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THE TRANSFORMATION OF EXTERNAL ATTRIBUTES OF 21ST-CENTURY EDUCATION AND THEIR IMPACT ON STUDENTS' INDIVIDUAL STUDY

Abstract. *There has been a socio-cultural shift among young people. One of the most important trends in modern education is the almost complete transformation of the external attributes of the educational process. These external attributes refer to the set of conditions, technologies, methodological tools, and forms of organizing educational activities that directly or indirectly influence the entire educational process. Given the transformation of the external attributes of education in the 21st century, it is necessary to assess*

their impact on the organization of individualized learning for students in higher education institutions and to develop a new strategy for creating academic and methodological literature to ensure high-quality individualized learning throughout the educational process.

Keywords: *educational activities, external attributes, individual study, individual learning, individual work, scientific and methodological literature*

Introduction. In the 21st century, the higher education system has undergone a significant transformation. This is due to the rapid development of information technology, the widespread digitization of society, and globalization [1].

In addition, there has been a socio-cultural shift among young people. The traditional model of education, which relied primarily on lecture-based work and direct interaction between lecturers and students, has gradually changed. Today's student is no longer a passive consumer of knowledge [2]. He or she is now an active participant in educational activities, engaged in the individual search for information, its analysis, and systematization.

One of the most important trends in modern education is the almost complete transformation of the external attributes of the educational process. These external attributes refer to the set of conditions, technologies, methodological tools, and forms of organizing educational activities that directly or indirectly influence the entire educational process. In today's reality, these attributes include digital platforms, distance learning, electronic repositories, as well as social networks, online courses, multimedia technologies, video conferencing, and other widely used tools of the digital educational environment.

At the current stage of educational development, a key distinction is that external attributes no longer serve merely a supporting role. From now on, they constitute an individual mechanism for organizing educational activities, one that also significantly influences the development of new models of individual study among students [3]. Whereas in the past, individual work was limited to studying printed materials, taking lecture notes, and completing practical or laboratory assignments in written form, it now includes the active use of digital resources, engagement with online research, and the use of interactive platforms and other means of electronic communication.

On the other hand, the concept of attribution is directly linked to an individual's (in this case, students') explanation of the causes of events occurring in their lives. In the context of educational activities, external attributions refer to the tendency to explain one's own successes or failures by circumstances beyond one's control [4–5]. These circumstances refer to the influence of external factors such as learning conditions, the complexity of the material presented, one's own technical capabilities, the strictness of the instructor's requirements, the specifics of using the educational platform, or the social environment. In an asynchronous learning format, the role of such external attributions increases significantly and, in some cases, noticeably. Since the learner is left alone with the learning material and must now individually organize their own educational process.

The research topic is highly relevant, and its urgency stems from the need to analyze the impact that external factors have on the organization of individual study by students in higher education institutions. Of particular importance here is determining exactly how digitalization is transforming the educational process, influencing students' motivation, shaping new competencies, and creating conditions for the professional development of future specialists. There is a need to reformat individual learning and change approaches to the creation of scientific and methodological literature that will support the educational process, taking into account the transformed external attributes.

Article Purpose: The objective of this study is to examine the process of change in external attributes of education in the 21st century, determine their impact on the organization of individual study among students in higher education institutions, and develop a new strategy for creating scientific and methodological literature to ensure high-quality individual learning during the educational process.

Results. At this stage of development in pedagogical and scientific-pedagogical science, the external attributes of education are viewed as a set of driving forces that ensure the functioning of the educational environment and influence the organization of the educational process as a whole. These factors include material and technical support, digital applications, and communication technologies. To this list, one can add the social conditions for obtaining an education and the modes of interaction among participants in.

In the 21st century, the development of information technology has completely transformed the very nature of educational activities. Higher education institutions are actively implementing electronic systems for managing the educational process, their own online platforms, multimedia technologies, and repositories. This approach enables students to easily access educational and academic materials regardless of their location or the time of day. This facilitates the convenience of an asynchronous format in the pursuit of education. The transformation of the external attributes of education is directly linked to cosmopolitan processes. From now on, students have the opportunity to participate in any international educational programs, take various online courses from the world's leading universities, interact with representatives of other cultures in real time, and receive rapid feedback. The educational space is becoming open, inclusive, and mobile. This promotes the intellectual consolidation of acquired knowledge and concepts – students gradually develop a research-oriented mindset regarding their surroundings.

It should be noted that, in addition to technological changes, the sociocultural aspects of education are also undergoing transformation. Young people of the 21st century have quickly become accustomed to instant access to information, vivid multimedia content, and interactive forms of engagement. This requires higher education instructors to update their teaching methods and develop new approaches to organizing students' individual learning using scientific and methodological literature.

It would not be an exaggeration to describe the digitalization of education as the primary driver of the transformation of individual study. This is because digitalization has become one of the key factors in the development of modern education. It has changed not only the forms and methods of presenting educational information, but also the very structure of the educational process. Whereas previously the primary sources of knowledge were the lecturer, printed teaching guides, manuals, and scientific research, students now have the opportunity to access information from a vast array of electronic resources.

Distance learning systems play a significant role in education. All stages of the educational process – lectures, practical and laboratory sessions, and individual consultations – now take place online.

In the context of globalization, the accelerated digitization of education, and socio-economic transformations, the organization of individual study of theoret-

ical material has become particularly important. It serves as a key element in the training of modern professionals. In a remote learning environment, students lose direct contact with their instructors. This complicates the immediate assimilation of theoretical material. Under such conditions, individual study becomes a key element of the learning process, as it allows students to build foundational knowledge and skills; develop analytical and critical thinking; increase responsibility and self-discipline; and prepare for practical and individual tasks. For individual study to be effective, it must be organized systematically and with a clear plan using modern digital tool. Individual study of theoretical material in distance learning is a systematic process that includes planning, working with electronic resources, and individual and group forms of individual activity. Individual study by students in a digital environment is gradually taking on new forms.

Table 1

Forms of individual study for students in the digital environment of the University of Railway Transport

Forms of individual study	Content
Individual forms of individual study for students	Studying regulatory and Legal acts, Fnalyzing practical case studies, Preparing written materials, Studying specialized literature
Group forms of individual study	Discussion groups, group case studies, Seminars and training sessions, Brainstorming sessions
Practice-oriented forms	Procedures for workplace inspections, Organizing information campaigns, Conducting training events
Electronic and distance forms of individual learning	Online courses and webinars, Electronic libraries and databases, Forum and Group discussions

Such activities will help students develop autonomy, responsibility, and self-directed learning skills. They will have the opportunity to manage their own time, choose a pace of study that suits them, and design their own educational path. On the other hand, digitalization creates new challenges. Receiving a large amount of information can lead to information overload, and constantly being in a virtual digital environment can lead to reduced concentration and general psychological fatigue.

Social media has become an integral part of the modern educational environment. It is now used not only for communication, but also for learning, sharing information, and organizing collaborative work among students. It is common practice among instructors to create study groups on social media, where instructional materials and assignment templates are posted, and issues related to ongoing and final assessments are discussed. Students have the opportunity to quickly access information, ask questions, and discuss academic topics. This facilitates feedback between the lecturer and students. Online communication generally fosters teamwork. Collaboration skills are gradually developed. Along with the positive aspects of using social media in the educational process, there are also certain risks. Social media can distract from the learning process, foster dependence on the digital environment, and contribute to a superficial and poor-quality perception of information. Therefore, the task for teachers now is to foster information literacy and critical thinking skills in students.

Individual work is an important component of the professional training of future specialists. It contributes to the gradual development of self-learning skills and a sense of responsibility, and encourages creative thinking. In today's environment, students' individual learning involves not only completing academic assignments but also engaging in scholarly and active research activities. Individual work also contributes to the development of lifelong learning skills. In modern society, even theoretical concepts are rapidly updated, so individuals must constantly improve their own competencies. Like any other activity, individual work during one's education requires proper planning. Effective planning of individual learning involves adhering to a number of principles. The first is the principle of systematicity, which involves the regularity and consistency of completing academic tasks. The principle of optimal time management itself requires consideration of the complexity of tasks, the student's individual characteristics, and the types of academic workload. The third is the principle of awareness, where the student clearly understands the purpose of each task and its place within the overall structure of the educational program. The fourth is the principle of self-monitoring, which involves regularly analyzing results and, accordingly, adjusting one's study plan.

In synchronous learning, the planning process is typically highly structured. This is because, in this case, the lecturer determines the scope and deadlines for individual assignments, and the student then fits them

into the established schedule. Ongoing monitoring, mid-term assessments, and discussions of results during practical sessions play a key role in this process. This helps maintain a steady pace of learning and reduces the risk of uncompleted assignments piling up. At the same time, synchronous learning presents certain challenges. In particular, a significant number of classroom hours may limit the time available for in-depth individual study of the course material. Furthermore, focusing on the group's pace of work sometimes fails to account for students' individual learning styles. Therefore, it is important that the planning of individual work allows for flexibility and the possibility of differentiating assignments.

The asynchronous format of education has the exact opposite effect. It opens up broad opportunities for personalized learning. Students can individually determine the time and duration of their own sessions, choose convenient methods for working with the provided learning materials, and, if necessary, revisit difficult topics as many times as needed. However, the effectiveness of this approach directly depends on the student's level of self-regulation skills. Planning in an asynchronous environment is based on setting short-term and long-term goals, creating a personalized schedule for working through the material, and using digital tools for time management. An important aspect here is the use of time-management technologies. It is advisable to break down large tasks into smaller parts (stages), set specific deadlines, and alternate between periods of intense mental activity and rest. In this context, methods such as prioritization-based planning, the use of electronic calendars, to-do lists, and productivity trackers can be helpful.

Motivation plays an equally important role. In synchronous learning, direct interaction with the lecturer and academic group, as well as the opportunity to discuss and participate in discussions, serve as motivational factors. In the asynchronous format, motivation is primarily internal. Here, it is more closely tied to the learner's personal goals and professional aspirations. Therefore, when planning individual learning, one must consider not only academic requirements but also individual interests and career development prospects.

Special attention must also be paid to monitoring and evaluating the results of individual work. In a synchronous learning format, monitoring is built into the process itself, occurring regularly and in a formalized manner. In an asynchronous learning format, it is appropriate to incorporate elements of self-as-

sessment and online testing. This will foster a sense of responsibility for one's own results and help develop self-assessment skills.

Planning individual study in both synchronous and asynchronous learning formats is a complex and multifaceted process. It requires a combination of competent guidance from the lecturer and a certain degree of autonomy on the part of the students. The synchronous learning format ensures structure and constant feedback, while the asynchronous format offers flexibility and the possibility of personalized learning. An optimal model for modern higher education could be a smart combination of both approaches, allowing for the most effective organization of students' individual work. Rational planning of individual activities during higher education will be the key to successful learning, will help students develop the planned professional competencies, foster their ability for continuous self-improvement, and assist them in adapting to the challenges of modern society. The ability to organize one's own learning activities will become one of the key competencies of any professional in the 21st century.

In today's educational landscape, the asynchronous format of learning is becoming one of the central models for organizing the educational process. It involves students individually working through educational materials at a time convenient for them, without direct real-time interaction with the lecturer. This format creates new opportunities for personalized learning, flexible planning of educational pathways, and the development of students' autonomy. At the same time, however, the issue of external factors influencing the organization and effectiveness of students' individual learning becomes more acute.

Individual study in an asynchronous learning environment is gradually becoming a central component of educational activities. It encompasses the entire educational process: from studying theoretical material and completing practical tasks to participating in discussions (forums), preparing educational projects, writing essays, and taking tests, including self-monitoring and self-assessment. The effectiveness of such individual work largely depends on how the student interprets the outcomes of their own results. If external attributions – which involve shifting responsibility to external circumstances – dominate, this can lead to a general decline in motivation, manifesting as procrastination and the development of a passive attitude toward education as a whole.

In an asynchronous learning environment, the absence of constant direct supervision by the lecturer will reinforce the influence of personal factors. The student will individually determine the pace, intensity, and order of completing practical, laboratory, or individual assignments. Under such conditions, the likelihood that external attributions will perform two opposing functions (protective and destructive) will increase significantly. The protective function will manifest itself in a reduction in the overall level of anxiety. At the same time, the student will temporarily attribute their own failure to external circumstances in order to maintain a positive self-esteem. However, if such a strategy is consistently and continuously applied, it will hinder the development of responsibility and self-regulation in general.

The destructive impact of external attributions lies in the formation of so-called "external locus of control," where the student is convinced that their academic successes and failures depend overwhelmingly on factors beyond their control—ones they cannot change or influence. When pursuing education in an asynchronous learning format, this may manifest in complaints about the instability of the internet connection, the inadequacy of the educational platform, the excessive complexity of the presented material, insufficient explanations, or an overwhelming volume of assignments. Although these factors can indeed influence the educational process, treating them as absolute will diminish students' intrinsic motivation and hinder their ability to overcome these challenges.

However, external factors cannot be completely ignored. The asynchronous format of education does indeed depend to a large extent on technical infrastructure, the quality of available electronic resources, the accessibility of learning materials, the clarity of instructions for completing assignments, and feedback. In a situation where the educational environment does not provide adequate conditions for learning, even a high level of self-discipline will not guarantee the effectiveness of individual learning. Therefore, the influence of external factors must be considered in direct relation to the realities of life – the organizational and technological conditions for obtaining an education during a specific period of time.

A distinctive feature of the asynchronous learning format is the increased demand for self-regulation. Self-regulation involves the ability to plan one's own activities, set specific goals, monitor the entire process of task comple-

tion, and evaluate one's own results. External factors can both hinder and stimulate the development of such skills. If a student acknowledges the presence of external obstacles but also seeks ways to overcome them, this indicates an active stance. If, however, the response is limited to merely noting the difficulties without attempting to change the situation, then self-regulation will remain at a low level.

Previous educational experience will have a significant impact on the nature of attributions. It is reasonable to expect that learners accustomed to a strictly structured learning environment with constant supervision will face difficulties in an asynchronous learning setting. Learners with such prior experience will be more likely to attribute their own failures to a lack of clear instructions or support from the instructor. The situation is expected to be diametrically opposite for learners who have experience with self-directed learning. They will be more inclined to take responsibility for their own results.

Motivation will also play a key role in the case of education in an asynchronous learning format. Intrinsic motivation, based on a person's interest in the content of the educational material and their own awareness of its significance for future professional activity, will reduce dependence on any external explanations. For example, a student who sees the value in learning will be less likely to justify their own inaction by citing external circumstances. Conversely, if external motivation – focusing solely on grades or formal requirements – predominates in a student, it will increase the risk of significant influence from external attributions, and this will be particularly noticeable in the event of failure.

We must not overlook the social dimension of the issue. Even in an asynchronous learning format, students remain part of the academic community. All forum discussions, group assignments, and online consultations create a space for social interaction. Support from classmates and lecturers can reduce the tendency toward destructive external attributions, as it fosters an awareness of shared responsibility and the possibility of receiving help.

The influence of the digital environment deserves special attention. Information overload, the sheer volume of digital resources, constant notifications, and multitasking can create a sense of overwhelming chaos. In such a situation, a student may attribute low productivity to an "excessive amount of information" or an "unclear course structure." However, basic requirements for appli-

cants when entering a higher education institution, along with the development of digital literacy and information management skills, will help reduce dependence on these factors.

From a pedagogical perspective, an important task is the formation of adequate attributional models during the learning process. First and foremost, this concerns the actions expected of the lecturer. Since he or she can contribute to the formation of attributional models through the clear formulation of practical or laboratory tasks, transparent criteria for their assessment, and regular feedback. Encouraging students to analyze their own mistakes during the learning process and to seek ways to correct them will facilitate a gradual transition from a predominance of external attributions to well-established feedback with the teacher and a more balanced system of explanations.

The influence of external attributions on autonomous work is also evident in time management. If a student believes that her success depends primarily on external conditions, she may underestimate the importance of systematic preparation. There is a tendency to put off tasks until the last minute, which increases overall stress and anxiety – for example, during exam week – and also lowers the quality of results. Conversely, recognizing one's personal role in achieving success will encourage a more responsible approach to planning one's own work time.

The psychological aspect of the problem of external attributions affecting individual study in asynchronous learning is directly linked to self-esteem and self-confidence. Frequent use of external attributions for self-justification can mask one's own insecurity or fear of future failure. In an asynchronous learning format, where the student does not receive constant confirmation of their competence from the instructor, such feelings may be intensified. This is precisely why it is important to develop a supportive educational environment.

Cultural differences must also be taken into account. In different sociocultural contexts, the dominance of external or internal attributions may have different causes. In some educational environments, responsibility for learning outcomes is traditionally placed either on the lecturer personally or on the system as a whole. This state of affairs significantly complicates the transition to autonomous learning. The asynchronous format itself will require a shift in these attitudes and the formation of a new culture of academic responsibility.

Undoubtedly, the impact of external factors on a student's individual work in an asynchronous learning format is a multifaceted and complex phenomenon. One cannot ignore the fact that objective external factors can significantly influence the educational process. However, if there is an excessive focus on these factors, there is a risk of creating obstacles to the development of autonomy, self-regulation, and intrinsic motivation among students. This would be an undesirable effect that could potentially negate learning outcomes or render them incomplete.

The effectiveness of asynchronous learning depends largely on the learner's ability to balance a realistic consideration of external conditions with taking personal responsibility for outcomes. Developing this ability requires systematic support from lecturers, the cultivation of reflective skills, the enhancement of digital literacy, and the creation of a supportive educational environment. External attributions can both hinder and stimulate a student's individual study in an asynchronous learning environment. Their impact is determined by the level of development of personal qualities, motivation, prior educational experience, and the organizational conditions of the learning process. Recognizing this influence and working purposefully to develop appropriate attributional strategies is a key prerequisite for improving the quality of education in today's digital environment.

The transformation of the external aspects of education has both positive and negative consequences.

Table 2

Advantages and negative aspects of introducing new forms of individual study

Advantages	Negative aspects
Accessibility of information	Information overload
Flexibility of the learning process	Insufficient self-discipline among students
Opportunity for personalized learning	Risk of academic dishonesty
Development of digital competencies	Decline in face-to-face communication
Expanded opportunities for international collaboration	Psychological fatigue caused by the digital environment
Development of self-directed learning skills	Dependence on the reliable functioning of technical equipment

The widespread availability of information and automated online services creates conditions conducive to plagiarism [6]. The approach to completing assignments has become increasingly perfunctory. Therefore, another key objective of modern education is to foster a culture of academic integrity and responsibility among students.

The introduction of synchronous and asynchronous forms of education is significantly changing approaches to the development of academic and methodological literature. This will be particularly evident in terms of organizing and ensuring the effectiveness of students' individual learning. Modern educational conditions require not only a rethinking of traditional methods of presenting educational material but also its adaptation to the digital educational environment. Within the framework of synchronous learning, scientific and methodological literature is geared toward supporting direct interaction between the lecturer and the student in real time. Such materials are most often clearly structured, concise, and the instructional content is presented succinctly. This is done so that students can quickly work through the designated instructional material during online classes. Interactive elements of the classes are of great importance: prepared presentations, edited instructional videos, electronic lecture notes, test questions, and thematic case studies [7]. These methodological recommendations are designed to stimulate students' cognitive activity, foster critical thinking skills, and develop their ability to apply knowledge effectively in practice.

Asynchronous learning, in contrast, involves students individually studying the provided educational materials at a convenient time. Therefore, the approach to creating scientific and methodological literature should also be different: it should feature a most clear and logically structured format, as well as precise instructions for completing practical, laboratory, and individual assignments. Special attention should be given to the development of didactic materials that ensure students' autonomy in learning. Such methodological guidelines should include algorithms for completing practical and laboratory work, step-by-step recommendations for solving case studies, self-assessment schemes and systems, and clearly defined evaluation criteria. These resources are designed to motivate students toward individual information search, analysis of scientific and educational sources, and the development of self-organization skills.

One of the key strategies applied in the creation of such scientific and methodological literature is the combination of textual, visual, and multimedia content. The development of video presentations together with infographics, interactive platforms, and links to additional educational resources increases the accessibility and effectiveness of the presented learning material. It is also desirable to apply the principle of modularity, where educational information is presented concisely in small, logically complete units. This facilitates comprehension and promotes the individualization of the learning process.

The methodological guidelines developed in accordance with the above-mentioned principles present approaches to planning the individual activities of students. The issues of organizing individual work and ensuring effective self-assessment for students enrolled in the educational and professional program "Safety and Occupational Health in Railway Transport" have been addressed in the methodological guidelines through the creation of a structured framework for studying course topics related to supervisory activities in the field of occupational safety and health.

Such coverage of the topics includes key points of the theoretical material for each topic as well as thoroughly developed forms of organizing students' individual work. These forms involve the study of regulatory and legal acts (students are advised to analyze the regulatory framework and examine the provisions of laws and international documents related to the assigned topic); preparation of reports or essays (a range of topics covering various areas of review is proposed); conducting comparative analysis (while completing this type of individual study, the methodological guidelines recommend comparing the general system of state supervision and its specific features according to the thematic content, as well as the functions of national and international control); development of structural diagrams (students are encouraged to create action schemes предусмотренных current legislation regarding activities in the studied field); analysis of practical situations (case study solving); preparation of presentations (examples of thematic areas and presentation components are provided); essay writing (proposed titles and recommended main stages for covering each topic are included); and self-assessment of knowledge (which involves individually compiling a list of control questions on the relevant topic).

It is clear that in the future the role of digital technologies in the educational process will only continue to grow. The active implementation of artificial intelligence, the improvement of virtual and augmented reality technologies, and the creation of fundamentally new automated systems for assessment and adaptive learning are expected. Artificial intelligence is anticipated to enable the personalization of the learning process. Moreover, virtual reality technologies are already creating opportunities for conducting virtual laboratory work and modeling industrial situations for the practical training of students. All of this indicates that the concept of lifelong learning will become increasingly important. Individuals will be required to continuously update their academic knowledge and improve their professional skills in accordance with the demands of the modern labor market.

Conclusions. The transformation of external educational attributes in the 21st century is a natural result of the rapid development of the digital society and cosmopolitan processes. Modern technologies are significantly transforming the educational process, and we are witnessing a tendency toward the further deepening of this transformation. At the same time, new opportunities are being created for updating approaches to the organization of students' individual work.

Digital platforms, online communication, various types of electronic resources, and interactive technologies have already become an integral part of higher education. Undoubtedly, they contribute to increasing the accessibility of educational knowledge, the development of self-education, and the formation of students' professional competencies.

At the same time, new challenges are emerging: information overload is becoming increasingly evident, issues of academic integrity arise, and there is a growing need to improve students' self-discipline. Under such conditions, the role of the teacher becomes especially important – as a mentor, consultant, and organizer of the educational process – as well as the development of scientific and methodological literature based on fundamentally new approaches.

In the current educational system, individual learning is becoming the foundation of an individual's professional development. It fosters students' abilities for critical thinking, self-organization, and lifelong learning throughout their professional careers. The transformation of the educational environment through the implementation of synchronous and asynchronous learning

creates the need to update strategies for developing scientific and methodological literature. Its primary task is not only the transfer of academic knowledge, but also the creation of conditions for effective individual student work, the development of responsibility, digital competence, and the ability for continuous learning.

The effective combination of traditional scientific and pedagogical methods with modern digital technologies will become an essential condition for training competitive specialists in the 21st century.

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ПЕДАГОГІЧНІ УМОВИ ФОРМУВАННЯ ДОСЛІДНИЦЬКОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ МАГІСТРІВ ФАРМАЦІЇ

Вступ. У сучасних умовах модернізації вищої фармацевтичної освіти особливого значення набуває підготовка здобувачів до науково-дослідної діяльності. Це зумовлено зростанням ролі доказової фармації, необхідністю прийняття професійних рішень на основі аналізу наукових даних, а також потребою у фахівцях, здатних здійснювати дослідження у сфері розробки, аналізу та оцінювання лікарських засобів. У зв'язку з цим формування дослідницької компетентності розглядається як один із ключових результатів професійної підготовки майбутніх магістрів фармації [1].

Основна частина. Дослідницька компетентність майбутнього фахівця фармацевтичної галузі є інтегративною характеристикою, яка поєднує систему знань, умінь, ціннісних орієнтацій та рефлексивних здібностей, необхідних для здійснення наукового пошуку у професійній сфері. Вона охоплює здатність формулювати дослідницьку проблему, обирати адекватні методи дослідження, проводити експериментальну роботу, аналізувати отримані результати та обґрунтовувати висновки [2].

Однією з провідних педагогічних умов формування дослідницької компетентності є компетентнісно орієнтоване проєктування освітнього процесу. Такий підхід передбачає узгодження результатів навчання з конкретними дослідницькими вміннями, які мають бути сформовані у здобувачів освіти. Важливим є використання проблемно-орієнтованого навчання. Залучення студентів до виконання міні-проєктів, кейсових завдань та навчально-дослідних робіт сприяє розвитку критичного мислення, аналітичних здібностей та готовності до самостійного наукового пошуку. У фармацевтичній освіті це може реалізовуватися через дослідження властивостей лікарських засобів, аналіз лікарської рослинної сировини, вивчення біологічно актив-

них речовин природного походження, а також моделювання професійних ситуацій, пов'язаних з оцінюванням якості та безпечності препаратів [3].

Не менш важливою педагогічною умовою є інтеграція дослідницької методології у зміст освітніх компонент фундаментальної та професійної підготовки. Окремої уваги заслуговує індивідуальний науковий супровід здобувачів освіти. Наукове керівництво, консультативна підтримка та наставництво забезпечують формування у студентів навичок планування дослідження, вибору методів, оцінювання достовірності отриманих результатів та підготовки наукових текстів.

Ефективність формування дослідницької компетентності значною мірою залежить і від системи діагностики, яка має оцінювати не лише рівень теоретичних знань, а й здатність застосовувати експериментальні та аналітичні методи в роботі з фармацевтичними об'єктами синтетичного та природного походження. Для цього доцільно використовувати тестування, структуроване спостереження, кейс-метод та портфоліо [4].

Висновки. Таким чином, формування дослідницької компетентності майбутніх магістрів фармації забезпечується комплексом взаємопов'язаних педагогічних умов: компетентнісною організацією освітнього процесу, використанням проблемно-орієнтованого навчання, інтеграцією дослідницької методології у фахові дисципліни, індивідуальним науковим супроводом та системною діагностикою результатів. Реалізація зазначених умов сприяє підготовці конкурентоспроможного фахівця, здатного до наукового пошуку та професійного прийняття рішень у сфері фармації.

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SECTION 2.

DIGITALIZATION OF THE EDUCATIONAL SPACE: FROM DISTANCE LEARNING PLATFORMS TO METAVERSES

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USE OF METAVERSES IN PHYSICAL EDUCATION LESSONS FOR HIGH SCHOOL STUDENTS WITHIN THE CONTEXT OF THE NEW UKRAINIAN SCHOOL CONCEPT

Introduction. The modern digitalization of education and the implementation of the concept of the New Ukrainian School (NUS) have intensified the search for innovative approaches to organizing the educational process [1; 2]. The use of metaverses in physical education lessons opens up new opportunities for increasing high school students' motivation, developing motor activity, and forming students' digital competence.

Main Part. In the current context of educational reform, physical education is no longer viewed solely as a means of students' physical development and is increasingly acquiring the features of an integrated educational environment in which digital technologies are actively used [3]. The concept of the New Ukrainian School involves the development of key competencies, among which innovation, digital literacy, lifelong learning skills, and the ability to work in teams occupy an important place. Therefore, the introduction of metaverses into the process of physical education

for high school students is considered a promising direction in the development of modern education. The metaverse is regarded as an interactive digital space in which users can interact with each other through virtual reality (VR) and augmented reality (AR) technologies. In the field of physical education, such technologies make it possible to simulate sports situations, conduct virtual training sessions, organize team competitions, and create personalized physical activity programs.

During the study, the possibilities of using metaverses in physical education lessons in high school were analyzed. It was found that the use of VR technologies contributes to increasing students' interest in classes, especially among those who have a low level of motivation for traditional forms of physical activity. The use of interactive simulators allows students to safely practice exercise techniques, monitor the correctness of movements, and implement an individual approach to learning. In addition, metaverses contribute to the development of communication skills and teamwork. In a virtual environment, students can participate in sports quests, team games, and interactive competitions, which positively affects socialization and the development of leadership qualities. This is especially relevant in conditions of distance or blended learning, when the traditional organization of physical education lessons becomes more complicated. At the same time, the introduction of metaverses into the educational process has certain challenges. Among the main problems are insufficient technical support in educational institutions, limited access to VR equipment, and an inadequate level of digital competence among some teachers. It is also important to consider the need to comply with sanitary and hygienic standards when using digital technologies in physical education lessons.

Despite these challenges, the use of metaverses corresponds to current trends in educational development and contributes to the creation of an innovative educational environment. The combination of physical activity and digital technologies makes the educational process more interactive, accessible, and focused on the needs of modern students.

Conclusions. Therefore, the use of metaverses in physical education lessons for high school students within the context of the New Ukrainian School concept is a promising direction for the digitalization of education. The application of VR and AR technologies contributes to increasing students'

motivation, developing digital competence, improving motor skills, and enhancing teamwork. At the same time, the effective implementation of such technologies requires appropriate technical support, teacher training, and adaptation of the educational environment to modern digital challenges.

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THERMAL CONDUCTIVITY OF THE GLASS FIBRE BICOMPONENT HEAT-INSULATING REFRACTORY MATERIALS

Introduction. The main areas of current scientific advancements in the field of heat-insulating refractory materials and products involve the development of technologies for fibrous refractory products that utilize combinations of different types of fibers, thereby reducing production costs while ensuring the necessary performance characteristics. Among fibrous refractory materials, glass fibers of an alumina-silicate composition – basalt and mullite-silica – are the most widely used. Basalt glass fibers, in addition to excellent thermal insulation properties and low weight, exhibit high resistance to chemically active environments, high temperatures, and open flames; however, their maximum operating temperature is limited to 700–800 °C [1, p. 363]. Refractory fibers of mullite-silica composition also have low apparent density, high chemical resistance, and low thermal conductivity – although higher than that of basalt fibers – with an operating temperature of up to 1300 °C; however, their cost is quite high due to the use of, among other things, expensive raw materials [2, p. 15]. Therefore, the development of a technology for a bicomponent fibrous refractory material based on basalt and mullite-silica glass fibers (with low thermal conductivity and an operating temperature of 900–1000 °C) is actual. Two types of bicomponent refractory fibrous products have been developed with different ratios of mullite-silica and basalt fibers, using a polyvinyl acetate dispersion and bentonite as binders [3, p. 75]. This study aims to determine

the thermal conductivity of the developed bicomponent refractory fiber products in comparison with refractory fiber products that do not contain basalt fiber.

