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DIGITAL PAYMENT SYSTEMS IN THE FINANCIAL SECTOR OF UKRAINE: CATALYST OF DEVELOPMENT AND INSTRUMENT OF TRANSFORMATION

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ЦИФРОВІ ПЛАТІЖНІ СИСТЕМИ У ФІНАНСОВОМУ СЕКТОРІ УКРАЇНИ: КАТАЛІЗАТОР РОЗВИТКУ ТА ІНСТРУМЕНТ ТРАНСФОРМАЦІЇ

Abstract. *It is researched that digital payment systems (DPS) are a key catalyst for development and a tool for transforming the financial sector of Ukraine. The evolution of payment systems is examined, from the initial stage of using paper instruments to the current phase of intensive digitalization, characterized by the dominance of electronic payment systems and financial technologies. It has been determined that DPSs are complex integrated architectures that provide electronic financial transactions, are characterized by a high degree of speed, efficiency, security, and the ability to adapt in a dynamic technological environment. The structural-functional model of the payment system, consisting of institutional-legal, infrastructural-technological and economic blocks, and their system integration, is analyzed. It is established, noted that the digitalization of financial services in Ukraine is accompanied by the growing popularity of mobile payment applications, QR payments, contactless cards, online payments and cryptocurrencies. The research reveals a tendency to strengthen the cybersecurity of transactions using biometric authentication, blockchain technologies, and artificial intelligence. A comparative analysis of the development of DPS in countries around the world is carried out, which allows identifying key trends in the introduction of central bank digital currencies (CBDCs) and other digital payment innovations. It is stated that Ukraine demonstrates dynamic development in the field of digital finance, which is in line with global trends, despite geopolitical risks. The advantages and disadvantages and risks that impede the*

spread and use of DPS in the country's financial sector are outlined. This primarily concerns ethical issues, transparency, unfair or discriminatory use of DPS, as well as problems with confidentiality and personal data protection. It was found that DPSs have limited capabilities in working with unstructured data and interpreting complex contextual nuances. It is found that DPSs, despite the presence of cognitive limitations, are an effective tool in the context of the development of the national financial sector, ensuring an increase in its competitiveness and operational efficiency by optimizing the paradigm of customer interactivity, introducing improved risk management models and enhancing the analytical accuracy of predictive models of economic trends.

***Key words**: transactional efficiency, fintech, digitalization, financial inclusion*

***Анотація**. Досліджено, що цифрові платіжні системи (ЦПС) є ключовим каталізатором розвитку та інструментом трансформації фінансового сектору України. Розглянуто еволюцію платіжних систем, від початкового етапу використання паперових інструментів до сучасної фази інтенсивної цифровізації, що характеризується домінуванням електронних платіжних систем та фінансових технологій. Визначено, що ЦПС є складними інтегрованими архітектурами, які забезпечують електронні фінансові транзакції, характеризуються високим ступенем швидкості, ефективності, безпеки та здатністю до адаптації в умовах динамічного технологічного середовища. Проаналізовано структурно-функціональну модель платіжної системи, що складається з інституційно-правового, інфраструктурно-технологічного та економічного блоків, та їх системну інтеграцію. Встановлено, що цифровізація фінансових послуг в Україні супроводжується зростанням популярності мобільних платіжних додатків, QR-платежів, безконтактних карток, онлайн-платежів та криптовалют. Виявлено тенденцію до посилення кібербезпеки транзакцій з використанням біометричної аутентифікації, блокчейн-технологій та штучного інтелекту. Проведено порівняльний аналіз розвитку ЦПС у країнах світу, що дозволяє виявити ключові тенденції впровадження цифрових валют центральних банків (CBDC) та інших цифрових платіжних інновацій. Констатовано, що Україна демонструє динамічний розвиток у сфері цифрових фінансів, що відповідає глобальним тенденціям, незважаючи на геополітичні ризики. Окреслено переваги та виокремлено недоліки та ризики, які перешкоджають поширенню та використанню ЦПС у фінансовому секторі країни. Це стосується насамперед питань етичних аспектів, прозорості, несправедливого чи дискримінаційного використання ЦПС, а також проблем зі збереження конфіденційності та захисту персональних даних. Виявлено, що ЦПС мають обмежені можливості в роботі з неструктурованими даними та інтерпретації складних контекстуальних нюансів. З'ясовано, що ЦПС, попри наявність обмежень когнітивного характеру, виступають ефективним інструментом у контексті розвитку національного фінансового сектору, забезпечуючи підвищення його конкурентоспроможності та операційної результативності шляхом оптимізації парадигми клієнтського інтерактиву, впровадження удосконалених моделей ризик-менеджменту та посилення аналітичної прецизійності прогностичних моделей економічних тенденцій.*

