

Ministry of Education and Science of Ukraine
Black Sea Universities Network

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of
Student Scientific Works

BLACK SEA SCIENCE 2022 PROCEEDINGS



ODESA, ONUT 2022

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BLACK SEA SCIENCE 2022

Proceedings

Odesa, ONUT 2022

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INTRODUCTION

International Competition of Student Scientific Works “Black Sea Science” has been held annually since 2018 at the initiative of Odesa National University of Technology (formerly Odesa National Academy of Food Technologies) with the support of the Ministry of Education and Science of Ukraine. It has been supported by Black Sea Universities Network (the Association of 110 higher education institutions from 12 countries of the Black Sea Region) since 2019, and by Iseki-FOOD Association (European Integrating Food Science and Engineering Knowledge into the Food Chain Association) since 2020.

The goal of the competition is to expand international relations and attract students to research activities. It is held in the following fields:

- Food science and technologies
- Economics and administration
- Information technologies, automation and robotics
- Power engineering and energy efficiency
- Ecology and environmental protection

The jury includes both Ukrainian and foreign scientists. In the 4 years that the competition has been held, the jury included scientists from universities of 24 countries: Angola, Azerbaijan, Benin, Bulgaria, China, Czech Republic, France, Georgia, Germany, Greece, Israel, Italy, Kazakhstan, Latvia, Lithuania, Moldova, Pakistan, Poland, Romania, Serbia, Slovakia, Switzerland, Turkey, USA.

At the same time, every year the geography has expanded and the number of foreign jury members has increased: from 46 jury members representing 25 universities from 12 countries in 2018, to 73 jury members of the 46 universities from 19 countries in 2022.

More than a thousand student research papers have been submitted to the competition from both Ukrainian and foreign institutions from 25 countries: China, Poland, Mexico, USA, France, Greece, Germany, Canada, Costa Rica, Brazil, India, Pakistan, Israel, Macedonia, Lithuania, Latvia, Slovakia, Romania, Kyrgyzstan, Kazakhstan, Bulgaria, Moldova, Georgia, Turkey, Serbia.

The interest of foreign students in the competition grew every year. In 2018, the students representing 15 institutions from 7 countries have submitted 33 works. In 2021 the number of submitted works increased to 73, authored by the students of 40 institutions from 18 countries.

The competition is held in two stages. In the first stage, student research papers are reviewed by members of the jury who are experts in the relevant fields. In the second stage of the competition, the winners of the first stage have the opportunity to present their work to a wide audience in person or online.

All participants of the competition and their scientific supervisors are awarded appropriate certificates, and the scientific works of the winners are included in the electronic proceedings of the competition. Every year the competition receives a large number of positive responses from Ukrainian and foreign colleagues with the desire to participate in the coming years.

2. ECONOMICS AND **ADMINISTRATION**

DIGITAL MODEL OF BLOCKCHAIN ECONOMY AND ITS IMPACT ON VARIOUS AREAS

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Abstract. *The constant development of competition in the market and the sharp differentiation of the needs of the population pushes global and domestic companies to find solutions to meet the desires of customers, make a profit and protect their own interests. It is these conditions that have led to the development of cryptocurrencies and the growing share of e-business algorithms that were used only in narrow areas, have become widely used and now perform the functions necessary for the stable development of enterprises. This is the most well-known and most profitable blockchain technology, which in recent years has proven its effectiveness by increasing the profits of companies that use it. This technology can significantly reduce the costs of companies, especially those that are participants in the stock market, and provides high stability and consolidation of market positions. It can reduce data processing resources and increase information flows. The article analyzes the advantages and disadvantages of this technology, its prospects and ways of development. With the help of clustering methods, global companies were distributed according to the amount of profit in terms of blockchain use, based on which it is possible to make initial conclusions about the effectiveness of technology for implementation not only by global companies but also domestic ones. . As a result, the introduction of this technology will allow companies to assess the risks of information loss, minimize them and develop algorithms that will be most effective in each case. This will lead to the construction of a high-quality customer-oriented approach, which can significantly increase revenue, affect the number of users and their level of satisfaction. Thus, blockchain technology can be recommended for use by Ukrainian companies to increase their productivity and innovate with minimal losses.*

Keywords: *blockchain, clustering, stock market, profit, profitability of companies.*

