MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY

Air Transportation Management Department

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Head of the Department
_____Yun G.M.
“_____” _____2020

MASTER THESIS
(EXPLANATORY NOTES)

Theme: “Implementation of Blockchain technology in aviation sphere”

Done by: Yarosh Oleksandra

Supervisor: Shevchenko Yu.V., PhD in Economic, Associate professor

Advisers on Individual Parts of the Notes:

Theoretical Part - Shevchenko Yu.V., PhD in Economic, Associate professor

Analytical Part – Shevchenko Yu.V., PhD in Economic, Associate professor

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Kyiv 2020

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Кафедра організації авіаційних перевезень

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
_____Юн Г.М.
«_____»_____2020 р.

ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ
«МАГІСТР»

Тема: «Впровадження технології блокчейн в авіаційну галузь»

Виконавець: Ярош Олександра Сергіївна

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Київ 2020

NATIONAL AVIATION UNIVERSITY

Faculty of Transport Management and Logistics

Air Transportation Management Department

Specialty: 275 “Transport Technolgies”

Educational-Professional Program: Air Transportation Management

APPROVED BY
Head of the Department
_____Yun G.M
“_____” _____2020

TASK

of completion the master thesis

Yarosh Oleksandra Serhiivna

1. Theme of the master thesis entitled “Implementation of Blockchain technology in aviation sphere” was approved by a decree of the Rector order № 2401/st. of October 17th, 2019.
2. Term performance of thesis: from 14 October 2019 to 29 December 2019 and from 20 January 2020 to 09 February 2020.
3. Initial data required for writing the master thesis: statistics of the State Statistics Committee of Ukraine, State Aviation Administration, global resoursce for aviation information as flightmaps analytics, legislative base, statistical data, materials of periodicals.
4. Content of the explanatory notes: abstract, introduction, theoretical part, analytical part, design part, conclusions.
5. List of mandatory graphic materials: Centralized transaction, Decentralized blockchain transaction, Blockchain technology (using electronic money as an example), Comparative characteristics of blockchain types, Blockchain Impact on Business Functions, Expected Benefits, Examples of the use of blockchain in supply chain management, The Blockchain technology development stages,

Possible Blockchain use-cases in the aviation industry, SWOT matrix of blockchain technology, The results of Ukraine aviation industry activity for 9 months of 2019, Dynamics of passenger traffic by Ukrainian aviation, Share of leading airports in total passenger traffic through Ukrainian airports, Passenger traffic through the airports of Ukraine, Share of Boryspil Airport in the structure of passenger transportation, Scheme of Boryspil International Airport, SWOT analysis of Boryspil International Airport, Income plan for 2019 compared to previous years, The structure of expenses of the Boryspil International Airport for 2017-2019, Dynamics of Operating Cost Elements for 2017-2019, Boryspil liquidity ratios, Business challenges blockchain does help solve, The payroll of the design department.

6. Planning calendar

№	Assignment	Deadline for completion	Mark on completion
1.	Collection and processing of statistical data	14.10.19 – 31.10.19	done
2.	Writing of the theoretical part	01.11.19 – 14.11.19	done
3.	Writing of the analytical part	15.11.19 – 30.11.19	done
4.	Writing of the design part	01.12.19 – 14.12.19	done
5.	Writing of the introduction and summary	15.12.19 – 20.12.19	done
6.	Execution of the explanatory note, graphic matters and the presentation	21.12.19 – 29.12.19	done

7. Advisers on Individual Parts

Part	Advisor (position, name)	Date, signature	
		Task given	Task received
Theoreticalpart	ShevchenkoYu.V.	14.10.2019	14.11.2019
Analytical part	ShevchenkoYu.V.	15.11.2019	30.11.2019
Design part	ShevchenkoYu.V.	01.12.2019	14.12.2020

8. Given date of the task: October 14, 2019

Supervisor of the bachelor thesis: Shevchenko Yu.V.
(signature) (name, surname)

The task was accepted for completion: Yarosh O.S.
(signature) (name, surname)

REPORT

Explanatory note to the diploma project “Implementation of Blockchain technology in aviation sphere” consists of 124 pages, 13 figures, 11 tables, 90 sourses used.

Key words: AIRLINE; AIRPORT; BLOCKCHAIN TECHNOLOGY, SMART CONTRACTS, P2P; PRIVATE BLOCKCHAIN; PUBLIC BLOCKCHAIN; SUPPLY CHAIN MANAGEMENT; TOOLS.

Object of study: activity of implementation of Blockchain technology in the field of aviation.

Subject of study: is the choice of scopes of Blockchain technology by Boryspil airport on the basis of creation of implementation mode.

Purpose of thesis: to determine whether blockchain technology has the potential to disrupt the traditional airport system and whether this technology will expedite the required transformation of the industry.

The master’s thesis actuality: during the working process on thesis, an Implementation of Blockchain technology project for Boryspil International Airport was proposed in order to develop stable and safe airport system to improve the quality of the enterprise.

Recommendations: the following materials of the master’s thesis can be used in further research and can be proposed as a high-quality blockchain system of enterprises around the world.

CONTENTS

LIST OF CONVENTIONAL SIGNS, ABBREVIATIONS AND TERMS

AD – Airworthiness Directive

CFR – Code of Federal Regulations

CRS – Certified Repair Station

DAO – Decentralized Autonomous Organizations

Dapp – Decentralized application

DSA – Digital Signature Algorithm

DSS – Digital Signature Standard

DLT – Distributed Ledger Technology

GDS – Global Distribution System

HTTP – Hypertext Transfer Protocol

ICO – Initial Coin Offering

NFC – Near Field Communication

P2M – Person and a machine

P2O – Person and an organization

P2P – Peer to Peer

Pk – Public Key

PoA – Proof of Activity

PoB – Proof of Burn

PoET – Proof of Elapsed Time

PoS – Proof of Stake

PoW – Proof of Work

QR codes – Quick Response Code

RFID – Radio Frequency IDentification

REST API – Representational State Transfer Application Program Interface

SHA – Secured Hash Algorithms

SHS – Secure Hash Standard

SITA – Société Internationale de Télécommunications Aéronautiques

INTRODUCTION

Air Transportation Management Department				*NAU 20.09.38.001 EN*			
Researcher	*Yarosh O. S.*			*INTRODUCTION*	*Letter*	*Sheet*	*Sheets*
Supervisor	*Shevchenko Yu.V.*				*D*	*9*	*4*
Normative Supervisor	*Shevchenk Yu.V.*				*FTML 275 ОП-202Ма*		
Head of the Department	*Yun G.M.*						

With the development of information technology and the digital economy, the emergence of a significant number of innovative areas in various sectors of the economy can be observed, some of which are prophesied to be revolutionary. One of these phenomena is the actively developing blockchain technology. Blockchain is a powerful innovation that can change many aspects of human life. By the depth of the consequences that the development of these technologies may have for the whole world, blockchain is often compared with the advent of the Internet in the early 1990s. Within the framework of the master's thesis, the possibilities and prospects of the application of technology of distributed registries in the field of aviation are examined.

The relevance of the chosen topic of the thesis is due to the expansion of the use of blockchain technology in modern companies, and especially in supply chains, airlines and airports.

Blockchain technologies are currently being actively developed, their use has serious prospects not only for financial spheres but for aviation sector as well. The most successful Blockchain implementation projects in aviation sphere such as: Lufthansa, British Airways and Heathrow Airport, FlightChain system, and others are actively studying and developing these technologies. Thus, the relevance of the blockchain will only grow. The use of technologies will significantly secure the work, simplify the coordination of decisions, optimize the costs of organizational processes and increase management efficiency.

Blockchain refers to those technologies, the introduction of which can trigger a chain reaction of changes in business models and processes, supply chains and relations of companies with customers in all sectors of the global economy. However, the implementation of blockchain technologies in various industries is hindered by certain barriers, the key of which are: technological; economic and social; regulatory issues; patenting issues.

Object of study is activity of implementation of Blockchain technology in the field of aviation.

Subject of study is the choice of scopes of Blockchain technology by Boryspil airport on the basis of creation of implementation mode.

Purpose of thesis is to determine whether blockchain technology has the potential to disrupt the traditional airport system and whether this technology will expedite the required transformation of the industry.

