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THEORETICAL STUDIES OF STUDENT BEHAVIOR IN THE PROCESS OF ACQUIRING KNOWLEDGE

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The article analyzes the probabilistic-statistical model of the student, according to which the student is identified by the distribution function (probability density) in the information space. In the process of assimilation of information, the behavior of the student has a random character, determined by the random nature of his psychosomatic state. Based on the solution of the continuity equation with respect to the probability density in coordinate space, theoretical distribution functions are found that identify students in the process of acquiring knowledge, which in form coincide with the distribution functions corresponding to the law of normal distribution. A comparative analysis of theoretical and experimental distribution functions has shown that these functions are in good agreement with each other. A study of the evolution of the distribution functions identifying students in the learning time interval from the first year to the fifth year inclusive showed that the variance of the distribution functions increases over time. In addition, the distribution functions that identify poorly performing students overlap. The overlap of functions occurs between the distribution functions related to the first and second, second and third, third and fourth, fourth and fifth years of study, increasing with the learning time. The overlap of distribution functions identifying strong students is insignificant. This means that in order to ensure optimal conditions for realizing the potential of weak and strong students in the process of obtaining education, it is advisable to use a system of step-by-step learning with branching.

Keywords: theoretical research, student, probabilistic-statistical method, information, distribution function, variance, mathematical expectation, step-by-step learning with branching.

Introduction

Currently, probabilistic-statistical methods are widely used in conducting psychological and pedagogical research, which include the classical or mass probabilistic-statistical method (MPS-method) and the non-classical or individual probabilistic-statistical method (IPS-method). The MPS-method is used to analyze the behavior of a large number of objects or events, because it is in this case that statistical patterns become apparent [1, 2]. The IPS-method is used to analyze the behavior of individual objects, which internally have a random character of behavior. Such objects include quantum objects (electrons, atoms, etc.) and a person in the process of activity, for example, a student in the process of acquiring knowledge [3, 4].

In the process of acquiring knowledge (assimilation of information), the student moves in the information space, which is a set of results of the semantic activity of mankind. Academic disciplines contain information blocks arranged in a strict logical sequence. This means that there are certain directions in the information space, along which students move. In computer science, information is usually measured in bits, and in pedagogy, when measuring students' knowledge, in points. There is a certain relationship between bits of information and scores, namely, the maximum score of the selected measurement scale corresponds to the amount of information contained in the academic discipline.

In accordance with the IPS-method, the student is identified by a differential distribution function (probability density), and, consequently, we can only talk about the probability of finding the student in one or another area of the information space [3]. Hereafter, for reasons of brevity, we will call the differential distribution function simply a distribution function. The student's knowledge is random in nature, since it is a product of his consciousness (the work of the brain), the determinism of which is realized through randomness due to the random nature of the psychosomatic state of a person. These arguments formed the basis for constructing a probabilistic-statistical model of the student, according to which he is identified by the distribution function in the information space.

The purpose of the study is the theoretical substantiation and application of an individual probabilistic-statistical method for analyzing the behavior of a student in the process of acquiring knowledge.

Materials and research methods

The distribution functions that identify the student are solutions of differential equations obtained on the basis of the law of conservation of probability [3]. They are continuity

equations that relate the change of probability density per unit of time in the space of coordinates, velocities and accelerations of various orders with the divergence of the probability flux density. These equations have the following form:

$$\frac{\partial \Psi(\sigma;t)}{\partial t} + div_\sigma[<\dot{\sigma}> \Psi(\sigma;t)] = 0 ,$$

$$\frac{\partial \Psi(\sigma, \dot{\sigma}; t)}{\partial t} + div_\sigma[\dot{\sigma} \Psi(\sigma, \dot{\sigma}; t)] + div_{\dot{\sigma}}[<\ddot{\sigma}> \Psi(\sigma, \dot{\sigma}; t)] = 0 ,$$

$$\frac{\partial \Psi(\sigma, \dot{\sigma}, \ddot{\sigma}; t)}{\partial t} + div_\sigma[\dot{\sigma} \Psi(\sigma, \dot{\sigma}, \ddot{\sigma}; t)] + div_{\dot{\sigma}}[\ddot{\sigma} \Psi(\sigma, \dot{\sigma}, \ddot{\sigma}; t)] + div_{\ddot{\sigma}}[<\dddot{\sigma}> \Psi(\sigma, \dot{\sigma}, \ddot{\sigma}; t)] = 0$$

$$.. , \qquad (1)$$

where, $\Psi(\sigma;t)$, $\Psi(\sigma, \dot{\sigma}; t)$ and $\Psi(\sigma, \dot{\sigma}, \ddot{\sigma}; t)$ are the distribution functions identifying the student in the information space; $\dot{\sigma}$, $<\dot{\sigma}>$, $\ddot{\sigma}$, $<\ddot{\sigma}>$, $<\dddot{\sigma}>$ are coordinate, velocity, average velocity, first–order acceleration, average first-order acceleration and average second–order acceleration, respectively; t is time.

This system consists of an infinite number of equations, and the question of which of the above equations to use to find the distribution function depends on the possibility of obtaining data on the average values of velocity and accelerations of various orders.

The first equation from the system of differential equations (1) allows us to explicitly find the distribution function describing the behavior of the student in coordinate space. We will now find a solution to this equation by writing it in the follo wing form:

$$\frac{\partial \Psi(\sigma;t)}{\partial t} + <\dot{\sigma}> \frac{\partial \Psi(\sigma;t)}{\partial \sigma} = 0. \qquad (2)$$

The solution to this equation is the argument function $(<\dot{\sigma}> t - \sigma)$, namely,

$$\Psi(\sigma;t) = \Psi(<\dot{\sigma}> t - \sigma). \qquad (3)$$

This can be verified by substituting (3) into (2). We will find a specific form of distribution function from the analysis of experimental material. To this end, we will use an experimental distribution function that identifies the student, obtained using the IVS method on a twenty-point scale and corresponding to 3 points on a five-point scale [5] (fig. 1).

The experimental distribution function is presented in the form of a histogram, which was obtained by averaging 28 individual distribution functions of students who took the physics exam. It is found that the histogram is well approximated by the distribution function (smooth line) corresponding to the law of normal distribution [6]:

$$\Psi(\sigma) = \frac{1}{\sqrt{2\pi\mu}} \exp\left[-\frac{(\sigma - <\sigma>)^2}{2\mu} \right], \qquad (4)$$

where σ is the coordinate; $<\sigma>$ is mathematical expectation; μ is variance.

Fig. 1. Distribution function: experimental (histogram); theoretical (smooth line)

When calculating the distribution function according to formula (4), a good approximation of the histogram was obtained at $<\sigma> = 6.5$ points and $\mu = 3$ point^2. The fact that the distribution function, which identifies the student in the process of acquiring knowledge, corresponds to the law of normal distribution, which describes the random nature of the behavior of a large number of objects, is natural from a mathematical point of view, since mathematics analyzes the general character of the behavior of objects, distracting from their nature. In this case, the random nature of the behavior is common for both a single object (student) and a large number of objects.

Research results and discussion

The joint analysis of equations (3) and (4) makes it possible to explicitly write down the distribution function that identifies the student:

$$\Psi(\sigma;t) = \frac{1}{\sqrt{2\pi\mu}}\exp\left[-\frac{(<\dot\sigma>t-\sigma)^2}{2\mu}\right]. \quad (5)$$

Function (5) will be distributed in the information space and in time, without changing its initial form. This means that the variance of the distribution function will remain unchanged, and this contradicts experimental data. We will obtain the information about the nature of changes in the variance of distribution functions over time from the analysis of the evolution of experimental distribution functions. To do this, first consider the evolution of the experimental distribution function obtained using the MPS-method (fig. 2a). This will allow us to find the dependence of the variance on time, and then calculate the theoretical distribution functions that identify the student, in accordance with the IPS-method, using formula (5) and the found dependence of the variance on time. Let's use a five–point knowledge measurement system, the absolute error in this case is 0.5 points, and the relative error is 10%. The construction of the distribution function will be carried out in terms of one academic discipline per semester in accordance with [5]. Thus, the assessment of a student who received 3 points on the exam should be written taking into account the error in the form of (3.0 ± 0.5) points, where 3 points is the mathematical expectation. This means that the student is identified by a distribution function, the width of which is 1 point, and the height is 1 point^{-1}. Therefore, after a two-semester year of study, the width of the distribution function will be 2 points, after the second – 4 points, after the third – 6 points, after the fourth – 8 points and after the fifth – 10 points. The average rate of movement of the mathematical expectation is 6 points per year ($<\dot\sigma> = 6$ points /year). The evolution of the distribution function by year is shown in fig. 2.
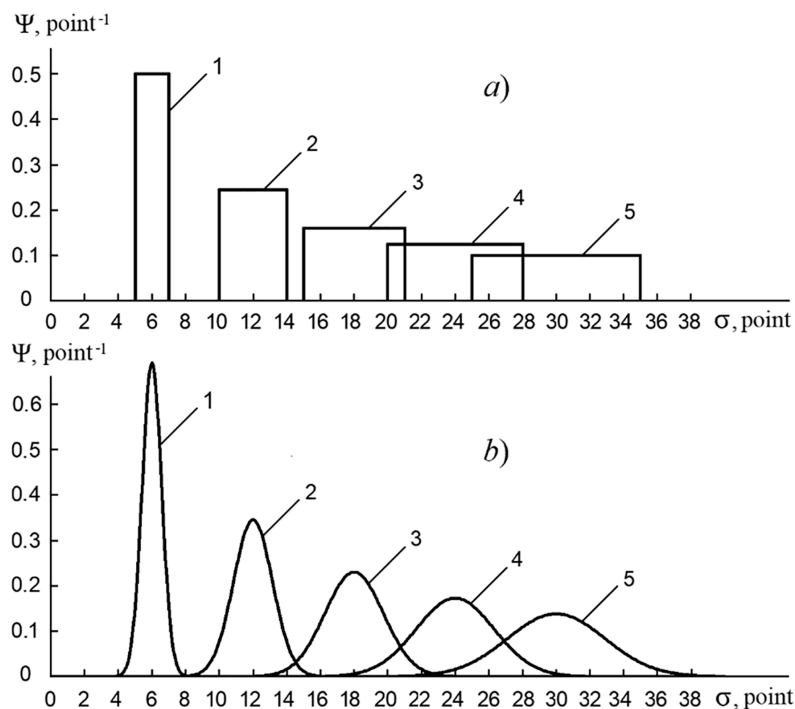

Fig.2. Evolution of distribution functions: *a*) – obtained by the MPS-method; *b*) – obtained by the IPS-method; 1, 2, 3, 4, 5 – after the first, second, third, fourth, fifth years of study, respectively
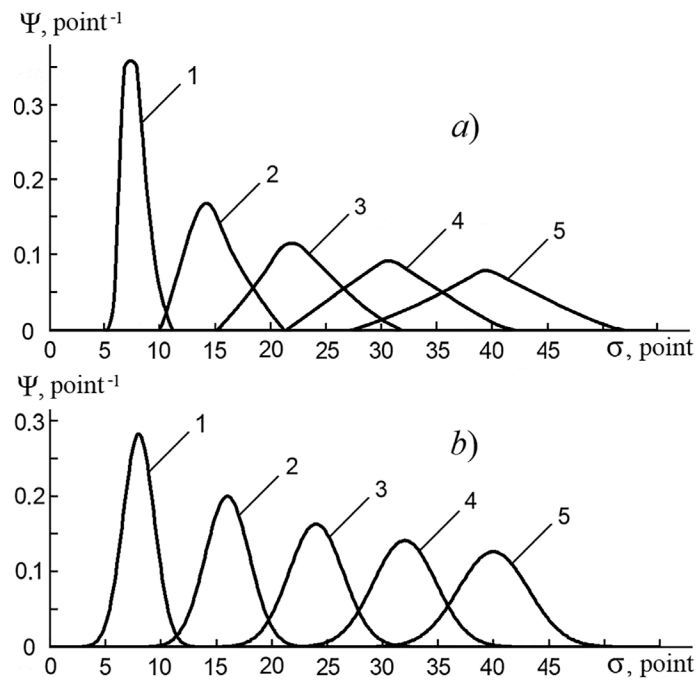
Fig. 3. Evolution of distribution functions: *a*) – experimental; *b*) – theoretical;
1, 2, 3, 4, 5 – after 1, 2, 3, 4, 5 years of study, respectively

The distribution functions shown in fig. 2*b* were calculated using formula (5) using the values of variance obtained by finding the moments of the second-order of rectangular distribution functions (fig. 2*a*). The analysis of the data presented in fig. 2 shows that the distribution functions obtained using the IPS-method are much more informative than the distribution functions obtained by the traditional MPS-method. Within the framework of a five-point measurement system, due to the large measurement error, it is impossible to obtain experimental distribution functions identifying the student using the IPS-method. This problem is solved when switching to measurement systems with a higher score, for example, to ten-point, twenty-point, hundred-point measurement systems. However, when analyzing the behavior of a large number of students, the distribution functions obtained by the IPS-method can be approximated by rectangular functions that actually coincide in shape with the distribution functions obtained by the MPS-method. This approach to obtaining experimental distribution functions was implemented in [5]. Fig. 3 shows the experimental and theoretical distribution functions.

The experimental distribution function (fig.3*a*) is taken from [5]. This function was obtained by averaging the individual distribution functions of the student flow (78 people). It can be seen that as we move in the information space, the variance of the distribution functions increases, and the distribution functions themselves overlap, and especially heavily starting from the third year of study. The weak students contributed to the tail part of the distribution function, and the strong students contributed to the head part. By the terms "weak", "average" and "strong" student we will conditionally understand students who receive an average of three points, four points and five points on exams according to the five-point system, respectively. An analysis of possible theoretical distribution functions has shown that the distribution function identifying the average student (fig. 3*b*), taking into account the linear dependence of mathematical expectation on time ($<\sigma>=<\dot\sigma>t$, where $<\dot\sigma>=$ 8 point/year) and variance on time ($\mu = at$, where $a = 2$ point^2/year), agrees well with the experimental distribution function.