***Ключові слова**: транзакційна ефективність, фінтех, цифровізація, фінансова інклюзія*

1. Statement of the problem in general terms and its connection with important scientific or practical tasks. In the context of the global digital transformation of the financial sector, digital payment systems (DPS) are becoming increasingly important, forming a new architectonics of financial flows, automating settlement processes, and contributing to the efficiency of economic entities. The introduction and development of DPSs is a strategic imperative for modernizing financial institutions, increasing financial inclusion, reducing transaction costs, and enhancing the competitiveness of the national economy. It is predicted that the integration of digital payment technologies will contribute to strengthening economic resilience, in particular by reducing the shadow capital turnover, improving the mechanisms for regulating money circulation, and creating preconditions for the development of financial innovations. At the same time, the active implementation of digital payment instruments is accompanied by a number of conceptual and practical challenges. In particular, the transformation of the payment infrastructure requires a comprehensive upgrade of the technological base, adaptation of the regulatory environment, and development of a modern digital ecosystem that would meet international cybersecurity standards and ensure the protection of users' personal data. Another important aspect is the need for substantial investments in the digitalization of the financial sector, which creates risks of uneven access to advanced financial technologies and deepening technological inequality between certain sectors of the economy. In addition, digital payment systems generate new challenges for monetary policy, including ensuring control over monetary aggregates, the effectiveness of interest rate policy, and preventing systemic risks in the event of possible technological failures or cyberattacks. Thus, the study of digital payment systems as a catalyst for development and a tool for transforming the financial environment is extremely relevant in the context of ensuring the sustainability and innovative development of the economy. Optimization of regulatory mechanisms, development of effective cybersecurity strategies, and formation of adaptive financial instruments are priority areas of scientific discourse that require in-depth theoretical and methodological understanding and empirical substantiation.

2. Analysis of latest research and publications. The role of digital payment systems in the financial sector of Ukraine has been studied in numerous scientific works by Ukrainian and foreign scholars and specialists. In the international context, digital payment systems are attracting considerable attention, particularly in terms of their impact on the development of financial services, modernization of banking infrastructure, and integration into global financial processes. T. Arora, N. Gupta, [1] examine the transformation of financial services in developing economies through digital payment systems, emphasizing their potential to modernize financial infrastructure and increase the availability of financial services to the general population. M. López, F. Pérez [2] emphasize the importance of digital payment systems in the context of the globalization of financial markets, in particular their integration into the international financial architecture, which facilitates cross-border payments and reduces barriers to international investment. J. Smith, L. Brown [3] explore the role of digital payment systems in enabling fast and secure cross-border payments, which facilitates the development of global financial services and reduces costs for international businesses and consumers. C. Fischer, A. Davis [4] analyzes the challenges of regulating digital payment platforms in developing countries, suggesting ways to improve them in order to stimulate economic growth and financial market development.

In turn, Ukrainian scholars have focused much of their research on the specifics of digital payment systems in the financial sector of Ukraine, their role in transforming the national financial infrastructure and promoting financial inclusion. In particular, G. Bey, A. Sperchuk, and A. Dumanska study the use of artificial intelligence technologies to improve payment systems, which increases their efficiency and security [6]. H. Demchyshak, R. Loik, and A. Loik focus on digital innovations in the banking system of Ukraine, especially in the context of lending, where digital payment systems help reduce risks and make financial services more accessible to the population [9]. O. Dmytryk, K. Tokarieva, and A. Kotenko emphasize the importance of digital payment systems in ensuring the security and speed of payment transactions, which is crucial for the stability of financial markets [10]. D. Riznyk, S. Stander, and V. Havryliuk point out the importance of decentralized payment systems such as cryptocurrencies and blockchain for the transformation of Ukraine's financial infrastructure, noting the potential for their integration into the traditional banking system [14]. I. Chunytska and L. Bogrinovtseva in their research focus on the impact of digital technologies, in particular payment systems, on the development of the financial market of Ukraine. They argue that the effective implementation of such systems has significant potential to accelerate the digitalization of the national economy, as well as to facilitate access to international financial instruments. This, in turn, contributes to Ukraine's integration into global financial markets and improves economic cooperation with other countries [13]. O. Baldueva, A. Gorbunov, and Y. Kusakova focus on the importance of digital payment systems for the globalization of financial infrastructure, noting that banks must adapt to new technological changes to remain competitive in international markets [7]. T. Staverska and Y. Litvinova highlight the evolution of payment systems, in particular the role of innovations in their digitalization, which makes digital payment systems the main tool for financial transactions in Ukraine [11]. V. Bilyavsky, Y. Bilyavska, and other authors emphasize that the use of digital payment technologies in the financial sector significantly increases the efficiency of payment transaction processing and reduces costs for end users [8].

In general, the results of the above-mentioned authors› research show that digital payment systems are a key factor in the transformation of Ukraine›s financial sector, acting as a catalyst for its modernization and structural adaptation to modern challenges. The integration of these technologies helps to increase the efficiency of financial transactions, expand the inclusiveness of financial services, and optimize the payment infrastructure. In addition, digital payment instruments ensure a high level of transaction security and compliance with international standards, which is important in the context of integration into the global financial space. At the same time, the further development of digital payment technologies requires improving regulatory and legal support, strengthening cybersecurity mechanisms, and building a sustainable financial ecosystem capable of operating effectively in the digital economy.

3. Formulation of the purposes of the article. The purpose of the study is to investigate the state of use of digital payment systems in the financial sector of Ukraine, to identify the main problems of their implementation as a transformation tool and a catalyst for the development of financial infrastructure, to assess their impact on the functioning of the financial system and the activities of financial and credit institutions, and to offer scientifically sound recommendations for improving the efficiency of their functioning in the context of the digitalization of the economy. The adaptation mechanism of digital

payment systems in the financial sector of Ukraine is studied using a system analysis. The study of the problem is carried out using a multilevel concept, which includes the use of various scientific methods, in particular, dialectical and general scientific principles of complex research, including: empirical methods (to identify existing approaches to the implementation of digital payment systems in Ukraine, to assess global and domestic trends in their development – observation, comparison, description); theoretical and cognitive methods (to study the essence and features of digital payment systems, formalize, formulate and test hypotheses); general logical methods (to identify methodological problems of integrating digital payment systems into the country's financial system and differentiate approaches to the concept of these systems in the financial sector) – analysis, synthesis, scientific abstraction, generalization, induction, deduction, analogy).

