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**Ensuring the security of the banking system on the basis of innovative  
metaspace technologies**

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**Abstract.** The article reveals scientific and applied aspects of ensuring the security of the banking system based on innovative metaspaces technologies. Modern trends in the development of the banking system in the context of the active implementation of Blockchain technologies, Big Data and digital financial platforms are studied. It is established that the rapid spread of digital banking services, VR/AR technologies and decentralized financial systems is accompanied by increased cyber risks, an increase in the number of digital frauds, data leaks and threats to the information security of banking institutions. The need to form a comprehensive system for protecting banking infrastructure based on modern metaspaces technologies is substantiated. **The purpose** of the article is to study the strategic directions of ensuring the security of the banking system based on innovative metaspaces technologies and to determine the impact of modern cyber threats on the functioning of financial institutions in the process of integrating Blockchain and AI technologies into banking activities. Particular attention is paid to the use of Blockchain technologies to ensure the transparency of financial transactions and monitor cyber risks, protect digital infrastructure and smart contracts to minimize the risks of financial fraud. **The research methods** are based on the use of a systematic approach to assessing the security of the banking system, methods of comparative analysis, statistical generalization, economic modeling and graphic visualization of research results. To assess the trends in the development of digital banking and the level of cyber threats, methods of dynamic analysis of statistical indicators were used. **The results** of the study showed that during 2020-2024, there was a significant increase in the volume of digital banking transactions due to the activation of the metaspaces platform in the banking system. It was found that the increase in the level of digitalization of the banking system is accompanied by a simultaneous increase in the number of cyber incidents, phishing attacks, software-on-demand threats and cases of compromise of digital assets. It was proven that traditional banking infrastructure protection systems do not provide a sufficient level of security. At the same time, it was determined that in the context of the development of innovative metaspaces technologies, as a



decentralized financial platform, Blockchain, AI, secure cloud services and biometric identifiers are being integrated into the banking system in order to increase the level of protection of financial transactions, ensure the transparency of digital transactions and minimize the risks of unauthorized access to banking transactions. A strategy for ensuring the security of the banking system based on innovative metaspaces technologies is proposed, which involves the formation of a multi-level cyber protection system, the development of the digital infrastructure of banks, the implementation of AI-risk monitoring and the adaptation of regulatory policy to the conditions of metaspaces development. **The conclusions** show that the use of innovative metaspaces technologies in the banking system security system contributes to increasing its cyber resilience by reducing the level of digital risks and ensuring the stability of banking activities in the conditions of digitalization of the economy. The implementation of the proposed strategy will allow to ensure effective protection of banking data, minimize financial losses from cyber threats and increase the level of customer trust in digital banking services. Further research should be directed at the development of adaptive models of cyber risk management, improving mechanisms for regulating the financial platform of metaspaces and forming international standards for digital security of the banking system.

**Keywords:** banking system, metaspaces, Blockchain, cybersecurity, cyber threats, cyber incidents, digitalization, financial security.

**Забезпечення безпеки банківської системи на засадах інноваційних технологій метaproctopу**

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**Анотація.** У статті розкрито наукові та прикладні аспекти забезпечення безпеки банківської системи на засадах інноваційних технологій метаспростору. Досліджено сучасні тенденції розвитку банківської системи в умовах активного впровадження Blockchain-технологій, Big Data та цифрових фінансових платформ. Встановлено, що стрімке поширення цифрових банківських сервісів, VR/AR-технологій та децентралізованих фінансових систем супроводжується посиленням кіберризиків, зростанням кількості цифрових шахрайств, витоків даних та загроз інформаційній безпеці банківських установ. Обґрунтовано необхідність формування комплексної системи захисту банківської інфраструктури на основі сучасних технологій метаспростору. **Метою статті** є дослідження стратегічних напрямів забезпечення безпеки банківської системи на засадах інноваційних технологій метаспростору та визначення впливу сучасних кіберзагроз на функціонування фінансових установ у процесі інтеграції Blockchain, AI технологій у банківську діяльність. Особливу увагу приділено застосуванню Blockchain -технологій для забезпечення прозорості фінансових операцій та моніторингу кіберризиків, захисту цифрової інфраструктури та смарт-контрактів для мінімізації ризиків фінансового шахрайства. **Методи дослідження** базуються