Fig.4 shows the dependences of the theoretical distribution functions on the learning time, describing the behavior of the weak and strong students.

When calculating the distribution functions, linear dependences of mathematical expectation on time were used, which were equal to 6 points/year for the weak student and 10 points/year for the strong student. The time dependence of the variance was assumed to be the same as when calculating the distribution function for the average student.
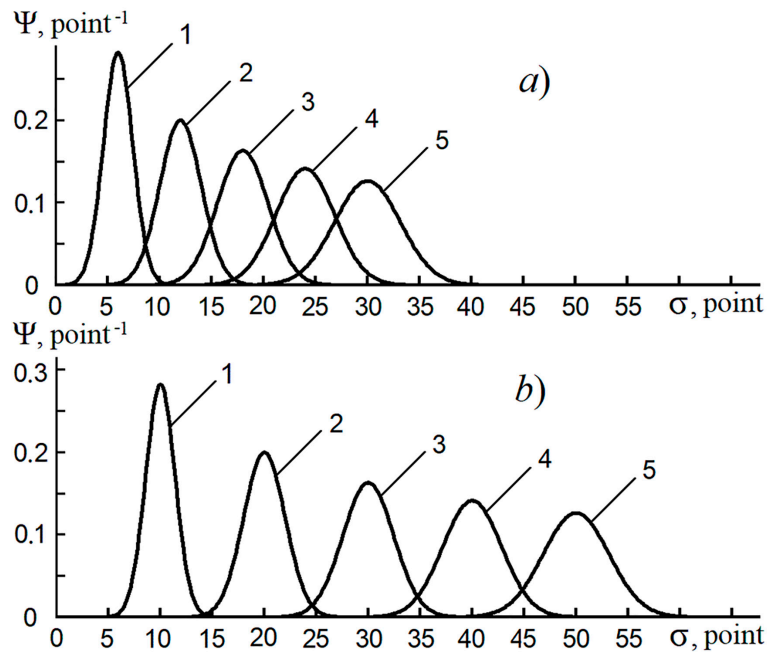
Fig. 4. Evolution of distribution functions: *a*) – identifying the weak student;
b) – identifying the strong student; 1, 2, 3, 4, 5 – after 1, 2, 3, 4, 5 years of study, respectively

The analysis of the data shown in fig. 4 showed that the distribution functions identifying the weak student (fig.4*a*) heavily overlap, especially at senior courses. This means that the weak student, figuratively speaking, seems to be "stuck" in the information space. At the same time, the distribution functions identifying the strong student (fig. 4*b*) overlap slightly and are significantly ahead of the distribution functions identifying the weak student. This means that co-education of weak students and strong students is not advisable. To ensure optimal conditions for realizing the potential of weak and strong students in the process of obtaining education, it is advisable to switch to a system of step-by-step learning with branching [5].

We will analyze stationary distribution functions – distribution functions that do not depend on time and characterize the stationary state of an object or system. The stationary state corresponds to the condition under which $\partial \Psi(\sigma; t) / \partial t = 0$. Then, in accordance with equation (2), we will have $<\dot{\sigma}> d\Psi(\sigma) / d\sigma = 0$. In this case, there are two solutions: the first corresponds to the condition $<\dot{\sigma}>= 0$, the second – to the condition $d\Psi(\sigma) / d\sigma = 0$. In the first case, the derivative of the distribution function from the coordinate can be determined by an arbitrary coordinate function, namely, $d\Psi(\sigma) / d\sigma = f(\sigma)$, where $f(\sigma)$ is an arbitrary function. To find the distribu-

tion function, we use the following integral transformation

$$\Psi(\sigma) = \int f(\sigma) d\sigma + const .$$

In [5], a method for finding the distribution function for this case is considered, based on the use of step functions [7], and the function itself is found, which has the following form

The differential distribution function is obtained in the form of a histogram by averaging the individual distribution functions identifying the students, and then approximated by a smooth line. The distribution function is represented in a dimensionless coordinate system ($\Psi^*(\sigma^*) = \Psi(\sigma)\sigma_{max}$, $\sigma^* = \sigma / \sigma_{max}$, where σ_{max} is the maximum value of the scale) and in a twenty-point coordinate system. Using a dimensionless coordinate system is convenient because the distribution function represented in a dimensionless coordinate system has the same appearance in all other coordinate systems. This allows direct translation of the distribution function from one coordinate system to another. Due to the presence of measurement scale boundaries, the distribution function has a "U"-shaped appearance.

Let's consider the second stationary solution corresponding to the condition $d\Psi(\sigma) / d\sigma = 0$. The solution of this equation is a function independent of the coordinate, namely, $\Psi(\sigma) = 1 / \sigma_{max}$. This distribution function is the same for both weak and strong students.
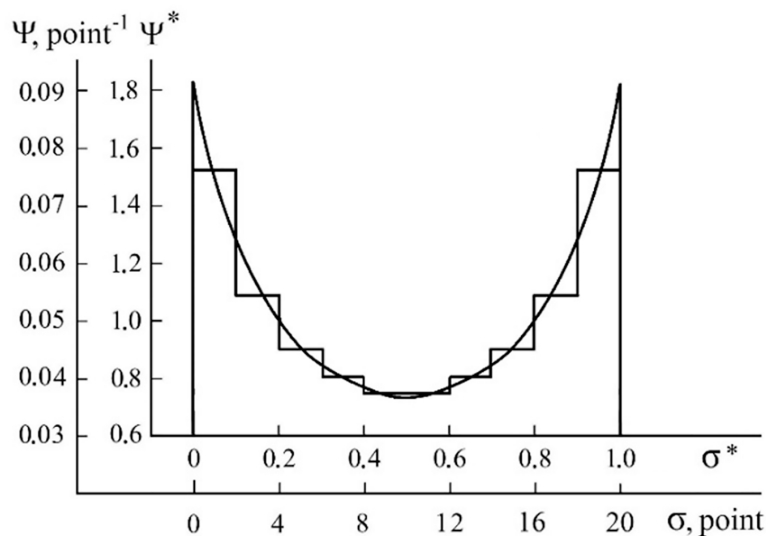
Fig.5. Differential distribution function

This means that the process of transition of the system to a stationary state should last as long as it takes, so that not only strong students could assimilate the material of a particular academic discipline, but also weak students.

Conclusions

1. The solution of the differential equation describing the progress of the student in the information space in the process of obtaining knowledge is obtained. The solution is a distribution function that identifies the student, which in form coincides with the normal distribution.

2. A joint analysis is carried out of the evolution of the experimental student distribution function (obtained by averaging the individual distribution functions of the students of the flow) and the theoretical distribution function identifying the student. It is established that the theoretical distribution function identifying the average student is in good agreement with the experimental distribution function.

3. A comparative analysis of the theoretical distribution functions identifying weak and strong students showed that the distribution functions identifying weak students begin to overlap after the second year of study, and the degree of overlap increases over time. The distribution functions identifying strong students overlap slightly.

4. It is shown that in order to ensure optimal conditions for the realization of the potential opportunities of weak and strong students in the process of obtaining education, it is advisable to use a system of step-by-step learning with branching.

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MODERN METHODS OF AUTOMATED SOFTWARE SECURITY ANALYSIS: FROM STATIC ANALYSIS TO COMPREHENSIVE APPROACH

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The article presents a comprehensive analysis of modern methods for automated software security analysis. The main approaches to vulnerability detection are considered, including static and dynamic code analysis, as well as hybrid methods using machine learning. Current problems and limitations of existing tools are analyzed, and promising directions for the development of automated security testing technologies are proposed. The study covers a wide range of issues, including the effectiveness of various analysis methods, problems of integrating tools into the development process, and the possibilities of using artificial intelligence to improve the accuracy of vulnerability detection. Special attention is paid to the problem of reducing false positives and prioritizing identified vulnerabilities. Based on the analysis, recommendations are formulated for improving existing approaches and developing new methods for automated software security analysis. The research highlights the critical importance of developing comprehensive approaches that combine different analysis methods and leverage modern machine learning technologies to enhance the effectiveness of vulnerability detection. The results show that no single method can provide full coverage of all types of vulnerabilities, necessitating the use of a hybrid approach integrating static and dynamic analysis with advanced AI techniques. The article also addresses issues of standardizing vulnerability descriptions, challenges in creating high-quality datasets for training machine learning models, and prospects for developing security analysis tools in the context of modern software development methodologies such as DevOps and continuous integration. The study emphasizes the need for ongoing research and development in this field to keep pace with evolving security threats and increasingly complex software systems. It also discusses the importance of balancing automation with human expertise in the security analysis process and the potential for AI-driven tools to augment rather than replace human security analysts.

Keywords: static analysis, dynamic analysis, software vulnerabilities, automated testing, software security, machine learning, security testing

Introduction

In the modern world, software plays a critical role in virtually all spheres of life – from household devices to industrial control systems, making security issues particularly relevant. The growing complexity of software systems and a significant increase in source code volumes, reaching millions of lines, make complete manual vulnerability testing practically impossible. In this regard, automated security analysis tools are becoming a necessary element of the software development process, allowing potential problems to be identified at early stages [1-3].

Existing solutions for automated security analysis include various approaches and methods that work at different stages of the software lifecycle. Static code analysis allows finding vulnerabilities without executing it, dynamic analysis checks security during program execution, and hybrid methods combine both approaches. However, their effective application faces a number of significant limitations, including a high level of false positives, reaching 30-50% of the total number of problems found, the complexity of configuration and integration into the development process, as well as insufficient coverage of various types of vulnerabilities [4].

An important problem is also the standardization of vulnerability descriptions – different tools use their own classifications and terminology, which makes it difficult to compare them and integrate analysis results. Existing initiatives such as Common Weakness Enumeration (CWE) and Common Vulnerabilities and Exposures (CVE) aim to create a unified classification system, but the process of mapping rules from different tools to these standards often leads to inconsistencies and gaps [5].

Special attention should be paid to the problem of "false negative" results, when existing vulnerabilities are not detected by analysis tools. Unlike false positives, it is much more difficult to assess the scale of this problem due to its very nature. At the same time, missed critical vulnerabilities can pose a serious threat to software security.

A promising direction for the development of security analysis tools is the application of machine learning methods, which allow increasing the accuracy of vulnerability detection and reducing the number of false positives.

However, the effective use of such approaches requires high-quality datasets containing examples of real vulnerabilities and their exploitation. Creating and maintaining the relevance of such datasets presents a separate challenging task.

*Comprehensive analysis
of the effectiveness of methods and tools
for automated software security testing*

As part of this study, a comprehensive analysis of existing methods and tools for automated software security analysis was conducted. The research was based on a systematic review of scientific literature, analysis of practical experience in applying various tools, as well as an assessment of promising directions for technology development in this area. To form a representative sample, more than 160 thousand vulnerability records from the Common Vulnerabilities and Exposures (CVE) database were analyzed, covering both proprietary and open-source projects.

The methodology included several interrelated stages. At the first stage, an analysis of existing approaches to vulnerability classification was conducted, including Common Weakness Enumeration (CWE) and specialized catalogs of major vendors. Significant discrepancies in terminology and classification between different systems were identified, which creates difficulties in integrating analysis tools [6, 7].

At the second stage, the features of applying static and dynamic code analysis were investigated. It was found that static analyzers, despite a high percentage of false positives (up to 30-50%), allow identifying potential vulnerabilities at early stages of development. Dynamic analysis demonstrates higher accuracy but requires the creation of special test scenarios.

Special attention was paid to studying the following key aspects:
• The effectiveness of various approaches to vulnerability detection, including code coverage analysis, detection accuracy, and false positive rate.
• Problems of integrating analysis tools into the development process, in particular issues of configuration, performance, and usability.
• Possibilities of applying machine learning to improve analysis accuracy, including the use of large datasets of known vulnerabilities.
• Methods for reducing the number of false positives by improving contextual analysis and prioritizing results.
• Approaches to prioritizing identified vulnerabilities based on criticality assessment and probability of exploitation.

The study also included an analysis of practical experience in using security tools in real projects. The main reasons for refusing to use analysis tools were identified, including configuration complexity, high cost, insufficient integration with development processes, and low quality of problem descriptions.

To improve the effectiveness of security analysis tools, it is necessary to:
• Improve integration with modern development environments.
• Provide more accurate prioritization of identified vulnerabilities.
• Provide more detailed problem descriptions and recommendations for their elimination.
• Reduce the number of false positives by improving contextual analysis.
• Expand support for various programming languages and technologies.

Additionally, issues of standardizing vulnerability descriptions and problems of mapping different classifications were considered. The analysis showed that existing initiatives such as Common Weakness Enumeration (CWE) and Common Vulnerabilities and Exposures (CVE), while providing a basic structure for classification, do not always allow accurate description of complex attack scenarios and relationships between various vulnerabilities [8].

Special attention was paid to the problem of "false negative" results, when existing vulnerabilities are not detected by analysis tools. Unlike false positives, it is much more difficult to assess the scale of this problem. Potential approaches to assessing and reducing the number of missed vulnerabilities were considered, including the application of machine learning methods and combining different types of analysis.

The study also touched upon issues of creating and maintaining up-to-date datasets for training machine learning models in security analysis tasks. Existing open vulnerability databases and their limitations were analyzed, and approaches to creating synthetic datasets for testing analysis tools were considered.

As a result of the analysis, recommendations were formulated for improving methods and tools for automated software security analysis, including the need to develop more flexible formats for describing analysis results, improving integration with modern development processes, and applying machine learning methods to increase the accuracy of vulnerability detection.

*Comparative analysis of modern
automated vulnerability search tools
and prospects for their development
using machine learning methods*

The analysis showed that existing automated security analysis tools can be divided into several main categories:

1. Static code analysis tools that work without executing it, including syntactic analyzers, semantic data flow analyzers, and model checking tools. These solutions allow finding potential vulnerabilities at early stages but have limitations in the form of a large number of false positives.