Tasks of work.

To achieve this goal, the following tasks were set:

— consider the concept of blockchain technology;
— identify types of blockchain technology;
— study the types of consensus algorithms in the blockchain;
— consider blockchain technology tools;
— analyze the blockchain market and the practice of introducing technology on an international example and directly in Ukraine
— consider the use of blockchain technologies in the field of aviation;
— identify the problems of introducing blockchain technology;
— make a SWOT matrix;
— determine the effectiveness of technology blockchain on the example of the airport Borispol;
— build an econometric model defining blockchain technology efficiency;
— develop recommendations on the use of blockchain technology in the airport based on the presented model.

Research tools.

In order to achieve this goal, correctly selected research strategy and tactics will help. Of the existing strategic models, the following should be preferred:

— study of the practical situation (it is necessary to understand the current situation in more detail);
— causal analysis (identify causal relationships between existing conditions and events).

The practical significance of the study.

The practical significance of this work is due to the fact that the results of studies in the construction an econometric model, it is possible to identify promising industries using blockchain technologies.

The structure of the work. The master's thesis includes an introduction, three sections, a conclusion, a list of sources used.

The first section discusses the concept of blockchain technology, identifies varieties of blockchain technology, considers the types of consensus algorithms in the blockchain, as well as the blockchain technology tools.

The second section discusses the possibilities of using blockchain technology in the field of supply chains and aviation. The blockchain and bitcoin market is analyzed on the example of international experience of implementation and directly in Ukraine, the problems of introducing blockchain technology are identified, a SWOT matrix is being built. The air transport market of Ukraine and the airport Borispol are analyzed.

The third section is devoted to the analysis of the effectiveness of the use of blockchain technology at the Boryspil airport. The section contains the development of recommendations on the use of blockchain technology in international companies based on the presented model.

1. THEORETICAL PART

Air Transportation Management Department				*NAU 20.09.38.100 EN*			
Researcher	*Yarosh O.S.*			*THEORETICAL PART*	*Letter*	*Sheet*	*Sheets*
Supervisor	*Shevchenko Yu.V.*				*D*	*13*	*38*
Normative Supervisor	*Shevchenko Yu.V.*				*FTML 275 ОП-202Ма*		
Head of the Department	*Yun G.M.*						

1.1. General characteristics of blockchain technologies

1.1.1. Blockchain definition

Blockchain technology is gaining rapid popularity today: articles are written about it, it has been the subject of discussion at forums and industry conferences, moreover startups in various sectors of the economy are launched on its basis. The blockchain system received its development in the use of bitcoin cryptocurrency and was originally used to hide transaction information. The concept of information blocks was proposed in 2008 by Satoshi Nakamoto. It was first implemented in 2009 as a component of the digital currency in which blockchain plays the role of the master common register for all bitcoin transactions [1]. Today, this technology, like any that has proven effective, is penetrating most areas.

Blockchain is a technology that potentially covers many areas of the economic activity of society and offers various possibilities for its application including, for example, finance, operations with tangible and intangible assets, accounting in organizations, public services.

In this regard, a detailed study and further integration of blockchain technology can be considered as a promising strategy and an appropriate direction for innovative development. The 2017 World Economic Forum Report predicts that by 2025-2027, 10% of world GDP will be stored in blockchain or blockchain technologies. At the beginning of 2017, the total value of bitcoin operating in blockchain was approximately $ 20 billion. (In 2014, this figure was $ 8.5 billion, an increase of $ 11.5 billion over almost three years) [2]. But with such optimistic experts' predictions, the technology needs testing and adaptation, it has a number of features and certain drawbacks to use that need to be understood and taken into account.

Revealing a simplified definition of blockchain technology, it should be noted that the blockchain offers an alternative view of the usual tool for recording economic transactions, it’s characteristics are publicity and “incorruptibility”.

Blockchain technology or Distributed Ledger Technology (DLT) is a decentralised technology based on peer-to-peer (P2P) transaction or information sharing, with no intermediaries. The block is called such an information package, which contains all the previous information and some new ones. And the whole chain is a database distributed among many participants, which operates without centralized management, that is, there is no intermediary in the form of a single "central server" on which all information is stored. The lack of centralization is an important element of technology, since all data is stored on users' computers. All users of the chain are equal and form a network of computers, each of which stores a copy of the blockchain data. It is impossible to break or disable the blockchain, as long as at least one computer connected to the network is functioning, the technology will work [3]. Transactions should not be considered solely as an exchange of goods for their cash equivalent, since the subject of the transaction can be any asset (tangible and intangible) of the real sector of the economy or the obligations associated with it, smart contracts help in this.

A smart contract is an electronic algorithm or condition under which the parties can exchange various assets. The programmed terms of the smart contract monitor the execution of the transaction, and the exchange (payment for services, barter) occurs only after the successful fulfillment of all conditions. In many ways, it is in them that the key technology potential for states lies. As States build the legal bridge between digital code and real assets, a new era will come in the global economy

Thus, according to the technological paradigm of the blockchain, data can be stored publicly and at the same time be in security. Data can be transferred without a single center and intermediaries, while guaranteeing the fulfillment of obligations of the parties, and, most interestingly, the data has programmable value, which subsequently becomes market value. This is possible due to the cryptocurrency tool and smart contracts. They allow you to go from digital code to a tool of a market economy. Thanks to them, it becomes possible to digitize any asset in the real sector of the economy. However, today the key barrier to this is the

discrepancy between legal institutions of the economy and the market potential of technology.

It may seem that blockchain technology is a priority only in the financial sector. On this technology, you can implement any database. Databases of socio-status restrictions (social status of a citizen or family, the presence of disability, criminal record or other restrictions) or offenses, decentralization of the population register can increase the availability of information about personal data for organizations, and with sufficient coverage of interested structures, the stability of the database will also increase. Accounting for employment and seniority will eliminate the need for the use of work books, collection of information for retirement benefits, etc. With the combined use of blockchain technology in these areas, it is possible to refuse to provide supporting documents to many government bodies and authorities.

According to a PwC Blockchain market research, by 2019, 20% of global central banks will start using blockchain technology, and over the next ten years their number will increase to 40% [6]. Despite statements by financial institutions about the immaturity of blockchain technology, the authors of the study claim that almost half of the world's central banks will begin to actively exploit blockchain over the next ten years. Some central banks said they are interested in using technology and have an interest in cryptocurrencies, including Bitcoin and Ethereum. 80% of banks surveyed said that they are planning to eventually issue their own cryptocurrency [6]. The study also noted that the level of use of blockchain technology in public administration is growing. Systems are emerging, such as Horizon State, that use blockchain technology to create an electoral system that excludes opportunities for manipulation of election results [6].

Despite all the advantages of the technology, today in the financial sector there are no really working successful global projects on the blockchain. This may be due to the traditionalism inherent in the global financial system, the resistance with which many classical banking institutions met a new technology, seeing in it not an opportunity, but a competitor or even a potential alternative to themselves.

To summarize, it is worth saying that blockchain is not only a way to exchange financial transactions. In a broader sense, it is a distributed, secure database in which information cannot be faked, deleted, or modified with a "backward" number. Thanks to these properties, the blockchain brings a number of capabilities and services where the reliability and integrity of data, as well as speed and availability are important.

However, such digital technology is not just a fantasy or the near future, it is already an accomplished fact, and how quickly society and the state plunge into the world of new technologies, their success and development path depend. Those who do not want to and do not seek to change after world trends should at least pay attention to this young technology.

1.1.2. General principles of blockchain technology

Blockchain technology is based on a sophisticated encryption system in which each block has its own unique key. Using a cipher ensures that users can only modify those blocks of the chain to which they have access, that is, which they own, knowing the appropriate key, without which writing to the file can not be done. This feature of blockchain databases makes hacking for hackers virtually impossible, since they need to simultaneously access copies of the database on all computers on the network. Even if the original document or transaction is further modified, the data will then receive a different digital signature, indicating that the system is inconsistent [4].