на використанні системного підходу до оцінювання безпеки банківської системи, методів порівняльного аналізу, статистичного узагальнення, економічного моделювання та графічної візуалізації результатів дослідження. Для оцінки тенденцій розвитку цифрового банкінгу та рівня кіберзагроз використано методи динамічного аналізу статистичних показників. **Результати дослідження** засвідчили, що протягом 2020-2024 рр. спостерігалось суттєве зростання обсягів цифрових банківських операцій через активізацію платформи метапростору у банківській системі. Встановлено, що збільшення рівня цифровізації банківської системи супроводжується одночасним підвищенням кількості кіберінцидентів, фішінг-атак, загроз програмне забезпечення на вимогу та випадків компрометації цифрових активів. Доведено, що традиційні системи захисту банківської інфраструктури не забезпечують достатнього рівня безпеки. Водночас визначено, що в умовах розвитку інноваційних технологій метапростору, як децентралізованої фінансової платформи здійснюється інтеграція Blockchain, AI, безпечних хмарних сервісів та біометричних ідентифікаторів у банківську систему задля підвищення рівня захисту фінансових транзакцій, забезпечити прозорості цифрових операцій та мінімізації ризиків несанкціонованого доступу до банківських операцій. Запропоновано стратегію забезпечення безпеки банківської системи на засадах інноваційних технологій метапростору, яка передбачає формування багаторівневої системи кіберзахисту, розвиток цифрової інфраструктури банків, впровадження AI-моніторингу ризиків та адаптацію регуляторної політики до умов розвитку метапростору. **Висновки** свідчать, що використання інноваційних технологій метапростору у системі забезпечення безпеки банківської системи сприяє підвищенню її кіберстійкості шляхом зниження рівня цифрових ризиків та забезпечення стабільності банківської діяльності в умовах цифровізації економіки. Реалізація запропонованої стратегії дозволить забезпечити ефективний захист банківських даних, мінімізувати фінансові втрати від



кіберзагроз та підвищити рівень довіри клієнтів до цифрових банківських сервісів. Подальші дослідження доцільно спрямувати на розробку адаптивних моделей управління кіберризиками, удосконалення механізмів регулювання фінансової платформи метaproctopу та формування міжнародних стандартів цифрової безпеки банківської системи.

**Ключові слова:** банківська система, метaproctop, Blockchain, кібербезпека, кіберзагрози, кіберінциденти, цифровізація, фінансова безпека.

**Formulation of the problem.** The current stage of development of the banking system is characterized by the active digitalization of financial services, the integration of artificial intelligence technologies, Blockchain, Big Data, cloud services and metaspac into banking processes. The formation of metaspac as a new environment of financial interaction creates not only additional opportunities for the development of banking institutions, but also generates new cyber risks associated with data leakage, digital fraud, manipulation of digital assets, violation of confidentiality and insufficient level of protection of financial information. In these conditions, the issue of forming an effective system for ensuring the security of the banking system on the basis of innovative metaspac technologies becomes particularly relevant.

In the context of global digital transformation, the banking sector is forced to adapt to new formats of interaction with customers through VR/AR platforms, digital avatars, smart contracts and decentralized financial services. At the same time, the lack of comprehensive mechanisms for regulating metaspac, an insufficient level of cyber protection, and the rapid growth of digital financial transactions increase the systemic risks of the functioning of the banking system, which necessitates the development of a modern strategy for ensuring the security of the banking system using innovative metaspac technologies.

**Analysis of recent research and publications.** The issue of digital security of the banking system and metaspac has been studied by many scholars. D. Tapscott and A. Tapscott substantiated the role of Blockchain in the transformation of the



banking sector and increasing the transparency of banking operations [16]. F. Mishkin identified the key risks of digitalization of banking services and the need to modernize financial security systems [9]. Y. Wang, Z. Su, N. Zhang and other researchers analyzed the architecture of the metaverse and identified the main threats to cybersecurity and data privacy [17]. K. Nguyen, D. Hoang, D. Nguyen developed the Blockchain framework MetaChain to protect metaspaces platforms [12]. V. Ahsani, A. Rahimi, M. Letafati proved the importance of integrating edge computing and Blockchain for the secure functioning of metaspaces [1]. P. Radanliev substantiated the concept of integrated cybersecurity for metaspaces systems based on Blockchain and cloud computing [13]. A.-S. Gogi identified the role of tokenization and Blockchain in the transformation of banking infrastructure [5]. A. Manta and C. Hercescu explored the prospects for the development of MetaFi and digital banks in metaspaces [7]. H. Sallegudin, N. Bahar and other scientists revealed socio-technical barriers to the implementation of banking metaspaces [14]. F. Jindre and G. Ibarra proved the effectiveness of using Blockchain to combat financial fraud [4]. K. Manzur, U. Noor, Z. Rashid proposed an NFT-oriented security system for a metaspaces platform [8]. F. Pradana and T. Dipsatara substantiated the role of smart contracts in minimizing systemic banking risks [13]. V. Liang, Y. Liu and other authors identified the problems of transaction confidentiality in Blockchain [6]. S. Akadiri and O. Ozkan investigated the relationship between cybersecurity, FinTech and the metaverse industry [2]. A. Faccia, N. Moșteanu substantiated the risks of electronic money laundering in FinTech systems [3]. Y. Zhang and H. Xu developed mechanisms for protecting the confidentiality of digital transactions [18]. B. Susanto, M. Masrek proved the effectiveness of smart contracts in financial services [15].