2. Dynamic analysis tools that check security during program execution by monitoring application behavior, tracking data flows, and identifying anomalous behavior. Such tools provide higher accuracy but require careful preparation of test scenarios.

3. Hybrid solutions combining various analysis approaches, including static and dynamic analysis, as well as machine learning methods. Such tools allow compensating for the shortcomings of individual approaches and increasing the effectiveness of vulnerability detection.

4. Specialized tools for analyzing specific types of vulnerabilities, such as SQL injections, cross-site scripting (XSS), or buffer overflow. Such solutions provide in-depth analysis of certain vulnerability classes.

However, each approach has its advantages and limitations. Static analysis is effective for early detection of potential security problems but often generates a significant number of false positives, which complicates practical application. According to research, up to 50% of static analyzer warnings can be false. Dynamic analysis provides higher accuracy by checking the actual behavior of the program but requires creating special test scenarios and cannot detect all potential problems due to limited code coverage [9].

The study showed that a promising direction is the application of machine learning methods to improve analysis accuracy and reduce the number of false positives. The use of neural networks and other machine learning algorithms allows considering the context of software use, identifying complex vulnerability patterns, and adapting analysis to specific requirements. For example, applying deep learning methods for source code analysis can reduce the number of false positives by 30-40% compared to traditional approaches [10, 11].

An important aspect is also the integration of security analysis tools into the software development process. Research shows that the effectiveness of tool application significantly depends on how conveniently they fit into existing development processes and tools. It is necessary to ensure support for popular development environments, version control systems, and continuous integration tools.

Special attention should be paid to the problem of prioritizing identified vulnerabilities. With limited resources, it is critical to correctly determine the sequence of addressing detected security problems. A promising approach is the application of risk-oriented analysis, considering both the probability of vulnerability exploitation and the potential damage from its use.

Additionally, the following aspects of developing automated security analysis tools were considered:

• Application of natural language processing methods for analyzing comments in code, documentation, and other textual artifacts of the project to identify potential vulnerabilities.

• Use of graph neural networks to analyze code structure and identify complex dependencies between various programs components.

• Development of interpretable machine learning methods to ensure transparency and explainability of analysis results.

• Creation of specialized language models pre-trained on large volumes of source code to improve analysis accuracy in specific subject areas.

• Application of active learning methods to adapt machine learning models to the specifics of projects and reduce the need for large volumes of labeled data.

• Development of analysis methods that consider the features of modern software architectures, including microservices and distributed systems.

The study also touched upon issues of evaluating the effectiveness of security analysis tools. Various metrics used to compare tools were considered, including accuracy, completeness, F1-measure, and analysis time. The need to develop more comprehensive evaluation methods that consider not only technical aspects but also usability, integration with development processes, and economic efficiency was noted.

Conclusion

The conducted study confirms the critical importance of developing methods for automated software security analysis. The results show that the most promising approach is a

comprehensive one, combining various analysis methods and using modern machine learning technologies to improve the effectiveness of vulnerability detection. Analysis of existing tools revealed that no single method can provide complete coverage of all types of vulnerabilities, making it necessary to apply a hybrid approach.

Static code analysis, despite a high level of false positives, remains an important component of the security testing process, allowing potential problems to be identified at early stages of development. Dynamic analysis, in turn, provides more accurate results by analyzing the actual behavior of the program, but requires significant resources to create test scenarios. Integration of machine learning methods can significantly improve analysis accuracy by considering the context of software use and adapting to specific project requirements.

Further research in this area should be directed towards developing more advanced methods of integrating analysis tools into the development process. It is critically important to reduce the number of false positives, which significantly reduce developers' trust in the results of automated analysis. It is also necessary to pay attention to the problem of false negative results, which can miss critical vulnerabilities.

Special attention should be paid to developing methods for prioritizing identified vulnerabilities and automating the process of their elimination. Existing approaches to vulnerability ranking are often based on simplified criticality assessment models that do not consider the specifics of projects. It is necessary to develop more advanced risk assessment methods that consider both technical aspects of vulnerabilities and features of business processes.

Integration of security analysis tools into modern DevOps processes presents a separate important task. It is necessary to ensure continuous security analysis at all stages of the software lifecycle without creating significant delays in the development process. A promising direction is the development of intelligent systems capable of automatically determining the optimal set of security checks depending on the context of code changes.

Standardization and unification of security analysis results presentation also requires further development. Existing standards such as CWE and CVE provide a basic classification of vulnerabilities, but do not always allow accurate description of complex attack scenarios and relationships between various vulnerabilities. It is necessary to develop more flexible formats for describing analysis results, ensuring effective communication between various participants in the development process.

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THE CHRONICLE OF THE MAIN EVENTS AND A BRIEF ANALYSIS OF THE MATERIALS OF XXV WORLD PHILOSOPHICAL CONGRESS IN ROME

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This article chronicles the main official events that took place at the XXV World Philosophical Congress, from opening to closing, as well as a brief analysis of some key substantive issues. Such important issues as the name of the congress, some problems of women's (gender), African, Asian and Russian philosophy in modern conditions were considered. Some attention is paid to the comparative statistical analysis of the works accepted by the organizing committee from Russia and the philosophers who actually traveled to Rome. It is important to emphasize that in difficult political and economic conditions, 25 delegates managed to come to the Congress, who actively pursued Russian topics at this high-level forum. There were delegates from different universities of the country, such as the Institute of Philosophy of the Russian Academy of Sciences, Lomonosov Moscow State University, MISIS National Research Technological University and other universities. The role of famous Western, Russian thinkers, philosophers from Belarus, Kazakhstan and Moldova was specially noted, without whose participation this congress would hardly have been able to become a real-world event.

Keywords: Invited Sessions, Plenary sessions, Philosophy, Round Tables, Symposiums, Thematic Sections, World Philosophical Congress

Introduction

The jubilee XXV World Philosophical Congress, which was held in Rome from 1 to 8 August 2024 under the motto «Philosophy across Borders», has completed its work [1].

The World Philosophical Congresses have been held every five years since 1900 under the auspices of the International Federation of Philosophical Societies (Fédération Internationale des Sociétés de Philosophie, (FISP), and are the largest forums in the field of philosophy. The official documents state that the purpose of these events is to contribute to the development of professional relations between philosophers of all countries, promote philosophical education and contribute to the influence of philosophical knowledge on solving global problems of our time.

In Italy, the World Philosophical Congresses have already been held three times (in Bologna in 1911, Naples in 1924 and Venice in 1958). The congress was held in Rome for the first time. We can say that the Italians were just lucky. The fact is that at first this congress was planned to be held in Melbourne (Australia), but due to the covid epidemic and financial problems, it was decided to move the congress to Rome.

Materials and methods of research

First of all, the well-known four rules of the Descartes' scientific research method [2, pp. 256-262] were applied in the article: intuitive insight is a direct immersion into the very atmosphere of the congress, analysis, generalization and consideration of all objective circumstances, of events and reports. The method of textual analysis of the congress program was used. Empirical research methods were also relevant for us: observation, fixation, comparison, classification and understanding of events taking place at the congress.

Opening of the Congress

It opened on August 1 in the late evening in the open air in the Baths of Caracalla (ital.: Terme di Caracalla) in Rome, where the ancient Romans loved to spend time discussing topical issues of the political and economic life of the country. The construction of the Baths was completed in 217 AD after the death of Emperor Caracalla, so they are officially called Antonina baths. After greetings from the Mayor of Rome Roberto Gualtieri, Rector of Sapienza University Antonella Polimeni, President of the Italian Organizing Committee Emidio Spinelli and President of FISP and the XXV World Philosophical Congress Luca Maria Scarantino, the artists of the Rome Opera House performed three arias from the opera by J. Puccini's «Tosca».

The Congress itself was held at the oldest university in Rome and one of the largest higher

educational institutions in Europe, La Sapienza (ital.: Sapienza Università di Roma), founded in 1303 by Pope Boniface VIII. The name of the university means «wisdom» in Latin.

The reports were severely selected: the Congress program committee selected 4309 applications from 109 countries and 997 articles for presentations at student sessions for 89 sections (Russian students should think about participating in the XXVI World Philosophical Congress, which will be held in Tokyo in 2028).

In addition to the sections, 5 plenary sessions, 10 symposiums and more than 300 Round tables were held. Professors invited by the Program Committee also spoke. Meetings of philosophical societies from different countries, a FISP meeting, invited sessions and other events were held. There were also accompanying persons at the congress who did not make presentations at the sections, but could speak at the «Round Tables».

The purpose of the Congress

One of the tasks of the Congress was to show that the philosophy of women is as important for humanity as the philosophy of men, and the philosophy of African peoples is no less important than European philosophy. Therefore, there were two sections at the congress devoted to African Philosophy (separately the philosophy of Africa and separately the philosophy of the Caribbean), but, unfortunately, for some unknown reasons the section «German philosophy» was not included in the general list of sections.

Various philosophical issues of ontology, epistemology, anthropology, social philosophy, philosophy of technology, ethics, aesthetics, history of philosophy and problems of national philosophy were discussed at plenary sessions, symposiums, round tables and sections.

It is also important to note that in recent years preceding the Congress, there have been certain changes in the value system of Western European philosophers. Thus, the famous French philosopher, the creator of the *theory of deconstruction*, Jacques Derrida, who yesterday was the idol of European philosophy, today almost no one is interested in his philosophy. On 552 pages of the Program no reports dedicated to his work could be found among representatives of Western Europe. Derrida saw the meaning of his work in overcoming traditional European philosophy, but it turned out the opposite, Western philosophy «overcame» Derrida himself. Note that Derrida is also ignored in the Anglo-American tradition of analytical

philosophy. Interest in this philosopher has moved to other countries: Chinese comrades devoted two whole speeches to him. It is possible that this is due to the desire of some Chinese philosophers to understand the principles of deconstruction of political systems.

Many philosophical questions often focused on the problem of social and especially gender inequality, which acquires new meanings and development trends against the background of the development of modern global civilization. Here we would like to draw attention to the symposium on the role of women in the history of philosophy. The performance of Marie Pauline Ebo (Federal Republic of Nigeria) was particularly striking.

Such social problems of the «gender war of the sexes» could not overshadow the overall bright atmosphere of the Congress. Thanks to its ancient history and culture, Rome has become a real place of spiritual and intellectual stimulation for scientists from all over the world. Here it is appropriate to quote the words from the welcoming speech of the President of the Italian organizing Committee, Emidio Spinelli that «Rome will once again become a crossroads for fruitful communication between a wide variety of people. By welcoming people from all over the world, the city will become an excellent platform for presenting and discussing its own views and proposals, its own special and unique approach to the world» [1]. This did not remain only a good wish, but was really embodied in the work of the Congress.

We were struck by the true love of many and many scientists and teachers from different countries and peoples for philosophy, who came to Rome, despite their advanced age and difficult weather conditions: the temperature in Rome rose to 36-37 degrees Celsius during the day. Before our eyes, some delegates fainted from overwork and fainted. We must pay tribute to the efficiency of Italian medicine; the ambulance immediately took people to the hospital.

Important organizational changes

It is impossible to ignore some significant organizational changes that have occurred as a result of the current political situation in the world over the past two years. All representatives of Russia in the World Philosophical Organization were removed from the leadership. Now there will be no one to represent the interests of our domestic philosophers at the international level. Nevertheless, Russian speech could be heard quite often both at sections and at Round Tables and other events. The attempt

to withdraw Russian from the eight official languages of the Congress has completely failed thanks to our friends from different countries, primarily from the republics of Central Asia, who have come out in defense of the Russian language.

English remained the international language of communication. However, philosophers preferred to speak their national languages, Chinese in Chinese, French in French, Germans in German, and Russians in Russian, when given the opportunity at sections and round tables. The main thing is that there was no Russophobia at the Congress during the communication process. All the delegates treated each other with sincere respect.

Famous western philosophers at the Congress

Among the participants of the Congress were such famous thinkers as the President of the XIX World Congress of Philosophy, Italian philosopher and professor of the University of *Genoa Evandro Agazzi*, who gave the final lecture on August 8. Unfortunately, due to his advanced age (89 years old) he performed on-line.

It was also possible to see and talk at the sessions with the President of the XXIII World Philosophical Congress, *William Leon Mc-Bride*. Our attention was attracted by *David John Chalmers*, who wrote the monograph «The Conscious Mind» in 1996 [3]., and Ph.D., university Professor *Jeffrey David Sachs*, an American economist and director of the Earth Institute at Columbia University.

Eduard Vasilyevich Demenchonok, a professor of foreign languages and philosophy from Fort Valley State University in Georgia, USA, actively worked at the Congress. He is included in the list of 2000 outstanding scientists of the XXI century and is the recipient of the XXI Century Prize for Achievements in philosophy from the International Biographical Center in Cambridge, UK. It should be noted that from 1999 to 2019 he was a member of the Russian Philosophical Society. At the congress, Eduard Vasilyevich co-chaired the Round Table «Philosophy, Globalization, Education and Peace», organized and held another Round table on the topic «Intercultural dialogue in a multipolar world: challenges and opportunities».

Russian philosophers at the Congress

The Program Committee included 80 speakers from Russia in the work of the congress sections, which is easy to see by watching the congress program. However, out of 80 invited Russian philosophers, only 25 people arrived in Rome. There were, of course, accompanying persons or guests from Russia who did not perform at the sections. For comparison, we point out that 161 speakers at the sections and 24 accompanying persons arrived from Russia in Beijing for the XXIV World Philosophical Congress (2018); 467 speakers and guests arrived from Russia to participate in the Congress in Athens (2013); 166 speakers and guests arrived from Russia in Seoul (2008) [4, pp. 15-21].