I. INTRODUCTION

Globalization of the economy, intellectualization of labor, development and dissemination of information and telecommunications technologies have led to the virtualization of economic relations and the emergence of virtual economy, a new concept of economic relations based on information technology and network systems aimed at producing intangible goods, information and knowledge in public administration is significantly transformed. The relevance of research on the use of blockchain technology in public administration is due to the institutional problems faced by society in the development of the information economy. These are, first of all, problems of trust, high costs of maintaining state registers and managing large amounts of information, risks of information attacks and the possibility of damage or loss of data due to various circumstances, including fraud, theft or unauthorized use of

registers. Issues of introduction of blockchain technologies in the field of public administration, business structures are widely discussed among politicians, lawyers, specialists in the field of information and telecommunications technologies, public administration.

Blockchain technology allows to solve the above problems in an optimal way, minimize the costs of participants in electronic interaction, opens new opportunities in the creation and management of electronic registers and their promotion in a network economy. Blockchain technology can be implemented to solve the problems of information management, in particular for maintaining public registers, in such areas as: banking, finance, office work, medicine and more.

In 2017, the World Economic Forum recognized blockchain technology as one of the most promising. In our opinion, blockchain technology is the most important modern technology that will ensure an innovative breakthrough and great progress of society in the coming decades in the field of Big Data, innovative technologies and public administration.

II. LITERATURE ANALYSIS

1. What is blockchain technology

A blockchain is a distributed database that contains information about all transactions made by system members. The information is stored in the form of a chain of blocks. Each of them records a certain number of transactions.

The blockchain analogy is a necklace. Each bead is a "block" or action record. This necklace - or "chain" - cannot be destroyed or destroyed. Thus, the blockchain is an indestructible digital record of actions. The reliability of this system has made it possible to use it to increase the efficiency of monetary transactions and the exchange of information among individuals, corporations and even the public sector.[1]

Consider in more detail.

Blockchain technology was created by Satoshi Nakamoto in 2008. Since it emerged in 2008 (Nakamoto, 2008), there have been several definitions for blockchain: a distributed accounting technology (Denny et al., 2017), a distributed database (Ferreira et al., 2017), distributed records (Wu & Tran, 2018) or a distributed ledger technology (DLT; Ølnes et al., 2017). Regardless of the definition, all approaches agree that decentralization is one of the benefits that grants this technology highly transformative power in several business models (Diniz, 2017) [2]. The basic principles of this P2P system (Peer-to-Peer system) are described in his work "Bitcoin: P2P electronic cash system". Blockchain is a mechanism that provides a high degree of accounting and identification of information, allows you to distribute this information among users of the network, while working with it to multiple users, recording the time of each transaction. Blockchain technology helps to eliminate the omission of transactions due to errors of people or technology, it is not possible to make changes to the register of transactions. Blockchain technology is the first digital medium for peer-to-peer exchange, based on a targeted protocol of globally distributed computing and encryption without the involvement of a third party - a trustee. Blockchain is a register of transactions, accounts, databases, etc. based on the agreement (SMART CONTRACT) and the target protocol.[3]

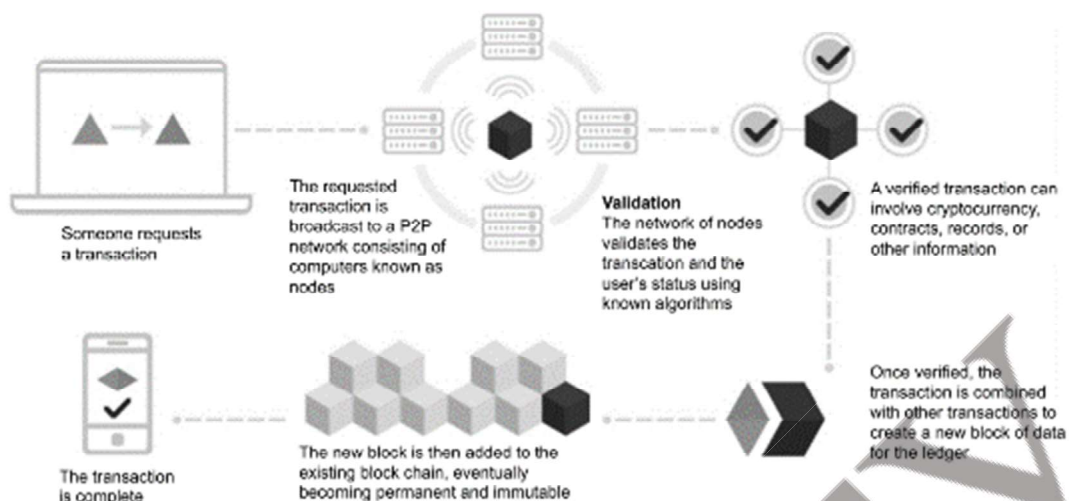


Fig.1: Blockchain illustration

At the figure 1 we can see how goes the process of forming blockchain.

