The use of innovative blockchain technology in the public finances of Ukraine in the conditions of the formation of the digital economy

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Abstract
The article reveals the essence of innovative blockchain technology and the features of its application in the management of financial processes in the country. The positive effects of the introduction of this technology in the field of public finance have been determined, in particular: it allows to improve the quality of control over monetary transactions, ensures information transparency and security of financial relations, reduces or eliminates transaction costs, creates a high level of trust in the participants of agreements, provides quick access to the database on financial transactions, etc.

The following promising areas of application of blockchain technology in the public finance system are substantiated: the mechanism of public procurement, management of state investments and assets, improvement of state registers, public administration, state financial control, payment of certain taxes and fees, increase in the level of financial security of the country.

The use of blockchain technology in public administration for the organization of electronic document flow and the formation of various registers to overcome corruption is argued. The prospects for the introduction of this platform in the field of state financial control are outlined to increase its transparency, and effectiveness and increase public trust in government institutions.

It is proposed to expand the application of blockchain technology in the domestic taxation system, in particular, to improve the mechanism of value-added tax, which will increase the effectiveness of the fight against the use of various schemes for evading its payment. To create a favorable investment climate and attract capital investments in the country's strategic industries, the expediency of introducing the blockchain platform into the system of protection of foreign direct investments in the national economy has been substantiated.

Keywords: blockchain, fast transactions, financial transactions, trust, financial security, transaction costs, public administration, public financial control, taxation system, public investment, public finance.

Introduction
Reforming the national economic system of Ukraine today takes place under the conditions of the increased influence of world globalization and the rapid development of...
information technologies, which initiated a new era of development of the digital economy and significantly increased the capitalization of the international financial market. Modern innovative digital technologies make it possible to speed up the flow of financial transactions, significantly increase the level of security of financial transactions and significantly increase trust in financial institutions and the state in general.

Today, blockchain is a leading information technology, the use of which in key areas of the financial and credit system will enable its main subjects to mobilize available financial resources, significantly increase the efficiency of their use, conduct constant monitoring of financial transactions, and conduct operational control over the spending of funds. This revolutionary technology is now being actively implemented in practice in the financial sphere of the countries of the European Union and its prospects for increasing the efficiency of the financial system are constantly being substantiated. Given Ukraine's adopted course towards European integration, the domestic government and business entities must take into account the possibilities of this technology, taking into account the peculiarities of the functioning of the domestic economy and considering its significant spread in the private sector.

Ukraine has great potential for introducing this technology into the economy. It is especially needed in the field of public finance, as blockchain will help to overcome corruption in the budget sphere, increase the competitiveness of the domestic tax system, increase the trust of business entities and the population in state institutions, reduce transaction costs for conducting financial operations in the government sector, and increase the efficiency of public finance management and ensure the growth of the level of economic security of Ukraine in general. This innovative technology has significant prospects for use in the budget system, taxation, compulsory insurance, financial management of state enterprises, etc., and is capable of changing the sectoral structure of the gross domestic product.

**Material and methods**


Taking into account the significant volume of work on the use of blockchain technology in the financial sphere, today there remain many questions and problems related to the realization of its potential in the chain of public finance. Special attention is required to study the possibilities and specifics of using this platform in the field of public financial management, organization of state financial control, taxation of business entities and the population, etc.

The concept and methodology of the research are based on the fundamental provisions of modern economic theories. In the scientific work, the methods of analysis are applied (to research directions for the use of blockchain information technology in the field of public finance in the context of the strengthening of European integration processes in Ukraine); dialectical method of scientific knowledge of social phenomena; search bibliographic method; general scientific and special methods of cognition: synthesis (to find opportunities for the implementation of blockchain technologies in the conditions of the formation of a digital economy); dogmatic (allowed to single out the purpose of blockchain in public finance); generalization (applied to
form proposals for the application of the main prospective areas of public finance for the use of blockchain); historical and legal method (made it possible to analyze the formation and development of the use of blockchain in the world and Ukraine).