4. Outline of the main material of the research with full justification of the obtained scientific results. In the context of rapid digitalization of the economy and growing requirements for the efficiency and security of financial transactions, digital payment systems are gaining dominance, exponentially expanding their scope. This makes it important to study the potential of digital payment systems as a catalyst for development and a tool for transforming the financial sector of Ukraine, which is of both theoretical and practical importance. The transformation of payment systems is a reflection of the evolution of socio-economic relations and technological progress. Since the emergence of the primary forms of non-cash payments, payment instruments have undergone significant changes, adapting to changing market conditions and social needs. The analysis of the stages of development of payment systems allows us to trace the dynamics of financial transactions, major technological changes and their impact on the formation of current trends. According to scientific research, the evolution of payment systems covers three main stages:

The first stage (XVIII – XIX century) is characterized by the formation of the legal framework for non-cash payments and the introduction of paper payment instruments, such as bills of exchange and checks, which became the basis for financial transactions in this period. This period laid the foundations of the banking system and developed clearing mechanisms.

The second stage (XX century) is associated with the introduction of electronic payment instruments, such as bank cards, electronic transfers, and the first attempts to create electronic money. This period was marked by significant automation of banking services, including the introduction of ATMs.

The third stage (XXI century to the present) is characterized by intensive digitalization and the development of financial technologies. The period of global availability of electronic payment systems, such as digital wallets, cryptocurrencies, as well as the expansion of contactless technologies and digital currencies provided via the Internet and mobile applications. Digital progress, changing consumer behavior, and global challenges are key factors in the dynamic development of the modern payment industry.

Despite the ongoing evolution of digital payment systems, a consensus on their ontological nature remains elusive. The conceptual multivariance of definitions of digital payment systems is due to their consideration as complex integrated architectures, a distinctive segment of digital financial technologies, and an independent field of scientific and applied research (Fig. 1). Scientists interpret digital payment systems as an interdisciplinary area of financial innovation aimed at developing and implementing digital tools and platforms that

enable transactional operations with a focus on efficiency, cybersecurity, and accessibility of financial services. In the broadest sense, digital payment systems are complex integrated architectural systems that provide electronic financial transactions and payment processing with a high degree of speed, efficiency, and security [8]. These systems are characterized by the ability to adapt to a dynamic technological environment, comply with regulatory requirements and respond to changes in macroeconomic indicators, and have the ability to self-optimize under resource constraints, including time and computing.

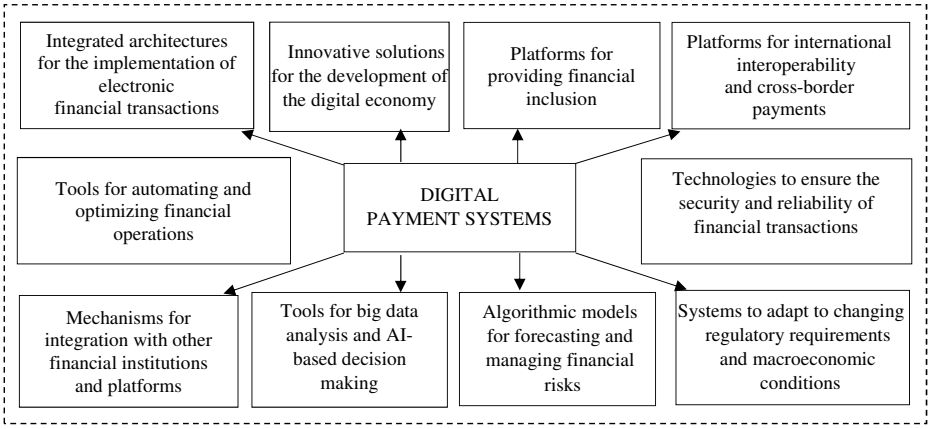

Fig. 1. Definitions of digital payment systems

Source: compiled by the author on the basis of [7; 8; 11]

Digital payment systems demonstrate the potential for self-learning and the evolution of algorithmic methods for solving problems arising in the process of transaction processing [2]. The analytical capabilities of the systems allow processing large-scale data sets, making informed decisions based on the analysis of internal and external factors, ensuring the adaptability and security of operations in real time. This helps to ensure the stability and efficiency of financial processes even in a highly volatile environment.

In a narrow context, digital payment systems specialize in performing discrete tasks, such as processing electronic payments, making instant money transfers, and integrating with other financial instruments and payment platforms [4]. They ensure high functionality and continuity of payment transactions within the established regulatory requirements and technical specifications.

The development of the national payment infrastructure in Ukraine gained a new impetus with the adoption of the Law on Payment Services [5]. This legal act has become fundamental for regulating key aspects of money circulation and payment services. The law systematizes the procedure for performing payment transactions, classifies payment services, establishes criteria for authorizing payment service providers, defines the principles of payment systems, and regulates the issuance and use of electronic and digital money. In addition, the law establishes the rights, obligations and responsibilities of payment market participants, as well as mechanisms for supervising the activities of payment service providers and oversight of payment mechanisms. This legislative act has

ushered in a new era in the regulation of payment systems in Ukraine, facilitating their modernization and integration into the global financial space.