Blockchain is seen as a technology that involves creating long lists of sequential data. Each component of the system remembers the previous one, and making unauthorized changes is immediately blocked. Not one centralized server is used to create encryption, but the computing power of all participants in the process. Any user of a system built on Blockchain can also own it. Blockchain should be seen as the accounting and exchange of ownership of digital assets in a peer-to-peer network that contains structured data in the form of a distributed registry. The main difference between Blockchain and traditional registries is the simultaneous storage of data that is distributed among a number of network nodes without being tied to a specific location. Some authors suggest that Blockchain technology should be seen as a multifunctional and multilevel information technology designed for distributed storage of records of all transactions, which is a more accurate definition. It is a chronological database in which the time at which the record was made is inextricably linked to the data itself, making it non-commutative. All transactions are performed with a cryptographic protocol. The information included in the chain of blocks cannot be changed ex post facto. Based on the above, it can be argued that the essence of Blockchain technology can be described as follows - these are digital records combined into blocks, which are based on an algorithm connected by a "chain" to each other according to the operations performed. The process of encrypting the write process into blocks, known as hashing, is performed by different computers running on the same network. If all computers on the network get the same result as a result of the calculations, the block is assigned a unique digital signature, which cannot be forged. This block can change only as a result of adding new records (performing new operations).[4] In this case, the register of information in the blocks is updated on all computers on the network at the same time. That is, this approach can significantly reduce the risk of hacking, because in this case the thief will have access and key codes to the entire computer network at once.

There are the following types of blockchain:

1) Public blockchain - Blockchain without restrictions, ie there are no restrictions on the formation, reading and conduct of transactions when creating, enabling and using Blockchain technology (creating a single network between the company and all contractors of the company);

2) Private blockchain - Blockchain technology is used by a narrow circle of users (for example, in the middle of the enterprise);

3) Permissionless blockchain - Blockchain technology is used by everyone, ie there are no restrictions on the identity of data processors and transactions;

4) Permissioned blockchain - Blockchain technology is used to create a system in which transaction processing is carried out among clearly defined entities, ie the range of users is limited.[5]

In addition, it should be noted that the use of Blockchain technology is possible with a number of requirements that help prevent risks.

1) reliability and relevance of data entry. Reliability, relevance, accuracy, efficiency of data entry allows management to respond more quickly to the economic situation, so creating an effective organizational and legal mechanism for reliable, efficient data entry in the registers is a priority when using Blockchain technology;

2) control of access to the Blockchain system and user identification. To ensure control over data entry and changes when using Blockchain technology, you need to create a mechanism for managing access rights (individual user identification) both to the system as a whole and to individual records. The system of individual identification of users can be created on the basis of biometrics of personal parameters;

3) database synchronization. Creating conditions under which the performance of a particular operation at any time on any of the nodes produces the same result;

4) control over system administrators and reliability of interfaces. Ensuring the maintenance of reliable information, preventing illegal modification of records in the database encourages constant monitoring of administrative staff and information entry. Therefore, when using Blockchain technology, the function of performing external control over the integrity and reliability of data entered into the system is entrusted to different network users. In this case, when the administrator tries to change the data located on the server, it will be impossible to falsify the dissemination of information on all network nodes in the process of changing the checksum of the chain of operations, thus forming the integrity of the registry. However, in order to exclude the possibility of forging the server's response to erroneous requests and distortions of information, this response must be protected by a digital signature of the server.