So, 25 Russian speakers from the Institute of Philosophy of the Russian Academy of Sciences, South Ural State Humanitarian Pedagogical University (Chelyabinsk), National University of Science and Technology «MISIS», Peoples' Friendship University of Russia named after Patrice Lumumba, Lomonosov Moscow State University, Ural Federal University named after the First President of Russia B. N. Yeltsin (Yekaterinburg), The Herzen State Pedagogical University of Russia (St. Petersburg), Plekhanov Russian University of Economics, Saint-Petersburg State University of Economics, Novosibirsk State University, Saratov State University named after N. G. Chernyshevsky spoke at the sections in Rome. Three philosophers from Kazan attended the congress.

The «Russian Philosophy» section was chaired by Evert van der Zweerd (Kingdom of the Netherlands), known for the 2017 book «An Outside View of the History of Russian and Soviet Philosophy». At the XXIV World Philosophical Congress in Beijing, Russian philosophers headed 10 sections, none in Rome. At the section «Philosophy of Culture», P. V. Chelyshev, Doctor of Philosophical sciences, Professor of the Department of Social Sciences and Technologies of the Institute of Basic Education of NUST MISIS, made a report on the topic «Philosophy of Culture of Aurobindo Ghosh: from barbarism, civilization and Culture to the spiritual transformation of man». At the same section, the message «Culture as a way to overcome unpredictability» A. D. Korolev, Senior researcher at the Institute of Philosophy of the Russian Academy of Sciences, spoke.

Of the major Russian specialists who came to the congress, one can only point to *Ilya Theodorovich Kasavin*, Corresponding Member of the Russian Academy of Sciences, Doctor of Philosophical sciences, Head of the Social Epistemology Sector of the Institute of Philosophy of the Russian Academy of Sciences, President

of the Russian Society for the History and Philosophy of Science. On his initiative and under his leadership, the invited session «Science in a Free Society» was successfully held for the 100 th anniversary of Paul Feyerabend.

Contribution at the Congress of philosophers of Belarus, Kazakhstan and Moldova to the treasury of world philosophy

Thanks to such remarkable leaders as Director of the Institute of Philosophy of the National Academy of Sciences of the Republic of Belarus *Anatoly Arkadievich Lazarevich*, Chief Researcher of the Institute of Philosophy, Political Science and Religion of the National Academy of Sciences of the Republic of Kazakhstan, Doctor of Philosophy, Professor *Ayazhan Sagievna Sagikyz* and Doctor of Philosophy, Professor, The head of the Department «Philosophy and Methodology of Science» of the Faculty of Social Sciences of the Mirzo Ulugbek National University of Uzbekistan *Nigina Arslanovna Shermukhamedova* adequately represented the philosophy of Belarus, Kazakhstan and Uzbekistan at the Rome Congress.

A.A. Lazarevich was the cohead of the «Round Table» «Philosophy, Globalization, Education and Peace». A. S. Sagikyzy was one of the heads of the section «Philosophy of Culture», and N. A. Shermukhamedova was one of the heads of the section «Political Philosophy», and also organized and with great success held the announced session «Philosophical heritage of the Turkic peoples».

There was only one speaker from Moldova at the congress: *Tatyana Borisovna Batyr*, Doctor of Philosophical sciences. She spoke at the section «Teaching Philosophy» with the report «To inspire and be inspired by philosophy», emphasizing in her speech that teaching philosophy should not only be an activity in terms of lecturing, writing philosophical books and articles or methodological recommendations for students; teaching philosophy means having a special mission for society and to be aware of it.

Presidential election, 2024

There were three nominees for the position of the new president of FISP: Heisook Kim was elected new President of FISP in November 2024! She won 56,10% of the vote. Congratulations to the new president on her victory. «Heisook Kim (Ph.D., University of Chicago) is Professor of philosophy at Ewha Womans University, Korea. She has been President of the Korean Philosophical Association,

President of Korean Association of Feminist Philosophy and President of Korean Analytic Philosophy. She was Nominated by the International Association of Women Philosophers (IAPh), the Red Española de Filosofía (REF) and the Korean Philosophical Association. Endorsed by the Deutsche Gesellschaft für Philosophie» [5].

The problem of the Congress name

Finally, we would like to add a few words about the general theme of the Congress – «Philosophy beyond borders». For the first time, such a topic was discussed in 2001 at the Faculty of Philosophy of Lomonosov Moscow State University as part of an international philosophical seminar [6]. And now the XXV World Philosophical Congress is being held under the same slogan, which causes some confusion. It seems that everything exists within certain boundaries, the overstepping of which leads to the destruction, rather than the unification of traditional ideas about the world, man and society in one or another national philosophy. There is a certain contradiction between the general purpose of the Congress and its result, which was quite rightly pointed out in her article «Philosophy beyond Borders» (for the upcoming XXV World Philosophical Congress) the famous Russian philosopher, Doctor of Philosophical sciences, professor M.T. Stepanyants. [7, pp. 5-13].

Conclusion

First of all, we can note the good organization of the Congress. But at the same time, we regret that the materials of the congress were not printed in paper form, which greatly complicated the daily work. *Secondly*, Russian philosophers, despite certain economic and political difficulties, were still able to come to Rome and adequately speak at the Congress on a number of topical issues of globalism, anthropology, social and national philosophy. *Thirdly*, it is important that there was no noticeable Russophobia in the daily communication of delegates. This concerned delegates from different countries and philosophers from Belarus, Kazakhstan, Moldova and the Czech Republic were especially positive. *The final results*: The Congress fulfilled its main task – a free exchange of opinions of hundreds of philosophers from all over the world took place. This will undoubtedly have a positive impact on the further development of the world philosophy. Goodbye, Rome, 2024! Hello, Tokyo, 2028! Registration for the XXVI World Philosophical Congress will begin in 2026. Don't miss it!

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ARTICLES

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MAIN REPRESENTATIVES OF OSMOTIC DIURETICS AND PRINCIPLE OF THEIR ACTION

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Hydrouretics, or osmotic diuretics, increase water diuresis (loss of water in the urine) due to high osmotic activity. Osmotic diuretics have very strong diuretic and decongestant properties (sometimes even superior to loop diuretics), but only in patients with normal glomerular filtration rate. The main representative of this group – mannitol – is most often used to reduce swelling of the brain and spinal cord of various origins, in the complex therapy of traumatic brain injuries and spinal injuries, volumetric (including malignant) formations of the central nervous system, as well as to control intraocular pressure in some ophthalmic operations. The main mechanism of the diuretic action of osmodiuretics is a significant decrease in the reabsorption of sodium ions in the distal nephron. The presence of a substance with high osmotic activity in the lumen of the collecting tubules leads to water retention and a drop in the intraluminal concentration of Na^+ ions, a sharp decrease in its reabsorption, and, moreover, to the absorption of sodium ions from the peritubular space. All this occurs against the background of an increase in blood flow in the renal medulla, which is due to the vasodilating effect of osmodiuretics. At the same time, there is a "washout" of the normal hypertonicity of the medullary interstitium of the kidneys and, as a result, a decrease in sodium reabsorption in the thin ascending section of the loop of Henle. Ultimately, the production of secondary urine increases against the background of a relatively low excretion of sodium ions, since the main diuretic effect is due to an increase in urine production.

Keywords: diuretics, osmodiuretics, mannitol, urea, chronic heart failure, arterial hypertension, chronic renal failure, nephron

Introduction

Diuretics in the medical environment are known as a class of medicines, the principle of action of which is aimed at providing forced diuresis, in other words, removing excessive amounts of mineral and organic salts, water from the body and eliminating edematous syndrome. The functional activity of diuretics is revealed in the nephron, the morphofunctional unit of the kidney. Primary urine is filtered from blood plasma in the nephron capsule, after which a further process of secondary urine formation takes place in the tubular apparatus of the nephron by reabsorption and secretion of various secreted substances into the urine. As a result of these processes, the volume of urine increases by 2 times with a decrease in the rate of reabsorption by only 1%. It is known that drugs with even a minor effect on the processes of reverse absorption of electrolytes in the renal tubules have the ability to cause a significant change in diuresis. The excretion of biochemically significant ions for the body (magnesium, potassium, chlorine, phosphates and bicarbonates) is one of several side effects of diuretic drugs. At the same time, the reverse situation is also possible, when pathological processes leading to a temporary or permanent change in the structure of the glomeruli and tubules can cause serious changes in the water and electrolyte balance in the body.

Osmotic diuretics are understood to be a group of drugs with a pronounced osmotic effect that are freely filtered by the glomerular apparatus of the kidneys, while being inert from a pharmacological point of view, as a result of which they undergo little or practically no reabsorption. Drugs of this pharmacological group have an effect on osmotic pressure by increasing the osmolality of blood plasma within 10 mOsm / kg. At the same time, diuretic drugs have a complex effect on systemic and organ hemodynamics, indirectly regulating the state of electrolyte balance and some metabolic processes. Among the representatives of osmodiuretics, a special place is occupied by the hexatomic alcohol mannitol, the scope of application of which in clinical medicine is very extensive: from combating brain oedema, increasing intracranial pressure in neuro–intensive care and neurosurgery, prevention and early therapy of acute renal failure of ischemic and toxic gen-

esis, to an antioxidant – for the prevention of ischemic and reperfusion disorders in cardiac surgery, vascular surgery, cardiology. Other representatives of the diuretic series are also known, including sorbitol, isosorbide, glycerine, and urea. Nowadays, they have found a narrow scope of application and are more often last-line drugs, due to a wide range of side effects and complications [1].

Relevance. In clinical practice, a lot of experience has been accumulated in the use of diuretic drugs, the beginning of widespread use of which dates back to 60-70 of the XX century. The first representatives of this class of drugs were mercury diuretics and carbonic anhydrase inhibitors. Today, diuretic drugs are presented much more widely, new groups have appeared, and new representatives in the groups of diuretics, in the synthesis of which the undesirable clinical properties of their predecessors were taken into account. All diuretics are divided into five groups, depending on the effect on different parts of the nephron.

The first group consists of diuretics acting on the proximal convoluted tubules. These include carbonic anhydrase inhibitors and osmotic diuretics. At the same time, osmotic diuretics (lure, urea) are characterized primarily by a dehydration effect, which determines the possibility of their clinical use [2].

The second group is represented by diuretics acting on the distal tubules. These include thiazide and thiazide-like diuretics. The first generation of thiazide diuretics is represented by hydrochlorothiazide (hypothiazide, disalunil, ezidrex; daily dose 25-50 mg) and chlorthalidone (hygroton, oxazoline; daily dose 15-30 mg). These drugs are characterized by a moderate natriuretic and diuretic effect, a high antihypertensive effect, and a long-lasting effect, which allows them to be widely used in the treatment of arterial hypertension and edematous syndrome. In addition, thiazide diuretics reduce the excretion of calcium ions in the urine, which makes it possible to give preference to these drugs in patients with concomitant osteoporosis [3].

The third group is diuretics acting on the ascending loop of Henle, or loop diuretics. They, like the previous group, are represented by two generations. The first generation is short-acting loop diuretics: furosemide (lasix, daily dose 20-320 mg), ethacrynic acid (uregit, edecrine daily dose 25-100 mg), bumetanide (bufenox, bumex, daily dose 0.5-5 mg). A feature of these drugs is a pronounced, powerful diuretic and natriuretic effect. Moreover, these effects are dose-dependent, the drugs are char-

acterized by a large range of therapeutic doses, and its increase is accompanied by an increase in diuresis. The second generation – long-acting loop diuretics is represented by torasemide (trifas daily dose of 5-20 mg). The peculiarity of the drug is that it is a modern loop diuretic, not inferior, and even superior in efficiency to short-acting loop diuretics [2].

The fourth group – diuretics, acting mainly on the glomerulus, are represented by aminophylline (eufillin) and theobromine. Currently, actually as diuretics are rarely used, for example, eufillin finds its application in some clinical situations in obstetrics, nephrology, pulmonology [4].

The fifth group – diuretics, acting mainly in the area of the collecting ducts. This group has another definition – potassium-sparing diuretics. Representatives of this group include spironolactone (veroshpiron, aldactone, spiro, spironol, daily dose of 25-400 mg), amiloride (mizamor, arumil, daily dose of 5-20 mg), triamterene (zaitek, pterofen, daily dose of 50-200 mg), eplerenone (inspra, daily dose 25-50 mg). This group of drugs finds its application in the treatment of edematous syndromes of combination therapy. The combination with loop or thiazide diuretics allows to achieve a more pronounced diuretic effect and reduce potassium losses. Representatives of this group, in particular spironolactone, are pathogenetically justified in the treatment of edematous syndrome against the background of portal hypertension [2]. **Purpose of research.** To study the list of Russian and foreign sources describing the features of the main representatives of several osmotic diuretics, their scope and purpose.

Materials and methods of research

To study the basic data on the pharmacological characteristics of osmotic diuretics, as well as the methods of their functional application, we have developed a list of Russian and foreign sources.

Research results and their discussion

Osmotic diuretic drugs – mannitol, sorbitol, urea – increase the osmotic pressure of blood plasma. These drugs, due to their filtration in the glomeruli of the nephron, enter the primary urine. From the inner space of the nephron, osmotic diuretics are practically not reabsorbed. Their presence in the primary urine increases its osmotic pressure, inhibits water reabsorption, and consequently, diuresis increases. The presence of osmotic diuretics in the circulating blood increases the circulating blood volume. The increased blood volume activates specific

(endothelial) cells of the atria and liver, which provide the release of natriuretic peptide, which inhibits sodium reabsorption in the renal tubules, thereby achieving increased diuresis [1].

Pharmacokinetics: osmotic diuretics are administered intravenously slowly by stream or drip. Mannitol – almost completely remains in the bloodstream (a dehydrating effect is observed in children), but a certain amount of it – up to 10% – penetrates into tissue cells. Sorbitol and urea penetrate the tissues in large quantities. Sorbitol can be metabolized to glycogen. Urea quite freely penetrates into the tissues of the body and for a long time, retaining in them, maintains their high osmotic pressure, which retains fluid in the tissues (the rebound effect). The diuretic effect of osmotic diuretics occurs almost immediately (after 10-15 minutes). The duration of the diuretic action lasts up to 4-6 hours and depends on the completeness of the withdrawal of the active pharmacological agent.