**Results and discussion**

Since Ukraine gained independence, the government has always had to solve several problems in the field of financial system development, which relate to overcoming the imbalance of the domestic economy, increasing the level of debt security, increasing risks in the production sector, reducing the financial potential of the economic system, carrying out an effective reform of the decentralization of the budget system, increasing efficient use of state financial resources. Solving these problems will ensure stable socio-economic development of Ukraine, increase the welfare of the population and require the use of innovative technologies in the management of the financial system, the key link of which is state finances. Blockchain may well be used for effective management of this link and will become a guarantee of its successful reformation.

The economic essence of blockchain technology is the application of the latest tool for the systematization of information data, which is based on a block into which relevant information is entered. This technology consists of a set of information blocks that do not have a specific numbering, but they are built taking into account the timeline (a new block is introduced taking into account the existing ones and their time sequence). A significant advantage of the blockchain is the impossibility of changing one block without changing the others, which greatly complicates unauthorized access since it is possible to adjust records only with the informed consent of all participants. This technology makes it possible to track the sequence of entering information into blocks throughout the entire period and makes it impossible to make changes in past periods, which significantly increases the level of security of such records.

The use of blockchain in the management of financial processes in the state will have several positive effects, in particular:

- facilitation of monitoring of financial transactions, as it makes it impossible to change past data contained in the data chain;
- makes it possible to control the implementation and increases the information transparency of operations due to the use of single-stage networks;
- significantly increases the degree of security of financial transactions because it stores the last entered information in all elements of the information system;
- application of the principle of mutual agreement, since a high level of trust of the participants, is ensured by the rules embedded in the mechanism, the violation of which is made impossible by the elements of the computer network as soon as it starts;
- quick access and use of programs and codes entered into the system to rationalize financial transactions and form methodological guidelines for the implementation of various types of transactions;
- aggregated formation of a much wider database of completed financial transactions.

The determined positive features of blockchain application in the financial sphere are presented in fig. 1.

The key positive side of the blockchain is that it significantly increases transparency, speed, and security, and reduces the costs of implementing financial transactions. The strategic direction of the use of this technology is the financial and credit system of the country, which will create prerequisites for the formation of effective and transparent mechanisms to identify and account for financial transactions, increasing the overall effectiveness of the economic activity. This will be possible thanks to a significant reduction in the level of costs for conducting financial transactions since the blockchain does not require the involvement of intermediaries and significantly reduces the risks associated with the violation of terms and
non-fulfillment of contracts by counterparties. There is an assumption that under the conditions of the introduction of this technology by the United States into the country’s banking system in 2008, with a high probability it would be possible to prevent the emergence of a global financial crisis and avoid significant economic losses and a slowdown in development.

### Figure 1. Advantages of implementing blockchain technology in the financial sphere

Source: suggested by the author

In general, it can be stated that blockchain technology is a decentralized system of forming a database of relevant operations, which are stored in information blocks that are
interconnected in time and are located on different computers of a single network. These blocks form a single sequence, which is determined by a special calculation algorithm. Such complex chains form high protection of the system against changes to the database since they are copied by many computers located in different countries, which, in turn, makes hacking impossible. Blockchain is usually equated with Bitcoin, as it is based on this technology (as in other similar cryptocurrencies). It is often defined as a special electronic register of operations, contracts, and agreements between counterparties in various types of economic activity. The mechanism of operation of the blockchain technology is highlighted using the diagram in fig. 2.

At the current stage of development of the world economy, blockchain technology has great prospects for implementation or is already used in the following areas: cryptocurrencies and payment systems; purchase and sale of instruments and conclusion of quick transactions on the financial market; digitization of state finances, public administration sector, socio-cultural direction, etc.

We will reveal the main promising areas of public finance for the use of blockchain shortly in Ukraine.

I. Improvement of the public procurement mechanism. This electronic mechanism is quite cumbersome, as it contains a large number of counterparties and cooperates with many types of economic activity that produce goods and services that must be purchased by the state. The functioning of such a system is defined in regulatory documents and corresponds to the principles of equality of all bidders, transparency, and public information.