Results. To determine thermal conductivity, samples were prepared using a layer-by-layer casting method with the following compositions:

Sample with polyvinyl acetate dispersion binder (20P):

Mullite-silica fiber content – 80%

Basalt fiber content – 20%.

Sample with bentonite binder (30B):

Mullite-silica fiber content – 70%

Basalt fiber content – 30%.

The sample preparation method is described in [3, p. 71]. Thermal conductivity was determined using the cylinder method according to the procedure described in [4, p. 13]. The results of thermal conductivity measurements for the manufactured samples are shown in Fig. For comparison, the same figure shows the thermal conductivity values of fibrous samples using polyvinyl acetate dispersion (P) and bentonite (B) as binders, without the addition of basalt fiber.

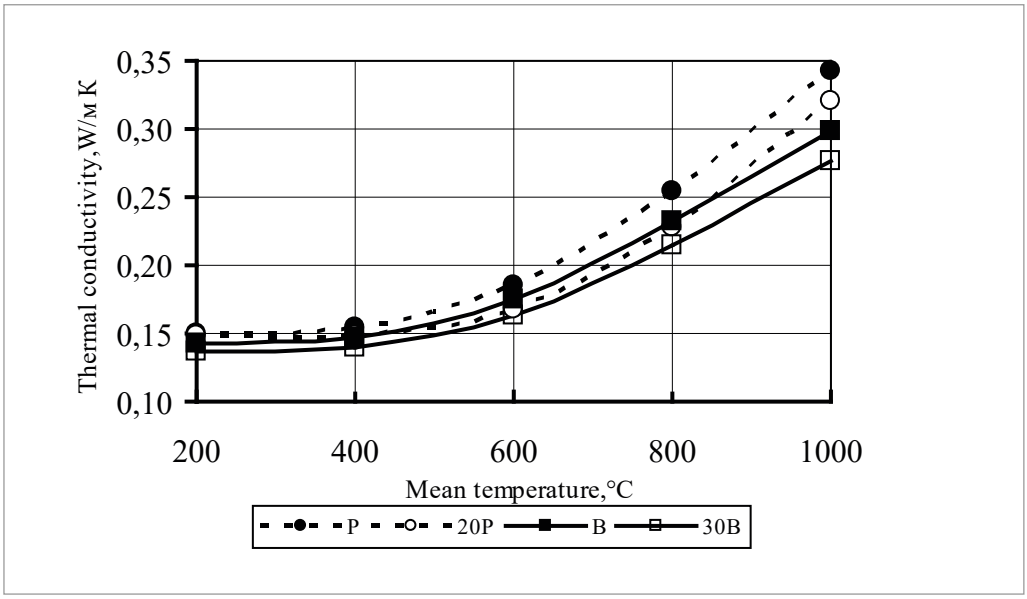

Figure. Thermal conductivity of samples containing 20% basalt fiber with polyvinyl acetate as a binder (20PA), containing 30% basalt fiber with bentonite as a binder (30BZ), and without basalt fiber with polyvinyl acetate dispersion (P) and bentonite (B) as binders.

As shown in the figure, the thermal conductivity of samples containing basalt fiber is significantly lower than that of the corresponding samples made of 100% mullite-silica fiber. The thermal conductivity of fibrous samples with bentonite as a binder is lower than that of samples with polyvinyl acetate dispersion as a binder due to the introduction of a larger amount of basalt fiber, and this difference is significant at temperatures above 700–800 °C due to the radiative component of thermal conductivity.

Conclusions. The thermal conductivity of refractory fibrous products with different ratios of mullite-silica and basalt fibers, using polyvinyl acetate dispersion and bentonite as binders, was determined. It was shown that the thermal conductivity of samples with basalt fiber is lower than that of the corresponding samples without basalt fiber, based on mullite-silica fiber, by 10–15%. The thermal conductivity of fibrous samples with bentonite as a binder is lower than that of samples with polyvinyl acetate dispersion as a binder due to the inclusion of a greater amount of basalt fiber, and this difference is significant at temperatures above 700–800 °C due to the radiative component of thermal conductivity.

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SECTION 6.
INNOVATIVE VECTORS FOR THE DEVELOPMENT OF ENGINEERING SCIENCES

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THEORETICAL ASPECTS OF THE PHILOSOPHY OF SCIENCE IN THE SPHERE OF SAFETY AND RISK

Abstract. *The issue of creating conceptual foundations for the interrelationship between safety and danger is extremely relevant. The philosophy of science can be effectively applied in the study of such a complex and multidimensional*

category as safety, since defining the basic formulations in the study of potential risk is accompanied by a number of difficulties directly related to the uniqueness and multifaceted nature of the phenomenon of safety itself.

In order to minimize the manifestation of dangers in any sphere of human activity, it is necessary to develop a clear conceptual framework for the relationship between safety, danger, and the probability of their occurrence. This will make it possible to understand the nature of risks, assess them in a timely manner, and develop effective mechanisms for human protection within society and the industrial environment.

The article outlines research directions that involve analyzing the essence of human life safety. The peculiarities of the interrelationship between safety and danger in modern society are identified. The issue of substantiating the need to form an effective state security model based on the principles of sustainable development is proposed to be resolved through the creation of a national safety culture.

Keywords: *safety, danger, life safety, potential risk, state security model, concept of sustainable development, safety culture*

Introduction. The issue of establishing a conceptual framework for the relationship between safety and danger is extremely relevant, as humanity constantly faces new challenges and threats both in everyday life and in the industrial environment. Industrial accidents and environmental disasters, military conflicts, and information risks, as well as global crises, require not only practical solutions but also a deep theoretical understanding of the very nature of safety and danger. It is the philosophy of science that will allow us to form a holistic understanding of risk as a unique safety phenomenon. Subsequently, it will be possible to identify the patterns of its occurrence and assess any type of risk that may affect individuals, society, and the environment. The relevance of the topic lies in the need to develop effective approaches to forecasting, preventing, and minimizing dangers in various spheres of human life, as the complexity of technical systems will only increase with the development of our technogenic civilization.

Article Purpose. The purpose of the study is to analyze the essence of human life safety, to determine the peculiarities of the relationship between safety and danger in modern society, and to substantiate the necessity of

forming an effective state security model based on the principles of sustainable development, safety culture, and the protection of the vital interests of individuals and society.

Results. The philosophy of science can be effectively applied when studying a category as complex and multidimensional as safety. Defining key concepts in the study of potential risks is accompanied by a number of difficulties directly related to the uniqueness and multifaceted nature of the phenomenon of safety itself. To minimize the occurrence of dangers in any sphere of human life, it is necessary to establish a clear conceptual framework for the relationship between safety, danger, and the probability of their occurrence. Such an approach will allow for a deeper understanding of the nature of risks, their timely assessment, and the development of effective mechanisms for human protection in society and in the industrial environment.

Even the simplest organisms possess self-preservation mechanisms. These mechanisms manifest as the ability to distinguish between negative and positive external factors [1]. At higher levels of biological development, a certain extraordinary biological significance begins to emerge. This occurs when a living organism projects meaning that is significant to it onto the surrounding world. And with the emergence of consciousness, mental forms of understanding the environment begin to develop.

Higher-order living beings (animals) possess an important ability: the capacity not only to perceive individual objects holistically but also to assess situations in their environment as a whole. It is precisely thanks to this ability that their behavior is proactive, allowing them to respond in advance to potential threats and avoid dangerous situations. This ability indicates that the foundation for the very concept of safety lies in a living organism's ability to assess the likelihood of negative consequences arising from external influences. Safety, when viewed in this sense, emerges not merely as a state of protection, but as a specific mode of interaction between an organism and the environment in which it exists.

By drawing parallels between any external influence and potential future consequences, an individual organism independently assigns specific meaning to observed phenomena and, through this process, forms an understanding of the likelihood of danger. It is precisely this understanding of potential threats that is crucial for the survival of a living being and

its adaptation to its environment. If an organism does not perceive the surrounding world in the context of potential dangers, it will be unable to respond to threats in a timely manner and will ultimately perish. Thus, the ability to anticipate danger is one of the most important conditions for the survival of any living being.

In human life, the uniqueness of the phenomenon of safety is further developed and takes on a more complex nature. Every individual possesses consciousness and developed thinking from birth [2]. Thus, humans are capable not only of assessing the negative impact on themselves or other elements of their environment, but also of analyzing their own condition in relation to potential dangers. Humans are capable of predicting the consequences of their own actions, as well as modeling potential risks and creating means of protection against them. That is why safety in human society is becoming more than just a natural need. Safety is becoming an important social value that determines the very conditions of existence and development, as well as the preservation of life for the individual and human society as a whole.

The uniqueness of a phenomenon such as safety arises as a specific way of defining the existence of any object in relation to a potential danger. In the human mind, the uniqueness of the phenomena of potential danger and safety are identical. Depending on the circumstances, only the attitude toward these concepts changes. Regarding the emergence of potential danger, in the vast majority of cases, a negative attitude is formed in the human mind in advance. Regarding the uniqueness of the phenomenon of safety, there is a relationship between the object itself (the individual) and the potential positive or negative impact on it.

A review of numerous scientific studies allows us to assert that the phenomenon of safety is unique. The understanding of these concepts has a dual nature in terms of how they are perceived by any individual. In its generality, the essence of safety constitutes the nature of things. In an objective sense, safety is synonymous with the preservation of the natural essence of existence. At the same time, it is necessary to take into account the fact that any denial of the essence of the nature of things is potentially dangerous. Therefore, the objective viewpoint is that the safety of things will be determined to a greater extent by their nature [3].

The concept of sustainable development of human society forms the basis of the science of human security [4]. The main tenets of this international concept include a number of assertions regarding the unique nature of security. And they include the following definition of life safety for the population of any country, which is based on the long-term process of sustainable development of the individual person and is not ensured exclusively by armaments or military force. Likewise, the safety of the life and health of every individual should primarily be considered as a component of the development of the cultural and spiritual sphere of society, and only afterward as a component of the socio-political, material-production, and everyday spheres.

The current state of rapid development of our technogenic civilization, along with the transformation and sometimes complete replacement of technologies, gives the issue of ensuring life safety particular importance. Human society is increasingly confronted with challenges that are multi-component in nature. That is why the concept of sustainable development defines safety not only as a state of protection of a person from dangers. The very attitude toward safety and danger is also being renewed.

The concept of sustainable development was created with the aim of establishing a balance among the economic, social, and environmental components of public life. In this context, safety is regarded as the result of effective interaction between the state, civil society, and the individual. An important aspect of this is the formation of a safety culture, which includes a whole set of components. Such a culture of safety is created on the basis of a system of knowledge, moral values, norms of behavior, and the responsible attitude of every individual toward their own life and the lives of others. A high level of safety culture will contribute to reducing the risks of dangerous situations and will thus ensure the population's readiness to act adequately in emergency circumstances. A high level of safety culture will become the driving force for the implementation of sustainable development concepts, since such readiness will not arise by itself or through coercion.

In ensuring life safety, the educational environment plays a particularly important role. It is during the educational process that an individual develops safe behavior skills. In the course of learning, each person gradually develops,

in their own way, environmental awareness, the ability to make well-founded decisions, and the capacity for critical thinking. Our own teaching experience allows us to say that an educated person (in the broad sense of this expression) adapts more easily to changes in the surrounding socio-technical environment. An informed person responds more effectively to threats, which contributes to the development of a safe society. At the same time, it is important not only for an individual to acquire professional competencies, but also to cultivate spiritual and humanistic values, which form the foundation for the harmonious coexistence of people.

By their nature, sciences are either fundamental or applied [5]. Life safety is an applied science that studies the means and methods for ensuring the safety of every individual. This science is directly related to practice and aimed at solving specific problems. In this context, all fundamental branches of knowledge – such as physics, chemistry, and biology – are applied. When it comes to the practical application of the aforementioned scientific principles of life safety, a paradoxical phenomenon arises. On the one hand, the rapid development of technology creates new opportunities for significantly improving the quality of life of humanity as a whole, yet the expected result does not occur. Moreover, technogenic threats are increasing in both scale and consequences, and new occupational risks are emerging within the industrial environment.

Equally important is the consideration of national specificity when creating a model of state security as a whole. Every country has unique historical, cultural, economic, and social conditions of development that are inherent only to that particular state. These characteristics influence the formation of the national security system. An effective security model requires a competent combination of international experience with established national security practices and the needs arising within society.

Conclusions.

Safety challenges themselves arise from an individual's interaction with the environment. Human safety is a general category that characterizes the safeguarding of an individual's life in any country. And a growing understanding of the unique phenomenon of safety will contribute to the creation of such a safety model based on a series of unique components specific to our country.

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ОЦІНКА КЛЮЧОВИХ МОЖЛИВОСТЕЙ НАВІГАЦІЙНОЇ СИСТЕМИ КОМП'ЮТЕРНОГО ЗОРУ НА ОСНОВІ ШТУЧНОГО ІНТЕЛЕКТУ

Вступ. Незважаючи на наявність на суднах сучасного навігаційного обладнання, залишаються певні обмеження у виявленні та інтерпретації навколишньої інформації. Радарні системи ефективні для виявлення великих об'єктів, але можуть не ідентифікувати невеликі судна чи плаваючі уламки. Автоматична ідентифікаційна система (AIC) судна покладається на сигнали, що передаються аналогічними системами, розміщеними на інших суднах, і тому не може виявляти об'єкти, які не містять передавачів AIC.

Ці виклики створюють потребу в впровадженні передових технологічних рішень, здатних покращити сприйняття морського середовища та ефективно підтримувати процеси прийняття навігаційних рішень [1,2].

Основна частина. Останнім часом дослідники все більше зосереджуються на вивченні унікальних можливостей штучного інтелекту (ШІ), зокрема, це: автоматичне виявлення об'єктів, аналіз умов навколишнього середовища та допомога судноводіям у визначенні потенційних ризиків в реальному часі.

Сучасні навігаційні платформи з використанням ШІ поєднують комп'ютерний зір, інтеграцію сенсорних даних та аналітику даних для виявлення потенційних небезпек і допомоги судноводіям у запобіганні зіткненням.

Одним із таких рішень, що вже застосовується в комерційному судноплавстві, є платформа Orca AI (artificial intelligence), яка забезпечує моніторинг навколишнього середовища судна в реальному часі за допомогою оптичних сенсорів і алгоритмів машинного навчання.

Система Orca AI включає бортовий спостережний модуль SeaPod, оснащений п'ятьма HD-камерами високої роздільної здатності для денного спостереження, що забезпечують поле зору в 225°, та трьома тепловізійними камерами для нічного бачення, що забезпечують поле зору 100°. Модуль SeaPod допомагає судноводіям інтерпретувати ситуації, не покладаючись виключно на радар чи AIC. Отримані дані комп'ютерного зору поєднуються з даними інших датчиків, встановлених на борту судна, і відображаються у зручному інтерфейсі на екрані комп'ютера на містку судна, включаючи інформацію про відносний розмір та швидкість інших суден. Технологія забезпечує всебічне уявлення про навколишнє середовище, особливо в сценаріях, коли судноводію може бути складно одночасно спостерігати за кількома цілями.

Оцінка навігаційної системи Orca AI проводилась в реальних морських умовах на суднах-контейнеровозах групи «Mediterranean Shipping Company» (MSC). Методологія випробування поєднувала кількісну оцінку нейромереж з аналізом досвіду користувача (Human Factors). Тестування також проводилось у в районах з високою щільністю руху. В якості джерела даних використовувалась інформація, яка зчитувалась через модулі SeaPod, дані збирались з інтервалами у 30 хв. у відкритому морі та кожні

5 хв. – у зонах інтенсивного трафіку. Для порівняння використовувались справжні показники, що фіксувалися шляхом агрегації даних радарів, систем AIC, електронних картографічних навігаційних інформаційних систем та візуальних спостережень судноводіїв.

Комплексний підхід під час оцінки роботи Orca AI передбачав, по-перше, використання метрики *Accuracy* – базового критерія у машинному навчанні, який дозволив оцінити якість класифікації (тобто, яку частку від усіх прогнозів Orca AI визначила правильно).

Для бінарної класифікації метрика обчислюється за формулою:

$$Accuracy = (TP+TN)/(TP+TN+FP+FN),$$

де: TP (True Positive, істинно позитивний результат) – об'єкт був істинно позитивним, і модель передбачила його як позитивний;

TN (True Negative, істинно негативний результат) – об'єкт був істинно негативним, і модель правильно передбачила його як негативний;

FP (False Positive, хибно-позитивний результат) – об'єкт був істинно негативним, але модель помилково передбачила його як позитивний (помилка I роду);

FN (False Negative, хибно-негативний результат) – об'єкт був істинно позитивним, але модель помилково вважала його негативним (помилка II роду).

По-друге, щоб отримати більш реальну картину роботи системи комп'ютерного зору на основі штучного інтелекту, *Accuracy* використовувалася разом з показником точності та показником повноти (рис. 1):

1) *Precision* = TP/(TP+FP) – точність прогнозу (показує, яка частка об'єктів, класифікованих Orca AI як небезпечні чи цільові, дійсно є такими є, тобто, наскільки можна довіряти моделі);
2) *Recall* = TP/(TP+FN) – повнота (показує частку істинно-позитивних результатів (TPR – True Positive Rate), іншими словами – яку частку всіх існуючих об'єктів позитивного класу модель змогла виявити).
3) F1 = 2 · (*Precision* · *Recall*) / (*Precision* + *Recall*) – метрика якості в машинному навчанні, яка є середнім гармонійним між точністю (*Precision*) і повнотою (*Recall*).

Оцінка системи комп'ютерного зору Orca AI показала 94% точності (*Precision*) та 98,6% повноти виявлення (*Recall*).

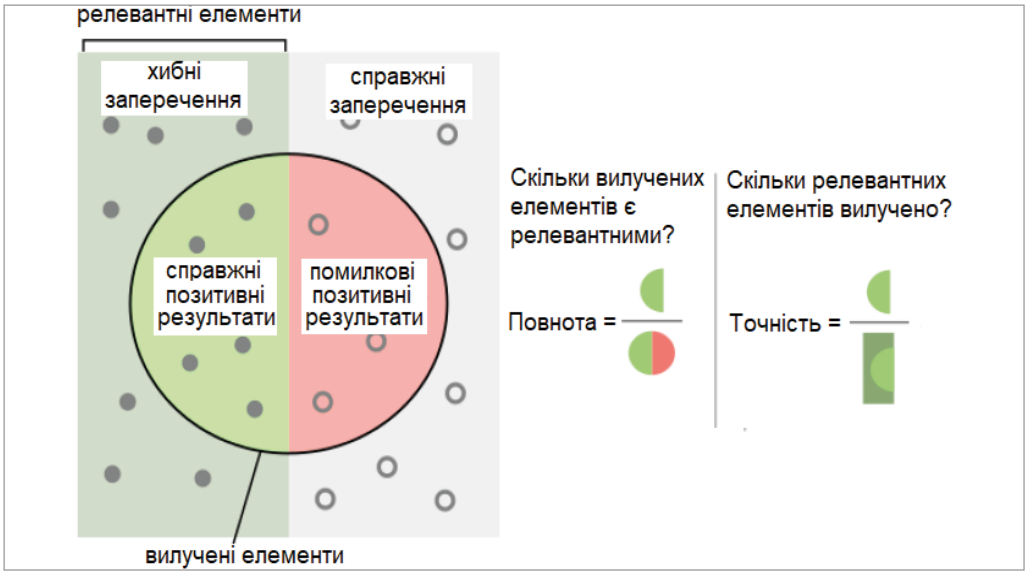

Рис. 1. Оцінка точності та повноти технології комп'ютерного зору Orca AI

Хибні спрацьовування спостерігалися переважно у двох категоріях: повторне виявлення одного й того самого об'єкта; виявлення, на яке вплинули візуальні умови, такі як відблиски або відображення. Обидва типи були включені до загальної кількості хибних спрацьовувань. Повторні виявлення, які становили приблизно 73% всіх хибних спрацьовувань, відображають повторну ідентифікацію існуючих цілей, а не виявлення неіснуючих об'єктів.

Випробування платформи Orca AI підтвердивши її високу надійність та переваги (табл. 1) [3].

Таблиця 1

Ключові переваги від впровадження Orca AI на контейнеровозах компанії MSC

Показники	Результат з Orca AI
1	2
Зменшення кількості зіткнень з близькими перешкодами	Зменшення на 27%
Зменшення кількості різких маневрів та відхилень від маршруту для уникнення зіткнень	Зменшення на 22%
Зменшення екстремального падіння швидкості	Зменшення на 18%
Збільшення мінімальної дистанції обгону	Покращення на 20-26%

Продовження табл.1

1	2
Зменшення кількості перетинів курсу	Зниження на 40%
Економія пального на контейнеровозах компанії MSC	Середня економія щороку від 100 000$ на судно
Загальне скорочення викидів CO2 завдяки більш «плавній» навігації	Зменшення викидів на 66000 т

Висновки. Випробування системи морського комп'ютерного зору Orca AI довели її ефективність як повноцінного електронного помічника, здатного розпізнавати малопомітні цілі в умовах щільного трафіку та низької видимості. Система дозволяє уникати людських помилок, оптимізувати маршрути та забезпечує значно безпечну та економічну експлуатацію суден у жвавих судноплавних зонах.

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SECTION 7.
SUSTAINABLE DEVELOPMENT & ENVIRONMENTAL SAFETY: SCIENTIFIC STRATEGIES FOR PRESERVING THE PLANET

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DIRECTIONS FOR IMPROVING NUCLEAR ENERGY IN UKRAINE IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT AND ENERGY SECURITY

Abstract. *It is essential to create conditions for the sustainable development of the national economy by ensuring access to reliable, resilient, and modern*

energy sources. This strategy предусматривает bringing the energy sector of our state as close as possible to climate neutrality. Climate neutrality of Ukraine implies the full functioning of national energy markets and their integration into international markets. It also includes the development of an innovative energy system, its decentralization, the production of clean energy, and overcoming the current problem of energy poverty.

To implement the key principles of Ukraine's Energy Strategy in terms of economic feasibility, environmental friendliness, and accessibility, it is necessary to take into account the fact that nuclear energy has its own advantages and disadvantages. Among these disadvantages is that, although nuclear power generation requires a relatively small amount of fuel, nuclear power plants produce a significant amount of waste. This raises the issue of its disposal in a way that does not harm the environment or future generations. This determines the relevance of developing methods for the processing and disposal of radioactive waste generated by nuclear power plants.

Keywords: *climate neutrality, development of an innovative energy system, nuclear energy, disposal of radioactive waste.*

Introduction. According to estimates by the International Energy Agency, global energy consumption has increased by more than 3 % annually over the past 30 years.

In accordance with the Energy Strategy of Ukraine until 2050, it is important to create conditions for the sustainable development of the national economy by ensuring access to reliable, resilient, and modern energy sources. This strategy envisages bringing the energy sector of our state as close as possible to climate neutrality over the next 25 years [1].

Climate neutrality of Ukraine implies the full functioning of national energy markets and their integration into international markets. It also includes the development of an innovative energy system, its decentralization, the production of clean energy, and overcoming the current problem of energy poverty [2].

Ensuring the state energy sector with its own resources, taking into account economic feasibility, can be achieved through the development of alternative energy sources. Nuclear energy belongs to such sources. It produces a huge amount of energy based on a relatively small amount of fuel.

The growth of the world's population, the depletion of fossil fuel reserves, the increasing impact of the greenhouse effect, and the lack of alternative sources with the required energy capacity contribute to the increasing role of nuclear energy in the energy supply of the global economy. Currently, more than 440 nuclear power units are operating and 25 more are under construction in 30 countries around the world. The capacity of nuclear energy sources may double by 2020 and quadruple by 2050. In a number of countries, nuclear energy occupies a dominant position, producing more than half of the required electricity. Ukraine is among these countries.

To implement the key principles of Ukraine's Energy Strategy in terms of economic feasibility, environmental friendliness, and accessibility, it should be noted that the use of nuclear energy has its own advantages and disadvantages. Among these disadvantages is the fact that, although nuclear power generation requires a relatively small amount of fuel, nuclear power plants produce a large amount of waste. This raises the issue of its disposal in order to avoid harm to the environment and future generations. This determines the current relevance of developing methods for the processing and disposal of radioactive waste from nuclear power plants.

Article Purpose. There is a need to study nuclear energy as a component of achieving sustainable development goals and its role in the energy security of Ukraine under conditions of achieving climate neutrality. In order to implement the key principles of Ukraine's Energy Strategy in terms of economic feasibility, environmental sustainability, and accessibility, there is a need to substantiate the improvement of methods for the processing and disposal of radioactive waste from nuclear power plants in order to minimize their harmful impact on the environment and future generations.

Results. Ukraine ranks among the top eight countries in the world in terms of electricity generation at nuclear power plants and among the top five countries in terms of the share of nuclear-generated electricity in the total volume of electricity production [3]. Table 1 presents the percentage of electricity generated by nuclear power plants in the total electricity production in different countries around the world for the period from 2015 to 2024 [4]. Nuclear energy in Ukraine is an important component of the overall fuel and energy complex and occupies a leading position in the country's electricity supply [5].

Table 1

Electricity generation at nuclear power plants in different countries (as a percentage of total electricity production)

Country or area	Nuclear share of electricity (%)										Nuclear electricity production (billion kWh)	
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2023	2024
Argentina	4.8	5.6	4.5	4.7	5.9	7.5	7.2	5.4	6.3	7.4	9.0	10.4
Belgium	37.5	51.7	49.9	39.0	47.6	39.1	50.8	46.4	41.2	40.5	31.3	29.7
Brazil	2.8	2.9	2.7	2.7	2.7	2.1	2.4	2.5	2.2	2.3	13.7	14.9
Bulgaria	31.3	35.0	34.3	34.7	37.5	40.8	34.6	32.6	40.4	41.6	15.5	15.1
Canada	16.6	15.6	14.6	14.9	14.9	14.6	14.3	12.9	13.7	13.4	83.5	81.2
Czech Rep	32.5	29.4	33.1	34.5	35.2	37.3	36.6	36.7	40.0	40.2	28.7	28.0
Finland	33.7	33.7	33.2	32.4	34.7	33.9	32.8	35.0	42.0	39.1	32.8	31.1
France	76.3	72.3	71.6	71.7	70.6	70.6	69.0	62.5	64.8	67.3	323.8	364.4
Germany	14.1	13.1	11.6	11.7	12.4	11.3	11.9	5.8	1.4	0	6.7	0
Hungary	52.7	51.3	50.0	50.6	49.2	48.0	46.8	47.0	48.8	47.1	15.1	15.2
Japan	0.5	2.2	3.6	6.2	7.5	5.1	7.2	6.1	5.6	8.0	77.5	84.9
Romania	17.3	17.1	17.7	17.2	18.5	19.9	18.5	19.4	18.9	19.8	10.3	10.0

During the period from 1990 to 2005, electricity generation at nuclear power plants in Ukraine increased from 76.2 to 88.78 billion kWh, while generation at thermal power plants decreased from 201.8 to 73 billion kWh. Thus, during this difficult period for Ukraine, nuclear energy remained the only stable source of electricity. Moreover, nuclear energy occupies one of the leading positions in the Energy Strategy of Ukraine [1,5].

It should be noted that the use of nuclear technologies in the world extends beyond the provision of low-carbon energy. These technologies also help control the spread of diseases, assist doctors in diagnosing and treating patients, provide energy for space exploration missions, and more. Accordingly, this diversity of applications of nuclear energy places

nuclear technologies at the center of global efforts aimed at achieving their sustainable development.

An analysis of statistical data for the period from 1970 to 2022 made it possible to construct the structure of nuclear energy production by continents (Fig. 1 Annual nuclear energy generation in the world from 1970 to 2022 (in GWh) [6]. Nuclear energy generation (GWh): Western and Central Europe, South America, North America, Eastern Europe and Russia, Asia, Africa.

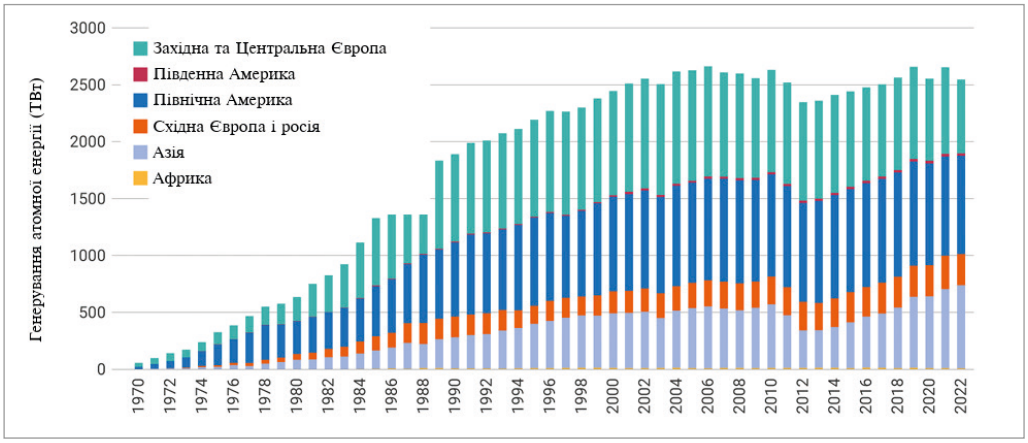

Fig. 1. Annual nuclear energy generation in the world from 1970 to 2022 (in GWh)

The main problems of nuclear energy in Ukraine include the need for continuous improvement of the safety and operational reliability of all control systems and equipment of operating nuclear reactors, as well as solving the problem of handling and storage of spent nuclear fuel (SNF) and radioactive waste (RW). There is also an urgent need to create an optimal infrastructure to ensure the reliable and safe operation and development of nuclear energy in Ukraine.

In the countries of the European Union, the classification of radioactive waste differs. The European Commission has developed recommendations for a classification system for solid RW. However, not all EU member states have implemented it in full.

The main categories of RW include very low-level waste, where the level of radioactivity becomes safe immediately after processing or during temporary storage [7]. Examples of such waste include construction debris, decontaminated metal parts after decommissioning, and uranium-containing

waste. In addition, "intermediate" waste is generated as a result of the operation of nuclear facilities.

There is also low- and intermediate-level waste (LILW). The category of low- and intermediate-level waste is divided into two parts corresponding to the half-lives of radionuclides (approximately 400 Bq/g). There is also long-lived waste, which contains a high concentration of long-lived radionuclides. The most common methods of processing solid radioactive waste (SRW) currently include incineration, cementation, low- and high-pressure compaction, plasma processing, and melting in electric furnaces.