According to the current legislation of Ukraine, a payment system is defined as a set of formalized arrangements and standardized rules governing the processing of payment transactions, clearing and settlement between its participants. According to Article 71 of the Law of Ukraine On Payment Services, payment systems are classified according to the following criteria [5]. By territorial scope: domestic and international. By significance: systemically important – affecting the financial stability of the state; important – affecting the national payment infrastructure.

The National Bank of Ukraine (NBU) supervises payment systems using a two-tier classification that takes into account the volume of transactions of system participants, the number of payment service providers and issuers of electronic money, and the territory of the payment system. Since 2022, the only systemically important payment system in Ukraine is the NBU's Electronic Payment System (EPS). Important payment systems include:

– international – MasterCard, Visa (USA);

– domestic – NovaPay, Financial world, Postal transfer (Ukraine).

The main participants in the payment infrastructure are: PrivatBank, FC Kontraktovyi Dim, Ukrainian Processing Center, TAS LINK, AC DISI PROCESSING. Ukraine has a number of domestic payment systems, in particular: EasyPay – electronic payment and wallet service; LiqPay (PrivatBank) – online transfer and payment system for goods; NovaPay – a payment system linked to the Nova Poshta logistics network; National Retail Payment System Prostir – a state payment system with a high level of security for corporate users.

In the Ukrainian market, the key international payment systems are: Visa – a global system with high security standards; MasterCard – introduces digital technologies, in particular through Crypto Card Program; Payeer, Wise, PayPal – services for international payments and money transfers.

The trend of digital transformation of the financial sector is driving the active development of a number of innovative technologies and services that help improve the efficiency, accessibility and security of financial transactions:

1. Mobile payment applications (Google Pay, Apple Pay, Samsung Pay), which provide contactless, fast and convenient transactions, are actively integrated into global financial systems and are popular in Ukraine, in particular among smartphone users.

2. Electronic wallets and online payment services (PayPal, Wise, Payoneer, Revolut, EasyPay, LiqPay), that help to expand the possibilities of international and domestic payments. At that time, such individual services as PayPal, have been widely used in Ukraine, others, such as Revolut or Wise, have certain limitations at the level of local regulation and access for Ukrainian users.

3. Blockchain technologies and decentralized payment solutions, such as Ripple, Stellar, Binance Pay, as well as digital currencies of central banks (CBDC), Ensure increased transparency, security and speed of financial transactions. Despite the growing interest in cryptocurrencies and blockchain solutions in Ukraine, the introduction of such technologies is limited by legal and regulatory aspects. The possibility of introducing CBDC is currently being discussed within the National Bank of Ukraine. These trends reflect the global processes of digital transformation of the financial sector.

However, for Ukraine, the key aspect is regulatory and technological adaptation to global changes. In this context, blockchain technologies that open up new horizons for financial transactions are attracting special attention. In particular, the technology Ripple Labs Inc. provides instant and efficient cross-currency interbank settlements, significantly minimizing time and transaction costs. The financial technology market also offers a variety of blockchain solutions, including public and private blockchain systems, each with unique advantages:

– public blockchain systems are characterized by a high degree of decentralization, transparency and openness of data, thereby ensuring increased security and trust;

– private blockchain systems increase confidentiality and control over participants, which is important for corporate users and financial institutions that work with sensitive information.

Thus, adapting to these technological innovations is an important factor for the development of a competitive and efficient payment infrastructure in Ukraine.

In order to detail the architecture of the payment system, Fig. 2 presents a structural and functional diagram illustrating the interaction of the institutional, infrastructure, and economic blocks. This model demonstrates the key components and their interrelationships that ensure the stability and efficiency of the payment system in a modern economy.

The payment system model is a complex integrated structure consisting of three main blocks: institutional and legal, infrastructure and technology, and economic, each of which performs specific functions and is critical to ensuring continuous, stable, and efficient payment transactions and maintaining financial stability. The interaction of these blocks ensures synergy that contributes to the efficient functioning of the payment system, its security and competitiveness in the context of the dynamic globalization of economic processes that determine modern financial and economic realities.

1. The institutional and legal framework serves as the basis for legal regulation of the payment system, ensuring its stability and security through a system of laws, regulations, and international standards. It forms the legal framework for the interaction of all payment system participants and defines their rights, obligations, and liability for violations of the established rules. The key components of this block are laws, regulations, international standards (e.g., ISO 20022 for financial messages, which defines standards for the exchange of information in international payment systems), PCI DSS (standard for payment card data protection) and principles of licensing and certification of payment process participants, including financial institutions. This block develops risk control measures, in particular to prevent fraud and abuse in payment systems, and ensures that payment systems meet the requirements of regulators (e.g., the National Bank of Ukraine or the European Central Bank). One striking example is the implementation of the policy KYC (Know Your Customer), which provides customer identification to prevent money laundering.

2. The Infrastructure and Technology Block is the basis for the physical and technical functioning of the payment system, as it includes all organizations and technological tools necessary for financial transactions. Innovative payment instruments and technologies are developed and implemented within this block. The main components include central and commercial banks, payment systems (Visa, Mastercard, SWIFT), settlement centers, as well as financial technology companies that provide the latest solutions for payment transactions.

For example, the implementation of instant payment systems, such as SEPA Instant Credit Transfer in the European Economic Area and Faster Payments in the United Kingdom, provides real-time transactions, which is imperative for the functioning of the modern economy, where speed and efficiency are the dominant determinants. In addition, technologies such as blockchain, artificial intelligence, cloud computing, and API integrations greatly simplify transactions and provide enhanced security for payment systems. In the context of payment systems modernization, it is worth mentioning the implementation of instant payment systems in Ukraine integrated with mobile platforms, as well as the experimental introduction of digital currencies by central banks (CBDC), in particular the digital yuan in the PRC.