International experience has proven the high effectiveness of transparent competitive procurement as an effective way of rationalizing government procurement and preventing various types of abuses during this process. A number of the world’s leading countries already

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Figure 2. A simplified algorithm for the operation of blockchain technology

Source: (How Blockchain will replace banks and intermediaries)
use blockchain in the field of government e-procurement, with the help of which a tender platform was developed, which significantly reduced the costs of conducting auctions and significantly increased the level of system security, that is, it made it impossible to interfere in the system and carry out cyber-attacks. Blockchain in this area makes it possible to significantly facilitate registration and participation in auctions, automatically form a database of participants, create their electronic accounts and a reliable degree of protection, minimize current costs, increase efficiency, and enable public control and security. Blockchain helps to quickly build a database of market offers for relevant goods and services for which a tender will be announced, and the use of artificial intelligence will help to make the right decision on procurement.

II. Management of public investments. The basis of the success of any investment project is change and configuration management, project document flow, contract and supply management, and project budget management with the function of aggregation by management levels (portfolio, government program). The management of the investment project involves its implementation within the framework of stipulated contractual relations, for the implementation of which smart contracts placed in the blockchain ecosystem can be implemented.

III. Improvement of keeping state registers, and management of state assets. Implementation of the task of «expanding the available information on the balance sheet of the public sector with an indication of all liabilities and assets, including land and real estate, their condition, level of wear and tear and value, as well as increasing the level of availability of such information for financial risk management and its use in budget planning», is also possible thanks to the use of blockchain technology.

Trust is a factor that determines the level of transaction costs in the economic system, which ultimately determines the effectiveness of business structures, households, and the state, that is, the economy in general. In countries characterized by a low level of trust in government institutions and a significant volume of the shadow economy, it is proposed to introduce innovative technologies in the management of public finances, the main one of which is the blockchain. It is based on a platform that makes it possible to significantly increase the level of trust in the country’s economic system. Blockchain is an innovative information technology that enables the exchange of data of any kind between participants without requiring a high level of trust between them. This is achieved due to the permanence of already made records and the lack of permission to change them both for a specific participant and their association. Blockchain makes it possible to conduct direct financial transactions between counterparties without the need to create a central data archive and the participation of any intermediaries to obtain certain guarantees of transaction execution.

The high security of financial transactions on the blockchain platform is ensured by electronic signatures – a cryptographic mechanism that includes several keys – personal and general (public). The payer encrypts his payment (an entry is made in the system that confirms that he owns a certain amount of funds) with a private key and sends it to the seller or buyer, who, using the common key received at the same time as the entry, unzips the payment and it is stored in his account. At the same time, this operation is recorded in the common chain (blockchain), so each of its participants will know about the transfer of a specific amount as payment from one participant to another. This new record is encrypted as a special block of information and added to the public chain, which also cannot be changed.

The level of trust in the conditions of using blockchain in public finance increases due to the ability to ensure reliable verification of property and capital, preservation of information about transactions, reliable data storage, and cost reduction. Let’s evaluate each of these advantages of using blockchain technology.
1. **Verification of assets.** It consists in confirming the counterparty’s ownership rights to the specific assets it disposes of (buying and selling, investing, leasing, renting, etc.). Under normal conditions, this is a complex and cumbersome procedure that requires the involvement of a large number of third-party participants, while the blockchain makes it possible to significantly simplify it with the help of a consensus mechanism. It consists of the agreement of all blockchain participants that the specified asset belongs to a specific person who is its participant. This agreement is ensured by the distribution of information about assets and transactions with them among all participants, each of whom has it in full. At the same time, none of them will ever be able to change it, which creates protection against falsification.

2. **Keeping records of operations.** The financial sector bears significant costs, which are associated with the low quality of information about the client and the impossibility of sharing it, the difficulty in achieving international standards for personal identification, the lack of effective tools for the formation of data placed in various information bases, etc. The use of blockchain technology makes it possible to overcome the identified problems because there is a technical possibility of their safe storage in the formed array, the access, and level of protection which is determined by the owner (for example, the Pension Fund of Ukraine, the National Bank of Ukraine). These data cannot be falsified, which is a guarantee of complete trust between the client and the state financial institution. The banking blockchain enables the central bank to transparently audit the activities of financial institutions and identify dubious transactions, which will significantly increase the stability of the national banking system and the functioning of depository institutions as subjects of primary financial monitoring in Ukraine.