The issue of the strategy for handling spent nuclear fuel from nuclear power plants and high-level radioactive waste remains controversial [8–9]. Many experts believe that spent nuclear fuel should not be considered RW, but rather should be used in the future as an energy resource for other types of reactors that have not yet found commercial application. There are three main criteria outlined in waste management concepts [7]:

a) whether to dismantle fuel elements or leave them intact;
b) whether to dispose of them in geological repositories or store them on the surface;
c) whether to carry out final disposal or temporary storage until new and more effective disposal methods are developed.

Conclusions. Leading positions in the ranking of countries by the sustainability of national energy policy are ensured by the predominance of renewable energy sources in the energy balance structure. Such governments stimulate, at the national level, the development of innovative green technologies to ensure the transition to a carbon-neutral economy, which guarantees the ability of the national economy to provide uninterrupted and equal access to energy resources for all interested parties in sufficient quantities and at competitive prices.

The above makes it possible to conclude that, in order to improve the economic efficiency of Ukrainian nuclear power plants and support their development, further research and development are necessary in such areas as the development and implementation of programs for the management of spent nuclear fuel and radioactive waste, as well as the creation of an optimal infrastructure to ensure the reliable and safe operation and development of nuclear energy in Ukraine.

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SUSTAINABLE HUMAN AND COMMUNITY DEVELOPMENT IN THE CONTEXT OF UKRAINE'S EUROPEAN INTEGRATION: PRINCIPLES, CHALLENGES, AND PROSPECTS

Abstract. *This article analyzes the main principles of sustainable development for individuals and communities in the context of contemporary social transformations in Ukraine. It identifies key drivers of sustainable development, such as improving the quality of life for the population, ensuring environmental safety, and providing access to education, healthcare, and conditions for personal fulfillment. Particular attention is paid to Ukraine's integration processes into the European community, the reconstruction of regions affected by the war, as well as the principles of harmoniously combining the environmental, social, economic, political, and cultural needs of society. The work summarizes sixteen*

fundamental principles of sustainable community development, which serve as a methodological basis for forming an effective model of local development. It is demonstrated that sustainable community development is a multifaceted process that requires active citizen engagement, the strengthening of social cohesion, adherence to moral and ethical principles, and the development of a long-term strategy for recovery and further development.

Keywords: *sustainable development, community, European integration, quality of life, social resilience.*

Introduction. Throughout the 21st century, the concept of sustainable development has established itself as one of the central principles of global politics, the economy, and social progress. Current challenges—including climate change, the depletion of natural resources, social inequality, armed conflicts, and economic instability—underscore the need to develop new approaches to societal development. For Ukraine, this issue is particularly relevant in the context of European integration processes, as it involves achieving sustainable development at both the local community level and for higher-level administrative units.

Sustainable human development involves creating conditions to improve the quality of life for the population, ensuring their physical and mental health, social security, access to quality education, and opportunities for personal development. This will be based on the principles of balanced development of their territorial communities, taking into account local natural resources and the level of sustainable natural resource management within these communities.

The development of local communities as the basic unit of social organization is crucial. Today, these communities are becoming the foundation of social unity, economic stability, and democratic governance. In connection with European integration, Ukraine is implementing new governance models aimed at reconciling the interests of the state, business, and citizens, as well as carrying out international programs for the reconstruction of affected territories.

Results. ***The Core Principles of Sustainable Human Development.*** The concept of sustainable development is based on the integration of three interrelated dimensions: economic, social, and environmental Fig.1). In the mod-

ern context, these are also complemented by political and cultural components, which determine the level of societal resilience and adaptability.

The main goal of sustainable human development is to create a social environment where every person has the opportunity to realize their potential, gain access to quality education and healthcare, and enjoy safe living and working conditions. An integral part of this is also ensuring ecological balance and the wise use of natural resources.

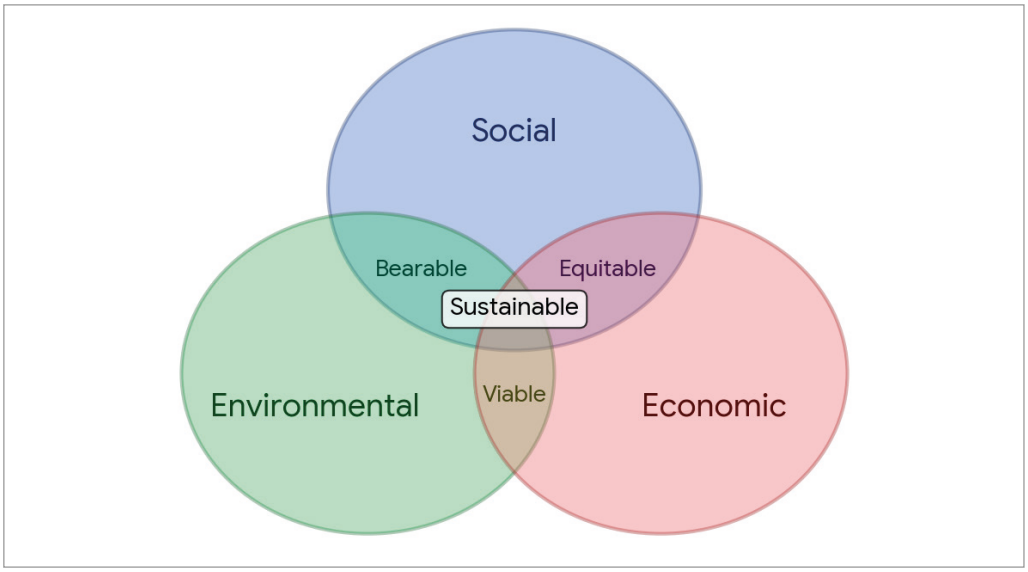

Fig. 1. Sustainable development in multidimensional vectors

The progressive development of the individual and society is inextricably linked to the development of civil society, the fostering of active citizenship, and the involvement of the public in decision-making within the sphere of governance. Consequently, the modern model of progress must be based on the principles of cooperation, fairness and accountability.

Sustainable development of Ukraine in the context of European integration. Ukraine's European integration involves not only economic or political transformation, but also a change in social relations in accordance with the principles of democracy, the rule of law, social justice and environmental safety. At the national level, comprehensive support for small businesses and community economic initiatives should be provided.

The key objective is to ensure balanced development by reconciling the interests of the government, the business sector and citizens. Local communities

must move from a passive role to active participation in governance, developing their potential independently. Local authorities will be provided with the necessary resources and incentives to perform their functions effectively. For the first time in the history of modern Ukraine, local communities will take responsibility for formulating their own development strategies and budgets, stimulating economic growth, attracting investment and supporting entrepreneurship. The state is implementing the decentralization process, transferring a significant volume of financial revenues and administrative functions to the local level. This should strengthen the accountability of local authorities to their populations and to the state for overall development. Of course, the expansion of resources and powers requires in-depth knowledge and a broad understanding of global trends, as cities compete with other cities not only within the country but also on the international stage. In today's reality, the development of local communities must be based on the principles of open public administration, transparency, public participation in governance processes, and the rational use of resources. Following the outbreak of full-scale aggression, initiatives to rebuild settlements and regions devastated by hostilities have become of paramount importance. In particular, this applies to international community reconstruction projects aimed at enhancing social stability, developing local infrastructure, assisting internally displaced persons and stimulating economic activity among the population.

Sustainable development in Ukraine requires a balance between the environmental, social, economic, political and cultural needs of society. Only a comprehensive approach can ensure the country's long-term stability and improve the quality of life for its people [7].

Principles of sustainable community development. An important aspect of implementing the concept of sustainable development is the creation of an effective system for the development of local communities. This process is underpinned by the fundamental principles of sustainable community development [6, 10].

1. Change as the foundation of development.

Development requires constant change and the active participation of people in the processes of social transformation. Communities should not simply wait for help, but take an active part in solving their own problems.

2. Development starts from within.

Real change comes from every individual, family and local community. External support is merely an additional tool in the process of self-improvement.

3. Recovery as an important part of development.

Rebuilding social ties, restoring trust between people and overcoming the consequences of hardship are key conditions for creating a strong community.

4. The principle of equality.

Sustainable development is impossible without ensuring equal rights and opportunities for all members of society, regardless of their status, age, gender or cultural background.

5. Having a clear vision.

Development requires a clear understanding of goals, future prospects and the paths to achieving the desired outcomes.

6. A comprehensive approach.

All aspects of social development are interlinked. Economic, social and environmental processes should be viewed as a single entity.

7. Shared responsibility.

The problems of one person or a group of people affect the whole community. Similarly, successes and achievements have collective significance.

8. Community unity.

Social cohesion is one of the main prerequisites for the successful development of local areas and for overcoming crises.

9. Active public participation.

Involving residents in the planning and implementation of development projects fosters a sense of responsibility and enhances the effectiveness of management decisions.

10. Moral values.

Moral principles, mutual respect, honesty and responsibility form the foundation of stable social development.

11. Lifelong learning.

Continuous learning helps to build new skills, develop human potential and adapt to modern challenges.

12. Durability of development.

Sustainable development involves the long-term preservation of the natural balance, economic stability and social well-being.

13. Support from the authorities.

The implementation of development strategies requires support from public authorities, civil society organisations and international partners.

14. Economic stability.

Economic development must ensure the fair distribution of resources and the creation of conditions to meet the basic needs of the population.

15. Focus on the positive.

Effective community development involves creating a supportive social environment and fostering constructive behaviour.

16. Leading by example.

Real change begins with personal responsibility and a willingness to set an example for others.

Measures to promote the sustainable development of local communities include implementing projects to develop and evaluate medium-term local community development programmes, as well as justifying plans to establish local ecological networks [1, 9].

The creation of local plans for the establishment and development of an ecological network involves a series of interrelated steps, namely:

- identifying areas of significant conservation, scientific, ecological, recreational, historical, cultural and aesthetic importance;
- mapping areas and sites that are already part of the ecological network or that are proposed for inclusion in it;
- preparing the grounds for justifying their inclusion in the ecological network, allocating land for the relevant purposes, granting them conservation status, and determining the necessary restrictions on the use of restoration, buffer and connecting areas;
- providing advice on rules for the conservation and use of nature reserve sites and areas, other natural features requiring special protection, as well as restoration, buffer and connecting zones planned for creation;
- ensuring that ecological network plans are consistent with existing project documentation, supporting the conservation of valuable landscapes and natural features, and ensuring their wise and sustainable use.

This approach ensures the preservation of the ecosystem's integrity and creates the conditions for sustaining the biological and natural diversity of the area.

Local communities must shift their role from being passive recipients of external influence to active participants in governance, capable of independently managing their own development and potential. As a result of decentralisation reforms, local authorities are gaining more opportunities and incentives to perform their duties effectively. For the first time since Ukraine's independence, communities are taking on genuine responsibility for strategic planning of their development, managing budgetary funds, promoting economic growth, attracting investment and supporting entrepreneurship.

The decentralisation policy involves the transfer of a significant portion of financial resources and administrative functions to the local level. This helps to increase the accountability of local authorities to community residents and the state as a whole for successes in socio-economic development.

At the same time, the increase in the volume of resources and management tasks requires local authorities to demonstrate a high level of professionalism, strategic vision and an understanding of current global trends. After all, today cities and communities are competing for investment, skilled personnel and resources not only within the country but also on the international stage.

Conclusions. Sustainable development, for both the individual and the community as a whole, is a complex and multifaceted process encompassing the environmental, social, economic, political and cultural aspects of society. For Ukraine, the issue of sustainable development is becoming particularly important in the context of European integration, military challenges and the need to rebuild affected regions.

The foundation of successful development lies in reconciling the interests of the state, business and the population, ensuring social justice and environmental safety, and actively involving citizens in governance. Local communities play a significant role, serving as centres of social cohesion and development at the grassroots level.

The sixteen principles of sustainable community development serve as a comprehensive methodological framework for effective territorial governance. Their implementation will contribute to strengthening social stability, fostering a responsible civil society and improving the quality of life for the population.

Ukraine's future development must be based on the principles of long-term stability, cooperation, environmental responsibility and human potential as the main driver of social progress.

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SECTION 8.
MODERN MEDICINE: CLINICAL RESEARCH & PREVENTIVE STRATEGIES

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ПРОМЕНЕВА ДІАГНОСТИКА ЯК ІНСТРУМЕНТ ПРЕВЕНЦІЇ ТЯЖКИХ УСКЛАДНЕНЬ ЗАХВОРЮВАНЬ ЛЕГЕНЬ

Вступ. Променева діагностика має важливе значення в сучасній медицині. Адже своєчасне виявлення критичних станів впливає на ризики смертності й інвалідизації. З цим пов'язані всі важливі для людини (пацієнта) категорії існування: життя, здоров'я, рівень фізичних можливостей, передбачення життєвих ризиків тощо. Тому роль радіолога виходить за межі підтвердження діагнозу. Призначення радіолога й його робота взаємопов'язані з вибором оптимального маршруту обстеження хворого і рекомендації щодо терміновості втручання в захворювання. Отже, низькодозова комп'ютерна томографія як спосіб отримання діагностичної інформації має важливе значення для процесу діагностування з мінімальним променевим навантаженням.

Основна частина. Існують різні хвороби легень. Розглянемо деякі з них. Наприклад, *тромбоемболія легеневої артерії*. Комп'ютерна томографічна ангіографія є методом вибору при проміжній або високій клінічній ймовірності. Ключовими ознаками тромбоемболії легеневої артерії є: дефекти наповнення у гілках легеневої артерії, збільшення правих відділів серця відносно лівих, дилатація стовбура легеневої артерії та перфузійні невідповідності. Стандартизований протокол скорочує час до початку антикоагуляції або реперфузійних

втручань і знижує ризик переходу у хронічну тромбоемболічну легеневу гіпертензію.

Щодо *деструктивного туберкульозу*, то низькодозова комп'ютерна томографія чутливіша за рентгенографію для раннього виявлення каверн, дрібновогнищевого ендобронхіального поширення за типом «дерево у бруньках», ураження бронхів і бронхоектазів. Рання ідентифікація дозволяє своєчасну ізоляцію та корекцію лікування до розвитку кровотечі або пневмотораксу.

Не менш складними є *пневмофіброз та інтерстиційні захворювання легень*. Комп'ютерна томографія високої роздільної здатності диференціює звичайну інтерстиційну пневмонію від неспецифічної, оцінює поширеність «медових сот», тракційних бронхоектазів і субплевральний розподіл. Виявлення прогресуючого фенотипу обґрунтовує ранній початок антифібротичної терапії і направлення на мультидисциплінарний консиліум або трансплантаційну оцінку.

У виявлені *легеневих абсцесів* контрастна комп'ютерна томографія верифікує товстостінну порожнину з рівнем рідини та перифокальним запаленням і відмежовує її від кістозних новоутворень чи вроджених кіст, а також дозволяє віддеференціювати від грибкових інфекцій (зокрема аспергильоз). Це визначає покази до перкутанного дренування і попереджає септичні ускладнення та прорив у плевральну порожнину.

Для виявлення *емпієми плеври* ультразвукове обстеження забезпечує швидку діагностику для виявлення випоту в плевральних порожнинах; з використанням комп'ютерної томографії ми можемо з точністю визначити об'єм випоту, ознаки його відмежування та ознаки компресії легеневої паренхіми. Це дає змогу для торакальних хірургів щодо своєчасної рекомендації дренування або відеоторакоскопії плевральної порожнини та запобігає організації щільних кірок і рестрикції легені.

Роль променевої діагностики як низькодозової комп'ютерної томографії безперечна, адже зменшення променевого навантаження дозволяє не втрачати діагностичну якість для більшості невідкладних пульмонологічних станів, таких як перевірка підозрілих інфільтратів, контроль динаміки при туберкульозі, уточнення причин задишки за відсутності чітких рентгенологічних ознак.

Також низькодозова комп'ютерна томографія дозволяє частіше контролювати не тільки резорбцію інфільтратів, але й стан порожнини абсцесу після дренування прогресування та інтерстиційних змін. Променева діагностика надає можливість повторних досліджень у динаміці.

Висновки. Низькодозова компютерна томографія є пріоритетною для обстеження дітей, молодих пацієнтів, а також для пацієнтів з імунодефіцитними станами. Додавання низькодозових протоколів дозволяє частіше й безпечніше виконувати діагностику і контроль, скорочує час до лікування та знижує ризик летальних і хронічних наслідків. Превентивний ефект максимальний за умови впровадження стандартизованих маршрутів і структурованих звітів у тісній співпраці з клініцистами.

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SECTION 10.
COMPUTER SCIENCE, INFORMATION TECHNOLOGY, CYBERSECURITY & BIG DATA ANALYSIS

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TOWARDS ONTOLOGICALLY CLOSED METADATA-NEUTRAL ARCHITECTURES FOR INFORMATION INTERACTION AND IDENTIFICATION

Abstract. *The paper examines the growing cyber threats associated with the compromise of cryptographic key material, credentials, and other digital identifiers that remain the foundation of modern information security systems [1, 2]. It is shown that even under conditions of high cryptographic strength, contemporary systems remain vulnerable to attacks aimed at compromising authentication mechanisms, digital secrets, and the structure of information interaction.*

The paper proposes the SAIC (Security Architecture Invisible Communication) architecture, within which the authenticity, confidentiality, and integrity of

information interaction are determined by the internal operational state of communicating systems rather than by external trust mechanisms. A model of coordinate cryptography, a mechanism of logical passwordless authentication, and a phase-based non-Markovian evolution model of the operational state are formalized. It is demonstrated that the proposed architecture makes it possible to conceal not only the content of information exchange, but also the fact of communication, the direction of interaction, and the structure of the information network.

A concept of integrating SAIC with the NATO Mode 5 system is proposed, in which the "friend-or-foe" identification system is used as a mechanism for the initial cryptographic initialization of a protected interaction channel. The practical significance of the work lies in the possibility of constructing a new class of compromise-resistant military information interaction and identification systems.

Keywords: *secure communications; metadata neutrality; passwordless authentication; friend-or-foe systems; NATO Mode 5; military information systems; cybersecurity.*

Introduction. Modern global digital infrastructure critically depends on secure information interaction between governmental, military, financial, industrial, and autonomous systems. Under these conditions, cybersecurity is becoming one of the key factors of global technological resilience, while the growing scale of cybercrime forms a systemic challenge to existing information security architectures.

Over recent years, global cybercrime has demonstrated stable growth. According to the Verizon Data Breach Investigations Report and the IBM X-Force Threat Intelligence Index, more than 60–70% of successful cybersecurity incidents are associated with compromised credentials, stolen access keys, phishing, credential stuffing, and other forms of digital identifier exploitation [1, 2]. Analysis of cyber incidents in 2024–2025 shows that most attacks are aimed not at cryptanalysis of encryption algorithms, but at compromising digital objects that function as carriers of trust within modern security systems.

Particularly illustrative is the 23andMe data breach incident, in which neither cryptographic algorithms nor communication channels were compromised;

however, the use of stolen credentials proved sufficient to compromise millions of user profiles. Similar incidents involving SolarWinds, Okta, LastPass, and other systems demonstrate a fundamental property of modern cybersecurity architecture: compromise of a digital identifier automatically leads to the loss of system security regardless of the cryptographic strength of the employed algorithms. As a result, a large-scale global market of stolen digital identities, credentials, access tokens, and cryptographic keys has emerged and continues to evolve as an independent segment of the cybercriminal economy.

Thus, the structural problem of modern cybersecurity systems acquires not only a technical but also a conceptual dimension, since most existing information protection systems are built around digital objects that can be stolen, substituted, reused, or imposed by an attacker.

Even modern approaches, including multi-factor and passwordless authentication, Zero Trust architectures, decentralized identity systems, Zero-Knowledge Proofs, and post-quantum cryptography, do not eliminate dependence on digital objects as carriers of trust, but merely complicate and modify the form of their usage [3–5]. In this regard, there is a need for fundamentally new architectures of information interaction in which security is determined not by possession of a digital identifier, but by the internal structure of the communication system itself.

Another major problem of modern information interaction systems is the observability of communication processes and metadata leakage. Even when plaintext content remains cryptographically protected, an external observer often retains the ability to determine the fact of interaction, the direction of exchange, transmission intensity, network topology structure, and behavioral characteristics of the system. As a result, metadata itself becomes an independent object of analysis and compromise, creating an additional attack surface against the security properties of modern information systems.

Within this work, an ontologically closed metadata-neutral architecture of information interaction and identification is proposed, in which security is determined by the internal structure of the communication process rather than by external digital trust mechanisms. Such an approach makes it possible to eliminate system dependence on digital identifiers as compromise objects and forms a new class of cybersecurity architectures oriented toward resilience against contemporary global threats to information interaction.

Purpose of the Article. The purpose of this article is to formalize an ontologically closed metadata-neutral architecture of information interaction and identification, in which security is determined by the internal structure of the communication process rather than by the use of digital identifiers as carriers of trust. Within the scope of this work, it is intended to substantiate the principles of constructing such an architecture, define its fundamental cryptographic properties, and demonstrate the possibility of its application for increasing the resilience of modern identification systems against compromise of digital objects and communication observability.

Presentation of the Main Material.

1. Concept of Ontologically Closed Communications

This paper considers the SAIC (Security Architecture Invisible Communication) model of information interaction aimed at forming ontologically closed mechanisms of authenticity and confidentiality. Within the proposed architecture, the communication process is interpreted not as the transmission of plaintext between communicating entities, but as the formation and reconstruction of cryptographic events within the internal operational state of the system. Unlike classical cryptographic models, where ciphertext is produced as the result of a cryptographic transformation of plaintext using a key, in SAIC the ciphercode is formed as an external projection of an internal cryptographic event triggered by information interaction within the current operational state of the system. In the SAIC architecture, the functionality of cryptographic key information is performed by a dynamic operational state whose stochastic non-Markovian phase evolution trajectory is determined by the set of verified cryptographic events of phase .

The ontological closure of communication means that the conditions of authenticity, integrity, and interpretability of information are determined exclusively by the internal dynamic operational state symmetric for communicating systems within a closed SAIC communication channel. Mechanisms for maintaining and restoring symmetric evolution of operational states do not depend on external trust infrastructures, digital identifiers, or cryptographic artifacts. Within such a model, there are no objects that can be isolated and used to compromise the confidentiality of the communication channel, transferred, or compromised outside the communication structure itself.

The cryptographic process in SAIC is realized within the current operational state of the system:

$$E_t=(GIS_t,LTT_t)$$

where GIS_t defines the internal coordinate space of the system, and LTT_t denotes the rules for interpreting cryptographic events together with the functional context at phase .

Each cryptographic event ε_t has two forms of representation – internal and external projections. Let C_t denote the set of cryptographic events generated at phase t. Then each cryptographic event $\varepsilon_t \in C_t$ possesses two forms of representation – internal and external projections:

$$e_t=\Pi_t^{int}(\varepsilon_t,Et), \quad c_t=\Pi_t^{ext}(\varepsilon_t,Et) \quad \forall \varepsilon_t \in C_t$$

where e_t denotes the latent internal representation of a cryptographic event within the operational state structure of the system, while c_t denotes its external observable representation in the form of a ciphercode. Hereinafter, $\widehat{\varepsilon}_t$ denotes a verified cryptographic event for which the condition of symmetric structural verification is satisfied.

Thus, within SAIC, the cryptographic process is interpreted not as the generation of ciphercode through the cryptographic transformation of plaintext, but rather as the formation, projection, and reconstruction of verified cryptographic events $\widehat{\varepsilon}_t$ triggered by an input message within the symmetric operational states of the communicating systems $\varepsilon_t^{(A)}$ *ma* $\varepsilon_t^{(B)}$.

The set of internal projections of all verified events within a phase forms an aggregated event vector $E_t=e_t^{(1)},e_t^{(2)},\ldots,e_t^{(Nt)}$, which acts as a factor determining the trajectory of the stochastic non-Markovian evolution of the operational state of the system. Although an individual verified event does not directly determine the phase evolution of the system, each such event induces a modification of the aggregated phase event vector.

Within this model, the ciphercode is not a carrier of plaintext and does not possess independent semantics. Its function is reduced exclusively to the reconstruction of a cryptographic event within the symmetric operational state of the system. In the event of a violation of the internal symmetry of the communicating systems, the ciphercode loses the ability for correct structural interpretation within the current operational state of the reconstructing system.

Thus, the structural interpretation of information in SAIC is determined not by the ciphercode itself, but by the correspondence between its internal structure and the operational state of the communicating system.

This paper demonstrates that confidentiality, authenticity, and integrity emerge as intrinsic properties of the ontologically closed communication structure of SAIC, without dependence on external cryptographic mechanisms.

2. SAIC Architecture

The SAIC architecture is based on a dynamic phase model in which the operational state of the system continuously evolves under the influence of exclusively verified cryptographic events $\hat{\varepsilon}$. The coordinate space of the system forms its internal geometric structure and defines the environment for the formation of cryptographic events within the current phase.

GIS_t consists of a set of parameterized objects: $GIS_t=g_1,g_2,\ldots,g_n$ each of which possesses unique coordinate parameters within the current ε_t. The coordinate space is not a static structure, but rather acts as a dynamic environment for the formation of . The set of objects within the coordinate space is divided into active and passive subsets:

$$A_t \cap P_t = \varnothing, \qquad GIS_t = A_t \cup P_t, \qquad |A_t| \ll |P_t|$$

where A_t denotes the active set of objects a_i that may be associated with the words of the input message and participate in the formation of ε_t, while P_t denotes the passive set whose objects do not participate in the formation of the current ciphercode.

The active set is formed as a phase-dependent function of the operational state of the system and defines the admissible configurations of cryptographic interaction within the current phase. After an active object has been used in a cryptographic event, its repeated use within phase t is not permitted without modification of the coordinate space of the system through the relocation of all g_i within .

Within SAIC, system operation is implemented in the framework of a discrete phase model. After the completion of a phase, the system transitions into a new operational state:

$$\varepsilon_{t+1} = \Psi_t(\varepsilon_t, H_t)$$

where Ψ_t denotes the phase-dependent stochastic mapping of system evolution;

$H_t=\{E_{t-r},\ldots,E_{t-1},E_t\}$ denotes the event memory of the system, where $r \in \mathbb{N}$ represents the phase depth of the event memory.

The event memory possesses a fixed structural size and implements a mechanism for the dynamic updating of event configurations. Verified

cryptographic events are always integrated into the aggregated event vector E_t and influence the formation of the subsequent operational state of the system.

In addition to cryptographic events, the event memory contains geometric conditions whose fulfillment depends on the mutual geometric arrangement of objects within the geometric coordinate space GIS_t. If a geometric condition is satisfied at phase $(t + n)$, where $n \in \mathbb{N}$, the corresponding event is removed from H_t and induces the formation of a new internal cryptographic event whose aggregated event vector E_t influences the trajectory of system evolution in the subsequent phase.

Since the triggers of cryptographic events are stochastic, while the internal and external projections of each event are formed within different functional regions of GIS_t and LTT_t, even identical input messages do not generate identical cryptographic projections. As a result, the prediction of any state ε_{t+1} becomes equiprobabilistic, and therefore the fulfillment of geometric conditions in future phases is unpredictable, while the trajectory of the phase evolution of the system becomes stochastic and acquires a non-Markovian character.

The phase depth r may vary dynamically in order to preserve a constant informational size of H_t and ε_t independently of the number of cryptographic events, the number of fulfilled geometric conditions, and the duration of phase evolution. Thus, the operational state of the system preserves a constant structural dimensionality, while its internal configuration evolves stochastically and unpredictably.

The evolution of the components of the operational state is determined by:

$$GIS_{t+1}=\Theta_t\,(GIS_t,\ LTT_t, H_t),\qquad LTT_{t+1}=\Lambda_t\,(GIS_{t+1},\ LTT_t,\ H_t)$$

where Θ_t denotes the phase evolution operator of the coordinate space, while Λ_t denotes the evolution operator of the functional context of the system.

As a result, SAIC forms a dynamic ontologically closed architecture of information interaction in which the cryptographic properties of the system are determined not by the use of external digital objects, but by the structure of the phase evolution of the internal operational state.

3. Coordinate Cryptography

The cryptographic model of SAIC is based on coordinate cryptography, within which cryptographic events are formed through vector-geometric coordinate encoding of parameterized objects of the internal coordinate space of the

system. The trigger of the cryptographic process may be either a component of the plaintext UA_t or an internal entropy vector of imitation data NA_t, which is used in cases of complete or partial absence of plaintext and is determined by the distribution D_{NA}, ensuring the masking of the message structure: $NA_t \sim D_{NA}$. The source of cryptographic events within the system is represented by the set:

$$S_t \in \{UA_t, NA_t, UA_t \cup NA_t\}$$

where the selection of the source S_t is determined by the sufficiency or absence of plaintext required for the formation of a ciphercode $c_t^{(i)}$ of fixed length defined for the current ε_t. Each input message m_i, interpreted as an arbitrary bit sequence acting as a trigger of the cryptographic process, induces a cryptographic event $\varepsilon_t^{(i)}$, which forms an internal projection $e_t^{(i)}$ and an external projection $c_t^{(i)}$ within the current ε_t.

Within phase t, the active set $A_t \subset GIS_t$ is partitioned into disjoint subsets $A_t^{(1)}, A_t^{(2)}, \ldots, A_t^{(k)}$ such that: for all $\forall i \neq j$: $A_t^{(i)} \cap A_t^{(j)} = \varnothing$.

Each subset corresponds to its own unique association rule $\varphi_t^{(i)}$, which defines the mapping between the semantic value M_i of the input message m_i and the active object a_i in such a way that each admissible semantic value M_i corresponds to only one object of the active set:

$$\exists!\, a_i \in A_t^{(i)}: a_i = \varphi_t^{(i)}(M_i), \qquad \varphi_t^{(i)} \in LTT_t$$
$$\forall LTT_t \; \exists!\, \varphi_t^{(i)}$$

In coordinate cryptography, a ciphercode is formed through the coordinate encoding of parameterized vector configurations of the dynamic GIS_t. Within SAIC, three fundamental methods of vector-geometric coordinate encoding are employed: VC_1, VC_2, and VC_3.

The VC_1 method is based on the direct coordinate encoding of the position of an active object within the coordinate space relative to the base origin and the zero axis. In this case, the ciphercode is formed as a parameterized representation of the coordinate vector $\overrightarrow{OA_i}$.