Hash, Hash sum (hash code) - the result of processing certain data with a hash function. The hash value can be used to verify the integrity of the data, its identification and search (for example, in P2P networks), and also replace data that is unsafe to store explicitly (for example, passwords, answers to test questions, etc.). Also, hashing algorithms are used to verify the integrity and authenticity of files [4].

Forging - is a technology for creating additional blocks in the blockchain. This process is applicable to any cryptocurrency, and is interesting in that it allows you to get a real share, which is expressed either in the commission or in a certain number of coins. One of the synonyms of forging is mingting.

The basic blockchain system is an ever-growing sequence of blocks that are shared between participants using peer-to-peer networks, which most people use to download and distribute torrents.

A time stamp (hash sum) is added to each block, which is easiest to imagine as a unique fingerprint. These blocks are strictly in a certain order stacked in chains ("blockchain"). If you try to rearrange the sequence of blocks, the system will reject the chain due to the mismatch of the structure and the hash sum.

So that no one can change the time stamp and recalculate the hash amount that is correct from the point of view of the system, the blockchain uses several methods of protection: Proof of Work (PoW) and Proof of Stake (PoS).

These are the two most well-known types of transactions in cryptocurrency payment systems. They provide two different mechanisms that prove that specific work has been done. The principle of their work is best presented in the context of cryptocurrencies. [5]

Proof of Work is a distributed systems algorithm that protects against malversation of services and its contents is covered in two main points:

1. It is necessary to perform fairly non-trivial work and large-scale tasks.
2. Possibility of easy and quick verification of the final result.

Tasks of this type are usually not intended for human performance, but the computer copes with them meeting deadlines, but it will require a lot of computing resources.

At the same time, checking the result is not too difficult, so it is carried out fairly quickly without spending a lot of computer resources. In addition, there is another, equally important, consensus mechanism that was first used in 2012 by PPCoin (cryptocurrency) - Proof of Stake. [5]

The essence of the method lies in the fact that the role of the resource are shares ("stake"), which determine which node will currently receive the privilege of receiving the next block. In this approach, the nodes try to hash the data to find a result that is less than the specified value, but the complexity is distributed proportionally and corresponds to the number of tokens of the particular node.

Thus, it can be concluded that the highest chances of generating the next block reach the node with the highest balance (number of tokens). You can also see that the system controls itself, because every time a transaction occurs, the blockchain goes through validation, meaning that it is validated as to whether a block with an unknown transaction with no history has appeared - that is, with an attempt at fraud or unreasonable issue. In the absence of blockchain validation, such a transaction is not carried out.

Compared to the traditional banking system, where the correctness of the transfer is certified by institutions that, moreover, can be mistaken or can be deceived, the authenticity of the blockchain is confirmed by other blockchains that participated in its history (i.e., formed its chain). Thus, it will not work (the bitcoin history confirms this: all the attacks were in one way or another connected with the storage places of the bitcoins, i.e., with the keys to access them, but not with the blockchain).

One of the goals of the blockchain was to create an “electronic payment system based on cryptographic evidence instead of trust, allowing any two interested parties to directly make transactions with each other without the need for a trusted third party and solving the double cost problem” [6].

Before the advent of blockchain technology, the only option was to use a centralized database (book) in which all digital transactions are recorded. This problem created the need to find a trusted third party - the banks that we use for money transfers. This process is shown in Figure 1.1.

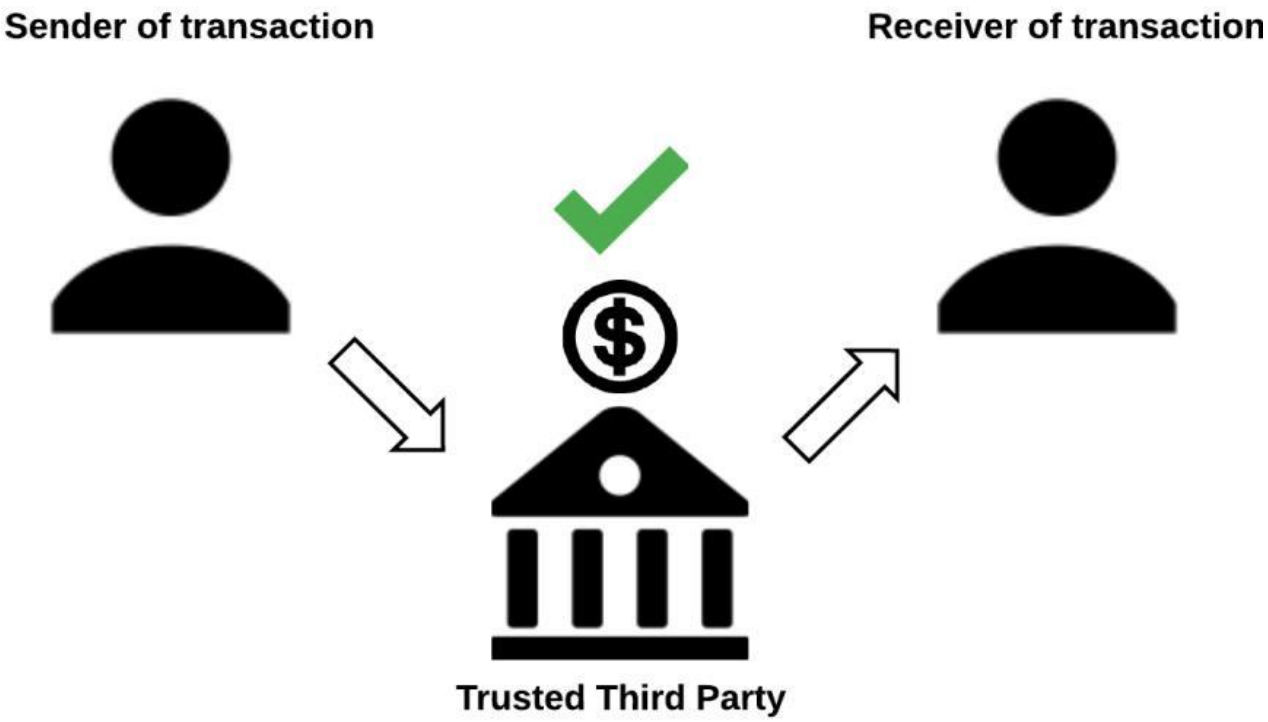

Figure 1.1. Centralized transaction

The sender transfers the transaction to a trusted third party, (bank) at the time of the financial transaction. The Bank verifies that the sender of the transaction can send coins to the recipient, thereby confirming the transaction. This transaction is recorded in the centralized database of the bank and the coins are transferred to the recipient of the transaction.

Using the blockchain technology, this trusted third party is no longer needed, because it does not centralize this book, but decentralizes it. This means that all digital coin users have access to this book. The blockchain transaction process is presented in Figure 1.2 and is explained below.