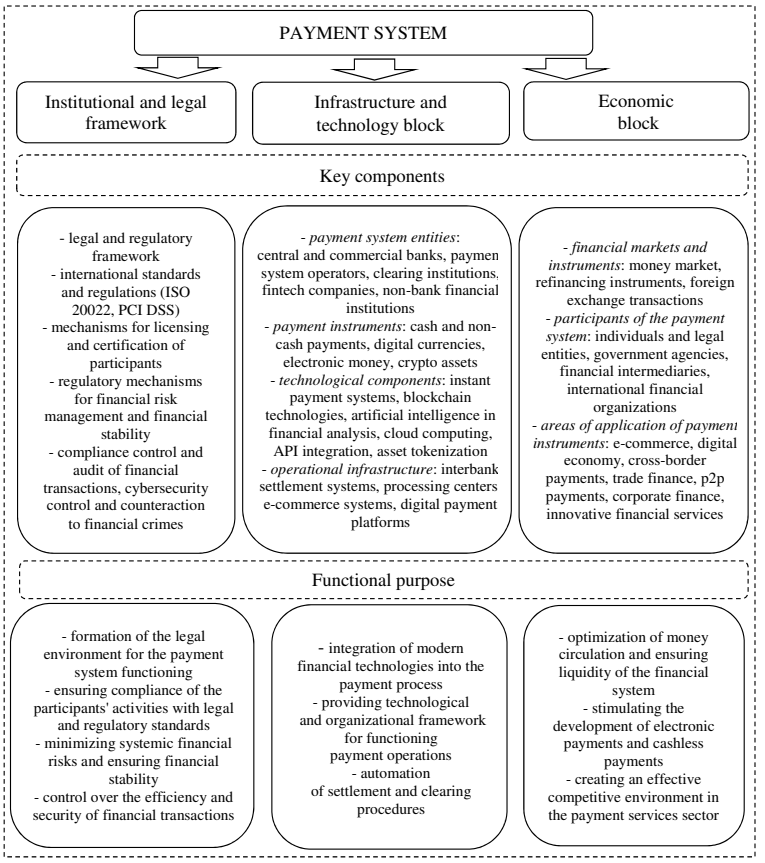

Fig. 2. Structural and functional model of the payment system

Source: compiled by the author

3. The economic block of the payment system reflects its functional role in ensuring economic processes both at the national and international levels. It defines the interaction between payment transaction entities (individuals and legal entities, government institutions, and financial intermediaries) and regulates the circulation of financial flows

through markets and instruments used to conduct money transactions. The key role in this block is played by the integration of digital technologies, in particular the development of e-commerce and financial technologies (FinTech), which contributes to the formation of new economic models and expanded access to financial services for the general population. For example, the introduction of digital banking platforms, such as Monobank in Ukraine, allows not only to simplify transactional operations but also to provide access to credit products for micro and small enterprises, which contributes to the development of entrepreneurial activity. The main functions of the economic block are:

– organization of efficient money circulation: ensuring liquidity of the financial system through optimization of interbank settlements (e.g., using the NBU's electronic payment system (EPS));

– ensuring the continuous execution of payment transactions: maintaining the stability of settlement systems, which is critical for the smooth functioning of trading platforms (e.g., Rozetka, Amazon);

– impact on the stability and development of the monetary system: creating conditions for an effective monetary policy by ensuring transparency and efficiency of payment flows (e.g., impact on the velocity of money).

Efficient organization of interbank settlements, for example, through the use of an international system SWIFT, not only increases the liquidity of financial institutions, but also minimizes transaction costs, which is an important factor for the development of international trade.

The integration of the institutional, legal, infrastructure, technological, and economic blocks is a prerequisite for ensuring the systemic integrity and homogeneous functioning of the payment system. The synergistic effect of the interaction of these blocks contributes to the achievement of operational efficiency, cybersecurity, and systemic stability of payment transactions. Such integration is a key determinant of the adaptability of national economic systems to the dynamic conditions of the globalized financial space. The cross-system interoperability of international payment systems, which minimizes transaction costs, enhances financial inclusion, and stabilizes exchange rates, is empirical evidence of the effectiveness of the integrative approach in the context of the digital economy.

Thus, ensuring systemic stability and dynamic development of the payment system is possible only if its structural components are integrated, which is the fundamental basis for the development of the digital economy, optimization of the functioning of financial markets, and ensuring their inclusiveness. Digitalization of financial services is rapidly gaining momentum in Ukraine. To analyze this trend, we present Table 1, which systematizes the key indicators of digital payment system development for 2022-2024.

The analysis of the data presented in Table 2 reveals a clear trend of progressive evolution of digital payment systems in Ukraine during 2022-2024, which reflects the global trend of digital transformation of the financial sector. In 2022, basic payment instruments such as mobile apps, payment cards, online platforms, and QR codes dominated, indicating the initial stage of digital payment development in the country.

Table 1

Dynamics of digital payment systems development in Ukraine in 2022-2024.