**Identification of unresolved parts of the problem.** Despite a significant amount of scientific research, the issues of forming a comprehensive strategy for ensuring the security of the banking system in the context of the integration of innovative metaspaces technologies into digital financial platforms remain insufficiently developed. Cyber risk management mechanisms, adaptation of regulatory policy,



and the formation of a multi-level system for protecting digital banking assets require further research.

**Formation of research objectives.** The purpose of the article is to substantiate the strategic directions of ensuring the security of the banking system based on innovative metaspaces technologies.

To achieve the set goal, the following research tasks were defined:

- to investigate current trends in the digitalization of the banking system;
- to analyze the dynamics of cyber risks in the banking sector;
- to develop a strategy for ensuring the security of the banking system based on metaspaces technologies;
- to propose mechanisms for implementing the strategy..

**Presentation of the main research material.** The development of innovative metaspaces technologies and digital financial platforms is shaping a new model for the functioning of the banking system. Banks are increasingly implementing VR/AR services, digital offices, NFT tools, biometric identifiers, Blockchain solutions, and a risk management process automation system. At the same time, the growth of digital activity is accompanied by an increase in the number of cyberattacks, financial fraud, and attempts to gain unauthorized access to banking systems.

In 2020-2024, there was a significant increase in the volume of digital banking transactions, which was a consequence of the COVID-19 pandemic, the active development of FinTech, and the transition to remote banking. In parallel, there was an increase in bank spending on cybersecurity and modernization of digital infrastructure (Table 1).

**Table 1**

Dynamics of digital banking transactions in the world in 2020-2024

Year	Digital Transaction Volume, trillion USD	Growth Rate, %
2020	6,8	–
2021	8,2	20,6



2022	9,7	18,3
2023	11,5	18,6
2024	13,4	16,5

*Source: constructed based on data from [10; 11]*

Analysis of the data in Table 1 indicates a stable growth in the volume of digital banking transactions. In 2024, compared to 2020, their volume increased by almost 2.0 times, which confirms the high level of digitalization of the banking system.

The data in Table 2 demonstrate that Ukrainian banks are actively investing in cyber defense systems, Blockchain analytics, AI monitoring, and cloud security. In 2024, cybersecurity spending increased by 77.1% compared to 2020.

**Table 2**

Dynamics of spending by Ukrainian banks on cybersecurity in 2020-2024

Year	Cybersecurity spending, billion USD	Growth Rate, %
2020	48	–
2021	56	16,7
2022	64	14,3
2023	73	14,1
2024	85	16,4

*Source: constructed based on data from [10; 11]*

The results of the analysis of Table 3 indicate a constant increase in the number of cyber incidents in the banking sector. The main threats remain phishing attacks, software-on-demand risks, digital asset compromise, and fraudulent transactions in the space platform.

**Table 3**

Number of cyber incidents in the banking sector in 2020–2024

Year	Number of cyber incidents, thousand	Growth Rate, %
2020	112	–
2021	129	15,2
2022	148	14,7
2023	171	15,5
2024	196	14,6

*Source: constructed based on data from [10; 11]*



In order to minimize risks, a strategy for ensuring the security of the banking system based on innovative metaspaces technologies is proposed (Fig. 1).

The proposed strategy involves the integration of innovative metaspaces technologies (Blockchain, AI, cloud services, Big Data, and VR/AR technologies) into the banking security system, which are capable of increasing the level of protection of financial transactions, minimizing digital risks, and strengthening the resilience of the banking system.