The VC_2 method is based on the relative position with respect to an active object reconstructed within the previous cryptographic event. The ciphercode is formed as a parameterized representation of the vector $\overrightarrow{A_iA_j}$, the reconstruction of which is possible only under the condition of correct interpretation of the previous cryptographic event.

The VC_3 method employs relative coordinate encoding using the base phase vector $\overrightarrow{XY}$ defined within the current operational state of the system. In

this case, the parameters of the current cryptographic event are determined as the relation between the parameters of the current event vector and the parameters of the base constant vector.

As a result, a sequential dependency of cryptographic events is formed, in which each subsequent event depends on the reconstruction of the previous one. Such a mechanism produces an effect similar to a ratchet mechanism, within which the disruption of the correct interpretation of any event results in the loss of the ability to reconstruct subsequent cryptographic events of the current phase configuration.

Since GIS_t continuously evolves into GIS_{t+1}, while active objects are not permitted to be reused within the same phase configuration, the property of phase anticollision of ciphercode emerges:

$$m_i=m_j \Rightarrow c_i \neq c_j, \qquad c_i=c_j \Rightarrow m_i \neq m_j$$

Thus, coordinate cryptography forms a mechanism of dynamic vector-geometric encoding of cryptographic events in which the ciphercode is determined not by the plaintext itself, but by the structure of the current operational state (GIS_t, LTT_t) and by the trajectory of the phase evolution of the system.

4. Logical Passwordless Authentication

Within SAIC, the authentication mechanism is implemented not through verification of possession of a digital object, but through verification of the structural consistency of a cryptographic event induced by the received ciphercode within the symmetric operational state of the system. This approach is defined as Logical Passwordless Authentication (LPA).

Unlike classical authentication models, LPA does not employ passwords, cryptographic keys, certificates, tokens, or other digital artifacts that may be independently stolen, transferred, reused, or compromised. Within SAIC, the authenticity factor is represented exclusively by the structural consistency of the phase evolution of the operational states of the communicating systems.

Let $G_t^{(c_t)}$ denote the coordinate-space configuration induced by ciphercode c_t. Then the verification of the ciphercode is defined by the predicate:

$$V_{\varepsilon_t}(c_t) \in \{0,1\}, \qquad V_{\varepsilon_t}(c_t)=1 \Leftrightarrow G_t^{(c_t)} \subset A_t$$

where $V_{\varepsilon_t}(c_t)$ denotes the logical verification function of the current operational state ε_t.

Successful verification means that the reconstructed cryptographic event is structurally admissible within the current phase configuration of the system.

Within such a model, authenticity is determined not by verification of knowledge of a secret, but by the possibility of correct symmetric reconstruction of a cryptographic event within $\varepsilon_t^{(A)}$ and $\varepsilon_t^{(B)}$.

Logical Passwordless Authentication possesses an intrinsic ontological nature and does not depend on the semantics M_i of the input message:

$$V_{\varepsilon_t}(c_t) = f(GIS_t, LTT_t, c_t), \qquad V_{\varepsilon_t}(c_t) \not\equiv f(M_i)$$

Successful verification of c_t constitutes a condition for the symmetric phase evolution of the systems:

$$V_{\varepsilon_t}(c_t) = 1 \Rightarrow (G_t^{(c_t)} \subset A_t) \Rightarrow \varepsilon_{t+1}^{(A)} = \varepsilon_{t+1}^{(B)}, \qquad \forall t \in \mathbb{N}$$

Any modification of the ciphercode is detected by LPA: $V_{\varepsilon t}(c_t) = 0$ therefore the event is not verified and is not integrated into the symmetric phase evolution of the systems. As a result, a modified ciphercode cannot be correctly reconstructed to recover the input message m within the current operational state.

Since authenticity in SAIC is determined by the internal structure of the phase evolution of the system, the model does not contain stable digital identifiers or digital fingerprints that could be used to construct an external communication profile. This prevents the formation of classical mechanisms for compromising authentication factors characteristic of traditional systems.

Thus, LPA forms a model of ontological authentication in which authenticity is determined not by possession of a digital secret, but by the consistency between the structure of the ciphercode and the symmetry of the structural evolution of the internal operational states of the communicating systems.

Within SAIC, a cryptographic event is considered fully verified not at the moment of the primary reconstruction of the ciphercode, but only after structural confirmation of its integrity within subsequent cryptographic events of the ratchet mechanism. As a result, the verification of cryptographic events possesses an event-delayed character.

Let c_n denote a ciphercode generated by Alice and reconstructed by Bob. Its successful LPA verification $V_{\varepsilon_t}(c_t) = 1$ allows Bob to conclude the structural integrity of the previous cryptographic event ε_{n-1}, since its internal projection has already been integrated into the ratchet-dependent configuration of the current ciphercode c_n. In this case, the internal projections of the previous cryptographic events: $\widehat{\varepsilon_1}, \widehat{\varepsilon_2}, \ldots \widehat{\varepsilon_{n-1}}$ may be integrated by Bob into the aggregated event vector of phase evolution $E_t^{(B)}$.

For Alice, the situation is different. Despite the successful primary reconstruction of ciphercode c_{n-1}, the final verification by Alice of the cryptographic event induced by c_{n-1} is postponed until the successful LPA verification of the subsequent ciphercode c_{n+1}. At the event moment of generating and transmitting to Bob, Alice can finally integrate into $E_t^{(A)}$ only the cryptographic events: $\widehat{\varepsilon_1}, \widehat{\varepsilon_2}, \ldots \widehat{\varepsilon_{n-2}}$.

Thus, the aggregated event vectors of the communicating systems may possess an admissible one-event displacement $E_t^{(A)} \neq E_t^{(B)}$ which arises exclusively within the mechanisms of delayed final event verification, symmetrically completes within the current phase, and does not lead to violation of the symmetry condition: $\varepsilon_{t+1}^{(A)} = \varepsilon_{t+1}^{(B)}$.

Therefore, only fully verified cryptographic events influence the trajectory of the phase evolution of the system, whereas unverified or partially confirmed events are not integrated into the aggregated event vector H_t.

5. Metadata Neutrality and Collapse of the Observation Model

One of the fundamental properties of SAIC is the metadata neutrality of cryptographic interaction, under which external observation does not allow the determination of the fact, direction, topology, or semantic content of information exchange. Within the model, the ciphercode does not act as a carrier of plaintext, a digital identifier, or addressing information, but exists solely as an external projection of an internal cryptographic event.

Let $\{C_t\}_{t\in T}$ denote a random process of ciphercodes, and let $S_t \in \{UA_t, NA_t, UA_t \cup NA_t\}$ denote the source of cryptographic events of the system.

Then the equality of probability distributions holds:

$$\mathcal{L}\left(\{C_t\}_{t\in T}^{(UA)}\right) = \mathcal{L}\left(\{C_t\}_{t\in T}^{(NA)}\right) = \mathcal{L}\left(\{C_t\}_{t\in T}^{(UA\cup NA)}\right)$$

where $L(\cdot)$ denotes the probability distribution law of the corresponding random process. As a result, for an external observer, the mutual information between ciphercodes and the source of cryptographic events tends to zero: $I(C_t; S\_t) \to 0$.

The mutual information between the ciphercode process and the input message also tends to zero: $I(\{C_t\}_{t\in T}; m_i) \to 0$ [6].

Within SAIC, ciphercodes do not contain stable addressing parameters, digital identifiers, or invariant topological features of communication. As a result, an external observer has no ability to determine the source of transmission,

the recipient, the direction of interaction, the association of ciphercodes with a single channel, or the structure of the communication topology.

Within such a model, information interaction possesses an addressless character, since the reconstruction of a cryptographic event is determined exclusively by the symmetry of the internal operational states of the systems rather than by the use of external routing or identification mechanisms.

A closed communication channel for which the conditions of ciphercode indistinguishability and informational neutrality of the communicating parties are satisfied is defined as a metadata-neutral communication channel:

$$Ch_{MN}=\{channel \mid I(Comm;\{C_t\}_{t\in T}=0\}, \qquad \forall t: I(Comm; Obs)=0$$

where $Comm\in\{0,1\}$ denotes the fact of communication, while Obs denotes the random observation process representing all information available to an external observer. Consequently, observation of the channel does not allow determination of whether a real information exchange has occurred:

$$Pr(Comm \mid \{C_t\}_{t\in T})=Pr(Comm)$$

Therefore, for any analysis algorithm A, its advantage based on channel observation tends to zero: $\forall A : Adv_A\ (channel) \rightarrow 0$.

The absence of observable communication parameters produces the effect of collapse of the observation model, under which external analysis does not permit the construction of a correct model of information interaction even under conditions of complete interception of ciphercodes.

As a result, a communication channel formed within SAIC may be defined as an ontologically closed channel Ch_OC for which the following condition holds:

$$Ch_OC=\{\{C_t\}_{t\in T} \mid \exists \varepsilon_t : Security=f(\varepsilon_t)\}$$
$$I\ (Security;\ External\ Infrastructure)\rightarrow 0$$

Thus, the cryptographic properties of SAIC are determined by the internal structure of the phase evolution of the system rather than by the use of external trust infrastructures, addressing mechanisms, or digital identification.

5.1. Evolutionary Implicit Channels

Within SAIC, unsuccessful LPA verification is not always interpreted as a terminal state of cryptographic interaction. In the case of structurally consistent deviations, the LPA mechanism may form an additional implicit information transmission channel induced by the configuration of ciphercode deviations relative to the current .

Let $\Delta(c_t)=\delta_1, \delta_2, \ldots, \delta_n$ denote the structure of coordinate deviations of c_t, where δ_i represents the deviation of a coordinate parameter from the expected configuration. If the deviation structure satisfies the evolutionary rule $R_t=f(\varepsilon_t)$ then such an event may be interpreted as an implicit signal $M_t^{(imp)}$.

As a result, an additional evolutionary non-bit implicit channel Ch_{eIC} is formed, operating in parallel with the primary cryptographic channel. The general communication model therefore takes the form $C_{total}=C_{pr}\oplus C_{im}$ where C_{pr} denotes the primary cryptographic interaction channel, while denotes the implicit information channel.

Since the implicit channel is formed through structural configurations of coordinate deviations rather than through additional ciphercode bits, its operation does not violate the metadata-neutrality properties of the primary channel. If each coordinate word admits k variants of structural deviation, while the ciphercode contains n coordinate components, then the space of possible coordinate-deviation configurations Ω_Δ of the implicit channel is determined as: $|\Omega_\Delta|=k^n$. As a result, an exponential space of potential implicit channels C_{im} of non-bit origin is formed.

5.2. Addressless Offline Communication

Within SAIC, offline communication may be implemented through a shared ciphercode pool $CCP=c_1, c_2, \ldots, c_k$ which is periodically downloaded by all participants of the system. Each system locally performs the LPA procedure for every ciphercode: $V\varepsilon_t(c_i)\in\{accept,reject\}$ ciphercodes do not contain addressing information, while their reconstruction is determined exclusively by the symmetry of the internal operational states of the communicating systems.

As a result, an external observer has no ability to determine: the sender; the recipient; the direction of interaction; the association of ciphercode with a single channel; the fact of information exchange between specific systems.

For an arbitrary ciphercode $c_i\in CCP$, there exists at most one system for which the following condition holds: $V\varepsilon_t(c_i)accept$. As a result, observation of the ciphercode pool does not permit the construction of a correct model of information interaction $I(CCP;Comm)\to 0$ where $Comm$ denotes the event of information exchange between participants of the system.

Thus, SAIC enables the implementation of a model of confidential addressless offline communication in which cryptographic protection is achieved not

only through message encryption, but also through the structural uncertainty of the very fact of communication interaction.

6. Integration of SAIC into Identification Friend-or-Foe Systems

One of the promising directions for the application of SAIC is the integration of the architecture into identification friend-or-foe systems, particularly into modern modifications of NATO Mode 5 [7].

Modern identification systems are based on the use of digital identifiers and PKI infrastructures; therefore, their security depends on the protection of external trust mechanisms. Compromise of key material potentially allows an attacking party to generate valid system responses.

An additional limitation is the observability of the structure of information interaction. Even under conditions of cryptographic resistance of transmitted messages, identification systems may produce stable radio-exchange parameters and repetitive protocol structures, thereby creating the possibility of external profiling of the system.

Within SAIC, authenticity is determined not by possession of a digital key, but by the possibility of reconstructing a cryptographic event within the symmetric operational states of the communicating systems. The LPA mechanism enables verification of the structural consistency of a cryptographic event without the use of stable digital identifiers or external trust mechanisms.

The metadata-neutral properties of SAIC minimize the observability of information interaction, as a result of which an external observer cannot determine the association of a response with a specific system, the direction of interaction, or the fact of successful authentication.

Thus, the integration of SAIC into identification systems opens the possibility of constructing metadata-neutral ontologically closed recognition systems in which authenticity and confidentiality are determined by internal factors rather than by the use of external cryptographic trust mechanisms.

7. Concept of Integration of SAIC and NATO Mode 5 (SAIC-NM5)

In the proposed SAIC-NM5 architecture, the NATO Mode 5 identification friend-or-foe system is used as a mechanism for the initial cryptographic initialization of the ontologically closed SAIC interaction channel.

The integration of SAIC into NATO Mode 5 systems enables the formation of a new identification friend-or-foe model in which authenticity is determined not by possession of a cryptographic key, but by the possibility of reconstruct-

ing a cryptographic event within the symmetric operational states of the communicating systems.

Let $P=\{P_1, P_2, \ldots, P_n\}$ denote the set of expected platforms within the coverage zone of a radiolocation station (RLS), and let $K^{NM5}=\{K_1, K_2, \ldots, K_n\}$ denote the corresponding cryptographic contexts within the standard NATO Mode 5 model.

In the proposed SAIC-NM5 architecture, the NATO Mode 5 cryptographic challenge is not transmitted directly into the radio environment. Instead, the result of its cryptographic processing is used as a trigger for the formation of the initial operational state of SAIC: $E_0^{(i)}=Init_{SAIC}(K_i^{NM5})$ where $\varepsilon_0^{(i)}$ denotes the initial phase state of interaction between the RLS and platform P_i.

The radiolocation station forms a data packet PD_t, which represents the external projection of a SAIC cryptographic event: $PD_t=\Pi_t^{ext}(\varepsilon_t)$. Instead of the NM5 cryptographic response, only the data packet PD_t is transmitted into the radio environment. Since the SAIC architecture is symmetric, the packet PD_t can be correctly verified only by platforms for which the condition of phase symmetry between $\varepsilon_t^{(RLS)}$ and $\varepsilon_t^{(P_i)}$ is satisfied: $\varepsilon_t^{(RLS)} = \varepsilon_t^{(P_i)}$.

A platform P_i for which successful LPA verification is satisfied: $V_{\varepsilon_t}(PD_t) = accept$ forms the response PD_{t+1} which contains its own phase-dependent context, the reconstruction of which is possible only within the symmetric SAIC channel.

The RLS performs double verification of the received packet PD_{t+1}. At the first stage, the structural admissibility of the data packet within SAIC is verified, while at the second stage the local correctness of the reconstructed cryptographic context within NATO Mode 5 is verified. Thus, after successful LPA verification, the NM5 cryptographic context is locally reconstructed: $Recon\ PD_{t+1} \Rightarrow K_i^{NM5}$.

Accordingly, platform authenticity is determined not by the transmission of a cryptographic secret, but by the ability to maintain a structurally admissible phase evolution within the ontologically closed interaction channel.

After the first successful SAIC verification, the entire set of NM5 key material is removed: $K^{(NM5)} \rightarrow \varnothing$ while subsequent authentication is performed exclusively through the mechanism of continuous LPA verification: $V\varepsilon_t(PD_t) \in \{accept, reject\}$.

Within SAIC, each data packet is formed within a unique operational state ε_t, which from a security perspective is equivalent to the use of a unique cryptographic context for every cryptographic event. Even in the event of compromise of an individual cryptographic context K_i^{NM5}, interception or modification of packet PD_t does not allow the attacking party to maintain the symmetric phase evolution of the SAIC channel: $\varepsilon_t^{(A)} \neq \varepsilon_t^{(B)}$.

As a result, an adversary is unable to perform: a MITM attack; covert reconstruction of information interaction; long-term reproduction of a cryptographic session; structurally correct generation of new data packets.

The metadata-neutral properties of SAIC additionally conceal: the recipient of the data packet; the direction of interaction; the fact of information transmission; the structure of command exchange; the topology of interaction between platforms.

This enables the implementation of concealed continuous authenticated interaction between the radiolocation station and platforms, as well as between the platforms themselves within distributed swarm combat models.

Thus, the integration of SAIC and NATO Mode 5 forms a new class of ontologically closed metadata-neutral identification friend-or-foe systems in which authenticity, confidentiality, and resistance to compromise are determined by the internal phase evolution of the ontologically closed operational space rather than by the protection of static cryptographic keys.

Conclusions

This paper proposes the architecture of ontologically closed metadata-neutral communications SAIC, in which authenticity, confidentiality, and integrity are determined by the internal phase evolution of the operational space of the system rather than by the use of external cryptographic trust mechanisms.

Unlike classical and post-quantum cryptographic models, the security of information interaction within SAIC does not rely on the transmission or storage of stable digital secrets, the compromise of which constitutes the primary cause of most contemporary cyber incidents.

Within this work, the model of coordinate cryptography, the mechanism of Logical Passwordless Authentication, the phase-based non-Markovian evolution of the operational state, and the concept of an ontologically closed interaction channel are formalized. It is demonstrated that the metadata-neutral properties of SAIC make it possible to conceal not only the content of

information exchange, but also the very fact of communication, the direction of interaction, the structure of command exchange, and the topology of the information network.

The proposed concept of integration of SAIC and NATO Mode 5 forms a new model of identification friend-or-foe systems in which authenticity is determined by the ability to maintain a structurally admissible phase evolution of the communicating systems.

After the establishment of SAIC interaction, NATO Mode 5 key material may be removed. Subsequent authentication is maintained through the mechanism of continuous Logical Passwordless Authentication of every data packet, while information interaction remains metadata-neutral and structurally indistinguishable to an external observer regardless of technological capabilities.

The practical significance of the proposed architecture lies in the possibility of constructing concealed compromise-resistant military information interaction systems of a new generation, in which interception of data packets or compromise of a cryptographic context does not allow an adversary to neutralize the protective properties of the channel, perform structurally admissible MITM interaction, or covertly reconstruct information exchange.

Under conditions of contemporary high-technology military conflicts, in which superiority is increasingly determined by the ability of systems to conceal the structure of their own information interaction, the SAIC architecture opens prospects for the creation of a new class of autonomous metadata-neutral communication systems whose resilience is determined not by the protection of sensitive data, but by internal structural factors that are not observable, are not transmitted, and cannot be reconstructed through communication-channel analysis.

A key role in ensuring such resilience is performed by the mechanism of Logical Passwordless Authentication, which enables continuous structural verification of information interaction without the use of stable digital identifiers, passwords, or static key material, the compromise of which constitutes the primary cause of most contemporary cyberattacks and successful MITM interactions.

This creates the preconditions for the construction of next-generation military interaction systems resistant to contemporary radio-technical reconnaissance, cryptanalysis, compromise of key material, and adversarial information dominance.

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SECTION 11.
MODERN ENERGY, MECHANICAL ENGINEERING AND TRANSPORT SYSTEMS.

UDC 004.8:621.9

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AGENT-ORIENTED AI ARCHITECTURE FOR DECISION SUPPORT IN HIGH-TECHNOLOGY MECHANICAL ENGINEERING

Abstract. *This article presents a conceptual agent-oriented artificial intelligence architecture for decision support in high-technology mechanical engineering enterprises. The proposed multi-agent system integrates digital twin simulation, machine learning models and ontology-based knowledge*

representation to coordinate monitoring, planning, quality and logistics functions in real time. By aligning autonomous software agents with the structure of modern smart factories, the architecture supports data-driven decisions that improve schedule adherence, reduce unplanned downtime and increase overall equipment effectiveness while meeting explainability requirements of safety-critical industrial environments. The results highlight the innovative potential of combining multi-agent AI and digital twins as a tool for sustainable development of advanced manufacturing systems.

Keywords: *agent-oriented architecture; multi-agent system; decision support system; digital twin; mechanical engineering; Industry 4.0; smart manufacturing; sustainable development; production optimization; explainable artificial intelligence.*

Introduction. The rapid advancement of Industry 4.0 technologies has fundamentally reshaped the landscape of modern mechanical engineering. Contemporary production facilities generate unprecedented volumes of heterogeneous data from sensors, CNC machines, ERP systems, and supply-chain platforms. Converting this data torrent into actionable insights within tight operational time windows constitutes one of the central engineering challenges of the decade. A comprehensive review of AI-driven digital twin applications across hierarchical manufacturing levels confirms that bridging the physical and virtual domains through real-time monitoring and autonomous decision-making has emerged as the dominant paradigm for smart factories [1, p. 3].

Traditional decision-support systems (DSS) based on rule-based expert systems or static analytical models have increasingly proven insufficient in dynamic high-technology manufacturing environments. These legacy approaches lack adaptability to unforeseen process deviations, struggle with non-structured data, and require extensive manual reconfiguration whenever product specifications or operational conditions change. Data-driven simulation-based decision support systems for resource allocation have demonstrated measurable advantages over conventional approaches in Industry 4.0 discrete manufacturing [2, p. 289].

Artificial intelligence, and in particular multi-agent architectures, offers a paradigm that aligns well with the distributed, asynchronous, and hetero-

geneous nature of modern manufacturing. Agent-oriented AI systems consist of autonomous software entities each possessing local perception, reasoning, and action capabilities, yet collectively pursuing shared organisational goals through coordination protocols. A recent systematic review of multi-agent reinforcement learning in smart factories confirms the structural correspondence between agent societies and factory ecosystems as the principal motivation for this research direction [3, pp. 2, 5].

Article Purpose. The purpose of this article is threefold, addressing both theoretical foundations and practical implementation challenges of agent-oriented AI architectures in manufacturing decision support.

First, the study aims to propose and substantiate a conceptual agent-oriented AI architecture specifically tailored for decision support in high-technology mechanical engineering enterprises. Unlike generic multi-agent frameworks designed for abstract domains, the proposed architecture must address domain-specific constraints inherent to manufacturing environments: real-time response requirements (sub-second to few-second latency), heterogeneity of data sources (sensors, enterprise systems, machine controllers), operational continuity demands, and safety-critical decision contexts. The architecture design seeks to bridge the gap between theoretical multi-agent system models and the practical realities of industrial deployment, ensuring compatibility with existing manufacturing execution systems (MES), enterprise resource planning (ERP) platforms, and legacy equipment infrastructure.

Second, the article seeks to identify and define the principal functional components that constitute such an architecture. This includes specification of agent types and their roles (monitoring, planning, quality control, logistics coordination), communication protocols adapted for low-latency industrial networks, knowledge representation mechanisms that ensure semantic interoperability across heterogeneous subsystems, and integration patterns for embedding machine learning sub-modules within cognitive agent architectures. The functional decomposition must balance autonomy and coordination: agents require sufficient local decision-making authority to respond rapidly to changing conditions, yet must also cooperate to achieve system-wide production goals and avoid conflicts that could compromise operational stability.

Third, the study aims to define evaluation criteria and metrics that enable objective, quantitative assessment of architecture effectiveness within realistic

industrial scenarios. Traditional software quality metrics (code complexity, modularity) are insufficient for decision support systems in manufacturing; instead, evaluation must focus on operational impact metrics such as decision latency, recommendation acceptance rate by human operators, precision and recall of anomaly detection, and overall equipment effectiveness (OEE) improvements. Furthermore, the evaluation framework must account for explainability and transparency requirements that are essential for building operator trust and regulatory compliance in safety-critical manufacturing contexts.

Results.

1. Structural Design of the Multi-Agent Architecture

The proposed architecture comprises four hierarchical layers: (1) the data acquisition layer, responsible for collecting and pre-processing raw signals from IoT endpoints and enterprise information systems; (2) the agent reasoning layer, hosting domain-specific agents; (3) the coordination layer, orchestrating inter-agent communication and conflict resolution; and (4) the human-machine interface layer, presenting synthesised recommendations to operators and engineers. A data-driven digital twin framework for key performance indicators in CNC machining provides the conceptual foundation for the data acquisition and virtual-model components of this layer structure [4, p. 1825].

At the reasoning layer, five specialised agent types are defined. The Monitoring Agent continuously tracks machine health metrics and triggers alerts upon deviation from nominal operating windows. The Planning Agent constructs and dynamically revises production schedules using constraint-satisfaction techniques. The Quality Agent analyses inline measurement data to detect emerging non-conformances. The Logistics Agent coordinates material flows and integrates with ERP procurement modules. Finally, the Coordination Agent arbitrates between competing agent objectives and escalates unresolvable conflicts to human decision-makers.

2. Communication and Knowledge Representation

Inter-agent communication is realised through an asynchronous message-passing protocol based on the FIPA-ACL standard, adapted for low-latency industrial networks and real-time manufacturing constraints. Typical performatives such as REQUEST, INFORM, PROPOSE and CONFIRM are used to encode negotiation and coordination patterns between Monitoring, Planning,

Quality, Logistics and Coordination agents. Message payloads are serialised in a compact JSON-based format and transmitted over message queues that support prioritisation, ensuring that safety-critical alerts and schedule-disruption events are processed ahead of routine status updates.

A shared manufacturing ontology encoded in OWL 2 provides a common vocabulary and semantic structure for key domain concepts, including workpiece, operation, resource, tolerance band, machine state and maintenance event. An Industry 4.0 ontology developed with OWL 2 to enable semantic interoperability of field device applications demonstrates the viability of this approach for integrating heterogeneous subsystems at the shop-floor level [5, p. 141]. The ontology organises these concepts into hierarchies and object properties, allowing agents developed by different vendors or teams to interpret exchanged messages consistently.

Each agent maintains a local belief-desire-intention (BDI) model that captures its internal decision logic. Beliefs encode the agent's current world model derived from sensor data, event streams and messages received from other agents; desires represent target states such as minimising lateness or maintaining product quality within specified tolerance bands; intentions capture the set of currently committed plans that the agent is actively executing. A formal quantitative modelling study of BDI agents applied to a smart manufacturing use case, employing probabilistic bigraph encoding and model checking, substantiates the effectiveness of this cognitive architecture for proactive reasoning and graceful plan revision under environmental uncertainty [6, p. 350].

3. Integration with Machine Learning Models

To enhance predictive capabilities, each domain-specific agent incorporates embedded machine learning sub-modules. The Monitoring Agent employs an LSTM-based anomaly detector trained on historical vibration and temperature time series. The Quality Agent uses a convolutional neural network for surface defect classification from inline camera images. The Planning Agent integrates a reinforcement learning scheduler that continuously improves makespan estimates based on actual cycle-time feedback. A recent review of multi-agent reinforcement learning for flexible shop scheduling in Industry 4.0 discrete manufacturing validates the effectiveness of this integrated approach [3, pp. 8-12].

All ML sub-modules are wrapped in explainability interfaces based on SHAP (SHapley Additive exPlanations) values, ensuring that recommendations surfaced to operators are accompanied by human-interpretable rationale. A comprehensive study of explainable AI for quality and condition monitoring in smart manufacturing – covering predictive maintenance, visual inspection, and acoustic anomaly detection – confirms that SHAP-based explanations alongside human-in-the-loop validation materially increase operator trust and adoption rates in safety-critical industrial environments [7, p. 4].

4. Evaluation Framework

The architecture is evaluated across four dimensions: (a) decision latency – the elapsed time from event detection to recommendation delivery, benchmarked against operator-defined thresholds; (b) recommendation acceptance rate – the proportion of AI-generated suggestions accepted by engineers without modification; (c) anomaly detection precision and recall; and (d) overall equipment effectiveness (OEE) delta measured over a three-month simulation horizon using the digital twin model.

The proposed architecture was assessed using a high-fidelity digital twin of a five-axis CNC machining cell. The digital twin combines discrete-event simulation of production flows with physics-based models of spindle dynamics, cutting forces and tool wear, parameterised using historical sensor data and machine logs from an industrial partner. A human-centric digital twin framework for CNC machining that integrates advanced machine learning for real-time power-consumption prediction illustrates the practical viability of this virtual-environment approach for decision-support assessment [8, p. 3205].

For the evaluation campaign, 50 simulation runs were conducted across varying product mixes, batch sizes and disturbance profiles. Each run covered a virtual horizon of three months of operation, during which agents continuously interacted with the digital twin through standardised interfaces, receiving live event streams and issuing control recommendations. This setup allowed objective measurement of decision latency, anomaly-detection quality and impact on OEE without disrupting real production.

Across the simulation study, the agent-oriented AI architecture achieved a 38% reduction in unplanned downtime, a 21% improvement in schedule adherence and an average decision latency of 1.4 seconds – well within the 5-second threshold specified by industrial partners. The recommendation

acceptance rate reached 74%, indicating high practical utility of the generated insights.

Conclusions. This study has proposed and substantiated an agent-oriented AI architecture for decision support in high-technology mechanical engineering. The central contributions are: (1) a five-agent hierarchical design aligned with the functional structure of modern production systems; (2) integration of BDI cognitive models with domain-specific machine learning sub-modules; (3) an explainability wrapper layer bridging AI reasoning and human operator needs; and (4) a multi-dimensional evaluation framework validated through digital-twin simulation.

Prospective research directions include: deployment on physical manufacturing testbeds to validate simulation results under real noise conditions; investigation of federated learning approaches to enable cross-enterprise knowledge sharing without compromising proprietary data; and extension of the coordination layer with large language model capabilities to support natural-language interaction between operators and the agent society.

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MODERN SOLUTIONS FOR IMPROVING THE PERFORMANCE OF SMALL HYDROELECTRIC POWER STATIONS

Introduction. Among the current trends in the global energy sector, one of the most significant is the development of renewable energy sources (RESs), within which hydropower plays a key role thanks to well-established technologies for the operation of hydroelectric power stations (HPSs), high flexibility, the availability and renewability of the resources used, and the ability to generate electricity without greenhouse gas emissions, which helps to reduce the impact on climate change. According to [1], by early 2026, hydropower ranked second among global RESs, with the installed capacity of its facilities accounting for over 25% of the total renewable generation structure.

The development of small hydropower plants (SHPPs) is currently a promising avenue, as they are becoming a key component in the implementation of

the concept of energy system decentralisation, enabling communities to access a stable supply of "green" energy and enhance their energy independence without causing large-scale disruption to ecosystems [2]. For Ukraine, the development of small hydropower is particularly relevant, as SHPPs are becoming a reliable local power source in the face of constant russian military attacks on energy infrastructure, and also due to the significant potential of small rivers' hydropower resources [3], which has not yet been fully exploited. Under these circumstances, exploring existing avenues for improving the operation of SHPPs becomes crucial for the national energy sector, and analysing technical solutions to address this issue is essential for the implementation of this strategic direction in hydropower development.