Indicator	Years		
	2022	2023	2024
Typology of digital payment systems	Mobile applications (Privat24, Monobank, EasyPay), payment cards (VISA, MasterCard), online payment platforms (LiqPay, PayPal), QR codes	Mobile applications (Privat24, Monobank, Revolut), contactless payment cards, QR payments, online payments, payments via messengers (Viber, Telegram)	Mobile applications with cryptocurrency integration (Revolut, Binance), payments through voice interfaces (Siri, Google Assistant), transactions using digital currencies, integration of artificial intelligence, expansion of contactless technologies, «tokenization»
Tools for automation and optimization of financial operations	NFC payments (contactless cards), mobile payment applications (Apple Pay, Google Pay)	QR codes, electronic wallets (LiqPay, WebMoney), contactless payment cards	Mobile applications with cryptocurrency functionality, transactions using digital currencies (Bitcoin, Ethereum), biometric authentication, personalized services based on AI, API development
Development of transaction cybersecurity technologies	Two-factor authentication, biometric authentication	Integration of multi-level security systems (fingerprint scanning, face recognition)	Blockchain technology, smart contracts, use of AI for fraud detection, quantum encryption, «tokenization»

However, in 2023, the range of tools will expand, including the integration of contactless technologies, messengers, and the expansion of mobile application functionality, reflecting the growing maturity of the market and adaptation to user needs. In 2024, we will see the introduction of advanced technologies such as cryptocurrencies, voice interfaces, artificial intelligence, and tokenization, which indicates the desire to create integrated and personalized payment ecosystems. The evolution of tools for automating and optimizing financial transactions can be traced from simple contactless payments (NFC) to complex systems that include biometric authentication and personalized services based on artificial intelligence, while the development of APIs facilitates the integration of various financial services. At the same time, there is a shift from basic authentication methods to multi-level security systems that include blockchain, smart contracts, and quantum encryption, and the use of artificial intelligence for fraud detection and tokenization indicates a growing focus on cybersecurity in the context of digital transformation. In general, there is a trend toward the integration of advanced technologies into digital payment systems, which helps to improve their efficiency, security, and convenience, and Ukraine is demonstrating dynamic development in the field of digital finance, which is in line with global trends.

Table 2 shows a study of the transformation of digital payment systems in Ukraine, characterized by a shift to more integrated and personalized payment ecosystems, with a focus on security, convenience, and speed of financial transactions.

Table 2

Transformation of digital payment systems in Ukraine

Type of payment system	Years		
	2022	2023	2024
Mobile payment applications (Super Apps)	Privat24, Monobank, EasyPay: basic P2P transfers, utility payments	Integration of messenger payments, crypto integration, NFC. Personalization of services	Super-applications: integration of fintech services, e-commerce, and logistics. Revolut, Wise, Crypto.com, PayPal, Google Pay, Apple Pay: integration with banks, AI for personalization, cross-platform, DeFi
QR payments (Dynamic & Static)	Static QR in retail and small business	Dynamic QR. Integration with state payment systems	International interoperability. Micropayments, loyalty programs
Contactless payment cards (Tokenized & Virtual)	VISA, MasterCard, PayPass, payWave. NFC interfaces	Tokenization. NFC extension	Virtual cards. Biometrics. Crypto cards. Transportation systems
Online payments (Digital Platforms & DeFi)	PayPal, LiqPay, WebMoney, Revolut: basic functions	E-commerce integration	Metaverse universes. DeFi protocols. CBDC
Cryptocurrency payment systems (Stablecoins & NFT)	Occasional crypto use	Stablecoins, bank integration	International crypto networks. NFT as a payment instrument
Voice payments (Voice Commerce)	Experimental projects	Integration into mobile applications	Smart devices, personalized commands
Messenger payments (Social Commerce)	Basic P2P	E-commerce integration	Social commerce, bots, fintech services

In the context of studying the development of digital payment systems in Ukraine, it is necessary to take into account global trends and international experience. To identify the key factors that influence the formation of a national strategy for the digital transformation of the financial sector, as well as to assess potential risks and opportunities, it is advisable to conduct a comparative analysis of the development of digital payment systems in countries with different levels of economic development and regulatory models. Table 3 presents a comparative analysis of the development of digital payment systems in the world for the period 2022-2024, which allows us to identify key trends in the introduction of central bank digital currencies (CBDCs) and other digital payment innovations, as well as to determine their potential impact on national financial ecosystems.

The results of the comparative analysis demonstrate that countries around the world are actively implementing digital payment systems, including CBDCs, to modernize the financial sector and increase financial inclusion. At the same time, each country chooses an individual approach, taking into account its own economic, regulatory, and technological characteristics. The key areas of development include improving cybersecurity,

ensuring interoperability between different payment systems, and developing effective strategies to attract a wide range of users. In the context of Ukraine's integration into the European financial area and given the geopolitical challenges, developing a comprehensive strategy for the digital transformation of the financial sector is a top priority. This strategy should be based on a thorough analysis of international experience, adapted to specific national needs. Key priorities include strengthening cybersecurity, developing digital infrastructure, ensuring access to digital financial services, and assessing the impact of digital currencies on monetary and financial stability.

Table 3

Comparative analysis of the development of digital payment systems in the world in 2022-2024.