Pharmacodynamics: increased diuresis; a slight initial increase in blood pressure (due to a slight post-infusion increase in BCC). Osmotic diuretics in the proximal tubules increase the osmotic pressure of the primary urine, which causes relative fluid retention in the primary and then in the final urine [2].

Side effects: headache, nausea, vomiting. When it enters the subcutaneous tissue, it causes haemorrhages and tissue necrosis. Osmotic diuretics increase the permeability of the blood-brain barrier to other drugs and bilirubin – which can lead to bilirubin encephalopathy. The effect of rebound and increase in the level of residual nitrogen (due to urea) is also undesirable.

Mannitol (mannitol) is a six-hydric alcohol.

Urea for injection (urea) is a specially purified, sterilized, lyophilized powder.

Indications:

• drug poisoning (barbiturates, salicylates, sulfonamides, PAS, boric acid); hemolytic poisons (acetic and oxalic acid, antifreeze); transfusion of incompatible blood. Contribute to the alkalization of urine – prevent the coagulation of proteins, which means they prevent blockage of the renal tubules,

• toxic pulmonary oedema (poisoning with gasoline, kerosene, turpentine, formalin),

• fluid retention in case of poisoning with non-steroidal anti-inflammatory substances (when loop diuretics are ineffective),

• burns, sepsis, peritonitis, osteomyelitis – improve the excretion of toxic substances, increase low blood pressure [3].

Osmotic diuretics are considered effective and adequately dosed if the increase in diuresis is more than 50 ml per 1 m^2 of body surface per hour.

In clinical practice, in the presence of tissue oedema (due, as a rule, to the retention of Na^+ ions), it is first of all necessary to increase the excretion of sodium ions, and osmotic diuretics, unfortunately, are weak saluretics; that is why they are rarely used as diuretics. They are prescribed mainly for dehydration in combination with other diuretics to force diuresis. Sometimes osmotic diuretics are used to prevent acute kidney failure: by increasing blood volume, they reduce the relative oncotic pressure of the blood serum, inhibit reabsorption, which increases glomerular filtration to a certain extent, which increases diuresis. Osmotic diuretics act throughout the tubular apparatus of the kidney. Mannitol is mainly used as an osmotic diuretic. Mannitol, unlike urea, does not penetrate cell membranes, the blood-brain barrier, and does not increase the content of residual nitrogen in the blood [2].

Side effects. Osmotic diuretics can disrupt water-salt metabolism, causing hyponatremia, hyperazotemia, especially in patients with kidney and liver failure, as well as in the presence of circulatory failure. Due to the fact that urea is partially reabsorbed (up to 50%) and is able to penetrate into the cells, with cerebral oedema, urea can cause rehydration of the cells. With insufficient heart function, an increase in the volume of circulating blood with osmodiuretics makes it difficult for the myocardium to work and somewhat worsens the patient's condition.

In the clinic, mannitol is most often used to relieve oedematous syndrome of the brain and treat intracranial hypertension in patients after severe TBI and with volumetric formations of the central nervous system. At the same time, it is recommended to administer mannitol in the form of a rapid intravenous infusion of 20% solution for 15-30 minutes, the average dose of the drug is 0.5-1 g / kg of body weight. In this case, it is preferable to use a bolus (discrete) administration of mannitol, which reduces the incidence of the "recoil" phenomenon in comparison with the constant infusion of large doses of mannitol. Like all osmodiuretics, mannitol is advisable to use to temporarily reduce cerebral oedema and reduce ICP, provided that the administration of this drug is followed by more radical and effective therapeutic measures that, if possible, eliminate the cause of cerebral oedema and intracranial hypertension, surgical interventions are most often performed [4].

Osmodiuretics are widely used in neurosurgical interventions, especially in deep brain tumors, to control intracranial pressure, reduce

oedema and swelling of the brain, and improve conditions for surgical access. As previously mentioned, mannitol is administered as an intravenous infusion of 20% solution for 15-30 minutes immediately after the start of general anaesthesia, with adequate monitoring of hemodynamics and electrolyte balance parameters. The clinical effect develops 15 minutes after the start of the infusion and lasts 1.5-6 hours. Mannitol has been shown to be effective in reducing intraoperative retraction ischemia. Moreover, mannitol can be considered as a promising cerebroprotector in various types of neurovascular interventions – carotid endarterectomy, temporary clipping of cerebral arteries during operations for arterial aneurysms, and also as a component of the treatment of ischemic strokes accompanied by the development of secondary cerebral oedema [3].

There is an assumption about the practical use of mannitol in the chemotherapy of CNS tumors, due to the possibility of a short-term violation of the integrity of the blood-brain barrier under the influence of significant doses of mannitol, resulting in a temporary increase in the permeability of the blood-brain barrier for a number of antitumor substances, including methotrexate, cisplatin, CCNU.

Mannitol has also found practical application in ophthalmology. Here, due to effective control of the level of intraocular pressure, it is used to temporarily reduce intraocular pressure during various ophthalmic surgical interventions in patients with open-angle glaucoma [4].

Mannitol has shown its effectiveness in the prevention and early treatment of acute renal failure of ischemic and toxic origin. In the first and in the second variant, a decrease in diuresis is associated either with a decrease in the level of glomerular filtration, or a change in permeability in the tubular apparatus of the kidneys under the action of a toxic agent. When an osmodiuretic enters the lumen of the renal tubules, water reabsorption decreases sharply and the concentration of a toxic substance drops, and early administration of mannitol reduces the potential damaging effect of a toxic agent. In oliguric states, accompanied by a sharp drop in glomerular filtration, almost all the water that reaches the distal nephron is reabsorbed. But in the presence of an osmotic agent, the filtration of which changes little, the degree of water reabsorption decreases and, although limitedly, the production of secondary urine is maintained [5].

With a relatively short ischemia of the kidneys, the nephron walls are impermeable to mannitol, but with prolonged ischemia with the development of acute tubular necrosis or a high concentration of nephrotoxic substances that damage the tubular epithelium, the selective permeability of the nephron walls for water molecules gradually decreases, which makes the use of osmodiuretics ineffective. As already mentioned, mannitol has certain vasodilator properties. Indeed, at medium to low doses of mannitol (< 200 mg per day or < 400 mg in 48 hours), mannitol causes severe dilatation of the arteries and arterioles of the kidneys. At the same time, there is a significant increase in renal blood flow, primarily in the medulla, which is especially sensitive to ischemia. The mechanism of this phenomenon seems to be associated with a mannitol-induced increase in the production of prostaglandins in the medullary apparatus of the kidneys [6]. In the oliguric form of acute renal failure, a test dose of mannitol is usually administered first – 1-2 mg / kg of a 20% solution as an intravenous infusion over 20-30 minutes. If a urine output of more than 30-50 ml per hour cannot be achieved after administration of a test dose or a repeated dose of mannitol after 1-3 hours, then the patient's condition should be analysed, and other treatment options should be considered. In case of an adequate response to mannitol, osmotherapy can be continued as a continuous infusion of mannitol at a dose of 50-200 mg per day. The goal should be to establish urine output at a level of at least 30-50 ml per hour. Mannitol is used for the prevention and initial treatment of acute renal failure in haemolytic syndromes, rhabdomyolysis, the introduction of iodine-containing X-ray contrast agents, as well as in the early period after cadaveric kidney transplantation. In the 1980s, mannitol was used quite often in hepatobiliary surgery, especially in the presence of hyperbilirubinemia due to obstructive jaundice [7].

Mannitol is actively used as a nephroprotective agent during surgical treatment of abdominal aortic aneurysms. The use of mannitol not only avoids the development of acute renal failure in the postoperative period, but also significantly reduces the frequency and severity of subclinical kidney damage. Many authors also consider mannitol as a reliable means for preventing systemic disorders (in particular, pulmonary oedema), which often occur during operations for aneurysms of the abdominal aorta, as a result of reperfusion disorders after removal of the clamp from the aorta [8].

The antioxidant properties of mannitol made it possible to use it to prevent ischemic and post-reperfusion disorders during cardiac surgery – coronary artery bypass grafting, cor-

onary angioplasty, and surgical correction of heart defects. There are also reports of the use of mannitol as an antioxidant in the treatment of early myocardial infarction.

Promising is the use of mannitol in patients with compartment syndrome with limb injuries (subfascial oedema, local ischemia, neurological disorders) or crush syndrome. In both cases, the use of an osmodiuretic reduces the severity of local subfascial oedema, improves perfusion of the injured limb, and reduces the severity of post-reperfusion disorders [9].

Conclusion

Currently, the most commonly used osmotic diuretics include glycerol, mannitol, and urea. The principle of their action is aimed not only at causing forced diuresis, but also at ensuring the release of excess salts (primarily sodium ions), maintaining water-salt homeostasis and eliminating residues of nitrogen-containing compounds. At the same time, a decrease in blood viscosity and a decrease in renin secretion are achieved.

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ГЕНЕТИЧЕСКИЕ ЗАБОЛЕВАНИЯ ОРГАНОВ ЗРЕНИЯ В ВОРОНЕЖСКОЙ ОБЛАСТИ. АТРОФИЯ ЗРИТЕЛЬНОГО НЕРВА ЛЕБЕРА

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Наследственная нейропатия Лебера – это заболевание с преимущественным поражением митохондриального аппарата, которое является специфическим к клеткам сетчатки, снижая их способность вырабатывать достаточное количество энергии, необходимое для нормального функционирования нервной ткани. Чаще наследование происходит по материнской линии. Мутации митохондриальной ДНК, вызывающие данное заболевание, могут проявиться как с рождения, так и при действии определенных триггеров. В основе патогенеза данной патологии лежит нарушение синтеза белков цепи переноса митохондрий или их полное отсутствие, в результате наступает дефицит энергии в клетках зрительного нерва. Происходит атрофия и склероз нерва из-за активации фибробластов, продуцирующих соединительнотканные элементы. Наступает замещение функционирующей ткани соединительной и нарушается основная функция зрительного нерва, проведение импульса от сетчатки к отделам головного мозга. В представленной статье описывается клинический случай наследственной оптической нейропатии Лебера. Был проведен анализ медицинской документации пациентки (данные осмотра и опроса больного, лабораторных, инструментальных и генетических исследований), поступившей в отделение медико-генетической консультации Воронежской областной клинической больницы №1. За время наблюдения произведена офтальмоскопия, а также исключены другие возможные причины зрительных нарушений. Выдвинуто предположение о наличии у пациентки болезни Лебера, в связи с чем она была направлена на генетическое исследование, по результатам которого выявлена мутация в гене MT-ND4. Разбор клинического случая данной патологии показывает, необходимость в информированности специалистов в данной области и позволяет своевременно провести необходимое обследование, а также направить пациента на генетическое консультирование, для того что бы своевременно установить диагноз и начать лечение.

Ключевые слова: наследственная патология, атрофия зрительных нервов, митохондриальное заболевание, болезнь Лебера, оптическая невропатия

GENETICS DISEASES OF THE ORGANS OF VISION IN VORONEZH REGION. LEBER OPTIC NERVE ATROPHY

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Leber's hereditary neuropathy is a disease with a predominant lesion of the mitochondrial apparatus, which is specific to retinal cells, reducing their ability to produce enough energy necessary for the normal functioning of nervous tissue. Inheritance occurs more often on the maternal side. Mitochondrial DNA mutations that cause this disease can occur both from birth and under the action of certain triggers. The pathogenesis of this pathology is based on a violation of the synthesis of proteins of the mitochondrial transfer chain or their complete absence, as a result, there is a shortage of energy in the cells of the optic nerve. Nerve atrophy and sclerosis occur due to the activation of fibroblasts producing connective tissue elements. There is a replacement of the functioning connective tissue and the main function of the optic nerve is disrupted, the conduction of an impulse from the retina to the parts of the brain. This article describes a clinical case of Leber's hereditary optical neuropathy. The analysis of the patient's medical documentation (data from the examination and interview of the patient, laboratory, instrumental and genetic studies), who was admitted to the department of Medical and Genetic consultation of the Voronezh Regional Clinical Hospital No. 1, was carried out. During the observation, an ophthalmoscopy was performed, and other possible causes of visual disturbances were excluded. It was suggested that the patient had Leber's disease, and therefore she was sent for a genetic study, the results of which revealed a mutation in the MT-ND4 gene. The analysis of the clinical case of this pathology shows the need for awareness of specialists in this field and allows timely conducting the necessary examination, as well as referring the patient to genetic counseling in order to establish a diagnosis and start treatment in a timely manner.

Keywords: hereditary pathology, optic nerve atrophy, mitochondrial disease, Leber's disease, optical neuropathy

Введение

Генетические патологии органов, относящихся к анализаторам, являются самыми редко встречающимися заболеваниями. В частности, самыми редкими являются болезни органов зрения. Данная статья включает клинический случай, который описывает редко встречающуюся патологию органов зрения, носящую генетическую основу. К такому заболеванию относят атрофию зрительного нерва Лебера.

Атрофия зрительного нерва Лебера – заболевание с преимущественным поражением митохондриального аппарата, которое

является специфическим к клеткам сетчатки, снижая их способность вырабатывать достаточное количество энергии, необходимое для нормального функционирования нервной ткани. Чаще наследование происходит по материнской линии.

Причиной этого заболевания является мутация в митохондриальной ДНК, которая приводит к нарушению энергообеспечения нерва, из-за снижения активности ферментов митохондрий. По мимо изменений в ДНК, есть факторы, которые являются «пусковыми» в развитии заболевания: стресс, курение, употребление алкогольных напитков, черепно-мозговая травма, воздействие наркотических веществ, интерфероны, стероидные гормоны, противотуберкулезные антибиотики, любое острое соматическое заболевание и другие факторы, способствующие возникновению данной патологии [1].