Similar to the banking sector, blockchain is being used in exchange activities, which will significantly help the government to develop the government securities market and increase the level of public trust in them.

3. **Data security.** Consumers of services constantly think about the security of their information in the process of cooperation with financial institutions, which must also conduct their activities transparently. This creates significant conflicts in this area, as clients of financial institutions always want to maintain anonymity and close access to data about their operations, while the latter is obliged to report to regulatory authorities and publish data on performance. Blockchain makes it possible to meet both of these needs surprisingly. The first is achieved with the help of reliable protection of personal data, and the distribution of the information base and the impossibility of its falsification ensures the need for transparency of records.

4. **Reduction of transaction costs.** The use of information technologies in the field of public finance and the financial system in general, the use of the Internet, and making payments online significantly lowers the cost of financial services and increases the degree of competition in the market. Financial institutions must constantly innovate to reduce transaction costs. Blockchain is defined as a universal platform, the use of which reduces the cost of clearing payment systems, and insurance and reduces the level of operational risks. Thus, under the conditions of settlements between banking institutions, clearing centers are involved, while the blockchain makes it possible to use direct payments and thereby reduce own costs. It is worth noting that the use of blockchain technology helps to reduce the costs of conducting financial transactions in the long term. However, in the short- and medium-term period, they will show an upward trend, as it will be necessary to invest funds in the development of information infrastructure on the blockchain platform.

Blockchain technology has great prospects for application in the financial sphere, so in scientific literature, it is usually compared to a giant electronic ledger that can contain, store and group any assets that can be represented in monetary form. The economic content of the
use of blockchain in data management in public registers is highlighted in the construction of a comprehensive system at the local, state, or international level for a specific register (land, real estate, and other assets). On this platform, its participants will be able to enter data on tangible and intangible assets, declare the directions of their use and monitor the change of owners, sales, and other use. This technology will help to completely transform the public register into an electronic form, which will contribute to the significant facilitation of database management. It leads to a unified form of data exchange based on quick agreements (smart contracts), which make it easy and understandable to use and does not require additional knowledge. A significant number of scientists and practitioners predict shortly the replacement of the standard management system of public registers with a blockchain platform, will contribute to a significant reduction in the cost of public services in the field of property rights registration, as it will not require the involvement of legal intermediaries. Today, there is an opinion that blockchain technology can be adapted to any financial activity related to accounting and registration of information (deals), purchase and sale, or transfer of ownership of tangible and intangible assets, and financial instruments. In addition, the blockchain platform makes it possible to attract a large number of counterparties regardless of their territorial affiliation and legal status, which creates prerequisites for the transformation of the state management system in the long term.

The key areas of public administration in which it is appropriate to use the blockchain platform are: public administration, in which the introduction of this platform will help to form decentralized government databases (registers) of land, water, forest resources, tangible and intangible assets and to determine their owners (for this purpose, they will form an extremely large database, which will become the basis of effective and transparent management of state property); organization of digital circulation of documents at centralized and decentralized levels; conducting an audit of the government’s purchase of goods or services, of product deliveries; protection of intellectual property rights through the conclusion of quick agreements; the agricultural sphere (formation of the animal registration register, which will facilitate tracking of the passage of manufactured products from the agricultural enterprise to the final consumer); energy industry – with the aim of optimal redirection of excess electricity by system participants; banking (accounting and formation of data on financial guarantees, etc.); health care – formation and analysis of medical databases and registers of patient documents.

The Cabinet of Ministers of Ukraine also has its interests in the field of using blockchain technology in the state management mechanism. Starting in 2017, an agreement was signed with the company BitFury regarding cooperation in this sector. This contract contains the prospect of transformation of all state digital information to the requirements of the blockchain system. It was proposed to implement this platform in the sphere of keeping government registers, social services, law enforcement agencies, medicine, and domestic energy. Blockchain will create prerequisites for the control bodies of Ukraine to carry out constant monitoring of the state of state property, holding various tenders and transferring it to private use. It was also proposed to use the blockchain system in the exchange trade of confiscated property to prevent corruption, falsification, and change of data in the registers in favor of certain persons.