Country	Feature
China	Active expansion of the digital CNY (e-CNY) ecosystem to integrate into retail, public sector, and interbank settlements. The steady growth in transaction volumes demonstrates the successful adaptation of CBDC in the national financial infrastructure. Strengthened regulatory oversight promotes standardization and security of operations.
Nigeria	Gradual increase of the eNaira user base aimed at increasing the level of financial inclusion. The Central Bank of Nigeria is focusing on infrastructure development, increasing digital literacy, and creating incentives for the use of CBDCs in remote regions.
Sweden	Continuing pilot studies of the digital krona (e-krona) with a focus on assessing technological integration, scalability, and cybersecurity. The Riksbank of Sweden is studying the potential risks and benefits of implementing CBDC to maintain the financial stability and efficiency of the payment system.
India	Active integration of the digital rupee (CBDC-R) with national payment platforms to improve accessibility and efficiency of transactions. The Reserve Bank of India is focusing on infrastructure development, increasing digital literacy, and creating incentives for the use of CBDC in remote regions.
Brazil	Completion of the Digital Real pilot project and preparation for its public launch. The Central Bank of Brazil plans to gradually introduce CBDC, focusing on modernizing the payment infrastructure, expanding financial inclusion, and ensuring cybersecurity.
Turkey	Gradual expansion of the use of the digital lira as part of a pilot project. The Central Bank of Turkey is conducting a study on the functionality, cybersecurity, and potential regulatory challenges associated with scaling CBDCs.
Japan	Completion of the initial stage of research and preparation for pilot testing of the digital yen. The Bank of Japan is focusing on studying the technical, operational, and regulatory aspects of implementing CBDC in a highly developed financial system, taking into account the need to ensure cybersecurity and interoperability.
Thailand	Conducting large-scale testing of the digital bot with the participation of a wide range of users. The Bank of Thailand collects data on the usability, efficiency, and impact of CBDCs on the country's economic dynamics, analyzing potential risks and benefits.
Ukraine	Continuation of the electronic hryvnia (e-hryvnia) pilot project on the Stellar platform. The National Bank of Ukraine is studying the technical, economic, and regulatory aspects of CBDC, assessing its potential to ensure financial stability and inclusion in the context of martial law and post-war recovery.
United Kingdom	Active dialog with the public and financial institutions on the prospects for the introduction of the digital pound (Britcoin). The Bank of England is analyzing the macroeconomic implications of the introduction of CBDC, including its impact on monetary policy, the banking sector, and financial stability, taking into account cybersecurity and data protection issues.

In order to assess the potential impact of digital payment technologies on the financial sector of Ukraine, a comprehensive analysis of international trends is necessary. The comparative dynamics of key indicators reflecting the pace of implementation of innovative digital payment technologies in the world for the period of 2022-2024 is shown in Fig. 3.

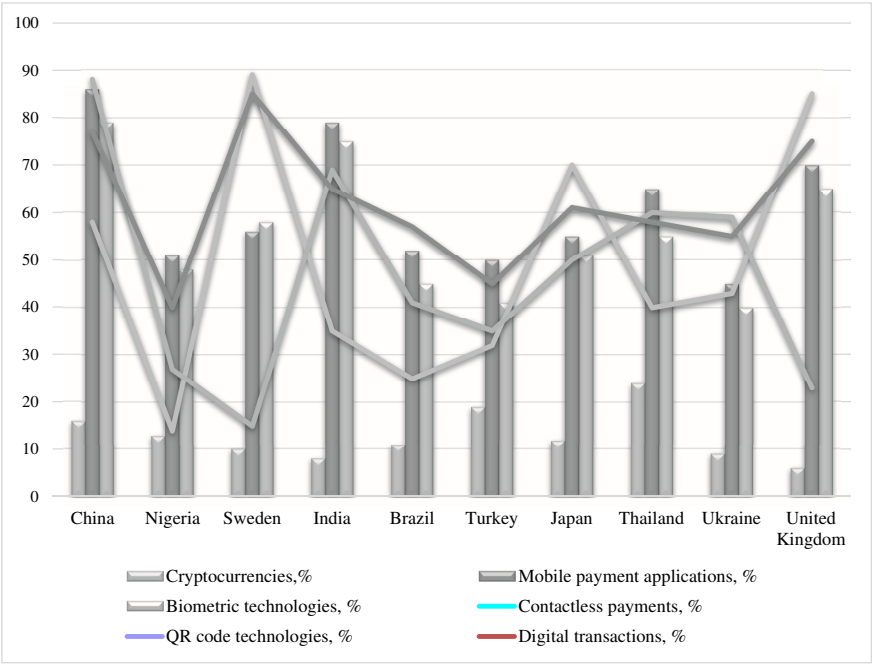

Fig. 3 Comparative dynamics of key indicators of digital payment technologies in the financial sector in the countries of the world for 2022-2024

Fig. 3 testifies a comparison of the dynamics of digital payment system adoption in different countries by key indicators: the use of cryptocurrencies, mobile payment applications, biometric technologies, contactless payments, QR codes, and digital transactions. The results of the study indicate a significant differentiation in the processes of digital transformation of the financial sector, which is due to the influence of macroeconomic, technological and regulatory factors that determine the speed and depth of integration of digital payment solutions into national financial systems. An international comparison of the level of development of digital payment technologies shows a variety of digitalization strategies, which reflects the specifics of the financial architecture and the degree of capacity of economies to implement financial technologies on a large scale. The leaders in digital payments are China and India, which demonstrate a high level of penetration of mobile payment services, QR codes, and biometric identification technologies. This is due to a number of factors, including government initiatives to create a cashless economy, a developed financial ecosystem, and high digital literacy of the population.

Countries with developed financial infrastructure, such as Sweden and the United Kingdom, are leading the way in contactless payments and digital transactions. This dynamic is the result of comprehensive financial policies to promote cashless payments, a high level of financial inclusion, and the banking sector's adaptability to technological change. At the same time,

emerging economies such as Nigeria and Brazil demonstrate significant potential in mobile payments and digital transactions, but their further development is limited by a lack of financial inclusion, weak institutional support, and insufficient payment infrastructure.