В основе патогенеза лежит кодирование информации о синтезируемых белках и ферментах молекулой ДНК. В результате нарушения, произошедшего в ДНК, снижается синтез белков цепи переноса митохондрий. Из-за изменения структуры ДНК искажаются процессы транскрипции и трансляции, в результате чего синтезируются либо отличные по структуре белки и выполняющие другие функции, либо белки, необходимые для процессов образования энергии в клетках вообще не синтезируются. К таким белкам можно отнести редуктазы, убихиноны и другие белки первого комплекса митохондрий. Эти белки играют роль транспортеров молекул АТФ, а также эти соединения участвуют в метаболизме веществ с дальнейшей выработкой энергии. При снижении их выработки падает процесс синтеза АТФ в клетке. И как следствие клетки зрительных нервов испытывают гипоэрготическое состояние или состояние нехватки энергии. Следовательно, нарушается функция нерва в целом, зрение начинает падать и в конечном счете нерв перестает функционировать. Происходит его атрофия и склерозирование тех участков в головном мозге, ответственных за принятие импульса с рецепторов сетчатки [2].

Для своевременной диагностики и расширения возможности этиологической и патогенетической терапии редко встречающихся генетических аномалий органов зрения необходимо уделять особое внимание клинической картине заболеваний у каждого отдельно взятого пациента. Как правило, лечения наследственной оптической невропатии Лебера не существует, но можно замедлить прогрессирование заболевания, путем приема различных витаминов и коферментов.

В связи с этим, основной **целью исследования** является описание клинического случая заболевания атрофии зрительного нерва Лебера, которая из большинства заболеваний органов зрительного аппарата, является самой редкой.

Материалы и методы исследования

Исследование проводилось на базе БУЗ ВО «Воронежской областной клинической больницы №1» в отделении медико-генетической консультации перинатального центра. Основой для составления статистики по частоте встречаемости данной патологии являлись медицинские карты, которые рассматривались за последние полгода 2023 года.

Согласно полученным данным частота встречаемости больных с атрофией зрительного нерва Лебера за последние 6 месяцев на базе БУЗ ВО ВОКБ №1 составила 9,09%, т.е. 1 случай из 11 обратившихся больных с подозрением на аномалию Лебера (таблица). Наряду с этим количество больных, обратившихся в стационар больницы по поводу приобретенных патологий, таких как миопия, помутнение хрусталика, повышенное внутриглазное давление и других заболеваний, составило около 223 человек, что в 20,27 раз больше, чем количество людей, с генетическими отклонениями зрительного аппарата. Что подтверждает редкость этой патологии в клинической практике и практике врачей-генетиков.

Исследование методом мультиплексной лигазной полимеразной цепной реакции (MLPA), один из часто используемых методов для подтверждения большинства генетических патологий.

Частота встречаемости атрофии зрительного нерва Лебера в практике БУЗ ВО «Воронежской областной клинической больницы №1»

Приобретенные патологии органов зрения, количество больных	Общее количество больных, с предполагаемыми генетическими аномалиями зрения	Количество больных атрофией зрительного нерва Лебера за последние 6 месяцев 2023 года
223	11	1

MLPA – это метод молекулярной генетики, служащий для определения относительного количества копий участков ДНК. Используется для подтверждения мутации в гене MT-ND4, которая и характеризует атрофию зрительных нервов Лебера [3]. Метод MLPA проводится следующим образом, сначала забирают кровь в пробирку с антикоагулянтом. На первом этапе самого анализа проводится разрушение ДНК и ее «слияние» со специфическими зондами. Зонды располагаются близко друг к другу. И к одному из их концов присоединена комбинация нуклеотидов или последовательность для прикрепления универсального праймера. На следующем этапе проведения анализа происходило расщепление проб с помощью фермента – лигазы. Далее производилась мультиплексная полимеразная цепная реакция-амплификация с использованием универсальных праймеров, при этом многократно увеличивается количество только лигированных фрагментов. В результате реакции амплификации получаются продукты, которые имеют разные размеры, они будут сепарироваться или отделяться с помощью капиллярного электрофореза. На компьютере будет отображаться пик и его высота, которые на электрофореграмме отражают состояние данного генетического локуса. То есть произошла ли делеция, дупликация или перед нами норма [4].

Обычно, для определения наследственной оптической невропатии Лебера, в комбинации с методом MLPA идет секвенирование по Сенгеру [5]. Для начала, у исследуемого забирают кровь в пробирку объемом около 4-5 миллилитров, содержащую этилендиаминтетрауксусную кислоту, выступающую в роли антикоагулянта. ДНК разделяют на 4 отдельные реакции секвенирования, содержащие все четыре дезоксинуклеотида (dATP, dCTP, dGTP, dTTP) и ДНК-полимеразу, достраивающую комплементарные цепи. В результате достраивания цепи можно получить на мониторе компьютера точную картину, в которой видны обрывы цепи из-за наличия мутации в ее ДНК [6].

Клинический случай

В июне 2023 года на прием в БУЗ ВО ВОКБ №1 в офтальмологическое отделение поступила женщина 30 лет с жалобами на резкое падение зрения. Из анамнеза: считает себя больной с августа 2022 года, когда на фоне полного здоровья стало постепенно снижаться зрение. В августе 2022 года стала появляться пленка перед глазами с обоих сторон. Врач-офтальмолог в августе 2022 года определил остроту зрения: справа 0,6-0,7, а слева – 0,02. Был поставлен предварительный диагноз прогрессирующая миопия. С этого момента зрение постепенно ухудшалось. В июне 2023 года офтальмолог направил женщину на обследование, для уточнения неврологического статуса пациентки. При обследовании у врача невролога было установлено: высшие мозговые центры у пациентки не нарушены, за молоточком при исследовании больная не следит (так как не видит его), объем движения глазных яблок не ограничен (смотрит по просьбе врача вверх, вниз, вправо и влево), птоза и нистагма не наблюдалось, мимика симметрична, парезов нет, сухожильные и периостальные рефлексы с конечностей равномерные живые, язык по средней линии, чувствительность (болевая и мышечно-суставное чувство) не нарушена. В пробе Ромберга устойчива, указательные пробы выполняет удовлетворительно. Пока происходили дообследования, врач-офтальмолог при повторном осмотре глазного дна через несколько дней наблюдал следующую картину: отек и бледность зрительного диска и точечные кровоизлияния в сетчатку глаза. Наследственный анамнез отягощен: мать больной в возрасте 28-29 лет потеряла зрение на оба глаза, в 32 года умерла во сне (причина неизвестна). У сына пациентки глухота с 3 лет – ему был установлен кохлеовестибулярный имплант.

В качестве инструментальных методов исследования больной было назначено МРТ головного мозга с внутривенным контрастированием. Была обнаружена картина единичного супратенториального очага глиоза (разрастания соединительной ткани в правой лобной доле, сосудистого генеза), интракраниальная асимметрия сегментов позвоночных артерий и сужение правой позвоночной артерии. Исходя из картины МРТ и неврологического статуса пациентки врач-офтальмолог назначил генетический тест ДНК методом MLPA, для подтверждения патологии атрофии зрительного нерва Лебера, с дальнейшим направлением пациентки в отделение медико-генетической консультации.

Результаты исследования и их обсуждение

По результатам метода MLPA была выявлена мутация m.11778G> A в гене MT-ND4 в гомоплазмическом состоянии. Этот ген ответственен за синтез специализированных белков первого комплекса дыхательной цепи митохондрий, к ним относятся различные виды редуктаз, убихиноны и другие белки данного комплекса. Это обуславливает нарушение процессов транспорта молекул АТФ в клетках, в результа-

те чего падает энергетический потенциал клеток зрительных нервных волокон и наступает их атрофия. В подтверждение лабораторных и инструментальных методов, указавших на генетически обусловленную атрофию зрительного нерва Лебера, был проведен так же анализ родословной. После составления схемы родословной, которая представлена на рисунке, был проведен ее тщательный анализ врачами-генетиками.
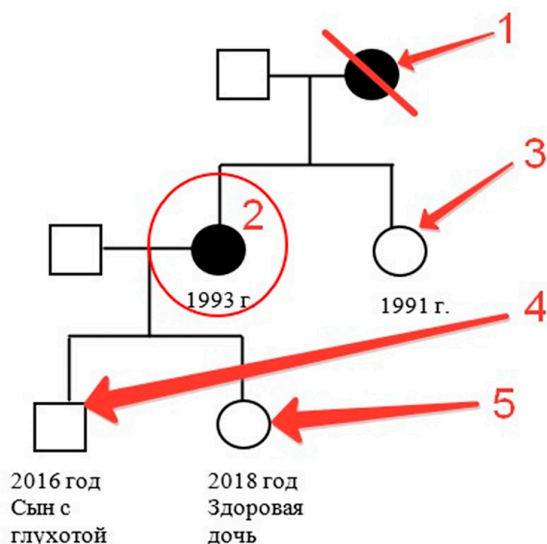

Схема родословной пациентки:
1 – мать пациентки, 2 – пациентка,
3 – сестра пациентки, 4 – сын пациентки,
5 – дочь пациентки

В родословной пациентки с ее слов, мама теряла зрение точно также как и она, следовательно она являлась носительницей мутантного гена, локализованного в митохондриальной ДНК. У пациентки имеется родная сестра, рожденная в 1991 году, у которой никаких отклонений в здоровье не наблюдалось. У больной были рождены двое детей: мальчик – родившийся в 2016 году и обладающий глухотой, и девочка, родившаяся в 2018 году, на данный момент не имеющая в здоровье никаких отклонений. Но высок риск передачи генов, ответственных за данную патологию как девочке, так и мальчику, так как передача происходит по материнской линии. Риск в потомстве высокий и стремится к 100%. Были даны следующие рекомендации: провести анализ ДНК сыну и дочери, осмотр в отделении медико-генетической консультации в динамике. Так же было назначено лечение: коэнзим Q10 (кудевита 30 mg внутрь 2 раза в день по 1 таблетке), L-карнитина постоянно в стандартных дозировках (элькар по 2,5 ml внутрь 3 раза в день).

Заключение

Таким образом, мутация, которую удалось обнаружить у женщины является, пожалуй, самой агрессивной и наиболее тяжелой формой данной патологии m.11778G> A – самая тяжелая форма атрофии зрительного нерва Лебера, а например m.3460G> A – более легкая форма. Так же существуют больные с еще одним видом мутации митохондриальной ДНК m.14484T> C – она дает наиболее благоприятный прогноз лечения.

Исследуя заболеваемость органов зрения, которые носят генетическую основу на базе БУЗ ВО «Воронежской областной клинической больницы №1», удалось выяснить, что наиболее редко встречающейся генетической патологией органов зрения является нейропатия Лебера, в данной клинике встречаемость составляет 9,09 % из обратившихся 11 человек по подозрению на эту патологию, то есть только у одного из них это заболевание подтвердилось. Так же эта патология имеет различный вид проявлений. Эта болезнь может проявляться с рождения, а может и не проявиться, и быть в форме носительства. Но при действии определенных факторов, таких как стресс, курение, алкоголь, возможно проявление атрофии зрительного нерва Лебера с быстрым прогрессирующим течением.

Данный клинический случай показывает, что осведомленность о данной болезни повышает информированность врача-клинициста в данной области, позволяет провести полное обследование, направить пациента на генетические исследования, своевременно установить диагноз, а так же назначить необходимое лечение, которое будет направлено на замедление прогрессирования заболевания.

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УДК 330.131.7

РИСКИ ПРИ СТРОИТЕЛЬСТВЕ ОБЪЕКТОВ ЖЕЛЕЗНОДОРОЖНОЙ ИНФРАСТРУКТУРЫ БАЙКАЛО-АМУРСКОЙ И ТРАНССИБИРСКОЙ ЖЕЛЕЗНОДОРОЖНЫХ МАГИСТРАЛЕЙ

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«Комплексный план модернизации и расширения магистральной инфраструктуры» является одним из крупных инвестиционных проектов, реализацией которого занимается Открытое акционерное общество «Российские железные дороги». Целью исследования являются инвестиционно-строительные риски, с которыми сталкивается Заказчик при реализации проекта. Для этого проведен анализ нормативной документации по данному вопросу, изучены статистические данные, исследованы такие внутренние нормативные документы железнодорожной компании как «Паспорт рисков», Инвестиционный план компании. Авторами дано определение риска, рассмотрены отечественные и зарубежные классификации рисков. Также определены риски, относящиеся к каждому участнику инвестиционно-строительного проекта. А также рассмотрены риски с позиции возникновения на разных этапах жизненного цикла проекта. При помощи метода анализа и синтеза информации проведена классификация рисков и проведен их анализ с участием экспертов, а также проранжированы риски по степени вероятности их возникновения. Проведен качественный анализ выявленных рисков с использованием карты рисков. В результате авторами установлено, что риски «Неэффективность деятельности по реконструкции» и «Неэффективность деятельности по строительству», имеют самые высокие показатели вероятности наступления. Также исследование показало, что для более точного определения наступления рискового события необходимо также провести количественный анализ выявленных рисков.

Ключевые слова: риск, инвестиционный строительный проект, Байкало-Амурская магистраль, Транссибирская железнодорожная магистраль, инвестиционная деятельность

RISKS IN THE CONSTRUCTION OF RAILWAY INFRASTRUCTURE FACILITIES OF THE BAIKAL-AMUR AND TRANSSIBERIAN RAILROADS

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The Comprehensive Plan for the Modernization and Expansion of the Mainline Infrastructure is one of the major investment projects implemented by the Open Joint Stock Company Russian Railways. The purpose of the study is the investment and construction risks faced by the Customer during the implementation of the project. To do this, an analysis of regulatory documentation on this issue was carried out, statistical data were studied, such internal regulatory documents of the railway company as the "Risk Passport" and the company's Investment Plan were investigated. The authors define the risk, and consider domestic and foreign risk classifications. The risks related to each participant of the investment and construction project are also identified. Risks are also considered from the point of view of occurrence at different stages of the project life cycle. Using the method of analysis and synthesis of information, a classification of risks was carried out and their analysis was carried out with the participation of experts, as well as risks were ranked according to the degree of probability of their occurrence. A qualitative analysis of the identified risks was carried out using a risk map. As a result, the authors found that the risks of "Inefficiency of reconstruction activities" and "Inefficiency of construction activities" have the highest probability of occurrence. The study also showed that in order to more accurately determine the occurrence of a risk event, it is also necessary to conduct a quantitative analysis of the identified risks.