2. Advantages and disadvantages and impact of using blockchain technology

It is interesting to further analyze the scope of blockchain technology. Experts identify several areas of application of blockchain technology, which should be considered in more detail. First of all, this is the financial and banking sector, for which most blockchain applications are currently being developed. The list of technological solutions based on blockchain technology that can revolutionize the financial system is quite wide. These are interbank settlements, settlements between legal entities and individuals, insurance. Worldwide, the financial services market is the largest sector of the economy by market capitalization, with the global financial system abounding in

inefficient processes such as cash transactions, asymmetric information, and vulnerable centralized systems that ultimately increase costs and delays for consumers. It is known that every year 45% of financial intermediaries suffer from fraud, such as payment networks of stock exchanges. If blockchain technology replaces only a small part of such transactions, as well as peer-to-peer transactions in other sectors, it can dramatically increase the efficiency of the financial sector. Not surprisingly, IBM, Microsoft and other blockchain developers who have announced the provision of services based on this technology, mainly focus their efforts on the financial sector. It is worth mentioning that the experts of the European Bank Santander estimated the potential savings from the introduction of blockchain technology at 15-20 billion dollars. in a year . The capabilities of blockchain and cryptocurrencies are being studied and tested by many central banks, including in Canada, Singapore and the United Kingdom, and although this technology can pose a serious threat to this area, it can maximize the benefits.[6]

Micropayments are one of the most promising areas of blockchain use. For example, until recently, payments of a few cents were too heavy for Internet users. Developing appropriate blockchain proposals will make such payments possible and practical. This will allow you to effectively monetize social networks, as well as make them an alternative way to pay for small work, such as filling out questionnaires or freelance editing for different clients. Financial market analysts also believe that micropayments can be a very profitable and promising project in the business world. For example, the financial company Wedbush Securities forecasts a bitcoin micropayment market of \$ 925 billion. until 2025. Smart contracts are one of the applications of blockchain technology that is of the greatest interest. A smart contract is an agreement between two parties that is stored in a blockchain. Such agreements can be made between two people, in other words, peer-to-peer, person and organization, or between person and machine. Smart contracts allow you to automate payments and transfers of currency or other assets under agreed conditions. As soon as this condition is fulfilled in the smart contract (sale of goods A on the exchange B), the contract is executed automatically and assets (money, digital currency, property rights, securities) are exchanged between the contracting parties. Subsequently, the transaction is accepted and checked on the blockchain. Smart contracts allow you to exchange an asset, even if third parties are unaware of its transfer. This opens the possibility to disintegrate the entire legal system and create a new form of virtual agreements. In practice, however, being only fragments of code that automatically execute them when the specified conditions are met, smart contracts cannot currently be considered as ordinary contracts from a legal point of view. Nevertheless, they can be used as evidence of a problem, so many areas are exploring the potential of such contracts.

However, it should be noted that experts see even greater use of smart contracts only in the long run, because, despite some attempts to implement them, this technology is in the experimental stage and is not yet ripe for the emergence of primary market products.

There are many research organizations, such as the Scanergy project in Belgium, which are based on the blockchain system and monitor the use of electricity and supply it to the grid. In addition, the cryptocurrency NRGcoin is offered for settlements with

domestic electricity producers when supplying electricity to the grid. Therefore, among the areas of use of blockchain technology that have already emerged today: government agencies, defense and security agencies, international organizations, including the insurance industry. Yes, insurance problems related to excessive centralization, non-transparency and money laundering can be solved today thanks to this technology. Of course, the biggest problem of today's insurance sector is the situation with the return of funds for the insured event. The procedure is so bureaucratic that it is sometimes difficult for an ordinary person to figure out why. The issue of insurance is more important in Ukraine today than ever, it is associated with the reform of many industries, even the introduction of insurance medicine requires comprehensive changes in the insurance industry. Of course, this will revive the development of insurance, but a common system is needed, where the relations between the participants can be tracked and which cannot be unilaterally administered and edited. The availability of such information will facilitate faster decision-making on insurance, and its absence, especially in the context of Ukrainian corruption, non-binding legislation, the possibility of non-performance or delay in fulfilling obligations under the contract, led to business forced to suspend active operations. appetites for risks. Everyone in general suffered from this - the country, the economy. A common and decentralized system will improve the business and investment climate and the conditions for more active insurance. There is great potential for blockchains, and insurance companies should be primarily interested in their implementation, pushing the legislature.[7]