It is worth noting that today our state has declared its intentions to use this innovative platform, which is evidenced by its use in the mechanism of trading state assets, conducting property auctions, forming the land cadastre, and introducing it as the basis of the electronic system of local self-government elections.

Blockchain technology, which is used in various branches of the financial system, has become widely used, therefore its
implementation in the sphere of state financial control in Ukraine is relevant today, as this platform will help to eliminate existing omissions in this sphere, increase its transparency and increase the level of public trust in state institutions. However, in the conditions of its implementation in Ukraine, it is necessary to form methodological and legal support and to adapt the methods of planning and documenting the results of inspections and audits in the state financial control system to blockchain.

Ignoring achievements in the field of information technologies and further solving existing problems using outdated approaches and methods will not increase the quality of control and will not contribute to the approved European integration course of Ukraine. Given the above, today it is necessary to investigate the positive and negative aspects of the use of this innovative technology in the field of government financial control, taking into account the experience of the developed countries of the world. The basis for this is the effective application of blockchain in related sectors of public finance and significant opportunities in the field of security, transparency, and cost reduction.

It is worth noting that the implementation of blockchain in this area of public finance is also caused by significant corruption problems in Ukraine and the need to overcome abuse of office, increase the efficiency of spending budget funds and avoid falsification of documents, etc. Foreign experience proves that this technology has significant opportunities for solving the outlined financial problems. In addition, the decentralization of information on this platform will significantly reduce the volume of audit procedures that are associated with determining the level of reliability of records (data), since all members of the network have the same access to the database.

It is worth noting that the application of blockchain technology in the mechanism of state financial control will enable:

- truthfully calculate in real time the norms of state financial resources in the process of forming forecast budget parameters, and later monitor the directions and volumes of their use, taking into account the requirements of various programs;
- in the online mode (a sequence of quick deals) to carry out constant control over the compliance with the requirements of the budget code and other normative legal acts in this area at all levels of the budget system in the process of government procurement;
- organize the electronic circulation of documents (budget accounting and reporting, development of estimates of budget institutions, and other accompanying documentation) at all stages of the budget process;
- implement interactive monitoring of the correctness of budget accounting and reporting, state property management, monitor the functioning of budget organizations and institutions, monitor the correction of recorded violations, etc.

To improve the government control system, it is necessary to apply effective innovative technologies and methods in combination with international standards in this area, which will ensure a reduction in the risk of violations of budget legislation and abuses in the chain of public finances. The introduction of blockchain technology into the system of state financial control, taking into account the domestic methodology of normative legal support in this area, will help to decentralize it, increase security and information transparency, and improve efficiency in general. Blockchain makes it possible to eliminate the human factor in the process of concluding agreements and conducting control, which significantly reduces the likelihood of errors and violations, and also creates important prerequisites for overcoming abuse and corruption in the process of forming, distributing, and using the state’s financial resources.

Today, blockchain technology is developing very strongly in the world, and its application is
taking place in almost all parts of the financial system. The governments of many EU countries are currently testing this technology in the field of taxation and hope to get several effects from its introduction: a reduction in the amount of tax evasion, an increase in the effectiveness of the mechanism for implementing control in the tax field, an increase in the competitiveness of national economies, etc. With the help of blockchain, the European Union wants to create prerequisites for the cooperation of public finance management bodies with the field of information technologies to improve the electronic circulation of documents between states, the formation of significant databases on the payment of mandatory payments, and the accounting of payers, and the complete overcoming of corruption. Taking into account the European integration aspirations, Ukraine must also assess the potential of the blockchain platform for its introduction into the tax system, which will help increase the level of trust in fiscal authorities, form a high level of tax culture, and reduce the size of the shadow sector of the national economy.

It is worth noting that the use of advanced technologies in the field of taxation today is usually available only to the developed countries of the world since they are expensive and require the presence of highly qualified specialists, which is also quite expensive for the state. However, the potential of using blockchain is growing significantly every day, so the government of Ukraine is considering the possibility of introducing this platform in the field of mandatory payment administration.