A number of countries are actively using cryptocurrencies as an alternative financial instrument due to the high level of devaluation risks, volatility of national currencies, and limited access to traditional banking services. Japan, despite its traditional focus on cash payments, is showing a gradual increase in the share of contactless payments, which indicates that financial institutions are adapting to changes in the payment behavior of the population. Despite geopolitical risks, Ukraine is actively adopting digital payment technologies, as evidenced by the growing use of QR codes and mobile payment platforms. This indicates a high level of adaptability of the banking system and financial institutions to changes in the global financial environment.

Thus, the analysis of the level of adoption of digital payment systems in different countries has revealed significant differences in the pace of their development, which is due to the level of financial inclusion, technological capacity, and regulatory support. Countries with developed financial markets demonstrate a high level of integration of digital payment technologies, which increases the efficiency of financial transactions and reduces transaction costs. At the same time, emerging economies face barriers in the form of low payment infrastructure, limited access to banking services, and insufficient digital literacy. Despite the challenging external environment, Ukraine is making progress in the digital transformation of its financial sector, which opens up new opportunities to strengthen its position in the global financial space. The further development of digital payment technologies requires improving the regulatory environment, expanding financial inclusion, and integrating innovative financial instruments, which will increase the competitiveness of the national economy in the context of digital globalization.

5. Conclusions from this research and prospects for further exploration in this direction. Based on the results of the study of theoretical aspects and pragmatic approaches in the context of Ukrainian realities and global trends in the adaptation of digital payment systems to the financial sector of the State in the process of digitalization of the financial system, the following can be stated:

1. In today's economic environment, DPS play a critical role in the transformation of Ukraine's financial sector by automating and optimizing transaction processes. They facilitate the analysis of massive financial data, ensuring fast and efficient execution of transactions. The use of DPS in risk management allows for predictive analysis of anomalies and minimization of potential financial risks. DPSs stimulate the development of personalized financial products and services, improving the quality of customer service. The introduction of DPS promotes innovation in the financial sector and improves the operational efficiency of financial institutions.

2. DPS are complex integrated architectural systems that enable electronic financial transactions. They integrate a variety of technological tools, including mobile applications, QR codes, contactless payment instruments, online platforms, and cryptocurrencies, to form an efficient and reliable payment infrastructure.

3. The evolution of payment systems has gone through three fundamental stages: the formation of paper-based instruments, the introduction of electronic payment instruments, and the current phase of intensive digitalization. The emergence of powerful computing resources, the development of the Internet, and the spread of mobile technologies have become catalysts for the DPS, providing conditions for their practical application in the financial sector.

4. Technologies DPS are a set of algorithmic methods, protocols, and platforms that enable electronic financial transactions. They are used in a wide range of industries, from retail to financial services, and are characterized by a high level of speed, security and convenience.

5. Digital payment systems in the financial sector are a reflection of the modern technological paradigm, which involves the use of various tools to automate and optimize financial processes, including investment, banking, and insurance operations.

6. Among technologies DPS the most widespread in Ukraine are mobile payment applications, QR payments, contactless cards, online platforms, and cryptocurrencies. DPS effectively interact with such modern technologies as blockchain, biometric authentication, artificial intelligence, and cloud computing.

7. Countries around the world are actively implementing DPS, including central bank digital currencies (CBDCs), to modernize the financial sector and increase financial inclusion. Each country chooses an individual strategy, taking into account its own economic, regulatory and technological characteristics. The key areas of development include improving cybersecurity, ensuring interoperability between different payment systems, and developing effective mechanisms for attracting a wide range of users.

8. Use DPS in the financial sector of Ukraine is accompanied by certain risks, such as the possibility of system failures, threats to information security, and loss of control over automated processes. An additional risk is the possibility of using DPS for illegitimate purposes, including fraud and cyberattacks. To minimize the risks associated with the use of DPS, financial institutions should introduce effective control and monitoring systems, conduct regular checks on the security and reliability of algorithms, and improve staff skills.

9. Development DPS in the financial sector can have positive consequences, such as increasing the efficiency of financial services, minimizing risks, and optimizing decision-making processes. However, the development of DPS may also have negative consequences, including increased cyber threats, uncontrolled operations, and increased inequality of access to financial services. Therefore, it is necessary to ensure effective regulatory oversight and ethical compliance in the use of DPS.

10. Leading Ukrainian and international companies are actively implementing DPS to solve various tasks in the financial sector related to lending, investing, financial management and insurance. This helps to implement innovative financial solutions for clients, introduce new approaches to data processing, risk analysis, and customer relations. Their growth and innovation make the financial sector dynamic and better able to meet the needs of the modern market.

11. DPS as a driver of development and a factor of modernization, transform the way financial services are provided, and accelerate decision-making processes, minimize risks and provide a personalized approach to clients. Usage DPS opens up new opportunities for process automation, big data analysis, and innovative product development, which contributes to the development of a competitive financial sector.

Further research is seen in expanding the research paradigm to the following areas: an in-depth study of the socio-economic impact of the introduction of digital payment systems, including a detailed analysis of their impact on the structure of the economy and the development of small and medium-sized businesses; a comprehensive study of the ethical aspects of the use of DPS, with a special emphasis on privacy, personal data protection and prevention of discrimination; systematic analysis of technological aspects of implementation DPS, including

assessing the effectiveness of artificial intelligence, as well as exploring the possibilities of using the latest technologies to improve the security and reliability of payment systems.

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