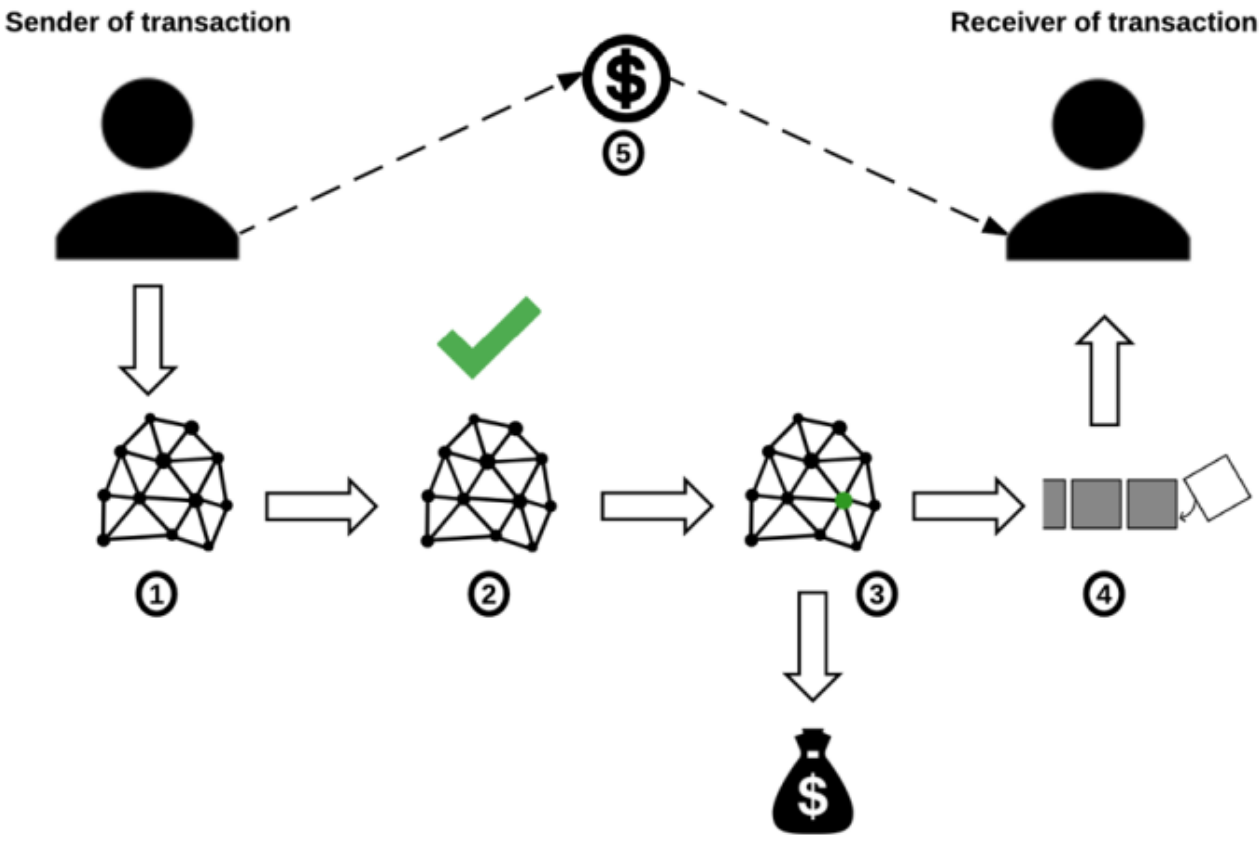

Figure 1.2. Decentralized blockchain transaction

1. The sender of the transaction transfers the transaction to all nodes of the network;
2. These nodes verify all transactions made on the network and confirm that the assets are not doubled. Only if there is consensus on the network, is the transaction approved by the network;
3. Since this process requires computational power, an incentive is needed for the verification process. Nodes that verify transactions try to combine all verified transactions into one package by solving a cryptographic task. The winner of the competition is rewarded with several coins. This process is called mining and provides cryptographic evidence on the blockchain;
4. Then this node (node) places the transaction package - block, on the blockchain;
5. This updates the decentralized database and transfers coins from sender to recipient.

Currencies that use blockchain (and therefore these cryptographic algorithms) are called cryptocurrencies. After the introduction of blockchain technology in bitcoin, other cryptocurrencies appeared, for example, DogeCoin and Litecoin.

This system is organized in such a way that every member of it constantly checks the information that comes to him. As a result, any transaction confirms the integrity and authenticity of the materials stored on the network. This guarantees the preservation and accuracy of information [3]. In addition, encryption guarantees that copies of the distributed blockchain are synchronized to all users. Thus, one of the most important functions of technology is establishing trust between users because the information cannot be forged, and at the same time it is accessible to everyone and everyone is responsible for himself.

Smart contracts are essential fragments of computer code that are executed on this decentralized global computer, based on blockchain technology. A smart contract is defined as “a mechanism using digital assets of two or more parties, where the assets of some or all parties are automatically redistributed between these parties according to a formula based on certain data that were not known at the time the contract started.”

Smart contracts allow you to exchange money, property, stocks or other assets without resorting to the services of intermediaries.

In order to conclude an ordinary transaction, you need to go to a lawyer or a notary public, pay and wait for the paperwork. Smart contracts work like vending machines: you simply drop Bitcoin into the machine (that is, into the registry), and the contract, driver's license or any other service that you ordered from a third party falls into your account.

In addition, unlike traditional agreements, smart contracts not only contain information about the obligations of the parties and penalties for their violation, but they themselves automatically ensure that all the conditions of the contract are met.

Figure 1.3 shows the technology for using blockchain with electronic money as an example.

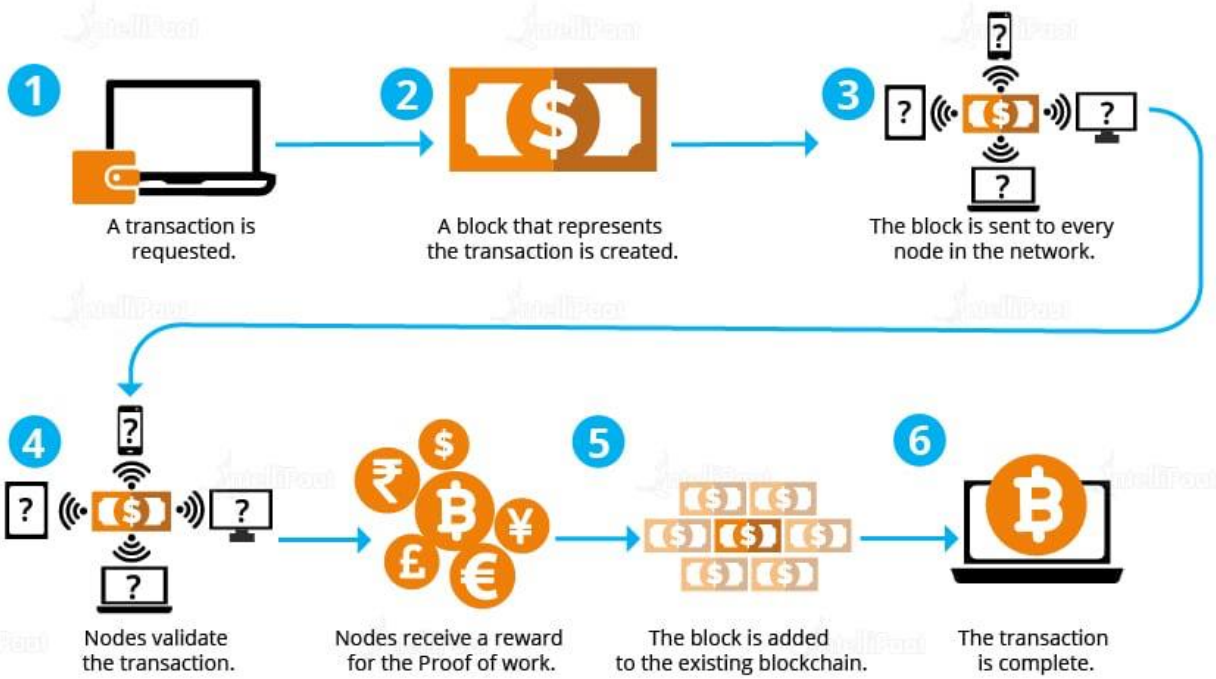

Figure 1.3. Blockchain technology (using electronic money as an example)

Thus, the key innovative advantage of blockchain technology is the architecture of a new decentralized system that does not require the trust of transaction participants, which allows for various transactions (of any type and between all parties) on a global basis.

Blockchain technology has many significant advantages, including the following:

– invulnerability for hacker attacks;
– information security;
– solving the problem of double costs;
– reduction in transaction fees;
– increase transaction speed.

First of all, an inextricable and interdependent chain transactional blocks can resist hacker attacks, since each subsequent block is connected to the previous one using a robust cryptographic algorithm based on the blocks that go in front of them. Transactions are encrypted with two keys (public and private), which

provide security. Therefore, it is almost impossible to change or delete blocks, since such actions lead to the receipt of another digital signature, which is considered as a signal of a system error. Every 10 minutes, all completed transactions are checked and recorded in a block that connects to the previous one, forming a chain of blocks.

Secondly, the blockchain technology is decentralized, which means that information is not stored in one database, which can be hacked. Instead, it is distributed around the world to ensure that no person or company controls a tangible or intangible asset that is encrypted within the block, which does not allow cybercriminals to control the community of holders of virtual currencies. The ledger is distributed among all participants in the P2P network, so there is no central database that can be hacked. Data is stored by all system clients. Therefore, adding a new block to the chain must be approved by all computers that are connected to the system (otherwise, such an operation will fail). This advantage guarantees the security of the information stored in the chain: if a third party tries to log into the system and remove or change any block, network computers will instantly restore information and stop the hacker. Moreover, if a hacker wants to steal just 1 bitcoin, he must rewrite the entire history of the blockchain, which is almost impossible.