The key direction of the digitalization of the tax system of Ukraine is the application of the blockchain platform in the process of making mandatory payments, in particular value-added tax. Proceeds from this tax form the lion’s share of state revenues, however, as a result of significant abuses in the field of its administration, the state budget loses large volumes of revenues, which annually reach about 30 billion UAH. The evasion of payment of this tax occurs with the use of virtual firms, winding up of budget compensation, reducing the number of liabilities, and applying a scheme tax on added value.

The positive sides of value-added tax settlement using blockchain technology are high resistance of the administration mechanism to various errors and failures, which is ensured by the decentralization of information; minimization of the processing time of fiscal invoices without the need for the tax service to form a computer network with significant capacity; timely bringing the digital information of the domestic taxation system to global standards and facilitating the implementation of internal and external tax control; simplifying submission and speeding up the circulation of tax data between fiscal service units, which will make it impossible to use various VAT evasion schemes; reduction of expenses for carrying out financial operations related to repayment of obligations and return of reimbursement from value-added tax.

The negative features of the value-added tax settlement mechanism using blockchain technology and the difficulties of its implementation in the domestic tax system include: the use of this platform will not allow to fully overcome all tax evasion schemes, therefore it will not be possible to completely avoid spending on additional audits; the peculiarities of the circulation and recognition of electronic instruments must be fixed in domestic legislation; low degree of awareness in computer technology of citizens of Ukraine; the need to speed up the development of the information technology market to increase the offer of outsourcing services; high risk of inventing innovative advanced computer programs that will allow to effectively deal with cryptographic coding, which in the future may significantly reduce the degree of protection of the platform and increase the number of unauthorized access and editing of electronic records. Given the mentioned shortcomings, the implementation of the blockchain platform in the domestic taxation system may require several years, although taking into account the pace of development of the IT technology
market in Ukraine and the availability of highly qualified workers in this field, this may happen shortly.

The use of the blockchain platform in the system of accounting for investment resources and property rights of investors has significant potential for increasing the competitiveness of our state in the field of attracting investments at the global level. Blockchain will help to overcome several negative phenomena in the national economic system and help to restore investors' confidence in it. It will become impossible to engage in the raiding and correction of information about investors and capital investment objects in the already formed database, which will help reflect the investment steps already taken and protect all elements of a single decentralized system.

Today, it is difficult to overestimate the positive aspects of the developed system of protection of foreign investments in the national economy, which has the potential to be implemented in various fields of social and economic activity of the state, in particular, in science and education, medicine, culture, the organization of customs affairs, the formation of a document circulation system in state structures and others. Its introduction into the state investment system will help to form a database of promising investment projects, to choose optimal proposals for the formation of investment resources, to prevent misuse and theft of funds, to ensure transparency of investment processes and to increase the level of protection of property rights of investors.

Successful implementation of any capital investment program covers the following components of management: development and elements of the program, circulation of documents for the project, agreements, and formation of reserves, and estimate of the program according to the simplified method. The implementation of the investment program must take place within the specified time limits based on contractual relationships, and its implementation can take place using quick transactions using the blockchain platform. This will significantly increase the effectiveness of the development and implementation of programs in the field of public capital investments and contribute to the improvement of the investment climate in the national economy in general.

Conclusions

So, blockchain technology has many positive economic, financial, information, and technological features. On the other hand, there are also many risks associated with insufficient technical skills in the application of blockchain, a low level of trust in this technology in society, an active search for ways to change cryptographic codes, and the use of the platform for various types of abuse and violations of the law. In addition, there are potential threats to the application of blockchain technology in other areas of criminal activity, which is facilitated by the lack of software to protect the platform, the lack of permission to cancel transactions after approval, the difficulty of adapting to other payment systems, etc.

The use of the blockchain platform in the financial sphere will affect the level of security, as it will reduce the degree of uncertainty, reduce the expenses of financial institutions due to the prevention of errors and fraud, and reduce the time of financial transactions to a minimum. Having assessed the wide possibilities of this technology, more than half a hundred financial institutions in different countries of the world today invested significant amounts of investment resources in the implementation of blockchain, as banks realized the significant advantages of working without the involvement of financial intermediaries, which contributes to significant savings of money. Such savings help to generate resources for the implementation of investment projects, which contributes to increasing financial results and social effects.
References