Having such a register on the blockchain would prevent corruption and data censorship, which in turn would make the credit mechanism transparent, understandable and attractive. Note that the most popular area of application of this technology - money transfers based on bitcoin and cryptocurrency in general. Bitcoin is even more popular than the blockchain technology on which it is based, and it is the emergence of which has shown the potential of this distributed registry technology and identified its other practical applications. Yes, the Bitcoin startup Circle, while no longer allowing users to buy and sell cryptocurrencies directly, is creating a protocol that will allow digital wallets to share values through a blockchain. The first IT company in Ukraine to develop based on blockchain technology presented a working model based on flight delay insurance at the Hackathon in 2017. In this model, when buying a ticket, the insurance payment was paid, which was kept in the Escrow agent's account, and the funds were not available to the insurance company until the end of the insured event. The smart contract specified the site-provider of flight data. In case of non-departure of the flight at the specified hour, the client automatically receives funds at his own expense at the same time. The model caused a stir, and at this stage negotiations are underway with Privat Group on the possibility of its implementation. We highlighted the benefits of blockchain technology for business in table 1.

However, the blockchain is not perfect. And it has some obvious shortcomings, especially in terms of mass introduction of technology. To use it, financial institutions, in fact, must abandon their current networks and start all over again. Trying to integrate current payment networks into a blockchain can be so challenging that no one will even try to go that route.

Table 1. Benefits of blockchain technology for business

Transparency	In a blockchain, a complete history of transactions is permanently maintained and simultaneously available to all network users. All users involved in a transaction are aware of any actions taken on any data or transactions executed, thus promoting increased transparency.
Business Continuity	The availability and continuity of services provided is a crucial requirement for all businesses. The absence of a vulnerable single failure point in the blockchain technology means the system is never down, despite some parts' failure, thus supporting business continuity.
Disintermediation	Blockchain infrastructure's being truly decentralized enables a significant level of disintermediation. Technology, protocols and elements can replace intermediaries, enhancing efficiency, and reducing friction-related direct and indirect costs between individuals and organizations, due to decreased trust.
Trust	The blockchain mechanism's underlying concept is the establishment of a trustworthy record between untrusted parties. The good design of blockchain-embedded protocols and cryptography property enforce trust and ease its verification.
Smart Contracts	Some functionality can be added to ledgers, as most blockchain applications provide some scripting languages. For instance, a rudimentary stack-based language is contained in bitcoin, whereas a language similar to JavaScript, a Turing complete imperative language, is provided by Ethereum. These programs, so-called smart contracts, are computer codes/software designed to digitally facilitate, verify, and enforce the business logic's negotiation or performance. Smart contracts are selfexecuted and automate the execution of credible transactions and actions (e.g., exchange of property, money, shares, or anything that has a value), without a middleman, as the terms of agreements are fulfilled. Smart contracts can be utilized in traditional systems, but data integrity and data availability to all parties make blockchain the right technology platform to leverage smart contracts

It is also still unclear whether the blockchain will be able to survive outside the cryptocurrency ecosystem and scale to handle a large number of transactions.

Another disadvantage of the blockchain is its high energy dependence, which makes it an expensive technology. Blockchain differentiation is also a concern. There are currently more than 1,400 digital coins, many of which have their own versions of the blockchain. It is unclear which of them will be able to survive and develop in the future, which of them will prefer to use developers and large companies, and which will disappear.[7]

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

Object of the research: the stock market where blockchain technology has become entrenched, among American companies.

Blockchain technology allow companies to do without the services of clearing houses, which greatly simplifies the work of the exchange and significantly affects the profitability of shares, as it reduces costs and strengthens the company's market

position. So, let's compare the profitability of companies that use blockchain technology and those that do not yet use these technologies.

Subject of the research: we use data on the activities of the 10 largest companies in the US stock market and examine their average profitability over five years to analyze the dynamics of their development.

So, the first company to use blockchain in the organization of its activities - Amazon. A retail company that is known worldwide for selling mass-produced goods on the Internet. This company was one of the first in the world to implement the blockchain. Yes, this company not only uses this technology in its work, but also is a provider of its own developments for the interpretation of the blockchain in other companies.

Facebook is the company with the largest social network of the same name, which is popular all over the world. This company uses the blockchain to protect its users, as well as for effective promotional activities.

Nestle is a Swiss food company. The company, which uses the blockchain to study the desires of customers, analyzes their individual needs and adjusts production to each region, which significantly increases profits.

Oracle is an American company that is the largest software developer in the world. This company uses blockchain algorithms to develop its own databases, which increases the competitive advantage of their product.