It should be noted that the system registers transaction times, which solves the problem of double expenses: it is impossible to re-spend the already transferred amount.

In addition, since the blockchain does not need an intermediary (for example, a bank), transaction fees may actually be lower than in traditional payment networks.

Finally, blockchain may offer the opportunity to significantly accelerate the pace at which transactions will be settled. Traditional banks may spend several days verifying the transaction. Not to mention the fact that financial institutions operate only during business hours. In the meantime, transactions on the blockchain are checked 24 hours a day, seven days a week, which can lead to

transactions being settled much faster than with the current payment system (or even instantly).

Blockchain allow you to send any value to any place in the world where a blockchain file will be available, provided a private key created using a cryptographic algorithm is allowed to allow only those blocks owned by a particular person.

1.1.3. Organization types of blockchain technology functioning

Blockchain, which has been widely used in various fields, can be built according to three types of protocols: public, private and combine. To understand the difference between public and private block chains, we need to compare the Internet, which is publicly accessible and intranets, which are created by certain companies and are accessible only to certain persons with permission.

A public or public protocol is the one which can be read by any user, each of whom has the right to make transactions. The operations are protected by cryptographic verification mechanisms, such as proof of work or proof-of-stake.

The public blockchain is controlled by the entire community of network members - developers, users, service providers, and participants - contributing to the integrity of the network and its convenience. Network performance is achieved through protocol updates that prevent malicious changes. That is why the system allows you to create decentralized applications with a minimum of maintenance costs.

Public blockchain also provides a way to protect application users from developers, limiting the ability of the last ones. In public blockchain applications, the developer cannot change the code or data by itself. If Thomas Schelling's words were interpreted, the weakness of the participants could be a great advantage to them.

In addition, public blockchains have network effects. The first users of applications built on a public blockchain are most often users of other applications

on the same blockchain who have learned about them through the effect of program interaction. For example, a mobile wallet that runs on a public blockchain can add a feature to interact with this application with other distributed applications on the same blockchain, greatly expanding its intended user base.

Blockchain-based solutions form a secure and naturally decentralized transaction processing framework. Bitcoin-blockchain is currently the safest public blockchain in terms of the cost of attacks on the system. In a public environment, the cost of an attack is proportional to the remuneration of the block creators, which in the case of bitcoins is approximately $ 2.1 million daily. At the same time, the cost of maintaining security is relatively small and is shaped by two factors: transaction fees and controlled inflation of the money supply (about 7% a year in 2016). [6]

One of the main advantages of blockchain over other distributed database models is the integration of information processing, tracking of correctness and security in a single protocol that minimizes the impact of the human factor.

The benefits of public blockchains, in particular, their transparency and openness to basic technologies and protocols, can lead to technology replacing many of the functions of traditional institutions, changing the principles of variety social systems.

Private blockchain is a technology that creates blockchain centrally, and all the rights to conduct such transactions belong to one organization. The general public can only read information - audit, but only trusted nodes can manage bases and other applications.

Private blockchains have certain advantages:

1. Low transaction cost because validation is done by trusted and high-performing nodes instead of tens of thousands of custom devices, as in the case of public blockchains. [7]
2. Blockchain can be set so that TPS (TPS - transactions per second) will be much larger than within public networks (at least in the near future). The

only limitation in this case is the throughput of the weakest node in the network. [7]

Another advantage of private blockchains is greater control of the system by the company. The point is that a private blockchain, for example, allows you to quickly update functionality. Therefore, it is attractive to institutions that work with registers and accounting systems because it creates a controlled and predictable environment, compared to publicly available blockchains.

Moreover, building blocks in a private blockchain often does not require proof-of-work. The blockchain protocol used in the BitShares project is an example. There is a set number of transaction handlers N, each of which has a key pair - secret and public. In this case, the creators of the blocks are known and determined by the digital signature in the header.

Operators form blocks in turn at predetermined time intervals. The block creation order is either fixed or mixed after a complete cycle (N blocks). If the operator is unable to form a block in the allotted time, he skips the round. If this behavior is the result of the attackers, then the situation is investigated. Thus, if transaction handlers are the only users of blockchain data, you can build a robust blockchain protocol (for example, complicating the algorithm above slightly) that will not use proof of operation. [7]

Although private blockchains may not use proof of operation, this protocol can still be connected to enhance security, simplify auditing and, as a result, increase system control for end users. This proof of work translates trust in the blockchain from subjective (trust in the system is equivalent to trust in its controlling organization) to objective (trust in the system follows from mathematical laws and is guaranteed a high economic cost of attacking a system that is independent of the attacker's personality).

"Private blockchain provides exciting business opportunities by enabling transparent technology for internal use," says Dan Wasyluk, Syscoin chief executive. "If contracts are worked out, technology can replace the many

centralized businesses that exist now." That is, private blockchains can become the basis for blockchain innovation in services using registries. [10]

Another example of a private blockchain is Citigroup. It has built three blockchains and a domestic currency based on them to minimize risks when interacting with other banks. It turns out that both public and private blockchains are capable of finding application in many industries. [10]

Combined blockchain - the type of blockchain in which identification occurs in networks, as well as the admission of network clients to certain information disclosure groups, for example, viewing their and/or other people's transactions and/or only headers, while there is a controlling body that sees the full information. The advantages of this type of blockchain are more reliable protection against hacker attacks, and the presence of a regulatory body, which is very important for the state, as this counteracts the proceeds of crime and the financing of terrorism. [11]

A more detailed comparative characteristics are presented in Table 1.1.

Table 1.1.

Comparative characteristics of blockchain types

	Blockchain type		
	Public	Private	Combined
Description	No Authentication	Identification of network members	Identification of network members
	No user restriction	Admission to participation in the network of a narrow circle of persons	Admission to the network according to certain rules
	No supervisory authority	There is a regulatory authority	There is a regulatory authority

One way or another, the complexity of business processes in the modern world entails the need for a clear and fair apparatus for their regulation, which will ensure that third parties do not have the opportunity to intervene in the execution of the contract and reduce the risks of ambiguous interpretations of the terms of the contract. The idea of introducing such a technology, called a “smart contract” was first proposed and described by the American programmer Nick Szabo in 1994. However, at that time for its practical implementation there were no necessary technological means. Today, the topic of smart contracts continues to be studied by Paul Vigna, Michael J. Casey [12], Melanie Swan [13], A.A. Barinova and S.V. Zapechnikov [14] and others.

A smart contract is an agreement between two parties stored on a blockchain. Parties to such an agreement can be people, in other words, peer-to-peer (P2P), a person and an organization (P2O), or a person and a machine (P2M). Using smart contracts allows you to automate payments and transfers of currency or other assets as agreed terms. When the conditions specified in the smart contract are met (for example, the sale of goods “1” on the exchange “2”), the contract is automatically executed and assets (for example, cash, ownership, digital currency, data) are exchanged between the parties to the contract. Smart contracts allow you to exchange assets without participating in the transfer of a third party. Thus, it becomes possible to disintegrate the entire legal system and create a new form of virtual agreements.

However, from a legal point of view, smart contracts cannot yet be considered as ordinary contracts. Nevertheless, they can be used as evidence of solving a particular problem, therefore, numerous industries are studying the potential for the application of such contracts. Nevertheless, experts see the widespread use of smart contracts only in the distant future, because now the technology is at the experimental stage and has not yet matured for the appearance of market products, despite some attempts at their implementation [15,16].

In a short time, blockchain technologies have gone from an idea to a tool that they seek to study and use in all areas. This indicates the uniqueness and

relevance of the blockchain, and only strengthens the belief that in the future the technology will reveal its potential even more.

