the endoscope should not be too long. For boroscopes, the length can be up to 300 diameters. The maximum length of a boroscope is 4200 mm. Fiberscopes can have a length of up to 670 working diameters. The standard length of a fiberscope is 3 meters. The length of a semi-rigid video endoscope usually does not exceed 700 mm. There are probes with a diameter of 6.1 mm and a length of up to 18 m and a diameter of 10 mm and a length of up to 30.5 m. In the case of a variety of objects to be inspected, you should not focus on the largest dimensions, but form groups of objects that are unified in size for inspection. The image quality does not depend on the length; with a long endoscope length, it is certainly possible to examine small objects, but not conveniently. Autofocus - as a rule, the camera built into the video endoscope automatically focuses 1...6 centimeters from the object.

The viewing angle (0°, 45°, 70°, 90°, 110° - the angle from the endoscope axis to the center of the viewing area) should correspond to the task at hand - searching for defects located on the side surface or in the direction of direct viewing. If the object of inspection is located in a straight line from the insertion point, the angle of the inspection direction is set to 0°. If the object of inspection is located close to the point of entry, for example, engine injectors near the spark plug holes, the inspection angle should be 120°. When inspecting the walls of pipelines, a side view of 90° is used. Lighting - to inspect an object, illumination of 1000...2000 lux is required. This is achieved with fiber optic lighting, in which fiberglass transmits light from an external light source through flexible light guides to the lens, or with LED illuminators installed next to the video camera. A dimming function is desirable, as glare can be a problem when inspecting polished surfaces, making it difficult to see.

Measurements using the comparison method are based on the dimensions of a known object in the field of view or placed in the viewing area. The accuracy of

the measurement depends on the operator's ability to assess the quality of the image and on his/her ability to place the measuring cursors.

Controlling the endoscope presents some difficulties at the initial stage of mastering the device - it is necessary to coordinate the movement of the lens or camera with the movements of the hands. Skills are acquired relatively quickly, but also quickly forgotten. Therefore, the inspection performed after a break increases in duration.

Obtaining a high-quality image Image quality requires some skill in holding the device and operating the probe. You will not be able to see a high-quality image with shaking hands.

Maintenance includes cleaning of optics (lenses) and endoscope elements with a cotton cloth moistened with glass cleaner or 70% aqueous alcohol solution. Do not use cleaning solutions.

To prevent injury during operation and to avoid damage to the endoscope, read the instructions for use of the endoscope, the instructions for use of the illuminator and power supply, and observe the restrictions for use. It is prohibited to use of the endoscope for examination of equipment under voltage or in operating mechanisms;

sharp ($R \leq 70$ mm) bends of the endoscope working part;

look towards the light flux emitted by the illuminator;

touch the illuminator and power supply with wet hands;

step on the working part or the light guide cable;

strike the working part against hard objects and contact with sharp edges;

drop the endoscope, its parts and components.

Immerse the endoscope in water, wash it under running water; apply excessive force, sudden movements during operation, when inserting and removing the working part, when putting the endoscope in the case; use the device in explosive atmospheres.

The advantages of using endoscopes are primarily related to the use of the information obtained. Visual fixation of the presence or absence of defects, obtained without disassembling the mechanism, allows you to make informed decisions about the timing and scope of

planned repairs. Illumination of the inspected surface with a beam of light creates conditions for involuntary concentration of attention on a small area of the surface. The combination of an endoscope with a computer, photo and video recording makes it possible to save the images and data obtained for further analysis.

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