Keywords: risk, investment construction project, Trans-Siberian Railway, Baikal-Amur Mainline, investment activities

Введение

Инвестиционно-строительная деятельность подвержена разнообразным рискам в силу своей специфики, которые нельзя заранее предусмотреть и просчитать. Работа по их выявлению и предупреждению должна быть организована в течение всего срока реализации проекта, на всех его стадиях. Это позволит максимально «безболезненно» достичь целей, ради которых данный проект реализуется.

Цель исследования: определить основные риски, возникающие при реализации строительно-инвестиционных проектов, реализуемых в рамках национального проекта «Железнодорожный транспорт» и дать качественную оценку рисков с помощью различных методов исследования.

Материалы и методы исследования

Основой для исследования выбранной темы послужили как научная литература, так и используемые в работе законодательные акты РФ. С помощью методов анализа и синтеза информации авторами проведена классификация и анализ рисков, возникающих в строительной деятельности.

Результаты исследования и их обсуждение

На сегодняшний день одним из инструментов расширения потенциала российской экономики являются национальные проекты. Так, реализуемый сегодня Комплексный план модернизации и расширения магистральной инфраструктуры, утвержденный Распоряжением Правительства РФ от 30 сентября 2018 года №2101-р, предусматривает повышение уровня экономической связанности территории Российской Федерации посредством расширения и модернизации железнодорожной инфраструктуры. Срок его реализации установлен до 2024 года [1].

Реализация данного плана предусматривает этапность работ. Первый из них завершен. С 2021 года воплощается в жизнь второй этап модернизации железнодорожной инфраструктуры БАМа и Транссиба.

В конце 2023 года проведена работа по организации третьего этапа работ. Этапы работ представлены на рис. 1.

Национальный проект направлен на увеличение пропускной способности БАМа и Транссиба к 2024 году в 1,5 раза, до 180 млн тонн в год, а также сокращение до семи суток сроков доставки транзитных контейнерных грузов на направлении «Восток – Запад» [2].

Перспективные перевозки грузов через Транссиб и БАМ, связаны главным образом со значительным увеличением объемов перевозок топливно-энергетических и массовых грузов, следующих в адрес дальневосточных портов, проект нацелен также на увеличения поездопотока, сокращения времени простоя вагонов в ожидании погрузки и разгрузки, снижения потребления электроэнергии.

Транссибирская железнодорожная магистраль или Транссиб – железная дорога, проходящая от Москвы через Восточную Сибирь до Дальнего Востока.

Байкало-Амурская магистраль или БАМ – железная дорога, соединяющая Восточную Сибирь (из города Тайшет) и Дальний Восток, проходящая севернее Транссиба и имеющая большое стратегическое значение (рис. 2).

При этом развитие дороги предполагает использование экологически чистого вида транспорта – электрификацию линий БАМа, для чего также требуется строительство подстанций и модернизация локомотивных депо. Реконструкция путей позволит экономить природные ресурсы.

Для достижения этих целей проводится глобальная модернизация, в том числе за счет строительства второго пути на всем протяжении БАМа, предусмотрено строительство тоннелей, мостов, перегонов и множества объектов инфраструктуры.

В Иркутской области и частично на территории Республики Бурятии ведутся работы по увеличению пропускной способности БАМа и Транссиба с участием в качестве заказчика Дирекции по комплексной реконструкции железных дорог и строительству объектов железнодорожного транспорта – филиала ОАО «РЖД» (ДКРС).

Участниками проекта являются – инициатор проекта, инвестор, заказчик, застройщик, подрядчик.

В зависимости от роли в реализации проекта у участников формируются риски, указанные авторами в таблице 1.

Деятельность всех участников проекта направлена на своевременный и качественный ввод в эксплуатацию строительного объекта. Кроме того, все участники строительного процесса обязаны обеспечивать минимизацию рисковых событий, влияющих на ход строительной деятельности.

При реализации крупномасштабного национального проекта в своей деятельности заказчик – ДКРС сталкивается с различными рисками, возникающими в ходе осуществления ИСП, анализ которых будет проведен в данной статье.

Из множества формулировок риска, приведенных различными авторами наиболее близкое к теме исследования определение указано в ГОСТ Р ИСО 31000-2010 «Менеджмент риска. Принципы и руководство» – риск (risk) – влияние неопределенности на цели. Необходимо учитывать и то, что в целом инвестиционно-строительная деятельность подвержена разнообразным рискам в силу своей специфики. Нельзя заранее предусмотреть и просчитать все риски. Работа по их выявлению и предупреждению должна быть организована в течение всего срока реализации проекта, на всех его стадиях. Это позволит максимально «безболезненно» достичь целей, ради которых данный проект реализуется.

Таким образом, можно уточнить определение риска как влияние неопределенности на достижение цели, на отклонения от поставленных целей.
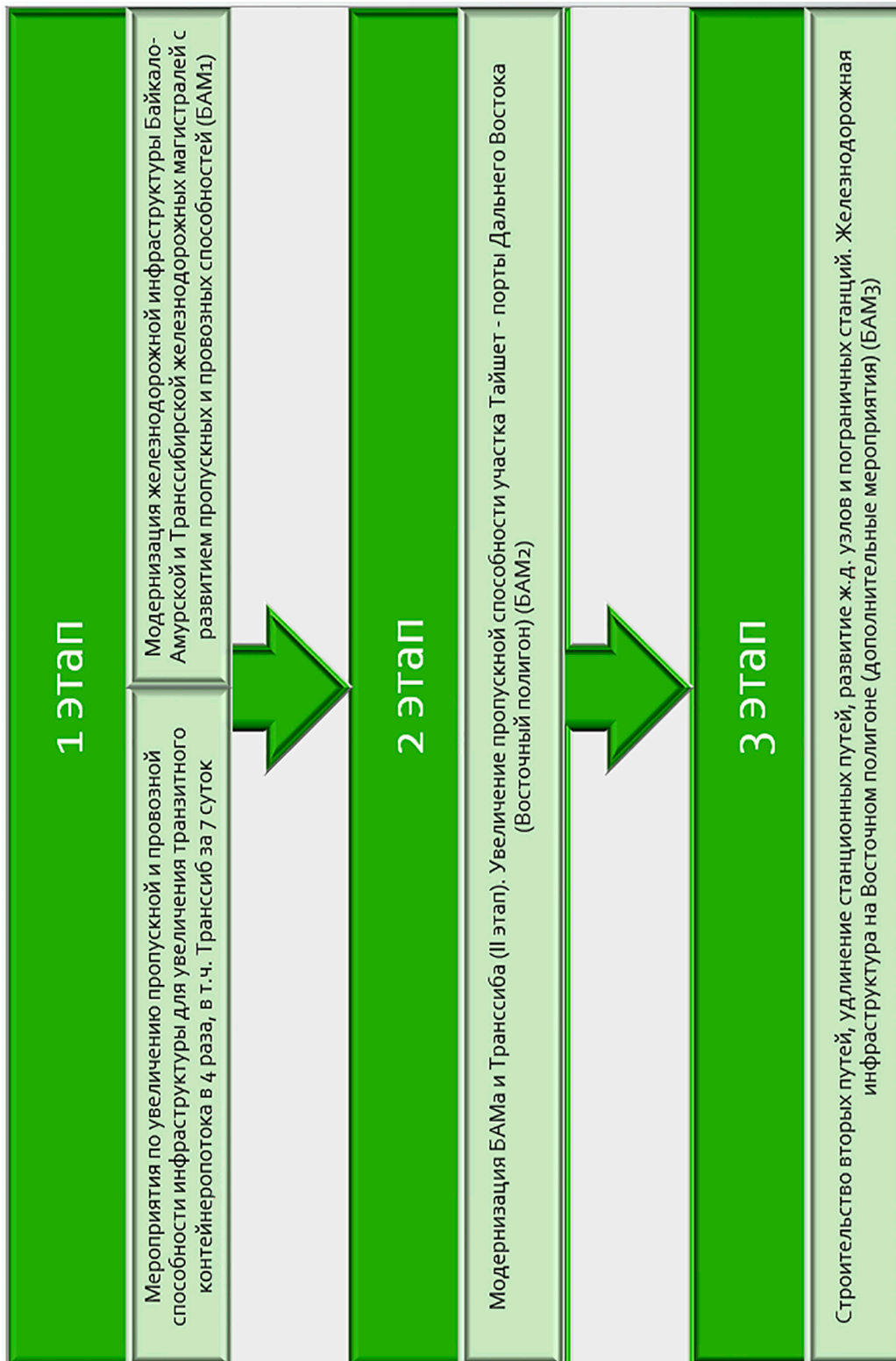
Рис. 1. Этапы выполнения работ по КПМИ
Источник: составлено авторами

Рис. 2. Расположение Транссиба и БАМа на карте России
Источник: https://www.yandex.ru/images/search

Рис. 3. Схема взаимодействия участников реализации проекта
Источник: составлено авторами

Таблица 1

Риски, формируемые в зависимости от роли участника проекта

Участник проекта	Наименование	Роль в проекте	Риск
Инициатор проекта	Государство – Российская Федерация	Инвестор. Финансирование за счет средств Федерального бюджета. Устанавливает физические параметры, которые необходимо достичь в результате реализации проекта	Финансовые, репутационные
Руководитель проекта	ОАО «РЖД»	Инвестор. Использование собственных средств ОАО «РЖД». Общее руководство проектом	Экономические, социальные
Управляющий проектом	Управление капитального строительства ОАО «РЖД» (ЦУКС)	Планирование, организация, координация участников проекта, контроль выполнения работ	Экономические, социальные
Заказчик/ Застройщик	ДКРС – филиал ОАО «РЖД»	Обеспечивает реализацию и выполнение работ по формированию инвестиционного актива в рамках объекта инвестиций	Экономические, финансовые, экологические, операционные, социальные
Подрядчик/ субподрядчик	Определяются конкурсом	Исполняет предусмотренные в договоре обязанности	Риск не выполнения условий договора, либо некачественного выполнения работ, выполнение работ не в соответствии с ПСД
Проектировщик	Определяются конкурсом	Подготовка проектной документации	Ошибки в расчетах, неправильное определение сметной стоимости строительства, просчеты
Балансодержатель	Эксплуатирующее подразделение ОАО «РЖД»	Принимает от Заказчика на баланс законченный строительством объект	Экономические

неизбежные риски, которые можно заранее учесть

- риски от природных катаклизмов и других стихийных бедствий
- риски потерь от аварий, краж, народных волнений
- потери от нечестности и небрежности работников фирмы
- от нарушений обязательств партнерами, подрядчиками и др.;

связанные с неопределенностью самого процесса бизнеса

- потери из-за непредсказуемого изменения рыночного спроса и предложения на товары и услуги
- изменения мировой конъюнктуры акций и других ценных бумаг, биржевой игры цен
- появления неожиданных достижений научно-технического прогресса и т.п.

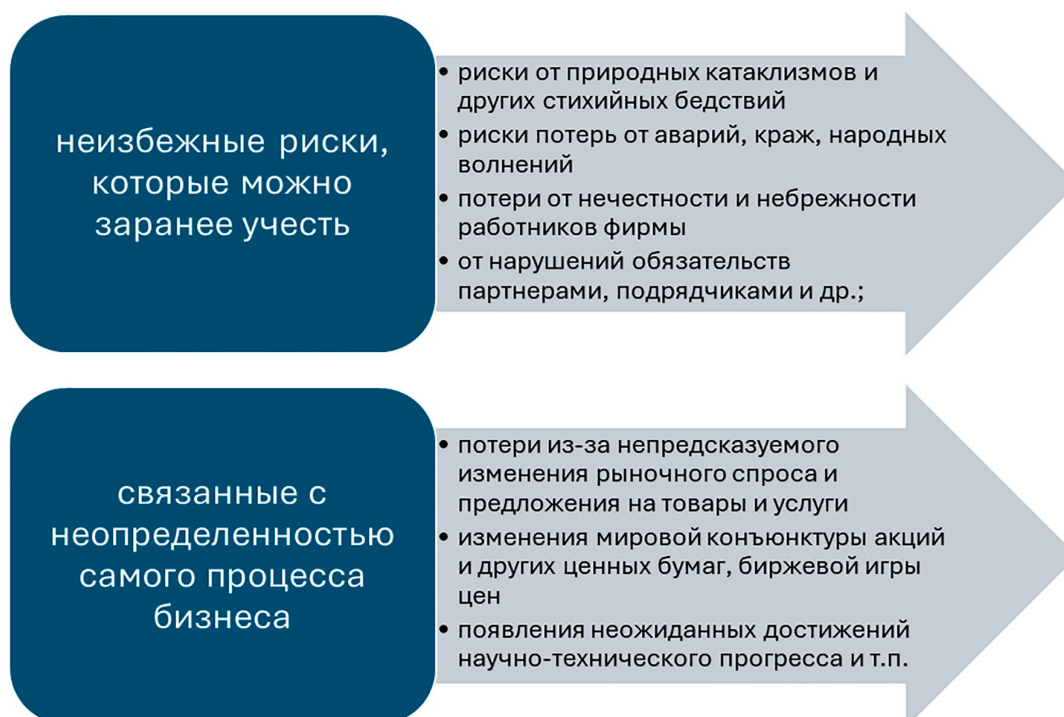*Рис. 4. Схема взаимодействия участников реализации проекта*
Источник: составлено авторами