After reviewing the technological capabilities of blockchain technologies, the following features can be distinguished:

- lack of a common central server for storing information;
- information is distributed and contained on the computers of all users of the blockchain networks
- there is a chronological inextricable link between each data block (each transaction) with the previous and subsequent blocks;
- any user has access to the data of the blockchain system;
- all data using mathematical algorithms are combined into blocks forming chain from start to end block;
- each data block contains a hash of the previous block, confirming the fact the availability of such information;
- anonymity of the sender and recipient of digital money (digital transactions) stored in the blockchain network is attractive to the criminal-corruption world, which slows down the development of technology.

Blockchain technology benefits

Blockchain technology positively affects the solution of key tasks of supply chain management, including the reliability, stability and flexibility of the supply chain [29].

The following advantages of using blockchain in supply chain management can be distinguished:

- reduction of logistics costs throughout the supply chain;
- reduction of systemic risks in operations [30, p. 31];
- improving the safety of goods, reducing losses in the process of delivery and storage of goods;
- ensuring transparency and reliability of information on producers (suppliers) of goods and the process of goods distribution;

- ensuring the complete anonymity of all transactions in the event of the implementation of closed decisions [31, p. 50];
- achieving a high degree of flexibility in the supply chain;
- a high degree of protection of information flows within the logistics system;
- providing unlimited storage time for permits and accompanying digital documents, including certificates, licenses, confirmations of payment of excise taxes, etc. [32, p. 13];
- increasing the speed of customs processing of goods during international trade;
- ensuring closer relationships and coordination among all participants in the supply chain;
- ensuring consumer rights by providing complete and undeniable information about the origin of goods received by the retail network;
- decrease in the share of gray imports;
- increased opportunities for the development of fair trade and green logistics; • reduction in the number of diseases associated with the consumption of low-quality, infected food products;
- applying a dynamic strategy pricing in the service sector, which can be built on the basis of real data, for example, taking into account the real speed of delivery, climatic conditions, etc.

For market entities that illegally produce goods, the blockchain will become an obstacle to further unfair entrepreneurial activity.

The use of blockchain technology will also simplify the process of state administration of the supply chain and will contribute to the implementation of state policy aimed at reducing the level of counterfeit products and improving the quality of goods entering the retail network.

A study conducted by DHL [33] emphasizes that the development of the global logistics system is associated with the development of a sharing economy.

In the framework of joint consumption, it is the use of blockchain technology and the introduction of smart contracts that help ensure transaction transparency.

Barriers to the development of blockchain in supply chain management

The results of the study show that foreign and Ukrainian experts equally evaluate the obstacles to the implementation of blockchain technology. The main obstacles they consider:

- the inability to assess the economic efficiency of introducing the blockchain system in the activities of organizations, as well as directly in the process of organizing goods distribution;
- lack of understanding of the essence of the blockchain and the features of its implementation by decision makers;
- the need for reengineering business processes;
- the need for additional investment in the design of new supply chains;
- insufficient number of qualified personnel in the field of blockchain;
- the need to integrate technology being implemented with existing technology platforms.

To sum up entrepreneurs and authorities are constantly finding new ways and means of applying blockchain technology in the modern economic system. Blockchain in supply chain management is a technology that allows transactions between equal participants in a single network in the process of managing material, information, financial and service flows.

Over the past two years, key projects for the application of blockchain technology have been implemented in the field of food supplies (vegetables and fruits, livestock products, fish and seafood). In the coming years, the scope of the effective application of blockchain technology in supply chain management will expand. Blockchain technology will cover both the supply of food and non-food products; first of all, this will concern goods for which a high proportion of counterfeit and substandard products is observed.

Further research in the field of blockchain in supply chain management will be interdisciplinary in nature and cover such areas of scientific research as

information technology, management, logistics and supply chain management, finance, law.

The highlighted features and advantages of blockchain technologies make their application relevant for many areas.

1.2. International experience of using Blockchain technology

Spheres and areas of application of blockchain technology in the modern economic system are constantly expanding. The largest multinational corporations give priority to digital technologies and make capital investments in relevant developments, including the creation of a blockchain system and its implementation in the construction of the supply chain. Such companies include the manufacturer and supplier of hardware and software IBM, Walmart distribution network, Amazon's online trading leader, multinational companies such as Unilever and Nestlé, UPS, freight forwarding company, etc.

Blockchain is expected to have a wide impact across retail organizations, with a high level of impact anticipated in finance (44%), IT (44%), operations (44%) and data management (39%) functions (see Figure 1.4). This is consistent with the notion that respondents often said they expect that blockchain will yield benefits in improved data management (52%), process automation (43%) and cost efficiencies (40%) (see Figure 1.5).

As retailers struggle to do more with less in a margin-squeezed environment, the potential for block- chain to reduce operating costs is one of its principal attractions. Blockchain adoption will result in cost savings of more than 2.5% according to 82% of respondents, while 36% said they believe the savings will be greater than 5%. Much of the cost savings could result from automation, with 76% of respondents predicting that blockchain will allow their organization to automate more than 2.5% of its jobs.