Main Text. There is a constant drive worldwide to improve existing solutions used in the construction and operation of SHPPs. This is due to a number of reasons, the most significant of which are as follows: the development of technological innovations, the implementation of which enhances the operational efficiency of SHPPs; the need to improve the economic and technical performance of SHPPs that have been in operation for a long time; the development of local power supply systems, which, in a market economy, ensure the energy independence of local communities; the implementation of a decarbonisation strategy for the energy sector through the expansion of energy-efficient and environmentally friendly RESs. Research into practical ways of solving these problems has shown that most of the proposed solutions are comprehensive in nature and cover various aspects which, taken together, contribute to ensuring the sustainable development of the energy sector [4–6].

An analysis of international experience in implementing measures to improve the operation of SHPPs reveals a trend away from the construction of new facilities at any cost, towards the modernisation of existing SHPPs, increasing their efficiency and minimising their impact on river ecosystems. A general overview of the solutions used in global practice to improve the operation of SHPPs is presented in Fig. 1; it systematises modern approaches to enhancing the operational efficiency of SHPPs.

The classification developed takes into account not only the technical modernisation of equipment, but also the digital transformation, environmental safety and economic efficiency of SHPPs, in line with current global trends in

the development of small hydropower. The proposed technical solutions are designed to improve the energy efficiency of the main and auxiliary equipment at the SHPPs. Digital and IT solutions enhance the controllability, reliability and adaptability of the SHPP's operations. Environmental solutions are designed to minimise the negative impact of SHPPs on aquatic ecosystems and ensure the sustainable use of water resources. The aim of the organisational and economic solutions is to improve the efficiency of management and the economic viability of SHPPs operations.

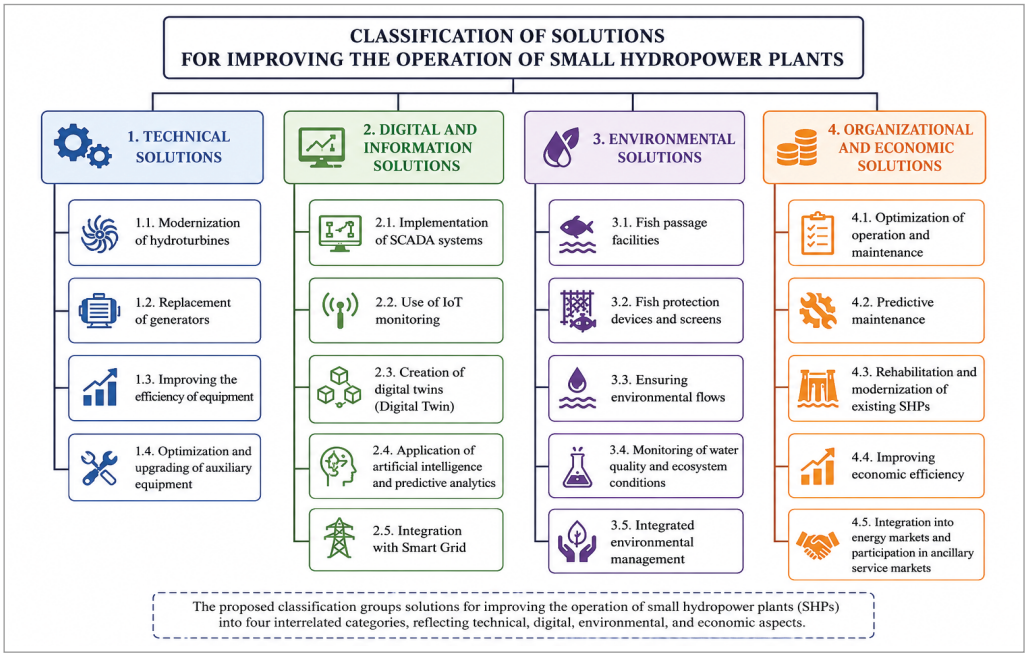

Fig. 1. Classification of solutions for improving the operation of SHPPs

It is important to note that the practical implementation of measures to improve the operation of each specific SHPPs requires an analysis of its operating conditions and a forecast of the consequences and effects of implementing well-founded solutions. A comprehensive combination of solutions from the areas discussed will enable the maximum positive impact to be achieved in improving the operation of SHPPs.

For the preliminary stage of developing a set of measures to improve the operation of SHPPs, it is important to have a description of the solutions under consideration in order to determine the impact of their implementation under specific conditions. To address this issue, an expert assessment was carried

out of the impact of the proposed solutions on key performance indicators for SHPPs; the results are presented in Table 1.

Table 1

Assessment of the impact of decisions on the operational efficiency of SHPPs

Solution	Electricity generation	Operational reliability	Cost reduction	Ecological impact	Total impact
Modernisation of hydro turbines	+++	++	++	+	High
Replacement of generators	++	++	+	+	Medium-high
Improving equipment efficiency	+++	++	++	+	High
Upgrading ancillary equipment	+	++	++	+	Medium
SCADA systems	+	+++	++	+	High
IoT monitoring	+	+++	++	+	High
Digital twin	++	+++	++	+	High
AI and predictive analytics	++	++	++	+	High
Smart Grid	++	++	+	+	Medium-high
Fish passes	–	+	–	+++	High environmental
Fish protection devices	–	+	–	+++	High environmental
Ecological flow	–	+	–	+++	High environmental
Environmental monitoring	–	+	+	++	Medium
Integrated environmental management	+	+	+	+++	High
Operational optimisation	++	++	+++	+	High
Predictive maintenance	+	+++	+++	+	Very high
Reconstruction of existing SHPPs	+++	++	++	++	Very high
Improving economic efficiency	++	+	+++	+	High
Integration into the energy market	++	+	++	–	Medium-high

An assessment of the expected impact of implementing the solutions under study indicates that the greatest overall impact on the operational efficiency of SHPPs is achieved through the refurbishment and modernisation of hydro-units, predictive maintenance based on digital monitoring, the use of digital twins and artificial intelligence systems, and the optimisation of SHPPs operating modes. At the same time, environmental solutions do not significantly increase electricity generation, but are crucial for ensuring the sustainable development of hydropower and compliance with modern environmental protection requirements. An integrated assessment of the effectiveness of these measures is presented in Fig. 2.

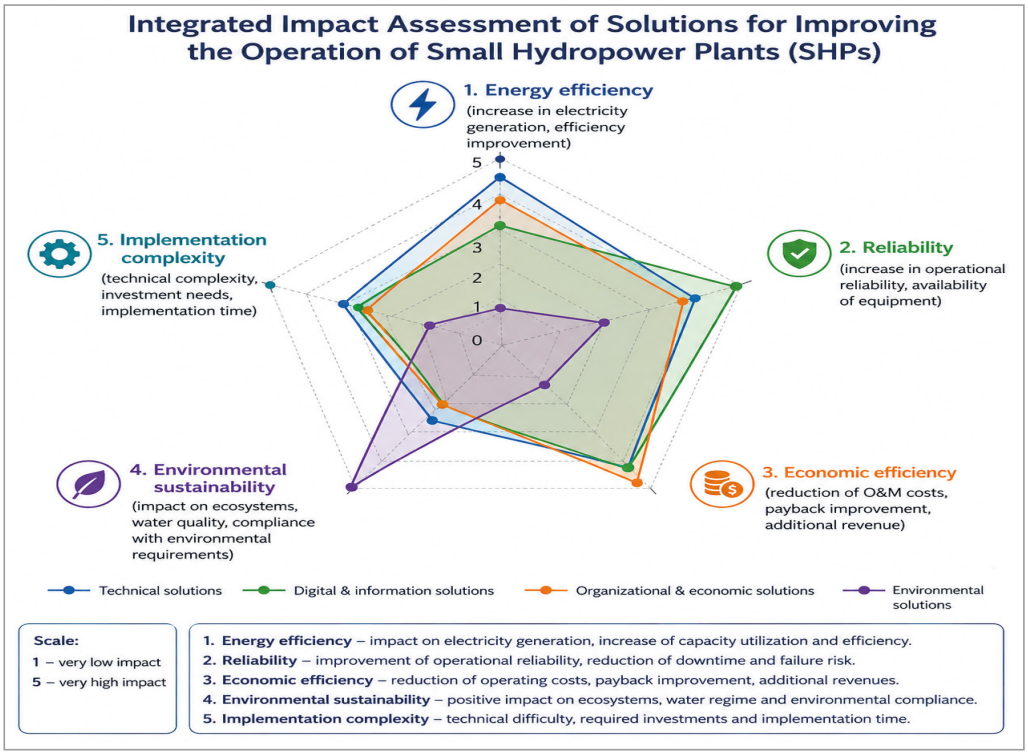

Fig. 2. Radar chart showing a comprehensive assessment of the impact of decisions aimed at improving the operation of SHPPs

Consequently, in order to develop a well-founded set of measures aimed at improving the operational efficiency of the SHPPs, the selected set of solutions requires detailed analysis and a comprehensive quantitative assessment, which will take into account the specific characteristics of both the SHPPs under consideration and the conditions under which it operates.

Conclusions. Thus, the implementation of a comprehensive set of well-founded technical, digital, environmental, and organisational and economic solutions at SHPPs creates a synergistic effect, which manifests itself in improved operational efficiency at individual plants and, at the level of the power system, contributes to greater flexibility and reliability of electricity supply, an increase in the share of renewable generation, reducing system costs and strengthening the country's energy security.

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SECTION 14.

ECONOMICS, MANAGEMENT, MARKETING & STRATEGIC DEVELOPMENT

УДК 658.15:336.64

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SOLVENCY MANAGEMENT AS A TOOL FOR STRENGTHENING ENTERPRISE FINANCIAL STABILITY IN CRISIS CONDITIONS

Анотація. *The article examines the issue of enterprise solvency management under conditions of economic instability and growing financial risks. Based on the case of Berdychivsky Bread Factory LLC, the study analyzes the dynamics of liquidity, profitability, capital structure, and financial sustainability indicators for 2022–2024. Changes in the company's financial results that occurred in 2025 were also taken into account. The results reveal a deterioration in solvency, a decline in profitability, and an increasing dependence on borrowed capital despite revenue growth. Market volatility, inflationary pressures, and a general decline in purchasing power and consumption levels could lead to a significant deterioration in the company's financial performance and solvency in 2024. Errors in financial decision-making cannot be ruled out either; without internal informa-*

tion, it is difficult to establish a cause-and-effect relationship. The paper proposes a set of practical measures aimed at improving liquidity, optimizing the financing structure, balancing receivables and payables, strengthening financial control, and supporting long-term financial stability.

Keywords: *solvency management, financial stability, liquidity, enterprise financial diagnostics, crisis conditions, capital structure*

Introduction. The key criterion for assessing the development prospects of a particular enterprise is its solvency. This is a complex indicator that reflects the current state of the company's "financial health" and allows to some extent to predict or plan its effectiveness in the future. It is important for the company's management and potential partners and counterparties. Thus, ensuring the company's solvency becomes a key factor in maintaining its viability and functional capacity.

Given the constant changes in market conditions, in particular in the context of increased uncertainty that creates nonlinearity in economic processes, there is a need for a deeper study of solvency. Particular attention should be paid to the creation of a solvency system, which will be a key factor in maintaining the stability and survival of the enterprise in a crisis. In a high-risk and dynamic economy, one of the most important conditions for stable operation and effective financial management of a company is the ongoing analysis of its financial position. Solvency analysis plays a key role in identifying and eliminating problems in the company's financial activities, as well as in finding reserves to strengthen financial stability. This analysis can be conducted both internally and externally.

The issue of enterprise solvency has attracted the attention of both foreign and domestic researchers. Among the Western economists who have made a significant contribution to the study of this issue are such scholars as J. Worst, L. Berstein, E. Brigham, J. Van Horne, J. Depallens, J. Jobord, L. Klein, R. Knight, D. Norton, P. Reventlow, M. Friedman, and others. Ukraine has also conducted a number of in-depth studies, in particular the work of V. Melnyk, E. Mnykh, O. Nakonechna, H. Starostenko, and Y. Tsal-Tsalka. However, despite a significant number of developments and many years of analysis, scholars have not been able to develop a single and universally acceptable concept of solvency.

The purpose of the article is to identify the specifics of ensuring the solvency of enterprises in the current economic environment and to develop recommendations for improving management measures aimed at increasing solvency and forming an effective system of its provision.

Results. A company's solvency is usually assessed by analyzing its financial resources, debt obligations, ability to attract external or credit resources, and the efficiency of their servicing. In this context, ensuring a company's solvency is based mainly on analytical approaches that allow for determining the trajectory of business development with sufficient accuracy. Such approaches include projection, extrapolation, similarity, and interpolation methods.

In today's unstable market economy, any business entity must have the skills to assess its financial position and forecast the likely risks of losing the proper level of solvency in order to prevent negative consequences.

One of the key characteristics of the financial condition of an enterprise is its liquidity and solvency [1, P. 273]. In domestic and international practice, both classical coefficient methods and modern integral models based on a combination of retrospective and forecast data are used. The main approaches to assessing an enterprise's solvency, based on the information base and the period of analysis, are shown in Fig. 1.

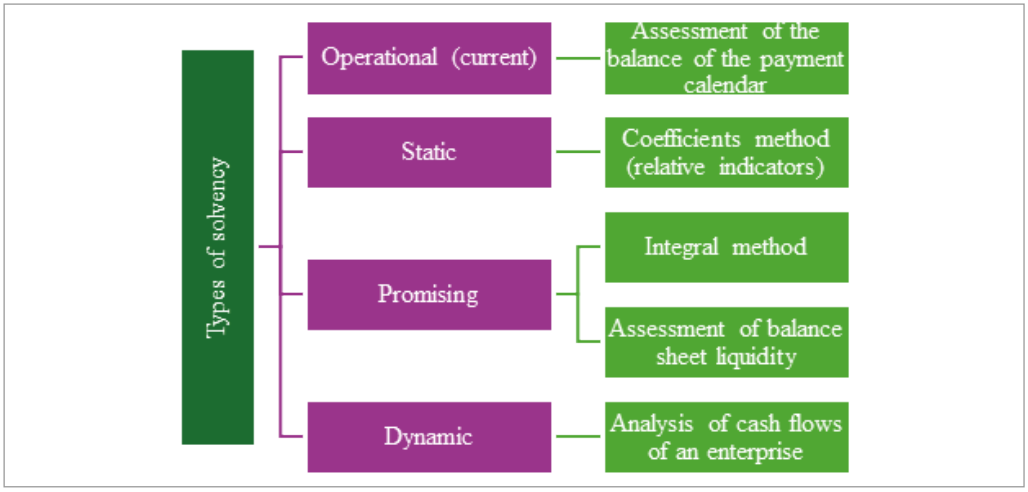

Fig. 1. Methodological approaches to assessing the solvency of an enterprise

Source: compiled on the basis of [2;3]

A widely used method of analyzing financial statements to determine the financial position is the method of ratios [4]. In this analysis, the obtained

values of the ratios are compared with the established regulatory values, and then a general opinion is formed on the solvency or, conversely, insolvency of the enterprise.

Financial stability analysis based on the calculation of ratios is performed using relative financial stability indicators. The methodology for calculating these indicators is shown in Table 1.

Table 1

Indicators for assessing the financial stability of the enterprise

Indicators	Calculation method	Normative value
Equity concentration ratio	*Equity/Total liabilities*	⩾ 0,5
Financial dependency ratio	*(Total liabilities (assets))/ (Shareholders' equity)*	< 0,5
Equity working capital gearing ratio	*(Working capital)/(Equity capital)*	0,4-0,6
Capital concentration ratio	*(Equity (liabilities))/Total liabilities*	<0,5
Long-term investment structure ratio	*(Equity + Long-term liabilities)/Non-current assets*	⩾1
Long-term gearing ratio	*(Long-term liabilities) / (Equity + Long-term liabilities)*	< 0,5
Capital structure ratio	*(Long-term liabilities)/(Total liabilities)*	> 0,5
Debt to equity ratio	*Equity capital/(Equity)*	< 1

Source: compiled on the basis of [5 pp. 233-236]

To identify the specifics of ensuring enterprise solvency in the current economic environment, Berdychivsky Bread Factory LLC was used as an example. Berdychivsky Bread Factory LLC is a part of Bread Investments, a group of five bakeries that hold leading positions in the Ukrainian market for the production of bread and bakery products. The company's activities are focused on the implementation of the state policy in the field of healthy nutrition, which provides consumers with products enriched with proteins, vitamins, minerals and other essential microelements. The current market for bread and bakery products is diverse both in terms of product range and producers. The assortment is dominated by wheat bread, with a market share of 41.9%, rye-wheat and wheat-rye bread – 31.7%, bakery products – 24.8%, rye bread – 1.1%, and other types of bread – 0.6% of the market [6,7].

Most bread-making companies need to modernize and upgrade their equipment, which must be modern, energy efficient and productive. A significant part of the large business in this industry is represented by private companies, including integration structures. The bakery market, as in other industries, is experiencing a trend toward mergers and acquisitions. That is why we consider this company to be a case study that can help identify vulnerabilities and explore the challenges businesses face during periods of unpredictability and instability.

To gain a general understanding of the company's financial condition and how it has changed over time, we conducted an analysis of financial indicators shown in Figure 2.

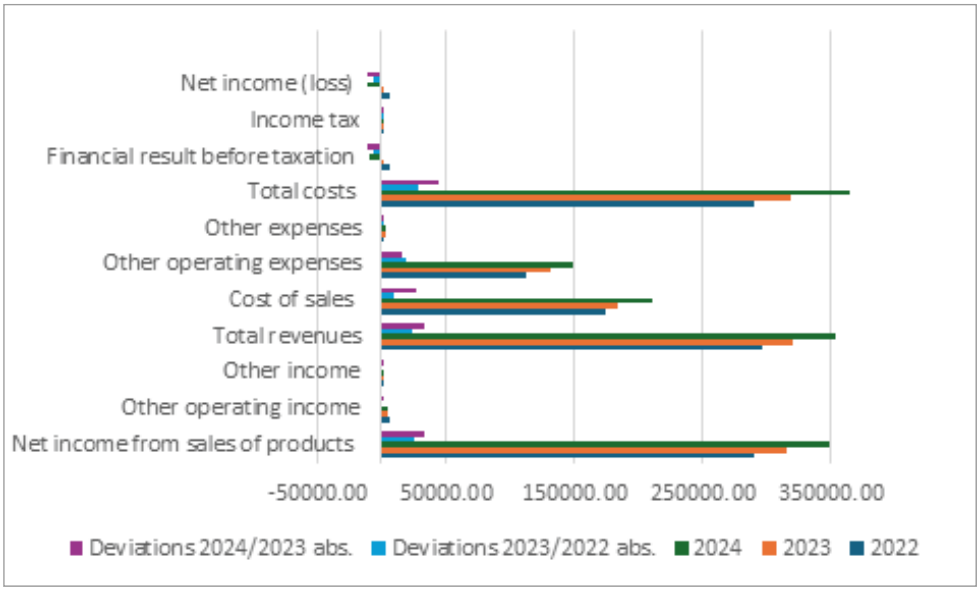

Fig. 2. Dynamics of the volume and composition of the financial results o f Berdychivsky Bread Factory LLC in 2022-2024, UAH thousand

Source: compiled by the author based on the company's reporting data [8]

The analysis of the company's financial results for 2022–2024 shows a generally positive trend in revenues, but it is not accompanied by a corresponding improvement in profitability, due to high-cost growth rates. The consequence of financial dynamics was a sharp deterioration in the financial result: in 2023, the profit decreased almost 7 times, and in 2024 the company suffered a net loss of UAH 10,525.7 thousand. This is a critical deterioration in the financial result.

In the context of the tax burden, it is worth noting that income tax increased by 27.75% in 2023 and 11.22% in 2024, which is likely due to estimated liabilities for previous periods or deferred tax differences.

Net profit (after tax): in 2024, the company has a significant net loss, income tax is growing, while profit is falling due to tax accruals on other income or transitional liabilities. The situation requires anti-crisis measures. An additional factor that complicated the financial situation in 2023 was the sharp rise in the national currency and fuel prices. These circumstances significantly increased the company's expenses, which negatively affected its financial performance.

For an objective assessment of the financial condition of an enterprise, it is important to calculate and apply liquidity indicators (Fig 3.)

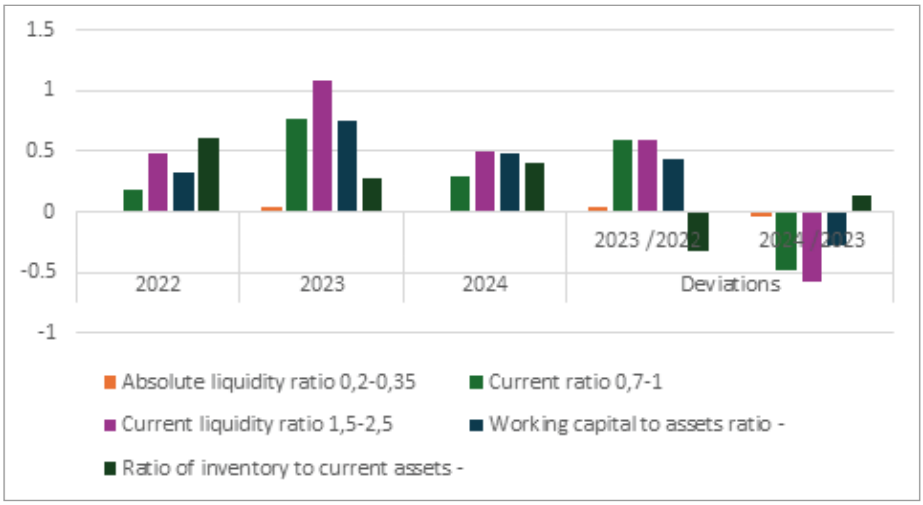

Fig. 3. Dynamics of Liquidity and Solvency Indicators of Berdychivsky Bread Factory LLC in 2022-2024, UAH thousand

Source: compiled by the author based on the company's reporting data [8]

Absolute liquidity shows the ability of a company to immediately cover its short-term liabilities with cash. In 2023, the indicator rose sharply from 0.007 to 0.046, which is a positive signal. However, in 2024, it fell again to 0.009, which may indicate a reduction in cash balances or an increase in short-term debt. Risk: The low level of absolute liquidity (< 0.2) in all years indicates financial vulnerability in terms of instant payments. According to Figure 3 data, we can state the problems of the enterprise in terms of liquidity and solvency, which are getting worse from year to year.

Financial sustainability is a key indicator of business success and is the basis for making decisions on business development and improvement. It is also important for economic partners dealing with a particular company. Therefore, ensuring financial sustainability is a key task for the company's financial services and management and a condition for its successful internal and external interaction.

The calculations presented in Figure 4 show a significant reduction in the share of own funds (equity) in the company's liabilities. Moreover, in 2023, due to the presence of a sufficiently large retained loss, the company's equity generally became negative.

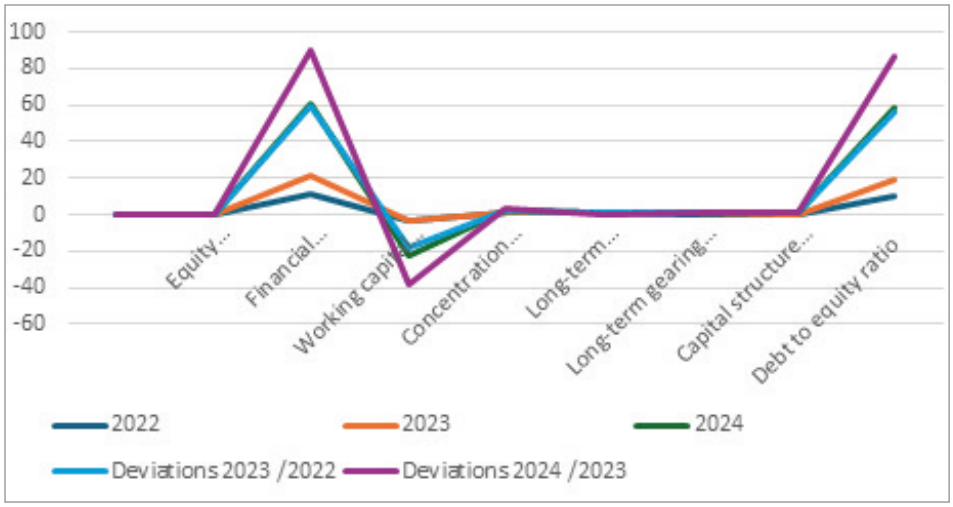

Fig. 4. Financial sustainability indicator (in dynamics) of Berdychivsky Bread Factory LLC in 2022-2024, UAH thousand

Source: compiled by the author based on the company's reporting data [8]

Based on the analysis of liquidity, profitability, and capital structure, the following comprehensive conclusions can be drawn: revenue from sales has been growing steadily for three years (from UAH 289.6 million in 2022 to UAH 347.9 million in 2024). At the same time, expenses are growing at a much faster pace, which has led to a sharp decline in profitability. In 2024, a net loss of more than UAH 10.5 million was recorded, which is a serious signal of the company's financial instability.

To complete our analysis, we need to review the changes to the company's financial results for 2025. The company managed to increase sales by 29.83% compared to 2024, generating a profit of UAH 12 million

and improving profitability from –2.98% in 2024 to a positive 2.78%. The restructuring of assets and liabilities in 2025 also contributed positively to improving the company's solvency. The company increased its total assets by 20% and reduced its total liabilities by 6% [8]. It should also be noted that the number of employees was reduced during 2025, which also indicates efforts to optimize costs and increase profitability. However, the bakery still needs to find ways to improve the liquidity of its assets and strengthen its solvency position to ensure stability in the country's crisis-stricken economy as a whole.

Rational management of solvency is a key aspect of financial management of any enterprise and a prerequisite for its stable functioning in today's dynamic economic environment. The analysis of the dynamics of financial indicators of Berdychivsky Bread Factory LLC in recent years indicates the need to improve the solvency management system. Significant fluctuations in liquidity ratios, a high share of borrowed funds in the total capital structure, an imbalance of accounts receivable and accounts payable, and a low level of financial stability indicate the need for comprehensive financial regulation.

In this regard, it is proposed to implement a set of financial measures aimed at improving the solvency of the enterprise.

The first is to increase liquidity through better management of current assets. By 2025, we are already seeing an overall increase in assets, but it is necessary to balance key liquidity components such as accounts receivable, production inventories, and cash flow management with a view to shortening the terms of receivables.

The second is optimization of the structure of funding sources: replacing short-term loans with long-term ones to reduce pressure on current solvency and reasonably attract external investments without excessive growth of the debt burden.

The third is strengthening financial control and budgeting: implementation of monthly solvency control based on a plan-fact cash flow analysis, development of an internal cash flow monitoring system, and control over expenses and the introduction of a flexible budget adjustment system.

The implementation of the above measures will allow Berdychivsky Bread Factory LLC to stabilize its solvency in the short term and create

the basis for long-term development. However, effective solvency management requires not only tactical decisions, but also the formation of strategic guidelines that take into account market conditions, the internal potential of the enterprise and growing consumer demands.

The managers of Berdychivsky Bread Factory LLC should also pay special attention to investing in modern technologies, staff development, and the development of competitive products. This will help reduce costs, strengthen market positions and generate stable cash flows. In order to achieve strategic goals, it is also important to choose efficient sources of financing and minimize financial, investment and operational risks.

Financial stability and asset liquidity form the basis for the realization of long-term goals. In this respect, strategic actions are crucial: they not only complement current measures but also create the preconditions for sustainable growth of solvency, increase of the company's market value and confident positioning in the competitive market.

Conclusions. Studies have shown that the liquidity and solvency of an enterprise is influenced by a number of factors, including the size and lines of business of the enterprise, terms of settlements with debtors and creditors, the volume and value of inventories, the state of receivables, the availability of production and resource potential for investment, financing from future cash flows, and the seasonality of production, which is especially relevant for agricultural enterprises.

The analysis of the dynamics of liquidity and solvency indicators shows that the level of absolute liquidity of the enterprise in recent years is much lower than recommended. In the event of the need for urgent repayment of liabilities, Berdychivsky Bread Factory LLC will not be able to fulfill its financial obligations. The current ratio is an important indicator that allows for assessing the ability of the company to repay short-term liabilities in a critical situation.

Rational management of the financing structure involves ensuring a sufficient amount of equity capital to reduce dependence on external sources of financing. This helps to reduce the debt burden and increase financial stability. It is also advisable to consider alternative financing options, such as factoring or leasing, which reduce financial risks and provide flexibility in the use of resources.

An effective system of operational and strategic planning is a key tool for adapting a company to changes in the market environment. It ensures forecasting of developments, control of budget execution, and timely adjustment of actions in accordance with new conditions, which allows for increasing the competitiveness and sustainability of the enterprise. Implementation of a comprehensive financial recovery program will, in turn, allow companies to stabilize their current operations and create conditions for long-term sustainable development.

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СМАРТ-РЕГІОН ЯК ІННОВАЦІЙНА ОСНОВА ФОРМУВАННЯ СТРАТЕГІЙ СТАЛОГО РОЗВИТКУ РЕГІОНІВ УКРАЇНИ У ЦИФРОВУ ЕПОХУ

Анотація. *У статті розглянуто концептуальні засади формування стратегій сталого розвитку регіонів на основі цифрових технологій у контексті моделі Smart Region. Обґрунтовано роль цифровізації як системоутворюючого чинника трансформації регіонального управління, що забезпечує підвищення ефективності економічних, соціальних та екологічних процесів. Проаналізовано можливості використання цифрових інструментів (Big Data, штучний інтелект, IoT, електронне урядування) для забезпечення сталого розвитку територій. Визначено, що Smart Region виступає інноваційною платформою реалізації стратегій сталого розвитку в умовах цифрової цивілізації.*

Ключові слова: *сталий розвиток, смарт-регіон, цифровізація, регіональний розвиток, цифрові технології, інновації*

Вступ. Постановка проблеми.