Классификации рисков российскими учеными [4]

| Автор	Виды рисков
Лукьянова А.Н. [5]	внешние непредсказуемые риски, внешние предсказуемые риски, внутренние организационные риски, технические риски, правовые риски
Прыкина Л.В. [6]	риски концептуальной стадии, планирования, проектирования, выполнения строительных работ, эксплуатации
Селина В.П. [7]	проектный риск, связанный с реализацией проекта, финансовый риск (не возврат кредитов, займов), производственный риск, политический риск, внешние риски
Леонов П.Ю. [8]	финансовые, экономические, рыночные, инвестиционно-коммерческие, производственно-технические, правовые, страховые, политические, экологические, социальные
Петрова О.И. [9]	риски гражданской ответственности перед третьими лицами, строительно-монтажные риски, риски неисполнения послепусковых гарантийных обязательств, финансовые риски
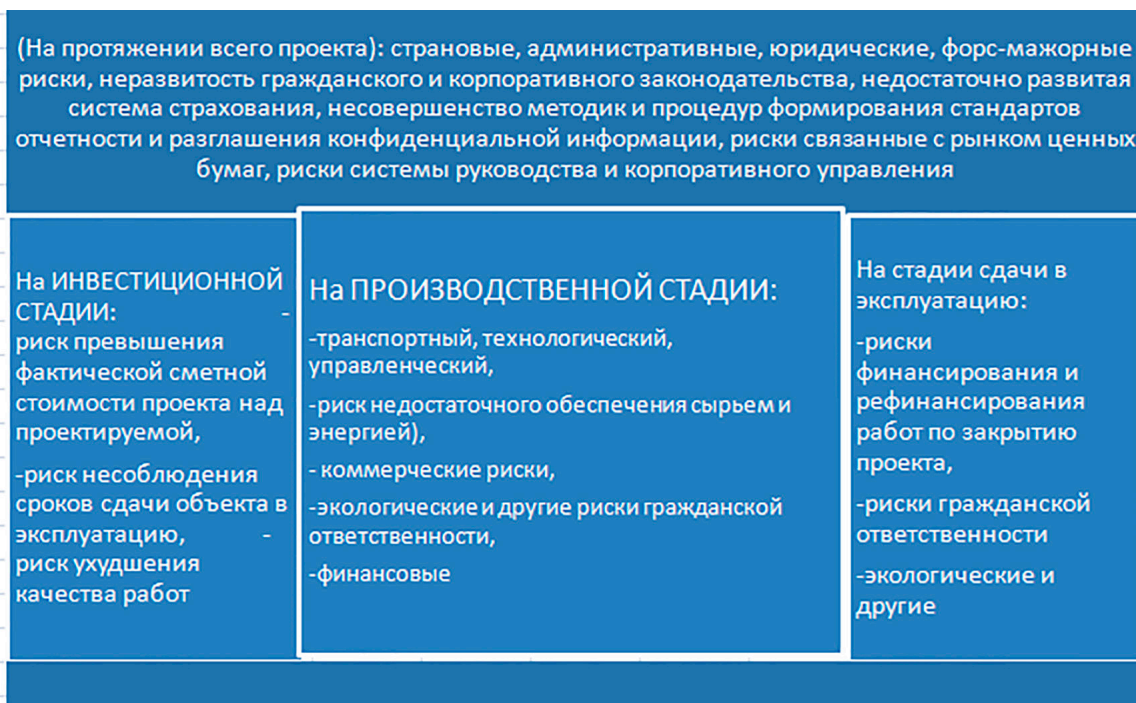
Рис. 5. Стадии жизненного цикла ИСП
Источник: составлено авторами

Существует множество точек зрения на классификацию рисков реализации ИСП.

Зарубежные исследователи выделяют две группы рисков, представлены на рис. 4 [3].

Российскими учеными разработано много классификаций рисков при реализации ИСП, некоторые из которых представлены в таблице 2.

Для проведения достоверного анализа рисков необходимо понимать на какой стадии жизненного цикла ИСП и какие риски возникают. Так, наглядно представлена схема в работе Аблязова Т.Х., Александровой Е.Б. на рис. 5.

В своем исследовании авторы рассматривают риски реализации ИСП на производственной стадии, когда проект уже реализуется, т.е. непосредственно в ходе строительства вторых путей, мостов, тоннелей и т.д.

Анализ рисков, возникающих в ходе реализации проекта, показал, что проект, реализуемый ДКРС подвержен влиянию девяти основным рискам, которые можно разделит на три группы, представленные на рис. 6.
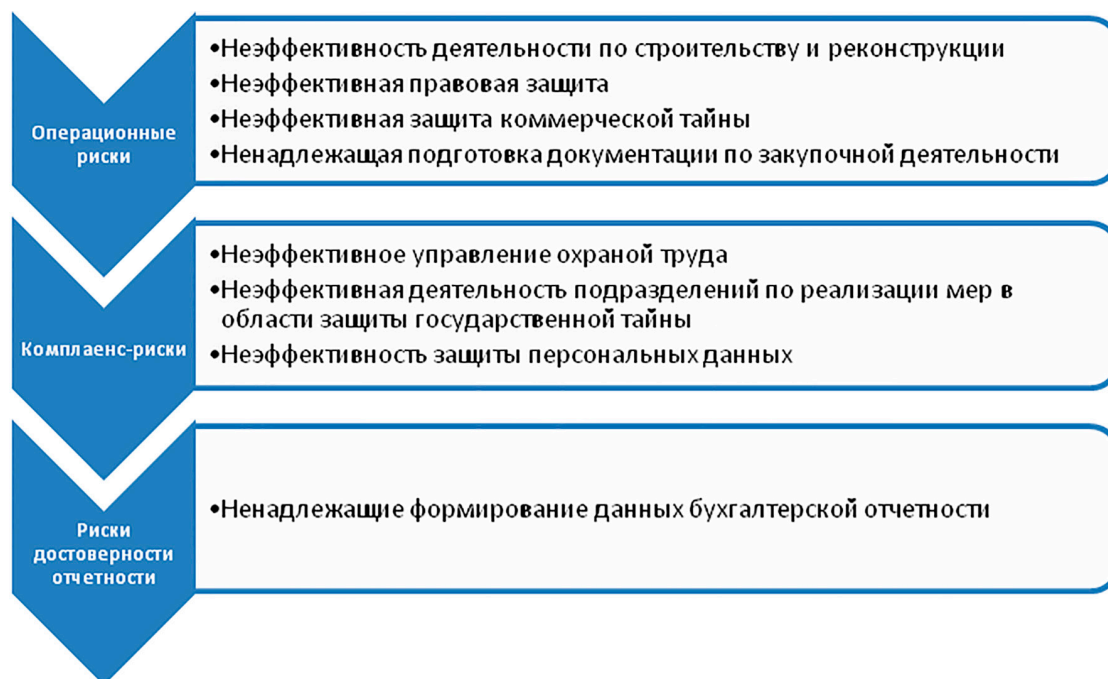
Рис. 6. Классификация рисков при реализации проекта
Источник: составлено авторами

Вероятность реализации риска	Баллы	Вероятность, %	Описание события
Крайне высокая	5	>75%	Событие почти точно произойдет
Высокая	4	51-75%	Событие скорее произойдет, чем не произойдет
Средняя	3	26-50%	Умеренная вероятность реализации события
Низкая	2	5-25%	Событие скорее не произойдет, чем произойдет
Крайне низкая	1	<5%	Событие почти точно не произойдет

Рис. 7. Шкала оценки рисков [11]

Перечисленные выше риски, с которыми сталкивается ДКРС при реализации проекта, отражаются в «Паспорте рисков», который ежеквартально обновляется на всех стадиях реализации проекта и состоит из следующих разделов:

- «Реестр рисков», в котором перечисляются подробно возможные рисковые события;

- «План мероприятий», в котором отражаются необходимые мероприятия, проводимые в целях недопущения или минимизации рисковых событий;

- «Отчет о реализовавшихся рисках».

Определив виды рисков, можно провести их качественный анализ.

В проведенном автором исследовании были применены качественные методы анализа – анализ экспертных оценок, карта рисков.

Метод экспертных оценок позволяет принять решение при отсутствии достаточно достоверных статистических данных или высокой степени новизны решаемой задачи [10].

Для проведения анализа рисков по методу экспертных оценок привлечены пять экспертов. С помощью двух параметров вероятность реализации и воздействие на риск произведен расчет средневзвешенной интегральной оценки важности риска с учетом уровня компетенции специалистов.

Показатели, характеризующие риски при реализации проекта

№ п/п	Наименование риска	Вероятность	Воздействие
1	Неэффективность деятельности по строительству	3,5	4,7
2	Неэффективная правовая защита интересов ОАО «РЖД»	2,8	3,5
3	Неэффективность деятельности по реконструкции	3,3	3,7
4	Неэффективность управления охраной труда	2,0	3,4
5	Неэффективность управления пожарной безопасности	1,9	3,9
6	Неэффективность защиты коммерческой тайны	3,0	4,3
7	Ненадлежащее формирование данных, используемых в целях бухгалтерской, налоговой, операционной и статистической отчетности	3,2	4,3
8	Ненадлежащая подготовка документации для осуществления закупочной деятельности на конкурсной основе	2,7	4,2
9	Неэффективная деятельность подразделения по реализации мер в области защиты государственной тайны	2,1	4,1
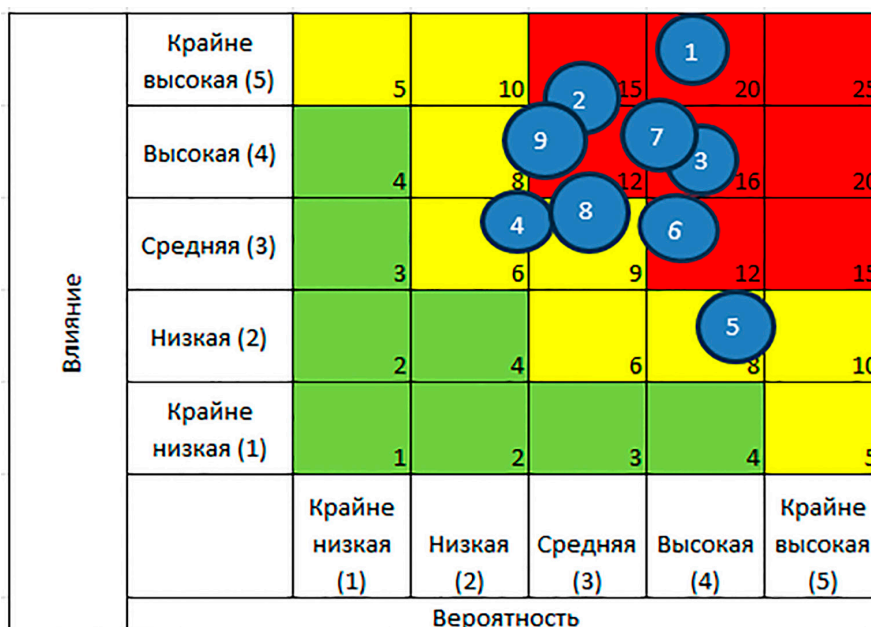
Рис. 8. Карта рисков при реализации проекта
Источник: составлено авторами

При проведении исследования использована пятиуровневая шкала (рис. 7).

По результатам оценки были выведены показатели, представленные в таблице 3.

Из проведенного анализа следует, что самые высокие показатели вероятности наступления имеют риски «Неэффективность деятельности по реконструкции» и «Неэффективность деятельности по строительству».

Самыми существенными рисками по воздействию стали риски «Неэффективность деятельности по строительству», «Ненадлежащее формирование данных, используемых в целях бухгалтерской, налоговой, операционной и статистической отчетности», «Неэффективность защиты коммерческой тайны».

При этом обращает на себя внимание такой факт, что при небольшой степени вероятности такой риск как «Неэффективная деятельность подразделения по реализации мер в области защиты государственной тайны» имеет большое воздействие на деятельность подразделения.

Карта рисков – инструмент графического отображения совокупности выявленных

рисков с учетом вероятности их реализации и влияния риска (рис. 8) [12].

Риски «Неэффективность управления охраной труда», «Неэффективность управления пожарной безопасности» и «Неэффективная деятельность подразделения по реализации мер в области защиты государственной тайны» находятся на грани «желтой» и «красной» зон, это риски средней чувствительности/ опасности/ критичности для компании. Но в данном случае в любой момент могут перейти в «красную» зону.

Такие риски как «Неэффективная правовая защита интересов ОАО «РЖД», «Ненадлежащее формирование данных используемых в целях бухгалтерской, налоговой, операционной и статистической отчетности», «Неэффективность защиты коммерческой тайны», «Неэффективность деятельности по реконструкции» и «Неэффективность деятельности по строительству», «Ненадлежащая подготовка документации для осуществления закупочной деятельности на конкурсной основе» располагаются в «красной» зоне. Это критические, наиболее опасные для компании риски, несущие существенные угрозы для компании, подразделения, его целей и устойчивости в целом.

Наглядность этого метода дает более точно представление о тех рисках, на которые следует обратить внимание для выработки стратегии по работе с этими рисками.

Для того чтобы оценить размер риска необходимо после проведения качественного анализа, провести количественный анализ, который также можно провести, используя различные методы, но такая задача не стоит в рамках данного исследования.

Заключение

Таким образом, для проведения качественного анализа рисков при реализации крупного инвестиционно-строительного проекта является важным выявить все возможные риски, возникающие на исследуемом этапе жизненного цикла проекта. Немаловажным является привлечение высококвалифицированных специалистов в области оценки рисков, которые дадут им профессиональную оценку, которая позволит проранжировать риски по степени вероятности их возникновения и по степени их влияния. А примененная карта рисков при реализации проекта обозначит самые вероятные риски, по работе с которыми необходимо разработать стратегию по минимизации указанных рисков. Постоянный мониторинг и качественная оценка рисков на протяжении реализации всего проекта позволит избежать значительные правовые и финансовые потери.

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