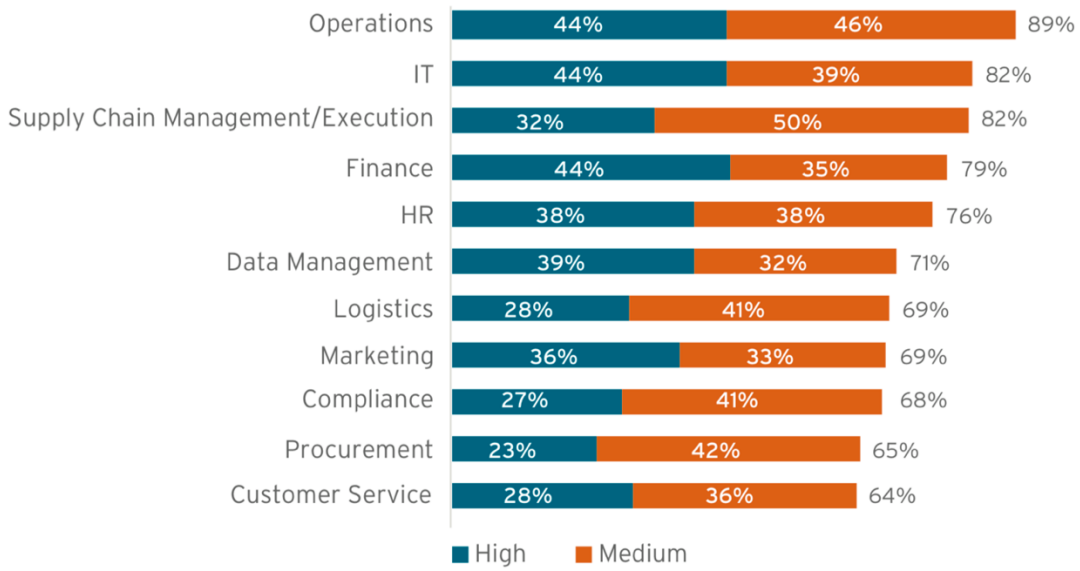

Figure 1.4. Blockchain Impact on Business Functions

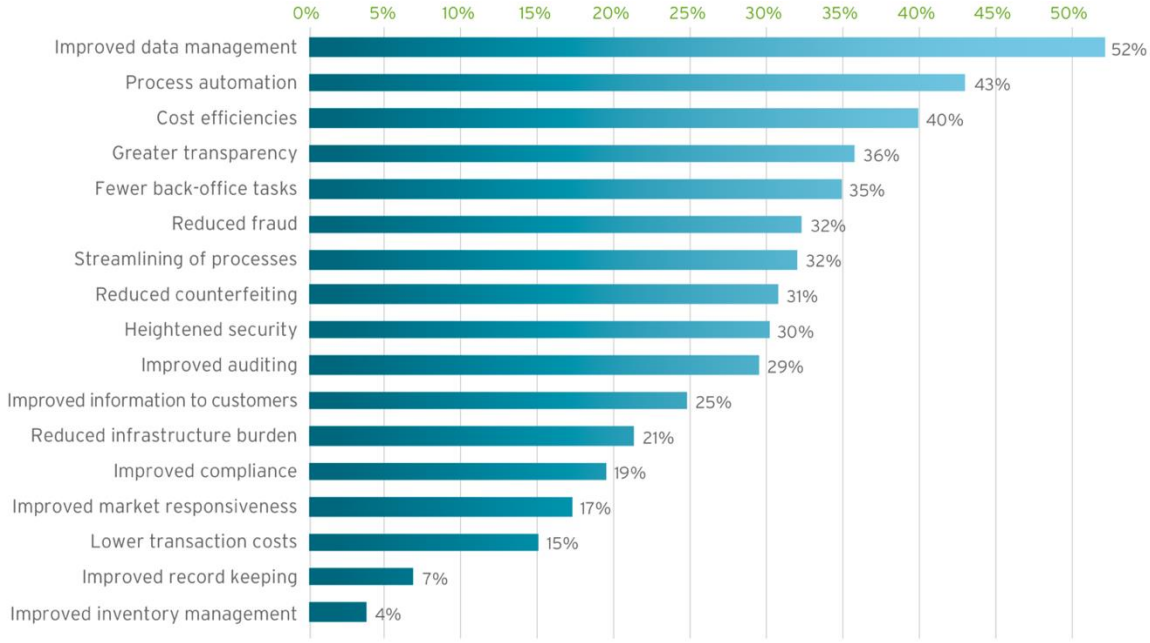

Figure 1.5. Expected Benefits

As a result of the analysis of the full-text database of foreign publications on ScienceDirect, we can conclude that the number of articles with the results of research on blockchain technology is increasing annually. If in 2016 there were 17 such publications, then in 2017 their number reached 72. It can be stated unequivocally that the number of studies in this field will constantly increase, and exponentially, due to a high degree of demand - Details of new business technology in various industries and fields of activity.

Based on a review of articles of scientific publications published in Ukraine and abroad, it is possible to establish the main areas of research in the field of blockchain:

• theoretical and methodological aspects of blockchain research, determining the essence and mechanism of construction;

• advantages and risks of using blockchain, impact on increasing the business activity of business entities;

• blockchain as the basis for the development of smart contracts in entrepreneurial activity [25];

• legal regulation in accordance with regulatory legal acts related to the use of technologies and the allocation of resources (does not require revision);

• application of technologies in state and commercial spheres, including in various industries and fields of activity.

Agreeing with the results of the research of D. V. Efanov and P. G. Roshchin [26], three successive stages of the development of blockchain technology can be distinguished.

Initially, the blockchain among entrepreneurs was associated only with the financial sector, in particular with the circulation of cryptocurrencies. Currently, there has been a steady increase in the number of branches of application of the analyzed technology. In our opinion, it is possible to talk about the implementation of blockchain in the supply chain management process at the stage of "blockchain 2.0". It is at this stage that the number of areas of application of the analyzed technology is constantly growing. Regardless of the scope of the blockchain, it is possible to achieve low risks of data loss due to the distribution of the system.

The blockchain allows you to track all movements of goods and record all the links in the supply chain, as well as provide undeniable evidence of the country of origin and the logistics processing of goods.

We will analyze the advantages that blockchain provides for participants in the supply chain.

1.2.1. Blockchain Technologies in Supply Chain Management

Blockchain-based applications can be used by chain retail stores to track the movement of their orders. In this system, you can place and study information about the processing time of a shipment, about the date it was received at each point on the way. In addition, it is permissible to monitor many parameters: storage temperature in a particular room, product status, list of responsible persons. Such transparency of the whole process reduces the risks of loss, theft, damage to parcels and cargo. Wave is one of the best-known companies in this market, supporting all kinds of delivery journals in a paperless environment. This type of blockchain-based software is likely to become very popular soon.

One of the first blockchains in trade was used by the world leader in retail trade - Walmart. In 2016, she launched a pilot project on the use of blockchain technology in the supply of pork from China. In addition to Walmart itself, Tsinhua University in Beijing and IBM participated in the project to improve the tracking system for goods transported from China. The next example of the application of blockchain technology by Walmart, a trading company, is the supply of mangoes from Mexico.

In 2018, France-based international retail trade network company Carrefour announced the expansion of the use of blockchain technology [27]. Buyers were offered the opportunity to track the entire chain of movement of livestock products and vegetables. By reading the QR code posted on the product, using a smartphone, the consumer can find out all the details of the origin of the goods, their transportation and storage.

After analyzing the practice of using blockchain in various fields of activity based on the data presented on the CHAINSTEP website, we can conclude that supply chain management and logistics are the areas of activity where the blockchain has the greatest development potential. So, as of March 10, 2018, out of 453 cases of introducing blockchain technology, 61 projects are in the block

“supply chain management, transport, logistics” (while the largest number of projects is still related to finance - 116) [28].

A number of multinational companies (IBM, Walmart, Nestlé, Dole, Tyson Foods, Kroger and others) agreed in 2017 on cooperation aimed at studying, using and further developing blockchain technology to track the movement of food products throughout the supply chain.

The development and testing of a blockchain trading platform for the global logistics industry, developed by IBM in conjunction with the world leader in container shipping, the Danish company Maersk, is also underway to create a digital trading platform built on open standards and designed for use by the entire global logistics ecosystem.

The international Blockchain consortium Hyperledger was launched by the Linux Foundation in 2015 and currently unites more than 115 companies from various fields, including finance, automotive, healthcare, IoT and aviation. The main goal of the consortium is to create a single open-source blockchain platform that will allow organizations around the world to implement blockchain technology in their business processes.

Transparency of the supply chain will also benefit end users, who can verify the safety of the product, its freshness, the absence of GMOs and undesirable additives. Or you can find out for sure that the purchased tuna was not obtained by poaching - just to protect itself from such accusations, blockchain began to use the British startup Provenance. The company uses blockchain technology to track the movement of tuna, controlling its fishing and delivery.

EverLadger uses the blockchain in the supply chain to validate the source of the diamond trade.

The startup Assetcha.in with the help of blockchain increases the safety of storing valuables.

Midasium, with the help of blockchain, concludes on-line lease agreements for housing in the real estate market.

In Australia comprehensive testing of the blockchain-based architecture of the TBSx3 security system was conducted, which is able to provide a whole new level of protection for global supply chains.

The Table 1.2 shows the current projects for the application of blockchain technology in supply chain management.

DP World, DB Schenker, Hamburg Süd and the Australian wine company IUS successfully completed testing of blockchain technology in the intermodal delivery chain from the Kunavarra region (South Australia) to Qingdao's Chinese port using road and sea transport (chain length 8100 km). The development is based on a 44-bit alphanumeric cryptographic coding adopted in the military-industrial complex (as opposed to the publicly used 6-digit digital cryptography).

Table 1.2.

Examples of the use of blockchain in supply chain management

Project	Brief description
EverLadger https://www.everledger.io	Tracking the source of diamonds. The company was founded in April 2015 by L. Kemp (Leanne Kemp)
Service Ripe.io - tracking the supply of agricultural products ("from the garden to the plate") http://www.ripe.io	The system records the ripeness, humidity and temperature of the products. The farmer can monitor what is happening with his product on the way, adjust the collection and delivery system based on the data received, and most importantly, always know in what condition his client received the products. The service is based in the United States by entrepreneurs R. Ramachandran (Raja Ramachandran) and F. Harris (Phil Harris)

Continuation of the Table 1.2.

Provenance - tracking food supplies to stores and restaurants http://www.provenance.org	Currently, over 200 retailers and manufacturers UK food and beverage companies use Provenance software to validate the origin of their products. Users have the ability to track the movement of food products from production until they hit the shelves. You can not only check the quality of the goods, but also find out whether it is produced legally
IMMLA - international multimodal logistics application http://immla.io	A logistics solution that combines instant consideration of applications and the conclusion of contracts for multimodal transportation on the basis of the best price. It provides interaction between the cargo owner and the carrier at all stages of the cargo transportation process based on the Etherium blockchain and smart-contracts. The founders are SBSolutions (an IT company with a focus on logistics), as well as the leaders of the logistics industry Global Transport Investments and Hellmann Worldwide Logistics

The creators of TBSx3 plan to continue multilateral testing of the system and hope to establish a new global standard for global supply chain security. Audit and consulting company KPMG confirmed the authenticity of goods throughout the supply chain, and also checked whether the system could potentially detect falsification.

As follows from the table, blockchain technology in the field of logistics can be applied both on individual domestic markets and internationally.