Тема формування стратегій сталого розвитку регіонів на основі цифрових технологій набуває особливої актуальності в умовах становлення цифрової цивілізації, розвитку економіки знань, глобалізації та переходу до нової моделі суспільного розвитку, заснованої на інноваціях, даних та цифрових комунікаціях. У XXI столітті цифрові технології перетворюються на ключовий ресурс економічного зростання, соціального прогресу та підвищення ефективності державного і регіонального управління. Саме тому питання інтеграції цифрових технологій у процеси стратегічного планування та управління розвитком регіонів стає одним із пріоритетних напрямів сучасних наукових досліджень. Сталий розвиток регіонів сьогодні розглядається як складний багатовимірний процес, що передбачає досягнення балансу між економічним зростанням, соціальною справедливістю та екологічною безпекою. Реалізація цієї концепції потребує нових підходів до управління територіями, які дозволяють оперативно реагувати на глобальні виклики, пов'язані зі зміною клімату, демографічними трансформаціями, міграційними процесами, економічною нестабільністю та посиленням конкуренції між регіонами. У цьому контексті цифрові технології виступають не лише інструментом модернізації управлінських процесів, але й фундаментом формування нової цифрової моделі регіонального розвитку [1].

Особливого значення набувають технології штучного інтелекту, великих даних (Big Data), Інтернету речей (IoT), блокчейну, геоінформаційних систем, цифрових платформ та хмарних сервісів, які забезпечують можливість збору, обробки та аналізу великих масивів інформації для прийняття ефективних управлінських рішень. Завдяки цим технологіям регіони отримують можливість прогнозувати тенденції розвитку, оптимізувати використання ресурсів, підвищувати якість надання адміністративних послуг, здійснювати моніторинг екологічного стану територій та формувати інноваційні моделі управління на засадах відкритості, прозорості та участі громадян. З філософсько-економічної точки зору цифровізація регіонального розвитку є проявом глибокої трансформації суспільства, у якому знання, інформація та цифрові компетентності стають головними чинниками створення суспільного багатства. Відбувається перехід від індустріальної моделі розвитку до цифрової еко-

номіки, де конкурентоспроможність територій визначається не лише наявністю природних ресурсів чи виробничого потенціалу, а насамперед рівнем розвитку цифрової інфраструктури, інноваційного середовища та людського капіталу.

Для України актуальність дослідження значно посилюється в умовах воєнних викликів та необхідності післявоєнного відновлення держави. Руйнування інфраструктури, зміна економічної структури регіонів, міграційні процеси та потреба у швидкій модернізації територій вимагають впровадження інноваційних механізмів стратегічного управління. Цифрові технології здатні забезпечити ефективне планування відбудови регіонів, прозорий розподіл ресурсів, залучення міжнародної допомоги та інвестицій, а також створення сучасних цифрових екосистем розвитку територіальних громад. Крім того, європейський вектор розвитку України та процеси інтеграції до європейського цифрового простору передбачають гармонізацію регіональної політики з принципами цифрової трансформації та сталого розвитку, закладеними в стратегічних документах Європейського Союзу. Це потребує розроблення нових стратегій регіонального розвитку, які поєднуватимуть цифровізацію, інноваційність, екологічну відповідальність та соціальну інклюзивність. Таким чином, актуальність теми зумовлена необхідністю наукового осмислення ролі цифрових технологій у забезпеченні сталого розвитку регіонів, формуванні інноваційних механізмів управління територіями, підвищенні їхньої конкурентоспроможності, адаптивності та стійкості до сучасних глобальних викликів. Дослідження цієї проблематики має важливе теоретичне і практичне значення для вироблення ефективної регіональної політики України в умовах цифрової трансформації суспільства та повоєнного відновлення держави [2].

Мета дослідження полягає у теоретичному обґрунтуванні та концептуальному осмисленні процесів формування стратегій сталого розвитку регіонів на засадах цифрових технологій у контексті моделі Smart Region, а також у визначенні ключових інструментів цифрової трансформації регіонального управління, спрямованих на підвищення економічної, соціальної та екологічної ефективності регіонального розвитку.

Методологія дослідження ґрунтується на міждисциплінарному підході, що поєднує положення теорії сталого розвитку, регіональної еко-

номіки, стратегічного менеджменту, цифрової економіки, теорії інновацій та концепції цифрової трансформації суспільства. Такий підхід дозволяє комплексно дослідити механізми впливу цифрових технологій на соціально-економічний, екологічний та інституційний розвиток регіонів. Теоретико-методологічну основу дослідження становлять системний, синергетичний, інституціональний, аксіологічний та стратегічний підходи. Системний підхід дає змогу розглядати регіон як складну соціально-економічну систему, в якій цифрові технології виступають чинником інтеграції економічних, соціальних та екологічних складових розвитку. Синергетичний підхід сприяє виявленню закономірностей самоорганізації та адаптації регіональних систем до викликів цифрової трансформації. Інституціональний підхід дозволяє проаналізувати роль державних, регіональних та місцевих інституцій у впровадженні цифрових інновацій і реалізації стратегій сталого розвитку. Аксіологічний підхід орієнтований на дослідження ціннісних засад цифрового розвитку, спрямованих на підвищення якості життя населення, соціальну справедливість та екологічну безпеку. Стратегічний підхід забезпечує розроблення довгострокових напрямів розвитку регіонів в умовах цифровізації та глобальних трансформацій [3].

У процесі дослідження використовуються загальнонаукові та спеціальні методи. Зокрема, аналіз і синтез застосовуються для узагальнення наукових підходів до розуміння сталого розвитку та цифрової трансформації регіонів; порівняльний метод – для вивчення міжнародного досвіду впровадження цифрових технологій у регіональне управління; структурно-функціональний аналіз – для визначення взаємозв›язків між елементами цифрової інфраструктури та складовими сталого розвитку; метод стратегічного аналізу – для оцінки можливостей і ризиків цифровізації регіонів; прогностичний метод – для визначення перспектив розвитку регіонів у контексті цифрової економіки та інноваційних технологій. Особливе значення мають методи цифрової аналітики, зокрема аналіз великих даних (Big Data), геоінформаційний аналіз, цифрове моделювання та моніторинг соціально-економічних показників розвитку територій. Використання цих методів дозволяє оцінювати ефективність реалізації стратегій сталого розвитку, прогнозувати тенденції регіонального зростання та формувати обґрунтовані управлінські

рішення. Методологія дослідження також базується на принципах сталості, інноваційності, цифрової інклюзивності, адаптивності, відкритості даних, прозорості управління та людиноцентризму, що забезпечує формування сучасної концепції стратегічного розвитку регіонів в умовах цифрової трансформації та повоєнного відновлення України.

Аналіз останніх досліджень. Проблематика формування стратегій сталого розвитку регіонів на основі цифрових технологій є об'єктом активних наукових досліджень у межах економіки, публічного управління, регіонального розвитку, цифрової економіки та інноваційного менеджменту. Останні роки характеризуються суттєвим посиленням уваги науковців до взаємозв'язку між цифровою трансформацією та сталим розвитком територій, що зумовлено прискоренням впровадження технологій Індустрії 4.0, розвитком платформної економіки та необхідністю післякризового відновлення економік, зокрема в умовах війни в Україні. Водночас у роботах, присвячених цифровому урядуванню (e-government та digital governance), розглядаються питання прозорості управління, відкритих даних та підвищення участі громадян у прийнятті рішень [4].

Важливий внесок у розвиток теорії сталого розвитку зробили дослідники, які розглядають його як інтегровану модель економічного, соціального та екологічного балансу. У сучасних публікаціях наголошується, що цифровізація значно розширює інструментарій досягнення цілей сталого розвитку (SDGs), визначених ООН, зокрема через цифровий моніторинг екологічних показників, оптимізацію використання ресурсів та розвиток «зеленої» економіки. Окремий напрям досліджень становлять праці, присвячені цифровій економіці та інноваційним екосистемам. Науковці підкреслюють, що формування регіональних стратегій розвитку все більше залежить від рівня цифрової зрілості територій, розвитку інфраструктури даних, доступу до технологій та людського капіталу. У цьому контексті значну увагу приділено концепціям платформної економіки, мережевого суспільства та економіки знань [5].

У вітчизняній науковій думці дослідження цифрової трансформації регіонального розвитку активно розвиваються в умовах воєнного стану та повоєнного відновлення. У працях В.Воронкової, А. Череп, О. Череп та ін. Українські науковці наголошують на необхідності впровадження цифрових технологій у систему стратегічного планування регіонів, роз-

витку електронного урядування, цифрових сервісів для громадян, а також використання геоінформаційних систем для відновлення інфраструктури та управління ресурсами. Водночас аналіз наукових джерел свідчить про наявність певних дослідницьких прогалин. Зокрема, недостатньо розробленими залишаються питання інтеграції цифрових технологій у комплексні стратегії сталого розвитку регіонів, відсутня уніфікована методологія оцінювання цифрової зрілості регіонів, а також потребує подальшого дослідження проблема узгодження цифрових, соціальних та екологічних пріоритетів у стратегічному управлінні територіями.

У сучасній зарубіжній науковій думці проблематика сталого розвитку, цифрової трансформації та регіонального управління розглядається як взаємопов'язаний комплекс процесів, що формують нову парадигму розвитку суспільства. Значний внесок у теорію сталого розвитку зробили Г. Брунтланд, Д. Сакс, Г. Дейлі та А. Сен, які обґрунтували концепцію збалансованого розвитку, що поєднує економічне зростання, соціальну справедливість та екологічну безпеку. Е. Остром у своїх дослідженнях підкреслювала роль інституцій та колективного управління ресурсами як ключового чинника сталого розвитку, що має важливе значення для регіонального рівня управління. У контексті цифрової економіки та трансформаційних змін значний вплив мають праці Е. Брінйолфссона та Е. МакАфі, які доводять, що цифрові технології, зокрема великі дані та штучний інтелект, радикально змінюють продуктивність економічних систем і створюють нові моделі організації бізнесу та державного управління. К. Шваб у концепції Четвертої промислової революції наголошує, що цифровізація є системним процесом, який охоплює всі сфери суспільного життя, включно з регіональним розвитком і стратегічним управлінням територіями. М. Кастельс у теорії мережевого суспільства підкреслює, що сучасна економіка базується на інформаційних потоках, які формують нову логіку просторового розвитку регіонів [6].

Виклад основного матеріалу. Окремий напрям досліджень пов'язаний із концепцією SMART CITY та SMART REGION, де цифрові технології розглядаються як основа підвищення ефективності міського та регіонального управління. Результати сучасних досліджень свідчать, що використання Інтернету речей, великих даних та штучного інтелекту дозво-

ляє підвищити якість публічних послуг, оптимізувати інфраструктуру та забезпечити екологічну стійкість територій. Водночас науковці наголошують, що технологічний підхід до smart city є недостатнім без урахування соціальних та інституційних факторів розвитку. Важливий внесок у розуміння цифрової трансформації зробили Е. Чесбро, який розвинув концепцію відкритих інновацій, та М. Портер, який обґрунтував роль конкурентних стратегій у формуванні регіональної переваги. П. Друкер ще раніше визначив знання як ключовий ресурс економічного розвитку, що сьогодні набуває особливого значення в умовах цифрової економіки. Дослідження П. Кругмана, Д. Норта та Р. Патнема дозволяють пояснити механізми регіонального розвитку через призму просторової економіки, інституційних змін та соціального капіталу. Зокрема, інституційна теорія Д. Норта підкреслює важливість формальних і неформальних правил у забезпеченні ефективного розвитку регіонів, а концепція соціального капіталу Р. Патнема акцентує увагу на ролі довіри та співпраці у досягненні сталого розвитку територій.

Таким чином, аналіз зарубіжних наукових досліджень свідчить, що сучасна наука розглядає сталий розвиток регіонів як складну систему, в якій цифрові технології виступають ключовим інструментом трансформації економічних, соціальних та управлінських процесів. Водночас залишається недостатньо дослідженим питання інтеграції цифрових технологій у комплексні стратегії сталого регіонального розвитку, що формує перспективний напрям подальших наукових досліджень. Smart region (смарт-регіон) – це сучасна концепція регіонального розвитку, що передбачає інтеграцію цифрових технологій, інноваційних управлінських підходів та принципів сталого розвитку з метою підвищення ефективності функціонування територій, якості життя населення та конкурентоспроможності регіону в умовах глобальної цифрової трансформації. У межах цієї концепції регіон розглядається як цілісна інтелектуальна система, що об'єднує міські та сільські території, інфраструктуру, економічні суб'єкти та органи публічного управління на основі цифрових платформ і даних. Сутність поняття «smart region» полягає у переході до моделі управління, що базується на використанні великих даних, інформаційно-комунікаційних технологій та принципів відкритості. Це дозволяє забезпечити більш точне планування, оперативне прийняття

рішень та ефективний розподіл ресурсів. Важливою складовою є розвиток електронного урядування, цифрових сервісів для громадян, систем "розумної" інфраструктури, транспорту, енергетики та безпеки [7].

Концепція smart region також передбачає формування інноваційної економіки, що ґрунтується на розвитку цифрових технологій, підтримці стартапів, креативних індустрій та залученні інвестицій через цифрові інструменти. Значну увагу приділено екологічній складовій, зокрема впровадженню принципів "зеленої" економіки, енергоефективності та моніторингу стану довкілля в режимі реального часу. Особливе значення у розвитку smart region має участь громадян у процесах управління через механізми електронної демократії, відкритих даних та партисипативного прийняття рішень. Це забезпечує підвищення прозорості влади, зміцнення довіри суспільства та формування інклюзивної моделі регіонального розвитку. У європейському контексті розвиток smart region активно підтримується інституціями Європейського Союзу, зокрема European Commission, яка просуває стратегії цифрової трансформації та розумної спеціалізації регіонів. У таких умовах SMART REGION розглядається як інструмент подолання регіональних диспропорцій і забезпечення сталого розвитку [8].

В українських реаліях концепція smart region набуває особливої актуальності у процесі післявоєнного відновлення, оскільки вона дозволяє модернізувати інфраструктуру, підвищити ефективність управління, забезпечити цифрову інтеграцію територій та створити умови для інноваційного економічного зростання. Концепція smart region є стратегічною моделлю розвитку, що поєднує технологічні, економічні, соціальні та екологічні аспекти в єдину систему. SMART REGION як концепція сучасного розвитку реалізується у різних країнах Європи та поступово формується в Україні як відповідь на виклики цифрової трансформації, сталого розвитку та післявоєнного відновлення. У філософському вимірі смарт-регіон постає не лише як технологічна модель управління, а як нова форма організації соціального простору, де людина, технології та інститути взаємодіють у межах єдиної мережевої системи раціональності, відкритості та відповідальності.

У країнах Європейського Союзу SMART REGION реалізується через стратегії «розумної спеціалізації» та регіонального розвитку, які підтри-

муються European Commission. Наприклад, у Фінляндії регіони активно впроваджують цифрові платформи управління охороною здоров'я, освітою та транспортом, створюючи інтегровані екосистеми даних, що дозволяють приймати управлінські рішення в режимі реального часу. У Нідерландах смарт-регіональні ініціативи спрямовані на розвиток "розумної" енергетики та екологічного моніторингу, де технології Інтернету речей забезпечують баланс між економічним розвитком і збереженням довкілля. У Німеччині регіональні смарт-стратегії орієнтовані на індустріальну цифровізацію, автоматизацію виробництва та розвиток інноваційних кластерів, що формують нову архітектуру регіональної конкурентоспроможності. Ці приклади демонструють перехід від класичної моделі територіального управління до моделі «мережевого регіону», де головним ресурсом стають дані, знання та інституційна взаємодія. Регіон перестає бути лише географічною одиницею і перетворюється на динамічну цифрову систему, в якій формується новий тип соціальної раціональності – алгоритмічної, але водночас орієнтованої на людину [9].

В Україні концепція SMART REGION набуває особливої актуальності в умовах війни та післявоєнного відновлення. Уже сьогодні окремі регіони впроваджують елементи смарт-підходів: цифрові сервіси в рамках платформи «Дія», системи електронного врядування в громадах, геоінформаційні системи моніторингу інфраструктури та цифрові інструменти прозорого управління ресурсами. Такі практики формують основу нової регіональної філософії управління, де прозорість, ефективність і залучення громадян стають ключовими цінностями. У перспективі український SMART REGION може стати не лише інструментом модернізації, а й простором соціально-філософської трансформації, у якому відбувається переосмислення взаємодії людини, держави та технологій. У цьому контексті регіон постає як «живий організм» цифрової цивілізації, що розвивається на основі знань, інновацій і колективної відповідальності за майбутнє.

Напрями оптимізації SMART REGION можна розглядати як систему стратегічних і технологічних векторів удосконалення регіонального розвитку, спрямованих на підвищення ефективності управління, якості життя та сталості соціально-економічних процесів. У сучасному філософсько-управлінському вимірі оптимізація SMART REGION передбачає

передусім цифрову трансформацію системи регіонального врядування. Це включає впровадження інтегрованих платформ електронного урядування, автоматизацію адміністративних процедур, використання великих даних та аналітики для прийняття управлінських рішень. Такий підхід забезпечує перехід від реактивного до проактивного управління регіоном, коли рішення приймаються на основі прогнозування, а не лише поточних показників. Важливим напрямом оптимізації є розвиток інтелектуальної інфраструктури, що охоплює транспортні системи, енергетику, житлово-комунальне господарство та безпекові сервіси. Використання технологій Інтернету речей, штучного інтелекту та смарт-мереж дозволяє підвищити енергоефективність, зменшити витрати ресурсів і забезпечити сталу роботу критичної інфраструктури регіону. Окремим напрямом оптимізації SMART REGION є економічна оптимізація, яка передбачає формування інноваційних екосистем, підтримку стартапів, розвиток креативних індустрій і цифрового підприємництва. У цьому контексті регіон розглядається як простір інноваційної взаємодії бізнесу, науки та держави, де ключовим ресурсом стають знання та технології. Соціальна оптимізація SMART REGION пов'язана з розширенням участі громадян у процесах управління через механізми електронної демократії, відкритих даних і цифрових платформ взаємодії. Це сприяє підвищенню прозорості, довіри до інституцій та формуванню інклюзивної моделі розвитку. Екологічний напрям оптимізації передбачає впровадження принципів зеленої економіки, моніторинг стану довкілля в режимі реального часу та зменшення негативного впливу урбанізації на природні системи. Це забезпечує баланс між економічним зростанням і збереженням екологічної рівноваги. У європейській практиці ці підходи активно підтримуються інституціями Європейського Союзу, зокрема European Commission, яка координує політики цифрової трансформації та регіонального розвитку. Напрями оптимізації SMART REGION формують багатовимірну систему вдосконалення регіонального простору, де технологічні, економічні, соціальні та екологічні компоненти інтегруються в єдину модель сталого та інтелектуального розвитку [10].

У сучасних умовах цифрової трансформації, воєнних викликів та післявоєнного відновлення Україна потребує системного впрова-

дження моделі SMART REGION як стратегічного інструменту модернізації регіонального розвитку. Узагальнюючи, можна зробити висновок, що смарт-регіональна модель є не лише технологічною інновацією, а й новою філософією управління територіями, де ключовими принципами виступають людиноцентризм, відкритість, ефективність та сталий розвиток. Для України SMART REGION має особливе значення, оскільки дозволяє поєднати процеси відбудови інфраструктури з одночасною цифровізацією управління, що підвищує прозорість використання ресурсів, зменшує корупційні ризики та забезпечує швидкість ухвалення рішень. Крім того, цифрові регіональні системи сприяють інтеграції громад, підвищенню якості публічних послуг і створенню умов для інноваційного економічного зростання. Практична реалізація SMART REGION в Україні повинна ґрунтуватися на кількох ключових напрямах. По-перше, необхідно забезпечити повну цифровізацію регіонального управління через розвиток електронного урядування, інтегрованих платформ даних та єдиних цифрових реєстрів. Це дозволить створити прозору та ефективну систему прийняття управлінських рішень. По-друге, важливо розвивати цифрову інфраструктуру регіонів, включаючи широкосмуговий інтернет, системи "розумного" транспорту, енергетичні смарт-мережі та цифрові сервіси безпеки. Це є основою для формування інтелектуального простору регіонального розвитку. По-третє, необхідно підтримувати інноваційну економіку на регіональному рівні через створення інноваційних кластерів, технопарків, стартап-екосистем та програм підтримки малого і середнього бізнесу, орієнтованого на цифрові технології. По-четверте, слід посилювати участь громадян у процесах управління через розвиток е-демократії, цифрових платформ участі та механізмів громадського контролю. По-п'яте, особливу увагу необхідно приділити екологічному виміру SMART REGION, впроваджуючи системи моніторингу довкілля, енергоефективні технології та принципи "зеленої" відбудови. У цьому контексті важливу координаційну роль у європейському просторі відіграє European Commission, досвід якої може бути адаптований для українських умов.

Висновки. Таким чином, впровадження SMART REGION в Україні є стратегічною умовою не лише відновлення країни, а й формування нової моделі регіонального розвитку, заснованої на знаннях, інноваціях

та сталості, що забезпечує довгострокову конкурентоспроможність держави у глобальному цифровому просторі. Тема формування стратегій сталого розвитку регіонів на основі цифрових технологій безпосередньо пов'язана з концепцією Smart Region (смарт-регіону), яка виступає сучасною моделлю просторового розвитку в умовах цифрової цивілізації. У межах цієї парадигми регіон розглядається не лише як адміністративно-територіальна одиниця, а як інтелектуальна, мережево-інтегрована система, у якій ключову роль відіграють дані, цифрові платформи, інноваційні технології та людський капітал. Саме Smart Region забезпечує практичну реалізацію цілей сталого розвитку через інтеграцію економічної, соціальної та екологічної складових на основі цифрових рішень. Цифрові технології – великі дані (Big Data), штучний інтелект, Інтернет речей (IoT), геоінформаційні системи та електронне урядування – формують нову управлінську логіку регіонального розвитку, де рішення приймаються на основі аналітики даних у реальному часі. У цьому контексті Smart Region стає інструментом реалізації стратегій сталого розвитку, оскільки він забезпечує: цифрову трансформацію регіонального управління; озвиток інноваційної економіки та креативних індустрій; підвищення якості життя населення через цифрові сервіси; екологічну збалансованість та ресурсоефективність; формування інклюзивного та відкритого суспільства участі. Отже, стратегія сталого розвитку регіонів у цифрову епоху фактично набуває форми Smart-стратегії регіонального розвитку, де цифровізація виступає не лише інструментом модернізації, а й фундаментом нової моделі регіональної конкурентоспроможності та стійкості.

Розвиток смарт-регіонів в Україні є ключовим напрямом модернізації державного управління та забезпечення сталого розвитку територій в умовах цифрової трансформації. Його основа полягає у впровадженні цифрових технологій, аналітики великих даних, інтернету речей та електронного урядування для підвищення ефективності управління, прозорості рішень і якості публічних послуг. Ключовими умовами успішного розвитку смарт-регіонів виступають: інноваційна інфраструктура, цифрова грамотність населення, інтеграція бізнесу, науки та влади, а також ефективні механізми кібербезпеки. Важливу роль відіграє децентралізація, яка дозволяє регіонам самостійно формувати цифрові стра-

тегії розвитку. В умовах війни та повоєнного відновлення розвиток смарт-регіонів в Україні набуває не лише інноваційного, а й стратегічно-відновлювального значення. Цифрові технології стають інструментом не модернізації "для майбутнього", а виживання, стійкості та швидкого відновлення територій уже сьогодні. У воєнний період смарт-регіон виконує функцію антикризового управління: цифрові системи дозволяють оперативно координувати евакуацію населення, забезпечувати роботу критичної інфраструктури, підтримувати дистанційні освітні та медичні сервіси, а також підвищувати ефективність реагування на надзвичайні ситуації. Особливого значення набувають геоінформаційні системи, цифрові реєстри, платформи електронного врядування та системи раннього попередження. У повоєнному відновленні смарт-регіони стають основою "розумної реконструкції" (smart recovery). Йдеться не про просте відновлення зруйнованого, а про перехід до більш ефективної, сталої та інклюзивної моделі розвитку: енергоефективна інфраструктура, цифрове планування міст і громад, розвиток "розумної" логістики, прозоре управління відбудовою через цифрові платформи та залучення громадян до прийняття рішень. З філософської точки зору це означає зміну парадигми: від відновлення минулого до проєктування майбутнього. Смарт-регіон у цих умовах стає не лише технологічною системою, а й інструментом соціальної стійкості, довіри та прискореної модернізації України в умовах глобальної нестабільності.

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ЕКОНОМІКА ВІДНОВЛЕННЯ: СТРАТЕГІЇ УПРАВЛІННЯ АКТИВАМИ ПІДПРИЄМСТВ У ПІСЛЯВОЄННИЙ ПЕРІОД

Вступ. Формування адаптивних стратегій управління активами підприємств в умовах економіки відновлення зумовлене масштабною деструкцією матеріально-технічного базису вітчизняного бізнесу та руйнуванням традиційних логістико-маркетингових зв›язків внаслідок воєнних дій на території України. У зазначених реаліях класичні моделі фінансового менеджменту втрачають свою релевантність, що імперативно вимагає наукового обґрунтування новітніх підходів до збалансування

оборотного капіталу та модернізації необоротних активів задля забезпечення життєздатності суб'єктів господарювання та постіндустріального відродження національної економіки.

Основна частина. Повоєнна економіка відновлення являє собою специфічний архітектонічний етап, який докорінно відрізняється як від фази гострого воєнного занепаду, так і від періоду стабільного економічного зростання. Головна сутність цього етапу полягає в імперативності тотальної трансформації бізнес-моделей та їхньої адаптації до параметрів нової економічної реальності. Внаслідок воєнних дій економічне середовище втрачає колишні системні орієнтири, ретроспективні статистичні дані повністю втрачають релевантність, а інституційні зв'язки розриваються. У таких турбулентних реаліях ключовим цільовим орієнтиром для підприємств стає не максимізація прибутку в короткостроковій перспективі, а забезпечення стратегічної живучості та структурної гнучкості. Специфіка повоєнного періоду вимагає одночасного вирішення завдань нівелювання наслідків фізичного знищення основного капіталу, подолання глибокої демографічної кризи та оптимізації кадрового забезпечення в умовах масштабних міграційних процесів. Держава на цьому етапі перетворюється на ключового макроекономічного регулятора, який через інструменти цільового фінансування, грантових програм та податкових преференцій формує нові інституційні межі функціонування ринку. Таким чином, повоєнна економіка відновлення стає каталізатором примусової еволюції бізнес-систем, де рівень конкурентоспроможності підприємства визначається швидкістю реформатування його внутрішнього потенціалу під мінливі безпекові та ринкові виклики.

У зазначених нестабільних умовах традиційні підходи до управління активами підприємства демонструють повну неефективність, оскільки класичний інструментарій розроблявся з розрахунку на прогнозованість та лінійність економічних процесів. Традиційний менеджмент необоротних активів, заснований на капіталомісткому плануванні та оцінці інвестиційних проєктів через показники чистої приведеної вартості чи періоду окупності, перетворюється на сукупність гіпотетичних припущень через неможливість формування верифікованих фінансових прогнозів. Великі виробничі площі, специфічне устаткування та інші стаціонарні основні

засоби за умов руйнування енергетичної інфраструктури чи втрати сировинних ринків миттєво трансформуються у неліквідний «мертвий капітал», генеруючи додаткові витрати на утримання без створення доданої вартості. Крім того, жорстка географічна прив›язка активової бази підвищує рівень стратегічної вразливості бізнесу, тоді як повоєнна диверсифікація вимагає високої просторової мобільності. Аналогічна криза неефективності характерна й для класичних моделей управління оборотними активами. Поширена концепція логістики мінімізації складських запасів у реаліях деструкції транспортних коридорів призводить до критичної зупинки операційного циклу, що змушує підприємства переходити до стратегії формування страхових буферів. Традиційні методи оцінки дебіторської заборгованості на основі ретроспективного аналізу звітності контрагентів не здатні забезпечити належний рівень контролю, а лібералізація комерційного кредитування за умов системного браку ліквідності неминуче провокує касові розриви. Навіть утримання значних залишків грошових коштів на рахунках втрачає економічну доцільність через високі інфляційні ризики, що потребує трансформації всієї системи управління капіталом у гнучку, діджиталізовану модель, здатну до миттєвого операційного маневру.

Висновки. На основі проведеного теоретичного аналізу сутності повоєнної економіки відновлення та деструктивного впливу воєнних шоків на діяльність суб›єктів господарювання можна сформулювати кілька узагальнюючих висновків. По-перше, етап повоєнного відновлення є унікальним і самостійним періодом у життєвому циклі бізнесу, який вимагає повної відмови від статичних моделей управління на користь динамічної стійкості та гнучкості, де головним критерієм успішності стає здатність до швидкої адаптації внутрішньої структури до умов нової нормальності ринку. По-друге, класичний інструментарій менеджменту необоротних та оборотних активів повністю втрачає свою релевантність в умовах гіперневизначеності, оскільки традиційні методи капітального інвестування перетворюються на теоретичні припущення, а концепції мінімізації складських запасів і ліберального комерційного кредитування провокують зупинку виробництва та глибокі касові розриви. По-третє, єдиним ефективним рішенням для реанімації підприємств та збереження їхнього іннова-

ційного потенціалу є розробка і впровадження адаптивних стратегій, у межах яких модернізація матеріально-технічної бази має відбуватися на принципах цифровізації та екологічності, перетворюючи важкі основні засоби на мобільні та технологічні ресурси, тоді як управління оборотним капіталом потребує створення безпечних буферних запасів, жорсткого контролю ліквідності у реальному часі та диверсифікації джерел постачання. Формування таких гнучких підходів на мікрорівні є життєво необхідним кроком не лише для виживання окремих компаній, а й для масштабного постіндустріального відродження всієї національної економіки України на принципово нових технологічних засадах.

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ТРАНСФОРМАЦІЯ ЮРИДИЧНОЇ ДОКТРИНИ В УМОВАХ ВІЙНИ (від теорії до правозастосування)

Вступ. Чи справді теорія права втрачає свої доктринально визначені позиції? Чи сучасні виклики (як-от природні катаклізми, війни, надзвичайні правові режими, втрата відчуття безпеки на рівні держави і окремої людини з акцентом на неминучості інших реальностей – віртуального світу, штучного інтелекту, криптовалюти, маніпуляцій із тілом людини та багато іншого) виводять право на новий рівень розвитку, а чи, навпаки, створюють злами й розриви між юридичною доктриною та юридичною практикою, руйнуючи нормативність права і тим самим нівелюючи його основну функціональну властивість? Чи, може, все із правом гаразд, а це тільки його сприйняття людиною набуває спотворених рис під впливом деструктивних чинників?

Насправді запитань навколо права набагато більше. Єдине, в чому є певність, – це те, що право дедалі частіше стає предметом міждисциплінарного вивчення з активним залученням філософії герменевтики і критичного аналізу. Завдяки цим методологічним підходам можна спочатку ставити правильні (тобто влучні) запитання і, відповідаючи на них, шукати та знаходити нові адекватні часу погляди на право.