Visa is the world's largest payment system. The company's cards are accepted in more than 150 countries, it is engaged in the development of innovative payment products and technologies. Blockchain technology helps reduce the number of cybercrimes and protects customers, as well as enables payments around the world, which, in turn, brings additional income. These companies have been using blockchain technology since 2017 and, according to statistics, their revenue has been growing steadily since this year.

Adobe is a software company, NIKE is an American company that specializes in sports shoes and clothing, Walt Disney is the world's most famous entertainment corporation, and the company is valued at more than \$ 130 billion every year. .

Goldman Sachs is one of the largest and most famous investment companies in the world. The company's profits have been rising, but stock prices have been falling in recent days due to the global economy.

McDonald's is an American corporation and one of the most famous chains of catering establishments, whose profits fluctuate according to the world economic situation.

These companies have been using blockchain technology since 2017 and, according to statistics, their income has been growing steadily since this year, while other companies are still in the process of getting acquainted with the blockchain.

Therefore, the income of companies for five years is given in table. 2.

The use of blockchain technology is directly related to the profitability of companies, as the cost of using databases and maintaining them significantly affects the profits of companies. Let's explore the relationship between company profitability and the use of technology using clustering techniques.

IV. RESULTS

The generalized division of companies into clusters is given in table. 3

Table.3 Clusters of companies formed on the basis of their profitability

Number	Name of the company
1	Amazon
2	Facebook
3	Nestle, Oracle
4	Visa
5	Adobe, Walt Disney, NIKE, Goldman Sachs, McDonald's

Thus, the first cluster included Amazon, which has the largest profit among selected companies. The company quickly mobilized its own resources to use blockchain algorithms to develop and sell its own technologies, which now brings it significant profits. The second, third and fourth clusters included companies with gradually declining profits. Of course, this is not just about using these technologies, as the economic situation in the world is not stable, and the popularity of food companies and their income may fluctuate throughout the year, as young brands are also gaining momentum. The last cluster included five companies that do not use blockchain technology. These companies are quite competitive and have a stable position in the market, but the lack of introduction of advanced technologies does not allow to make higher profits. Yes, Goldman Sachs can use these algorithms to protect investors' investments, to forecast the investment market and to take into account possible risks. And transparency in the direction of investment would significantly increase confidence in the company. The example of Nestle shows that cultural differences and individual preferences play an important role in the development of our own product related to the nutrition of citizens, which allows us to collect and turn blockchain technology into new income.

V. CONCLUSIONS

A blockchain is a distributed database that contains information about all transactions made by system members. The information is stored in the form of a chain of blocks. Each of them records a certain number of transactions.

The introduction of a blockchain increases the speed of exchange, reduces time costs, improves the quality, reliability and availability of services. At the same time transparency and reliability increase, risks decrease. Blockchain projects are used in the banking sector, financial services, payment services, public sector (public services, real estate registers, notary, electronic voting, etc.), transport and logistics, IoT, healthcare, intellectual property management, energy, etc.

Among the advantages of blockchain technology are:

- security and two-level identification of users with private and public keys, as well as digital signatures;
- successive chains prevent unauthorized change of information;

- with the help of high-level programming languages allows you to create business logic that helps in making management decisions.

The disadvantages of this technology are the lack of a single regulatory framework governing the use of this technology. This means that the level of trust of technology users is much lower. The big disadvantage for small companies is the high energy consumption of this technology, and although over time all costs are covered, the initial stages of use are quite expensive.

Analyzing all of the above, we can say that the blockchain is a revolution, as opposed to just evolutionary innovations. Distributed registry technology generally undermines the hierarchy by allowing you to work in a distributed network without intermediaries, using the consensus of participants instead of control. Effective cash management is perhaps the most important role of government institutions. Therefore, it should be understood that in the near future the world's financial institutions will not give full control of the protocol, and therefore systems based on blockchain technology, because a single standard requires more time, must be compatible with many areas of financial activities (insurance, banking, etc. further).

Many companies are becoming users of cloud blockchain technologies, which allows them to make quite high profits and explore a new niche in the market. Clustering has shown that companies with implemented blockchain technology have a high level of profitability and can be more stable in the market in the current or potential crisis. Ukrainian companies should use the experience of foreign companies and develop in this direction, which will significantly improve the quality of the company's work and eliminate high risks of information loss, especially in the field of security.

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