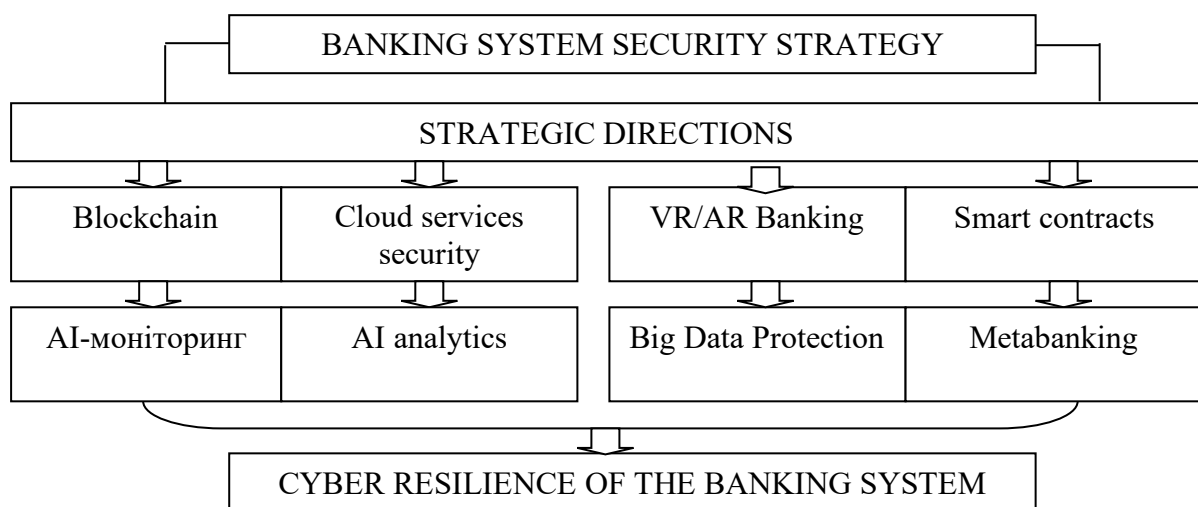


Figure 1. Strategy for ensuring the security of the banking system based on innovative metaspaces technologies

*Source: developed by the authors*

To implement the strategy, it is advisable to use a complex of organizational, technological, financial and regulatory mechanisms (Fig. 2).

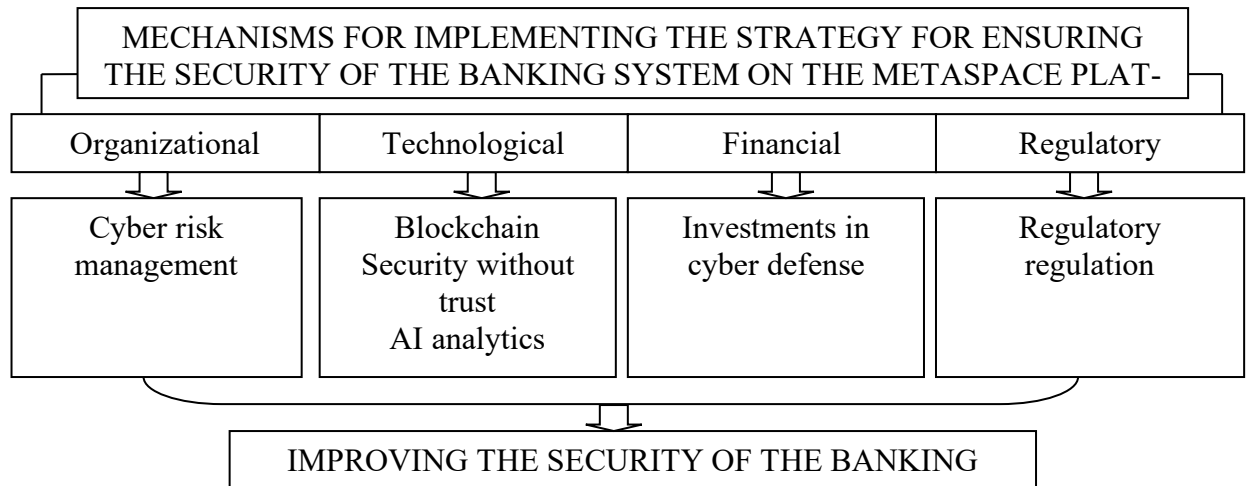


Figure 2. Mechanisms for implementing the security strategy of the banking system on the metaspaces platform

*Source: developed by the authors*

Organizational mechanisms should include the creation of cyber risk monitoring centers, the formation of a digital audit system and the training of cybersecurity specialists. Technological mechanisms should be based on the use of Blockchain, AI analytics, biometric identifiers and trustless security systems. Financial mechanisms include investments in the modernization of the digital infrastructure of banks. Regulatory mechanisms should ensure the adaptation of legislation to the conditions for the development of digital assets on the metaspaces platform.

**Conclusions.** The study found that the development of metaspaces and digital financial technologies is significantly transforming the banking system, creating new challenges in the field of cybersecurity. The growth of digital transactions, the active use of Blockchain, AI-analytics and metaspaces platforms is accompanied by an increase in the level of cyber risks and requires the formation of a comprehensive system for protecting banking infrastructure. The feasibility of implementing a strategy for ensuring the security of the banking system based on innovative metaspaces technologies, which involves the integration of Blockchain, cloud services, Big Data and VR/AR solutions into the banking protection system, is substantiated. The implementation of the proposed mechanisms will contribute to increasing the cyber



resilience of the banking system, minimizing digital threats and ensuring the stability of the financial sector.

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