Основна частина. У контексті трансформації юридичної доктрини доцільно окреслити три основні проекції:

- ✓ що саме трансформується (доктрина як система ідей про право, чи принципи як основні підвалини права, а чи сам процес праворозуміння як прояв мисленнєвих спроможностей людини);
- ✓ що впливає на цю трансформацію (соціальна реальність суспільства, стан війни в державі, заміна і підміна цінностей на рівні спільнот і на рівні індивіда, розгалуження потребових концептів людини чи щось інше);
- ✓ що виникає в результаті цієї трансформації (більший обсяг прав у людини з наголосом на їх (прав) та її (людини) самоцінності, розширення повноважень державних органів та їх представників щодо застосування «власного» розсуду, нові моделі процесів і процедур правореалізації, зміна пропорцій між нормою і винятком тощо).

Поняття «юридична доктрина» – це одна із категорій сучасної теорії права, що залишається дискусійною, бо одночасно визнається і формою юридичних знань, і системою ідей та концепцій, і складовим елементом правової культури, і засобом впливу на процеси правотворчості та правозастосування, і навіть джерелом права.

До того ж, у сучасній теорії права спостерігається термінологічна «розмитість»: методологічно нетотожні поняття часто вживаються як синонімічні (юридична доктрина – правова доктрина – доктрина права – судова доктрина – доктринальне праворозуміння тощо).

Наукова література містить декілька підходів до розуміння юридичної доктрини, які умовно можна згрупувати у класичні та новітні. До класичних способів пояснення юридичної доктрини належать природноправовий (Густав Радбрух, Лон Фуллер), позитивістський (Джон Остін, Ганс Кельзен), історичний (Фрідріх Карл фон Савіньї), соціологічний (Євген Ерліх, Роско Паунд). Звичайно, ідеї «класиків» форму-

вання юридичної доктрини (як-от концепти: внутрішня мораль права, чиста юридична наука, живе право, правовий дух народу, соціальна інженерія та інші) пройшли апробацію часом і мають чимало адептів та опонентів. Тож усі наступні теорії можна було би вважати як послідовні. Але новітнє бачення юридичної доктрини має свої особливості, оскільки на відміну від попередніх підходів (що базувалися на аналізі права в контексті його походження – природного, державного, історичного, соціального) спроектувало дещо інший ракурс і сфокусувало увагу мислителів на праві та способах його реалізації. Тож новітня типологія юридичної доктрини розкривається через інтерпретаційний (виокремлюється призма суддівського угляду, Роналд Дворкін), комунікативний (акцентується мова юридичного дискурсу як спосіб порозуміння, Юрген Габермас; та комунікація соціальних систем, Ніклас Луман), інституційний (наголошується на стабілізаційній спроможності юридичної доктрини як легалізаційній інституції, Ніл МакКормік; та альтернативній теорії дії «логічних норм», Ота Вайнбергер), постпозитивістський (домінантами стають права людини, принцип пропорційності у їх реалізації, правова визначеність соціальної дійсності та юридичної практики, Карл Поппер), аксіологічний (пріоритет надається законним інтересам та потребам людини як соціального суб'єкта і як біологічного виду, Петро Рабінович, Тімоті Снайдер) та метамодерністський підходи.

І власне цей останній – метамодерн як філософія та погляд на життя (Деніел Гьорц та Еміль Ейнер Фрііс, які друкують свої дослідження під колективним псевдонімом Ганзі Фрайнахт) – найчіткіше відповідає цифровізованій, постіндустріальній, глобалізованій епосі, базуючись на ідеях модерну (віра в науку, прогрес, демократію, меритократичний соціальний порядок і розум людини) та постмодерну (критика всіх сфер науки, недовіра до прогресу, акцентування на символах і контекстах, мультикультурний порядок і знищення біосфери самою ж людиною), демонструє доктрину як спосіб адаптації політики / економіки / права / інших соціальних систем до світу, який стає дедалі складнішим, виокремлення унікальної ролі людства в екосистемах тощо. Метамодернізм вірить не в «кінцеві сутності» (як-от свідомість, добро, зло, маскулінність, фемінність тощо), а в те, що всі ці феномени є контекстуальними інтерпретаціями, які постали зі зв'язків і порівнянь; що неодмінне право кожної істоти – бути такою,

якою вона є; що біологія і фундаментальний життєвий досвід людства будуть змінюватися завдяки науці та технологіям (це називається трансгуманізм – безособове та світське прагнення любити ближнього з радикальним незасудженням) [2, с. 148-149].

Набутий досі концептуальний матеріал теорії права, побудований на минулій практиці, вже не задовольняє теоретичного узагальнення нового правового досвіду і обумовлює необхідність якісного оновлення цієї теорії. Очевидно, актуальними тут є проблеми співвідношення природного і позитивного права, гуманізації законодавства, діалектики публічного та приватного права, національного законодавства та міжнародного права, здійснення загалом правового регулювання сучасних суспільних відносин тощо. Можна сказати, що сучасна правова практика породжує, по суті, нову теорію права (чи метатеорію), яка покликана й узагальнити весь досягнутий практичний досвід, і передбачити шляхи його подальшого розвитку [1, с. 86].

Європейська традиція аналізу юридичної доктрини дедалі більше орієнтується саме на практику міжнародних судів, зокрема Європейського суду з прав людини.

Серед українських теоретиків права, які займаються вивченням юридичної доктрини, зараз особливо актуалізуються позиції розуміння її як джерела права, методологічного плюралізму та інструменту правотворчості й правозастосування. Особливо це проявилося з початком повномасштабної війни, в контексті вимушеної трансформації всієї правової системи України та подальших тенденцій до євроінтеграції.

І в цій ризик-орієнтованій правовій дійсності викристалізувався один важливий момент – справді відбулася зміна дослідницького фокусу: від класичного теоретико-правового аналізу юридичних явищ до міждисциплінарності, знакової, ціннісної та комунікативної природи права.

Тому можна прогнозувати, що найближча перспектива розвитку юридичної доктрини, принаймні в Україні, матиме вектор семіотичного аналізу (візуальних і вербальних символів і знаків правової дійсності) та набуде форми юридичної комунікації (із застосуванням метамови права та юридичного дискурсу в надзвичайних умовах). Одним із найбільш показових прикладів цього є інтерес до діяльності судів, суддівської аргументації та практики, їх ролі у формуванні національної юридичної док-

трини. Це зумовлено потребою балансу між оперативним реагуванням правотворців на виклики часу та якістю законодавства, правовою визначеністю й адаптивністю до стандартів ЄС і світу, а також необхідністю трансформації суспільної правосвідомості з одночасним збереженням правової ідентичності України. Звичайно, не обійдеться без трансформації галузевих юридичних доктрин і появи нових наукових концепцій праворозуміння (як-от безпекової, інформаційно-цифрової тощо).

Висновки. Загалом можна говорити про певну тенденційність модерної юридичної доктрини з чіткою практикоорієнтованістю (коли доктрина використовується у правотворенні та правозастосуванні), євроінтеграційною спрямованістю (з активним запозиченням доктрин ЄСПЛ та інших міжнародних судів), воєнною трасформативністю (через пріоритет безпеки, прав людини в умовах війни, перехідного правосуддя, цифровізації та ін.). Усе це та ще багато іншого впливає на сучасне розуміння юридичної доктрини і демонструє перехід від вузького нормативізму до комплексного міждисциплінарного бачення, а це доводить, що юридична доктрина претендує на статус самостійного елемента правової системи держави як ефективний інструмент юридичної аргументації та легітимації судової практики, як форма соціально-правової комунікації у забезпеченні верховенства права та захисту прав людини, як додатковий механізм формування правової дійсності й навіть правової політики держави. Сучасна юридична доктрина перебуває у стані трансформації від «системи знань» до «джерела правового впливу».

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THE WAYS OF THE DEVELOPMENT OF BURNOUT SYNDROME OF SPECIALISTS

Introduction. Burnout syndrome was described by scientists (Drigas & Karyotaki, 2017). The scientists observed its manifestations in themselves and their colleagues. Scientists studied the dominant characteristics, in particular, of the psychological state of healthy people who were in intensive

and direct communication with their clients, patients in an emotionally tense atmosphere while providing their clients with psychotherapeutic and psychocorrectional professional assistance.

The main part of the article. Modern foreign researchers call this phenomenon the term "burnout", which means burnout, meaning professional burnout, which is well and in detail remembered, and it is also used in colloquial speech to denote the effect of chronic addiction to alcohol, toxic substances and drugs. It should be noted that in the English-language psychological literature, scientists distinguish between the terminological meanings of "burnout" and the psychotherapeutic and psychiatric semantic content of the term "burn out". The latter meanings are entirely related to the residual phenomena of schizophrenia, the symptoms of which manifest themselves somewhat differently than, say, chronic addiction to alcohol, toxic substances and drugs. That is, in English, the term "burnout" is used for all these phenomena, including professional burnout. While in Ukrainian, scientists distinguish between the terms "dependence" and "professional burnout". These terms are completely different in their meanings and connotations, they are used in different contexts and with different semantic loads.

We believe that the first stage of studying the problem of professional burnout of a specialist, including a psychologist, was started with the phase of searching for scientific terminology (starting from the 70s of the 20th century, in the USA). The goal that scientists had in those years was to investigate the nature, structure, functions and operationalize the concept of "professional burnout of the individual". The object of empirical research in the 70s of the 20th century, in the USA were specialists of the so-called "serving professions" (doctors, psychologists, nurses, psychiatrists). At this phase of organizing empirical research in the 70s of the 20th century, in the USA, the phenomenon of professional burnout was studied in two aspects – psychiatric and socio-psychological ones.

Over time, the term professional burnout began to be applied to almost all professions due to their "Man-Man" orientation, when the subjects of a specialist's professional activity are other individuals with all the variety of their tasks, problems and difficulties. Over time, the professional burnout syndrome began to be studied in a broad paradigm of socio-psychological professions, as well as

in various office workers, military personnel, managers of various composition and levels. Also, representatives of certain professions from the "non-social sphere" (for example, programmers, military personnel, pilots, drivers, engineers, etc.) began to be considered subjects of psychodiagnostics (starting from the 80s of the twentieth century).

Initially, the concept of professional burnout meant a state of inhibition of a specialist's personal resources, with the formation of feelings of his/her own futility, uselessness and worthlessness. It is interesting that in modern researches in Ukrainian science, different versions of the translation of the English term "burnout" are used to describe this complex phenomenon: "professional burnout", "professional out burnout", "professional down burnout", etc. The terms "professional burnout" and "mental burnout" are also used somewhat synonymously. Although in the general scientific sense these ideas about burnout are not identical, since they are based on similar mechanisms, then they are perceived as somewhat synonymous ones.

Since the emergence of the term professional burnout, the study of this complex phenomenon has been significantly complicated in terms of its multicomponent nature, semantic ambiguity and multiplicity. In empirical studies deal with the description of the phenomenon of professional burnout, three main theoretical fundamental approaches can be distinguished:

a) an individual approach to professional burnout, when the main personal characteristics of one individual are perceived, which characterize this phenomenon of professional burnout;
b) an interpersonal approach to professional burnout, when interpersonal relationships between subjects of social interaction are taken into account, that is, the relationships between the psychologist and his/her client (clients);
c) an organizational approach to professional burnout, when not just the relationships between the psychologist and clients are perceived in the foreground, but the organizational space of these relationships, that is, the organization of the professional activity of the psychologist with his/her clients.

Each of the approaches mentioned and described by us describes the emergence of the phenomenon of professional burnout at separate levels of existence of this burnout, existing as if autonomously and independently of each

other. This contributes, first of all, to the fact that quite often there appears an original tendency towards some exaggeration of the significance of certain psychological factors, in particular, hyperbolization of the significance of either highly personified personal factors, or individual disparate factors associated with the so-called production, professional and organizational stresses.

Among the individual approaches to the burnout syndrome, the most famous it is the existential approach. According to the scientists (Gathercole, Pickering, Ambridge & Wearing, 2004), professional burnout is most likely to occur, first of all, in social workers who have too high a level of personal and professional demands. When highly motivated specialists who always identify with their professional activities and consider them to be extremely important and especially socially useful, as a result experience great troubles and failures in achieving their professionally significant goals. Therefore, psychologists begin to feel that they are completely incapable of making a significant contribution to a well-organized professional activity, and they, as a rule, as a result of this negatively defined professional activity, burn out professionally. Professional activity, which was the meaning of existence for this psychologist, initiates great disappointment in him/her, which over time leads to professional burnout.

Representatives of interpersonal professionally significant psychologically centered approaches see the cause of professional burnout as significant for disharmony of relationships between psychologists and clients, which emphasizes the importance of professionally significant interpersonal interactions in the emergence of the burnout syndrome. In particular, scientists believe that the main cause of professional burnout is quite tense in terms of relationships between psychologists and clients as subjects of their professional activity. The psychological danger of such relationships between psychologists and clients lies, first of all, in the fact that professional psychologists deal with personal personified and socially significant problems, which sometimes contain in their content a negative professionally significant actualizer, which in any case exists in the professional activity of a psychologist.

Unlike the individual and interpersonal approaches, the organizational approach focuses our attention, first of all, on the psychological factors of the professionally significant social environment as the dominant psychological factors of professional burnout. Such psychological factors also include an

unusual paradigm of professional activity and the actualization, first of all, of its deep component, a narrowed, undetailed field of personally and professionally significant contacts, the psychologist's lack of absolute independence and sovereignty in their professional activity.

Conclusions. At the present time, there is also an active discussion on the problem of the correlation of such concepts as "professional stress" and "professional burnout". Thus, professional burnout is often considered through the actualization of the phenomena of "absolute professional deformation", "psychological and professionally significant protection", "psychological stress", "psychological state", etc. Nevertheless, professional burnout is an absolutely independent, independent sovereign phenomenon that is not reduced to other professionally significant states of the personality that occur, in particular, in the professional activity of a teacher (stress, fatigue, neurosis, depression, psychosis, psychasthenia). Although some researchers and theorists tend to consider the mental process of professional burnout as a sufficiently long professionally significant stress that determines the experience of the influence of actualized stress factors. However, most researchers agree that stress and burnout are, although largely related, somewhat independent phenomena that determine their significant impact on the individual, their professionally and personally significant experiences.

The relationships between professional burnout and stress of a psychologist can be considered by us from the standpoint of a psychologically significant, temporary factor that primarily affects the successful adaptation of a psychologist to his or her own professional activity, in order to update ways to prevent professional burnout of psychologists. In our opinion, the main difference between stress and professional burnout lies, first of all, in the duration of the consultative, psycho-correctional process that a psychologist organizes in professional work with clients.

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SECTION 21.
HISTORICAL SCIENCES: FROM ANTIQUITY TO MODERN CHALLENGES

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ЕЛЕКТРОННІ ІНФОРМАЦІЙНІ РЕСУРСИ В ДІЯЛЬНОСТІ АРХІВІВ

Архіви, бібліотеки та музеї переживають складний етап свого розвитку, однак їхній сучасний стан суттєво відрізняється від минулого. Попри виклики сьогодення, перспективи їхнього подальшого розвитку, на нашу думку, залишаються позитивними.

Зазначимо, що сучасне міжнародне інформаційне суспільство потребує забезпечення такого способу доступу до інформації, що міститься в архівах, як оцифрування документів і надання доступу до них через Інтернет. Сьогодні вітчизняні державні архіви активно здійснюють оцифрування своїх документальних комплексів, метою якого є їх збереження для майбутніх поколінь, а також долучення до міжнародних цифрових архівних проєктів.

Важливі зміни в інформаційно-комунікаційній діяльності сучасного суспільства зумовили інтенсивне впровадження та використання цифрових технологій і електронних форм комунікації в усіх сферах життя. Сьогодні складно уявити людину XXI ст. поза межами Інтернету. Унаслідок таких процесів з'явилися нові джерела інформації та механізми роботи з нею [1, с. 88].

Важливим сьогодні є не лише забезпечення доступу до архівних колекцій, а й надання користувачам через Інтернет максимально повної інформації про склад і зміст архівних фондів. Так, професор Ярослав

Калакура[1] увів до наукового обігу дефініцію «інформатизація архівної справи». Ярослав Степанович є автором розділу підручника «Архівознавство» (2002 р.), в якому розглянуто основні поняття інформатизації архівної справи [2, с. 243–250].

Державні архіви розмістили на своїх вебсайтах насамперед такі інформаційні ресурси, як електронні версії довідкового апарату: анотовані переліки фондів, їх списки, путівники, описи тощо. Безумовно, така інформація є надзвичайно важливою для користувачів. Крім того, на багатьох сайтах архівних установ представлено інтернет-виставки з актуальних питань вітчизняної історії, що дає можливість дистанційно ознайомлюватися з архівними документами.

Наприклад, провідне місце у фондах Центрального державного аудіовізуального та електронного архіву посідають електронні інформаційні ресурси. Зокрема, тут зберігаються матеріали, присвячені парламентським, президентським і місцевим виборам в Україні 2010–2019 рр., Революція гідності, чемпіонату Європи з футболу UEFA Euro 2012 та іншим подіям. Про події квітня 1986 р. можна дізнатися з фонду «Чорнобильська катастрофа – 25 років потому». Інформацію про відомих діячів української історії, науки й культури – Івана Франка[2], Лесю Українку[3], Михайла Грушевського[4], Миколу Амосова[5], Михайла Карцева[6] та ін. – містить електронна архівна колекція «Гордість України» (9 од. зб.), створена 2018 р. Джерелом ознайомлення з культурними надбаннями українського народу є також електронні ресурси «Краєзнавство та народне мистецтво України» (20 од. зб.) і «Культурна спадщина України» (4 од. зб.) [3].

ЦДАЕА надає користувачам доступ до своїх архівних матеріалів із метою їх наукового опрацювання, отримання необхідної інформації та для

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інших цілей за умови дотримання вимог чинного законодавства України щодо інтелектуальної власності, авторських і суміжних прав [4, с. 88–89].

Для дослідника архівних матеріалів в електронній формі важливими є вивчення та аналіз як відкритої, так і прихованої інформації.

Слід також зазначити, що електронним архівним ресурсам притаманні такі ознаки [5]:

- прихованість матеріальної форми інформації;
- потреба у спеціальних технічних засобах для відтворення змісту документа;
- збереження інформації у файлі за допомогою цифрового коду;
- складність і багаторівневість внутрішньої структури.

Комплекси історичних документів, що розглядаються, мають свої особливості, серед яких важливе місце посідає питання авторства. Існує ймовірність того, що у створенні та наповненні електронного інформаційного ресурсу одночасно бере участь значна кількість осіб. Так, перебуваючи у власності навіть однієї юридичної або фізичної особи та, як правило, відображаючи її діяльність та інтереси, таке джерело може мати багатьох авторів і дописувачів, а отже – одночасно репрезентувати суспільні настрої та світогляд представників різних соціальних груп [6].

Актуальним сьогодні є законодавче закріплення положення про те, що інформація в електронних джерелах має документний характер. Важливість цього полягає в тому, що збереження такої інформації відповідно до вимог ст. 5 Закону України «Про Національний архівний фонд та архівні установи» (яка визначає архівний документ основним типом інформаційних об'єктів, з яких формується НАФ [7]) має ініціюватися, підтримуватися і контролюватися державою.

Наразі існує практична необхідність на законодавчому рівні визначити критерії віднесення електронних документних ресурсів до складу НАФ України та закріпити конкретні вимоги до їхнього статусу в його структурі. Такі зміни є надзвичайно важливими для розвитку архівної системи України.

Серед актуальних і недостатньо вирішених питань діяльності архівних установ України можна назвати такі:

- недостатня мотивація власників щодо передавання електронних матеріалів до державних архівів на постійне зберігання;

- наявність перешкод в отриманні або копіюванні архівними установами окремих електронних ресурсів у процесі ініціативного документування;
- відсутність уніфікованого підходу до критеріїв відбору електронних документів для передавання на архівне зберігання тощо.

Темпи накопичення електронних інформаційних ресурсів в архівних установах значною мірою уповільнює складний процес експертизи їхньої цінності. Причинами цього є складність внутрішньої структури таких документів, значні обсяги інформації, видовий склад та інші чинники [8].

Отже, в Україні, з огляду на безпекову ситуацію та інші сучасні виклики, достатньо активно відбуваються процеси відбору, архівування й упорядкування електронних інформаційних ресурсів, які є важливими історичними джерелами для наукових досліджень. Водночас обсяги цифрової інформації постійно зростають, що потребує нових методів і механізмів її зберігання та наукового опрацювання. Питання надання таким інформаційним об'єктам відповідного статусу, розроблення методики їх опрацювання та оформлення бібліографічних посилань на архівні електронні документи у наукових текстах залишаються відкритими й потребують належного нормативно-методичного забезпечення.

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CORRESPONDENCE BETWEEN KOSHA AND THE GOVERNMENTS OF THE YEDICHKUL AND YEDISAN ORDS IN 1768: PREVENTIVE DIPLOMACY AND BORDER SECURITY.

Abstract. *The article examines the southern vector of the diplomatic communication of the Kosh of the New Zaporozhian Sich during the Koliivshchyna uprising of 1768. It focuses on correspondence with the administrative leaders of the Yedychkul and Yedisan hordes, which served as intermediary institutions between the Sich and the Crimean political centre. Based on documents from files nos. 227–229 of fond 229 of the Central State Historical Archives of Ukraine in Kyiv, the study reconstructs the content, structure, and functions of this communication channel.*

The author demonstrates that the correspondence with the Horde leaders was not a routine exchange of information, but a tool of preventive diplomacy, border security, and intelligence sharing. Through standardized formulas, references to the "peace between the highest empires," and appeals to common interests in maintaining order on the steppe frontier, the Kosh sought to prevent contacts between the haidamak groups and Tatar detachments, avoid accusations of cross-border interference, and preserve its own autonomy under the pressure of imperial politics. The article concludes that this southern diplomatic channel formed an important part of the Kosh's broader strategy of manoeu-

vring between the Russian Empire, the Polish-Lithuanian Commonwealth, and the Crimean Khanate during the crisis of 1768.

Keywords: *Zaporozhian Sich, Kosh, Koliivshchyna, Yedychkul Horde, Yedisan Horde, preventive diplomacy, border security, intelligence exchange, steppe frontier, diplomatic communication.*

The scientific problem is the specific question or gap in knowledge that a study aims to solve. It usually arises when existing explanations are incomplete, inconsistent, or unable to account for the observed evidence, and it becomes the starting point for formulating a hypothesis and designing research.

The methodological basis The methodological basis of the study rests on source criticism, formulary-semantic analysis of diplomatic correspondence, comparative historical analysis, and the methods of political and institutional history. This combination makes it possible to reconstruct the diplomatic communication of the Kosh of the New Zaporozhian Sich in 1768 not as a set of isolated documentary references, but as a coherent system of administrative practices shaped by crisis conditions, border security concerns, and imperial pressure. By examining the structure, language, and functions of letters, memoranda, and orders, the study reveals how the Kosh adapted its documentary practices to changing political circumstances and used them as instruments of communication, control, and institutional self-preservation.

Analysis of recent research and publications. Recent scholarship on the Koliivshchyna uprising and the diplomatic practice of the Kosh of the New Zaporozhian Sich has increasingly moved away from simplified political narratives and toward a more nuanced analysis of institutions, communication, and border governance. Researchers now tend to treat the uprising not only as a social or confessional explosion, but also as a crisis of imperial border management in which the Sich had to balance loyalty, autonomy, and security.

A second important trend is the growing attention to archival documentation of the Kosh itself. Studies built on orders, reports, memoranda, and correspondence have shown that the Sich responded to the events of 1768 through a coordinated administrative strategy rather than through sponta-

neous actions. This has shifted the focus from heroic or purely military interpretations to the documentary and institutional mechanisms through which the Cossack administration operated.

A third line of recent work concerns frontier diplomacy and inter-imperial communication. Scholars are increasingly interested in how the Kosh communicated with Russian, Polish, and Crimean authorities, and how formulas such as references to "peace between the highest empires" functioned as practical political instruments. In this perspective, diplomatic language is not decorative rhetoric but evidence of the Sich's effort to preserve its institutional space under pressure.

For your article, the key gap in the literature is the southern diplomatic vector of the Kosh: correspondence with the Yedychkul and Yedisan Horde administrations, preventive diplomacy, and the use of intermediary border actors. That angle gives the article clear novelty, because it brings together border security, intelligence exchange, and steppe diplomacy within one analytical frame.

Formulation of the article's aims. The aim of the article is to examine the southern direction of the diplomatic communication of the Kosh of the New Zaporozhian Sich during the Koliivshchyna uprising of 1768 and to determine how correspondence with the Yedychkul and Yedisan Horde administrations functioned as an instrument of preventive diplomacy, border security, and institutional self-preservation.

More specifically, the article seeks to show how the Kosh used this communication channel to monitor movements of suspicious groups, prevent contacts between haidamaks and Tatar formations, avoid cross-border escalation, and maintain its autonomy under conditions of imperial pressure and frontier instability.

Presentation of the main research material.

The southern vector of the diplomatic communication of the Kosh of the New Zaporozhian Sich during the Koliivshchyna uprising of 1768 was implemented primarily through correspondence with the administrative authorities of the Yedychkul and Yedisan hordes. These entities, functioning as frontier institutions of the Crimean Khanate, acted as intermediaries between the Sich and Bakhchisarai, facilitating the exchange of intelligence and the coordination of measures aimed at securing the steppe frontier. The docu-

ments preserved in files nos. 227–229 of fond 229 of the Central State Historical Archives of Ukraine in Kyiv (hereinafter — TsDIAK of Ukraine) include a series of memoranda and letters addressed to serasker-sultans, which make it possible to reconstruct the content, form, and functions of this communicative channel.

The thematic structure of the correspondence with the Horde authorities centred on the transmission of information about the movement of suspicious groups along the southern borders of the Volnosti. In a memorandum to the serasker-sultan of the Yedychkul Horde dated July 1768, the Kosh otaman Petro Kalnyshevsky reported the detection of "argats from Ochakiv," who were "roaming the steppe" and could "cause harm to both sides" [3, doc. 36, p. 78]. A similar letter to the head of the Yedisan Horde requested, "in view of the flourishing peace between the two highest empires," assistance in intercepting such groups and informing the Kosh of their routes [3, doc. 43, p. 86]. These documents testify to the deliberate use by the Kosh of diplomatic rhetoric that appealed to shared security interests and to the observance of peace treaties between the Russian Empire and the Ottoman Porte.

The formulary structure of the letters addressed to the Horde authorities was distinguished by standardized elements adapted to the traditions of steppe diplomacy. The salutations were accompanied by a titulature system that emphasized the status of the recipient: "To the most illustrious Sultan-Serasker of the Yedychkul Horde," "To the highly respected head of the Yedisan Horde" [2, file 228, fols. 46–47]. The main body contained a concise statement of facts: the date and place where suspicious individuals were identified, their number, armament, and probable direction of movement. The closing section usually included a request for mutual information exchange and a reference to the "ancient friendship" between the Zaporozhian Cossacks and the Horde communities. This composition ensured the promptness of communication and minimized the risk of ambiguous interpretation.

If you want, I can now continue in the same way with the next fragment and keep the terminology fully consistent throughout the article.

The functional purpose of this correspondence went beyond a simple exchange of intelligence. First, it served as an instrument of preventive diplomacy: by informing the Horde administrations about the movement of haid-

amak detachments, the Kosh sought to prevent possible alliances between the insurgents and Tatar groups, which could have seriously destabilized the situation along the southern frontier. Second, the correspondence performed an apologetic function: by recording the fact that the Tatar side had been informed, the Kosh created a documentary basis for demonstrating its loyalty to imperial requirements concerning border security. Third, the correspondence helped maintain channels of communication with the Crimean administration at a time when official diplomatic relations between Russia and the Ottoman Empire remained tense.

At the same time, the source base reveals certain limitations of this communicative vector. The correspondence with the serasker-sultans did not include direct diplomatic notes to Bakhchysarai, which indicates the intermediary character of the Horde authorities in relations between the Sich and the Khanate administration. In addition, the documents contain no evidence that the Kosh received detailed replies from the Tatar side, which may point either to the limited effectiveness of this channel or to the loss of the relevant correspondence. Even so, the available materials make it possible to argue that informing the Horde leaders about the movement of insurgent detachments was an important element of the Kosh's three-sided diplomatic strategy aimed at neutralizing threats from the southern direction.

Thus, in 1768 the correspondence of the Kosh with the serasker-sultans of the Yedychkul and Yedisan hordes functioned as an instrument of preventive diplomacy and intelligence exchange under conditions of border crisis. The transmission of information about the movement of haidamak detachments, formalized through a standardized formular structure, enabled the Cossack administration to prevent possible alliances between the rebels and Tatar groups, demonstrate loyalty to imperial requirements, and sustain communication channels with the Crimean administration. Despite the intermediary character of this communicative vector and the limited documentary evidence of responses, the existing materials confirm its importance as part of the Kosh's multi-vector strategy of diplomatic manoeuvring during the Koliivshchyna uprising.

In the diplomatic practice of the second half of the eighteenth century, references to existing international agreements were a standard means of justifying the limited competence of frontier institutions. In the documen-

tation of the Kosh of the New Zaporozhian Sich in 1768, the formula of the "peace between the highest empires" (and its variants, such as "peace and concord between the two highest courts" and "observance of peace treaties") acquired concrete institutional significance, transforming from a conventional phrase into an effective argument for diplomatic distancing. By referring to the peace arrangements between the Russian Empire and the Ottoman Porte, the Cossack leadership justified the impossibility of pursuing haidamak detachments beyond the borders of the Volnosti, combining international-legal rhetoric with the practical tasks of preserving autonomy and avoiding external escalation.

In correspondence with the serasker-sultans of the Yedychkul and Yedisan hordes, this formula served as a guarantee of stability in the frontier regime. In the memoranda of July–September 1768, the Kosh informed the Horde authorities about the movement of suspicious groups while emphasizing the need to act "in accordance with the flourishing peace between the two highest empires" and to avoid any steps that could be interpreted as a violation of the peace terms [3, doc. 36, p. 78]. This construction not only demonstrated the loyalty of the Cossack administration to imperial restrictions, but also functioned as a preventive warning: it indicated the reluctance of the Zaporozhian Host to become the initiator of a conflict that could endanger frontier winter settlements and fishing crews. In this context, the reference to the "peace of empires" was not merely a rhetorical device, but an instrument for the legal justification of the Kosh's limited competence in matters of cross-border security.

At the same time, the same line of argument was employed in communication with representatives of the Polish-Lithuanian Commonwealth. In letters to border starostas and commandants, the Kosh explained its refusal to take part in joint military operations against the haidamaks by referring to the obligation to observe the "treaties concluded between the highest states" [3, doc. 45, p. 92]. The Polish administration, which regarded Zaporizhzhia as a natural ally in the struggle against the insurgents, received an official reply that shifted responsibility for inaction onto the level of interstate agreements. Such a diplomatic strategy allowed the Cossack leadership to avoid direct participation in armed confrontation on the Right Bank while simultaneously demonstrating formal respect for international obligations.

Importantly, the reference to the "peace of empires" was not accompanied by criticism of Russian policy; on the contrary, it underscored the Kosh's unconditional subordination to the imperial orders of St. Petersburg, making the argument practically unassailable for Polish officials.

The functional purpose of this formula went beyond simple information transfer. It served as a mechanism of institutional protection that, first, legitimized the Kosh's passive position in external affairs by transforming forced neutrality into an act of compliance with international law; second, minimized the risk of accusations of border violations from both the Polish-Lithuanian Commonwealth and the Crimean Khanate; and third, created a documentary basis for reporting to the imperial administration, since reports to the Kyiv governor-general recorded "careful watch over the peace" and "prevention of any breaches of the peace terms" [1, fol. 18]. In this way, diplomatic rhetoric was transformed into an internal instrument of administrative control, enabling the Cossack leadership to coordinate the actions of the palanka administrations without violating external constraints.

Thus, the diplomatic use of the formula of the "peace between the highest empires" in the Kosh documentation of 1768 was not a conventional linguistic cliché, but a deliberate institutional strategy of neutrality. By referring to the existing peace treaties, the Cossack leadership legitimized the limits of its own competence in cross-border matters, avoided direct involvement in the armed conflict on the Right Bank, and minimized the risks of interstate escalation. Adapted to communication with Polish and Horde addressees, this argument also served as a reporting instrument before the Russian administration, demonstrating formal loyalty to imperial demands. In this way, the formula of the "peace of empires" functioned as a multi-vector diplomatic shield that enabled the Kosh to preserve the institutional integrity of the Volnosti under conditions of acute frontier crisis.

The strategic danger of a possible alliance between haidamak detachments and Tatar hordes was one of the most sensitive aspects of the border policy of the Kosh of the New Zaporozhian Sich in the summer and autumn of 1768. In the context of deteriorating Russian-Ottoman relations and the large-scale insurgent movement on the Right Bank, any uncontrolled contact between participants of the Koliivshchyna uprising

and representatives of the Yedychkul or Yedisan hordes could be qualified by the imperial administration as treason, and by the Polish side as proof of Zaporozhian instigation of the uprising. The archival materials of files nos. 227–229 of fond 229 of the Central State Historical Archives of Ukraine in Kyiv show that Hetman Petro Kalnyshevsky and the military seniority developed a targeted system of preventive measures aimed at isolating the haidamak movement from steppe communications and neutralizing the risks of cross-border coordination.

The main instrument for blocking a potential coalition was a set of strict preventive instructions sent from the Kosh to the palanka colonels and kurin atamans of the frontier districts. The orders clearly prohibited the admission of any persons without proper travel documents, especially those moving from the Right Bank or from Tatar uluses. The documents contained direct instructions for the immediate detention of suspicious groups, inspection of their equipment, and seizure of any correspondence that might indicate attempts at agreements between the insurgents and Horde leaders [3, doc. 36, p. 78].

A crucial feature of these instructions was their preventive rather than reactive orientation: the Cossack administration ordered that "no contacts whatsoever be allowed between the Polish rebels and the Tatar argats," emphasizing that even passive observation of such contacts without interrupting them would be treated as criminal negligence [2, file 228, fol. 46]. To ensure the practical implementation of these orders, the Kosh organized a network of reconnaissance raids carried out by specially assigned Cossack detachments. These units, staffed by experienced steppe riders, patrolled key crossings, winter settlements, and routes connecting the Right Bank voivodeships with nomadic camps. Their reports contained detailed information about the number, routes, and armament of groups attempting to cross Zaporozhian territory.

When attempts to coordinate between haidamak leaders and Tatar patrols were detected, the Cossack detachments intercepted them, and the detained persons, together with the seized letters, were brought to the Sich for further interrogation [1, fol. 18]. This reconnaissance activity not only provided оперативне awareness of developments in the southern sector, but also created a documentary basis for reporting to imperial institutions, demonstrating the Kosh's real control over frontier communications.

Alongside physical control of movement routes, the Sich administration introduced a system of transit restrictions across Zaporozhian lands that combined administrative barriers with diplomatic correspondence. The Kosh government ordered the closure of illegal river crossings, leaving open only officially registered points where travelers were carefully searched and their documents checked.

At the same time, the Kosh sent promemoria to the serasker-sultans of the Yedychkul and Yedisan hordes, in which it emphasized the need to observe the existing peace treaties and to prevent the Horde population from crossing the border in order to communicate with the insurgents [3, doc. 43, p. 86]. These texts clearly reveal an institutional logic: by referring to the "peace between the highest empires," the Zaporozhian seniority transformed internal prohibitions into external diplomatic obligations, thereby making it impossible to accuse the Kosh of facilitating transit. Archival records show that, despite the geographical expanse of the Volnosti, this combination of physical patrolling, administrative control, and diplomatic pressure significantly reduced the intensity of uncontrolled movements between the Haidamak and Tatar groups.

Thus, preventing a coalition between the Haidamaks and the Tatars in 1768 was based on a comprehensive system of preventive instructions, reconnaissance raids, and strict restrictions on transit, which was integrated into the broader strategy of the Kosh's diplomatic neutrality. The Kosh administration deliberately transformed traditional frontier practices into an instrument of institutional protection, demonstrating to both Russian and Polish authorities its fundamental inability to allow any contacts between the insurgents and Horde detachments.

This preventive model not only minimized the risks of external escalation and imperial sanctions, but also reinforced the administrative autonomy of the Zaporozhian Host by documenting control over cross-border communication flows. An analysis of the archival materials suggests that the Kosh's measures were not a sporadic reaction to the crisis, but a carefully designed mechanism for preserving stability under conditions of multi-vector pressure, where information control served as an instrument of institutional survival equal in importance to military force.

The southern direction of the diplomatic communication of the Kosh of the New Zaporozhian Sich in the summer and autumn of 1768 was charac-

terized by structural limitations caused both by the framework of international law and by the internal hierarchy of the Crimean Khanate. Unlike its correspondence with the Russian administration or Polish border officials, the Zaporozhian seniority did not send direct diplomatic notes to Bakhchysarai or the Ottoman Porte.

This absence of an official channel of communication with the central institutions of the Khanate was not a result of ignoring the Crimean vector, but rather reflected the caution of the Kosh administration in observing the existing peace treaties between the Russian Empire and the Ottoman state. Any attempt to establish direct political contact with the Khan's divan could have been qualified by St. Petersburg as a violation of imperial foreign policy, creating additional institutional risks for the Sich.

Instead of direct communication, the Kosh used the network of border Horde authorities as an intermediary instrument of diplomatic influence. The main addressees of the Zaporozhian promemoria and letters were the serasker-sultans of the Yedychkul and Yedisan hordes, who controlled the nomadic uluses adjacent to the Volnosti. The documents of files nos. 228–229 of the Central State Historical Archives of Ukraine record regular appeals to these leaders, requesting that they inform the Kosh about the movement of suspicious groups, restrain Horde detachments from crossing the border, and cooperate in preventing Haidamak leaders from penetrating southward [1, file 228, fols. 46–473, doc. 36, p. 78]. This practice corresponded to the established tradition of steppe diplomacy, in which border beys and sultans functioned as local security managers, possessing sufficient autonomy for operational decisions but not bearing responsibility for the overall policy of the Khanate.

The intermediary character of communication with the Horde authorities had both advantages and significant limitations. On the one hand, it enabled the Kosh to exchange intelligence rapidly, coordinate the actions of frontier patrols, and avoid direct clashes with nomadic detachments that could have provoked a large-scale conflict. On the other hand, the absence of direct ties with Bakhchysarai made it impossible to conclude official agreements or obtain guarantees of neutrality from the Khanate administration.

The instructions of the serasker-sultans often had a recommendatory character and depended on the local conjuncture, the loyalty of individual

murzas, and the economic interests of the nomads. In the event of escalating tensions, the Kosh could not rely on the central authority of the Khanate, since it formally adhered to its peace commitments to Russia and could distance itself from the actions of the border uluses. This made the southern vector of diplomatic maneuvering situational and dependent on informal understandings.

Despite these limitations, the Cossack senior leadership deliberately transformed the intermediary character of communication into an instrument of institutional protection. The absence of direct notes to Bakhchysarai enabled the Kosh to avoid accusations of violating international treaties while maintaining the minimally necessary level of interaction to ensure the security of the southern borders of the Volnosti.

In its correspondence with the Horde authorities, the Zaporozhian administration consistently appealed to the "peace between the highest empires" and to traditional frontier practice, which made its position intelligible to both sides of the conflict. Thus, the Kosh's southern diplomatic vector functioned not as a channel for concluding official agreements, but as a network of preventive communications adapted to the constraints of imperial protection and the internal structure of the Crimean Khanate.

Thus, the limitations of the Kosh's southern diplomatic communication during the Koliivshchyna were conditioned by the absence of direct contacts with Bakhchysarai and by its compelled dependence on the border Horde authorities as intermediaries. This structural feature did not indicate the isolation of the Sich; rather, it reflected a deliberate adaptation to international legal constraints and the hierarchical realities of the Crimean Khanate. The use of the network of serasker-sultans and nomadic elders enabled the Kosh administration to maintain a fluid exchange of information and prevent local conflicts, while refraining from entering into official agreements that might be interpreted by imperial authorities as a violation of its foreign policy. Thus, the intermediary character of the southern diplomatic vector became not an obstacle, but an instrument of institutional maneuvering that ensured a balance between the security needs of the Volnosti and the demands of imperial control.

The office practice of the Kosh of the New Zaporizhian Sich in the summer of 1768 demonstrates a high degree of formalization in correspondence,

which transformed documents into reliable instruments of administrative and diplomatic influence. An analysis of files No. 227–229 of fond 229 of the Central State Historical Archives of Ukraine (CDIAK) shows that the Kosh government deliberately standardized the structure of letters, orders, and reports, turning them not only into carriers of information but also into mechanisms of coercion and control. Such formulaic stability was not the result of bureaucratic inertia but a response to crisis conditions, when the rapid and unambiguous transmission of orders to dispersed palanka and kurin structures became a matter of institutional survival.

The mandatory requisites of Zaporizhian correspondence in 1768 followed a clear logic of hierarchical addressing and legal fixation. Each document began with identification of the recipient, which necessarily included rank and name: "To Mr. Polkovnyk Bohuhardovyi Moisey Holovko with the starshyna" [2, file 227, f. 4]. This was followed by a heading marker — "Order" or "Letter" — placed on a separate line, which legally separated dispositive acts from private correspondence or reporting materials. The closing section always contained a registration number, date, and place of drafting, for example: "1768, July 1, No. 2405" [3, doc. 15, p. 39]. Such numbering made it possible to exercise end-to-end control over the life cycle of a document, allowing the Kosh chancery to record delays in execution or the loss of correspondence. The presence of the military scribe's signature and that of the Kosh otaman completed the form, conferring public-legal force on the act.

The linguistic constructions used in the texts performed the function of diplomatic coding, adapting the message's content to the specific addressee. In letters to the Russian administration, formulas of subject loyalty predominated: "in execution of the highest will," "with zeal and reverence," which created the image of unquestioning compliance with imperial orders [3, pp. 52–54].

In communication with the Polish–Lithuanian Commonwealth, formulations of institutional distancing were employed: "we do not have the right to intrude into your borders," "we act only under compulsion of circumstances," which shifted responsibility for non-intervention onto external constraints [4, p. 119]. Correspondence with Ottoman (Ordin) authorities contained references to "silence between the greatest empires" and "long-standing friendship," which legitimized neutrality through international-legal rheto-

ric [3, doc. 36, p. 78]. The unification of these linguistic templates minimized the risk of ambiguous interpretation and ensured predictability in recipients' reactions.

Sanctioning clauses constituted a key element of the form, transforming the will of the starshyna into concrete legal consequences for non-compliers. Orders to palanka polkovnyks regularly featured standardized warnings: "if, because of your lack of restraint, certain offenses begin to be committed, then you, as unable to ensure obedience, will be subjected to the severest punishments" [2, file 227, f. 21].

The specification of punishments depended on the nature of the offense: permitting suspicious persons to pass was punished corporeally with clubs, while a late report could result in a monetary fine or temporary suspension of official powers [3, doc. 14, p. 36]. These clauses were not emotive threats but reflected norms of Cossack customary law adapted to wartime conditions. Their systematic use produced a preventive-control effect: recipients were made aware in advance of the cost of noncompliance, thereby reducing the need for actual repressive measures.

The combination of mandatory requisites, standardized linguistic constructions, and sanctioning clauses formed an integrated system for ensuring order execution. The formal structure guaranteed the document's legal validity, linguistic templates provided diplomatic flexibility, and sanctioning provisions maintained discipline at a distance. This communicative model allowed the Kosh administration to coordinate the actions of dispersed Volost structures effectively, minimizing the risks of informational isolation and preserving the institutional integrity of the Kosh amid the multidirectional pressures of 1768.

Thus, the formular unification of the New Zaporizhian Sich's Kosh correspondence in 1768 was not mere bureaucratic formality but a deliberate instrument of institutional control and diplomatic response. Mandatory requisites enabled traceability of a document's life cycle; linguistic constructions adapted message content to the specifics of each external or internal vector; and sanctioning clauses translated administrative will into enforceable mechanisms of compulsion. This triad of formulary elements allowed the Kosh leadership to compensate for the physical remoteness of palankas from the Sich, avoid communicative contradictions, and sustain a vertical

chain of command during an acute frontier crisis. Consequently, the Kosh's diplomatic maneuvering relied not only on substantive strategies but also on a precise diplomatic-chancellery architecture that transformed each document into a means of institutional survival.

The Kosh's operations during the political crisis of 1768 were characterized by a deliberate separation of communicative channels, enabling the administration to perform internal governance and external diplomatic representation simultaneously. The dual-communication strategy consisted of differentiating content, tone, and functional purpose of documents according to their addressee. Internal orders directed to palanka polkovnyks and kurin atamans were imperatively formulated and focused on discipline, mobilization, and control.

External correspondence addressed to imperial officials, representatives of the Polish–Lithuanian Commonwealth, or Crimean seraskers followed an apologetic model that prioritized official distancing from the insurgent movement and the demonstration of formal loyalty to external authorities. This communicative dichotomy was not the result of administrative inconsistency but a deliberate mechanism of institutional survival under multidirectional pressure.

Internal Kosh orders were concise, direct in their injunctions, and clearly stipulated sanctions for noncompliance. Documents sent to palanka administrations predominantly contained instructions on organizing border patrols, prohibiting Cossacks from abandoning winter quarters, and detaining persons heading to the Right Bank. For example, the order addressed to Bohuhardiv polkovnyk Musii Holovko in May 1768 included the categorical injunction "we earnestly request all your subjects to refrain from this," and, in cases where suspicious persons were discovered, directed that "such persons are in every possible way to be seized and sent to the Kosh" [3, doc. 15, p. 38].

The language of these documents did not contain diplomatic courtesies or references to binding international obligations; instead, the emphasis fell on military discipline, Cossack customary practice, and the inevitability of punishment for violations of orders. Sanctioning formulas ("you will be punished with a severe fine," "they will be mercilessly punished with clubs") underscored the imperative character of internal communication, where the

leadership's will was transformed into an unambiguous command not open to discussion [1, file 227, f. 4; file 228, f. 25].

By contrast, the Kosh's external letters were constructed according to principles of apologia and institutional distancing. In correspondence with the Kyiv and Little Russian (Malorossiya) general-governors, as well as with Polish frontier officials, the Kosh leadership consistently employed formulas of loyal submission, emphasized their "efforts" to comply with imperial demands, and stressed the impossibility of military intervention due to the lack of appropriate mandates. In a July 1768 letter to F. Voyeykov, the Kosh otaman affirmed that "under no circumstances does the Zaporozhian host have any connection to these disorders," describing the insurgents as "rabble and Polish peasants" acting without the Sich's knowledge [3, doc. 27, p. 68].

Such rhetoric functioned as a diplomatic shield: it minimized grounds for imperial sanctions, avoided explicit acknowledgment of Cossack participation in the uprising, and reframed responsibility for events on the Right Bank as internal problems of the Polish–Lithuanian Commonwealth. Letters to Polish officials additionally invoked the "silence between the greatest empires" and constraints imposed by the Russian administration, rendering the refusal to undertake joint military action legally justified rather than politically motivated [4, p. 119].

Coordination between these two communicative streams was ensured through centralized oversight by the Kosh chancery and the office of the military scribe. The content of internal orders was carefully filtered before transmission to the palankas to prevent accidental convergence of external and internal narratives that might give rise to accusations of duplicity. At the same time, when necessary, specific provisions from external letters were transferred into orders in an adapted form, enabling palanka polkovnyks to present the Kosh's actions to local populations in a consistent manner. For example, an imperial injunction prohibiting "allowing Cossacks to the Right Bank" appeared in external correspondence as "compelled compliance with the highest will," while in internal orders it was transformed into a categorical prohibition with detailed procedures for patrols and detention of violators [1, file 228, ff. 45–47]. This adaptation ensured coherency of action across administrative levels without compromising diplomatic loyalties.

Therefore, the Kosh of the New Zaporizhian Sich's dual-communication strategy during the Koliivshchyna was not an institutional contradiction but a rational mechanism of diplomatic maneuvering and internal governance. The imperative character of internal orders ensured discipline, the mobilization of border detachments, and control over the Cossack community, whereas the apologetic tone of external letters minimized imperial pressure, avoided international accusations, and preserved formal loyalty toward all three geopolitical actors.

A clear separation of communicative channels, coordinated through the Kosh chancery, turned the information flow into an instrument of institutional protection, enabling the Zaporozhian Host to retain autonomy at a time when any error in diplomatic rhetoric could provide grounds for the Sich's dissolution. This dual-communication model attests to the high level of administrative flexibility of the Kosh leadership and its capacity to adapt traditional clerical practices to the demands of a complex, multidirectional crisis.

The political crisis of 1768 required the Kosh of the New Zaporizhian Sich not only to respond operationally to external challenges but also to exercise deliberate management of information flows. The filtering of reports, strategic silences, and construction of alternative narratives for different addressees were integral elements of the Kosh administration's diplomatic communication. These practices did not indicate administrative inconsistency but reflected a rational strategy of institutional survival in circumstances where any lapse in information transmission might lead to imperial sanctions or international conflict.

Filtering of reports addressed to the Russian administration was guided by a risk-minimization principle. The Kosh chancery systematically selected and adapted factual material before transmitting it to the Kyiv and Little Russian general-governors. In reports to F. Voyeykov and P. Rumyantsev the emphasis was placed on measures that demonstrated compliance with imperial orders: organization of border patrols, detention of suspicious persons, and reporting on the movements of haidamaka detachments [3, doc. 96, p. 150]. At the same time, documents avoided detailing circumstances in which Zaporozhian Cossacks had refrained from active measures against insurgents or where palanka units limited themselves to observation.

This selectivity was not accidental: it allowed the Kosh to formally satisfy reporting requirements while preserving room for maneuver in internal affairs. Archival materials from files No. 227–229 record that reports to imperial institutions often contained generalized formulations such as "careful surveillance was conducted" or "all possible measures were taken," statements that could not be empirically verified by the recipient [1, file 228, f. 34].

Selective silence represented another dimension of information control. The Kosh administration deliberately refrained from reporting events that could be interpreted as support for the haidamaka movement or as failure to comply with imperial orders. Specifically, correspondence with the Russian authorities contains virtually no references to instances in which Zaporozhian Cossacks sheltered insurgents, supplied them with provisions, or passed along intelligence. By contrast, internal orders to palanka polkovnyks include instructions to "permit no contacts with the rebels," indicating both the reality of such contacts and the need to conceal them from imperial oversight [3, doc. 15, p. 38].

Silence also extended to internal disputes within the Zaporozhian community: reports to St. Petersburg avoided references to episodes of disobedience to Kosh orders, mutinies within units, or palanka commanders' refusal to carry out directives. This communicative strategy enabled the Kosh to preserve an image of a disciplined and loyal institution even amid significant internal tensions.

Constructing alternative narratives for different addressees was the most complex element of this information-control regime. For the Russian administration, the Kosh constructed a narrative of unconditional loyalty and effective fulfillment of border duties. In letters to F. Voyeykov and P. Rumyantsev, the haidamaka movement was framed as a "bandit enterprise," while the Zaporozhians were portrayed as "faithful subjects" who "with zeal" execute the highest will [3, doc. 27, p. 68]. A different narrative was deployed for the Polish administration: official distancing from the uprising, invocation of imperial constraints, and the impossibility of military intervention on the territory of the Polish–Lithuanian Commonwealth.

In memoranda to border starosts and commandants, the Kosh emphasized the "silence between the highest empires" and the lack of mandate

for cross-border operations [4, p. 119]. For Crimean seraskers and sultans, a third narrative was used: stress on shared interests in frontier security and the preventive sharing of information about suspicious movements, without explicit commitments to joint military action [3, doc. 36, p. 78]. Such multidirectional communication required meticulous coordination within the chancery to avoid contradictions among the different versions of events that could be revealed by comparative analysis of the correspondence.

Methodologically, the identification of information-control strategies is founded on a comparative analysis of documents addressed to different recipients, as well as on juxtaposing external correspondence with the Kosh's internal orders. Divergences in event classification, differences in degrees of detail, and the presence of lacunae in texts indicate deliberate management of information flows. It is important, however, to avoid excessive interpretation: not every discrepancy between documents results from strategic silence; some differences may be explained by the specific nature of the addressee, procedural requirements, or objective constraints on communication in wartime conditions.

Thus, information control in the diplomatic practice of the Kosh of the New Zaporizhian Sich in 1768 constituted not a set of sporadic manipulations but an integrated strategy of institutional protection. Report filtering allowed the Kosh to demonstrate formal compliance with imperial demands while preserving autonomy in decision-making; selective silence minimized the risks associated with transmitting compromising information; and the construction of alternative narratives for different addressees provided flexibility in three-way communication. These practices did not contradict the principles of Cossack clerical procedure but adapted them to the demands of intensified external pressure, transforming the information flow into an instrument of diplomatic maneuvering. Source analysis confirms that information control was an integral element of the Zaporozhian Host's survival mechanism at a time when any communicative error could justify the elimination of the Sich's institutional autonomy.

The Kosh's diplomatic maneuvering during the Koliivshchyna of 1768–1769 produced a paradoxical outcome: short-term institutional survival accompanied by systemic erosion of autonomy in the long term. Analysis of the documentation in files No. 227–229 of fond 229 at the Central State His-

torical Archives of Ukraine (CDIAK) reconstructs the mechanisms by which the Kosh leadership avoided immediate imperial sanctions while also revealing structural constraints that rendered this strategy temporary and ultimately unable to prevent the abolition of the Zaporozhian Host in 1775.

In the initial months of the uprising, the effectiveness of the Kosh's diplomatic maneuvering manifested in its ability to transform external imperatives into internal administrative procedures. Receiving orders from the Kyiv and Little Russian general-governors, Kosh otaman Petro Kalnyshevskyi did not merely provide formal confirmation of their execution but adapted the content of directives to the actual capacities of the palanka network [3, doc. 15, p. 38].

Correspondence with Polish officials and Ottoman (Ordin) sultans was organized on principles of institutional distancing, which enabled the Sich to avoid being classified as a center of insurgent organization and to preserve a formal status as a reliable border partner [4, pp. 119–120]. This communicative model produced temporary stability: the imperial administration received regular reports of "careful surveillance," the Polish side received official declarations of neutrality, and Crimean leaders received information on border security without commitments to joint action [3, doc. 36, p. 78]. In the short term, this allowed the Kosh to maintain internal cohesion, avoid direct military intervention, and preserve traditional forms of self-government.

However, the effectiveness of such maneuvering had clearly defined limits, determined by the asymmetry of the political weight of the conflict's actors. The Zaporizhian Sich did not function as an equal actor in international relations but as an institution whose status depended on the will of the imperial center. Diplomatic instruments—such as references to the "silence between the highest empires" or apologetic rhetoric in letters to voivodes—did not alter the essentially subordinate position of the Host [5, p. 145].

The imperial administration regarded the Kosh's diplomatic flexibility not as an expression of sovereignty but as a temporary convenience that allowed it to maintain the border zone without additional military expenditure. Reports to St. Petersburg recorded only those aspects of the Sich's activity that confirmed control, while internal contradictions, financial dependence, and demographic changes were ignored or framed as indicators of the need for reform [3, pp. 52–54]. Thus, diplomatic

maneuvering operated within limits defined by imperial pragmatism rather than by Cossack initiative.

The long-term consequences of this strategy manifested in the gradual integration of Zaporizhian lands into the imperial administrative system. The apparent successes of 1768–1769 created an illusion of restored autonomy but in fact accelerated centralizing processes that culminated in the abolition of the New Sich in 1775. After the end of the Russo–Turkish War and the annexation of Crimea, the geopolitical importance of the Zaporizhian frontier sharply declined, and imperial authority no longer required an institutional intermediary to manage the steppe borders [4, p. 121]. The diplomatic mechanisms that had preserved the Kosh during the Koliivshchyna lost their functional purpose: the absence of an external threat enabled St. Petersburg to shift from indirect control to direct administration. Orders, reports, and memoranda that had previously structured communication among nominally equal partners became instruments of vertical subordination. The liquidation of the Sich in June 1775 was not a sudden reaction to the uprising but the logical conclusion of a process in which the diplomatic maneuvering of 1768–1769 constituted only a transitional stage in institutional transformation.

Thus, the effectiveness of the Kosh's diplomatic maneuvering during the Koliivshchyna was ambivalent. In the short term, communicative flexibility, institutional distancing, and adaptation of imperial requirements enabled the Zaporozhian Host to avoid immediate sanctions and preserve internal cohesion. However, these successes did not offset the Sich's structural dependence on the imperial center, rendering diplomatic instruments temporary and functionally constrained. The long-term loss of autonomy in 1775 demonstrates that maneuvering could not alter the geopolitical reality: the disappearance of external threats and the empire's centralizing policy transformed Zaporozhian diplomacy from an instrument of survival into a historical artifact of a bygone era. Analysis of this process confirms that institutional adaptation under conditions of asymmetric power affords only provisional existence rather than guaranteeing long-term preservation of autonomy.

Conclusion. This study of the Kosh of the New Zaporizhian Sich's diplomatic maneuvering during the Koliivshchyna of 1768–1769 provides an integrated account of the institutional mechanisms by which the Zaporozhian

Host responded to a multidirectional political crisis. Analysis of the documentation in files No. 227–229 of fond 229 at the Central State Historical Archives of Ukraine (CDIAK), published in the 2019 corpus, shows that the Kosh administration did not merely react passively to external challenges but developed a systematic communication strategy toward three key political actors: the Russian Empire, the Polish–Lithuanian Commonwealth, and the Crimean Khanate.

Along the Russian-imperial vector, the Kosh's diplomatic activity rested on adapting external imperatives into internal administrative procedures. Receiving orders from the Kyiv and Little Russian general-governors, Kosh otaman Petro Kalnyshevskyi transformed general directives on the "neutralization of insurgents" into concrete instructions for palanka polkovnyks, combining demonstrations of loyalty with retention of room for maneuver in internal affairs [3, doc. 15, p. 38]. This strategy allowed the Sich to give formal effect to imperial commands while avoiding open confrontation with haidamaka bands, among which many Zaporozhian Cossacks were present.

In communications with the Polish–Lithuanian Commonwealth, the Kosh consistently employed the instrument of official distancing. Memoranda to border starosts, letters to Prince A. Yablunovsky, and correspondence with the merchant commandant J. Kwiatkiewicz contained a unified argument: the impossibility of military intervention on Polish territory owing to restrictions imposed by the Russian authorities and the absence of a mandate for cross-border operations [3, doc. 27, p. 68; 4, p. 119]. This rhetoric, reinforced by the semantic reclassification of the haidamaky as "rabble" and "Polish subjects," allowed the Kosh leadership to minimize Polish claims without assuming real obligations to undertake joint military action.

The southern vector of diplomacy was conducted through correspondence with the serasker-sultans of the Yedichkul and Yedisan ordas. Informing the ordan governments about the movements of suspicious groups, the Kosh appealed to the "silence between the highest empires" and to shared interests in border security [3, doc. 36, p. 78]. Although there were no direct diplomatic notes from Bakhchisaray, this communication functioned as preventive diplomacy aimed at averting possible alliances between haidamaka bands and Tatar detachments.

The institutional basis of the three-way maneuvering combined formulary unification of correspondence, a dual-communication strategy, and information control. The Kosh's internal orders, cast in an imperative register, ensured discipline and the mobilization of palanka detachments, while external letters, composed according to an apologetic model, signaled formal loyalty to all three geopolitical actors. This communicative dichotomy was not a sign of administrative incoherence but a deliberate mechanism of institutional survival under conditions of asymmetric political weight among the conflict's participants.

The effectiveness of the Kosh's diplomatic maneuvering was therefore ambivalent. In the short term, communicative flexibility enabled the Zaporozhian Host to avoid immediate imperial sanctions, preserve internal cohesion, and sustain traditional forms of self-government. Yet these successes did not offset the Sich's structural dependence on the imperial center. The diplomatic instruments that preserved the Kosh during the Koliivshchyna lost their functional utility after the end of the Russo–Turkish War and the annexation of Crimea, when the geopolitical significance of the Zaporizhian frontier sharply declined. The abolition of the New Sich in 1775 was the logical culmination of a process in which the diplomatic maneuvering of 1768–1769 constituted only a transitional stage of institutional transformation.

The Kosh's diplomatic maneuvering during the Koliivshchyna was not the product of spontaneous reactions but of an institutionally constructed system of external relations adapted to the challenges of a frontier crisis. Analysis of this system expands our understanding of the institutional history of the Lower Zaporozhian Host, demonstrating how traditional forms of Cossack self-government were transformed under the pressure of imperial expansion. These findings provide a basis for further comparative study of diplomatic practices among early-modern border communities and for assessing the long-term consequences of institutional adaptation under conditions of asymmetric power.

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