Blockchain in supply chain management is mainly used in the following main functional areas: documentation of logistics operations, conclusion

agreements and enforcement of other multilateral agreements, cargo tracking, financial support for the logistics process, etc. In 2017 - early 2018, pilot projects for the application of blockchain technology were launched in the field of food supplies of such groups of goods as vegetables and fruits, livestock products, fish and seafood. In our opinion, this trend will continue in the next two years, but at the same time the scope of the effective use of blockchain technology in supply chain management will expand.

Based on the analysis of cases in the field of application of the blockchain in supply chain management, one can formulate the principles that are recommended to be followed when forming a strategy for introducing the blockchain system in organizations:

- Target orientation. The goals and objectives of the implementation of the new system should be clearly defined, their compliance with the strategic goals of the organization. The system to be implemented must comply with the specifics of the business;
- Systematic and market orientation. Coordinated interaction of all participants in the supply chain during the implementation of the blockchain system, taking into account constantly changing environmental factors;
- Cross-functionality. Within each organization, all departments involved in the process of building a new relationship system should be involved in the development and subsequent management of the blockchain system;
- Economic expediency. Profit from the implementation of the blockchain system in the supply chain, an increase in sales and turnover, an increase in the capacity utilization factor of the organization.

1.2.2. Features of blockchain technology implementation in Ukraine

At the end of the twentieth century the information revolution has begun. It has so expansively entered into the life and professional activity of people, that it is impossible to imagine life without information technology [34]

On December 9, 2014, Digital 5 (D5) was launched in London. It is a union of leading digital powers (Estonia, Israel, New Zealand, South Korea, UK) to develop the digital economy. The governments of these states have undertaken to transform government relations with technology through support for open standards and open source software code, as well as enhancing the effectiveness of digital government. Digital 5 participants identified the main ones principles of digital development: user needs; open standards; source code; open markets; open government (transparency); opportunities connection; teaching children programming; availability of digital services; the obligation to share and to learn [35]. These principles may be supplemented and refine to meet new challenges and information technology capabilities.

Wide application of the latest innovative approaches and technologies have led to a transformation forms and methods of activity of legal entities to increase their functionality, protect data and reduce costs. With each the number of public and public entities increases private law is used to increase their efficiency and effectiveness modern information and telecommunication technologies (hereinafter - ITT), namely: Internet of Things, Cloud Technology, Blockchain, Mobile ID, Big Data.

In February 2018, the United Nations Global Compact initiative published The Global Opportunity Report 2018, which outlines, that “Blockchain technology and artificial intelligence is the foundation of two of the four best opportunities this year” [37]. In addition, the report from the research institute IBM Institute for Business Value "Strengthening confidence in the government" states that "nine of ten heads of state plan to invest in 2018 to develop Blockchain technology in the

field financial transactions, asset management, contract management and regulatory compliance" [36].

Implementation of the world's best practices e-government allowed Ukraine [39] in January 2018 to be on the list of 14 countries in the world (Australia, Brazil, United Kingdom, Georgia, Estonia, Israel, Canada, China, Germany, United Arab Emirates, United States America, Ukraine, France, Sweden) [40], which are recognized blockchain technology leaders.

Blockchain technology is mainly used in the banking, financial and insurance sectors. However, its potential impact and use in public administration has not yet been fully explored.

British researcher Melania Swan in the book 'Blockchain: Blueprint for a New Economy' [38], considering the current and potential technological aspects of blockchain, identifies the stages of technology evolution: blockchain 1.0 is the currency. Cryptocurrency is used for digital transfers and payments. Blockchain 2.0 provides the ability to handle different types of financial transactions, in particular

transactions with securities, shares and interests of companies, crowdfunding instruments, debt obligations, pension funds and derivatives (forwards, futures, options and swaps); blockchain 3.0, which extends beyond the economic and financial spheres and extends to government, healthcare, science, education, culture and the arts [38]. The Blockchain technology development stages can seen on the Figure 1.6.

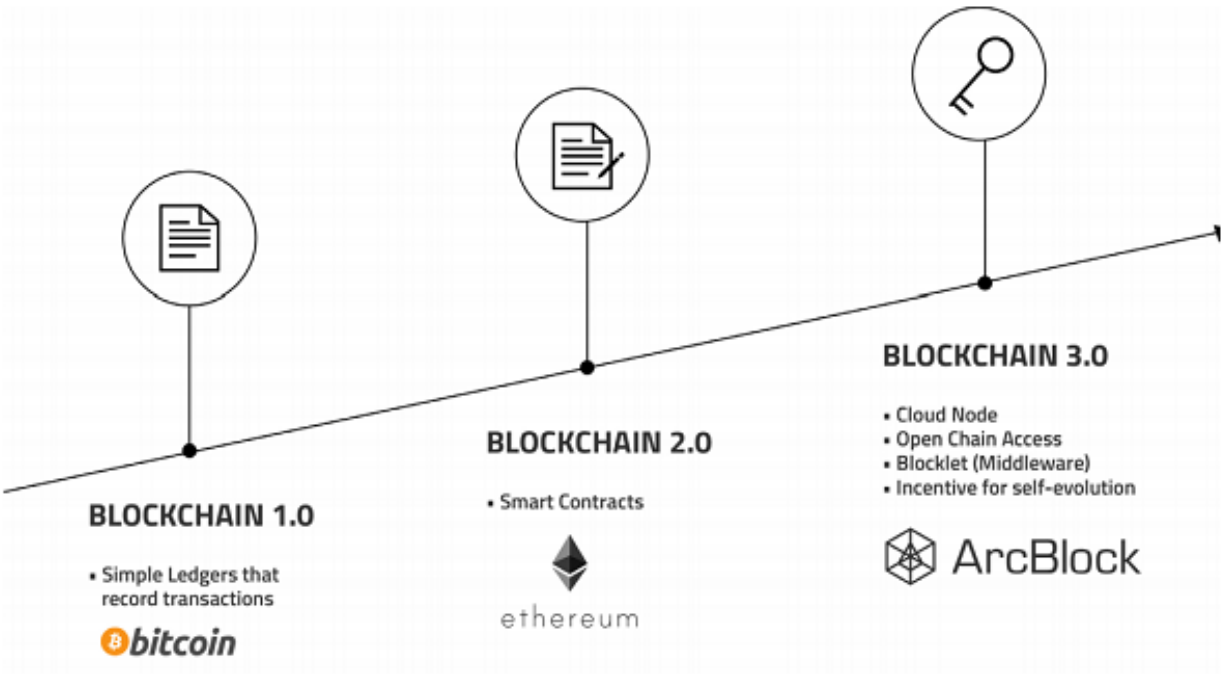

Figure 1.6. The Blockchain technology development stages

In an ideal model, according to O. Simson, when blockchain technology is introduced into the legal field - control by banks, government bodies, auditors and other financial market entities is unnecessary; there is no need for lawyers, notaries and guarantors of obligations [47]. However modern states and large corporations are only trying to actively use blockchain to improve service delivery, control and data protection in areas such as digital currency/payments; registration of land ownership; election; HR; supply tracking; health care; proxy voting; corporative management; taxation; management of accounting data [51].

One of the most common applications of Blockchain is the keeping of land registers. In 2017/2018 increased number of states (Bermuda, Honduras, Georgia, Rwanda, Brazil, Sweden, Andhra Pradesh in India, South Burlington in Chittenden County, Vermont (USA), Japan, Dubai city in the UAE) working on the implementation of land and property registration systems rights based on Blockchain. However, it should be borne in mind that all cases of registry building based on blockchain technology still function as pilot projects. Officials are introducing this technology to improve registration processes property rights, reducing the time to conclude and register land ownership agreements sites,

making fraudulent acts and mistakes during the registration process of the relevant rights impossible.

In today's realities, the idea of applying blockchain technology into society is very popular according to I.M. Doronin, due primarily to the general distrust of the activities of state bodies, which must keep such registers, protect the rights of owners and keep information in an unaltered state [52].

The first pilot projects in Ukraine that use the storage and data protection system of Blockchain are electronic land bidding, the work of the State Land Cadastre [42], the State Register of Property Rights for real estate and the "Electronic auctioning systems for seized property" ("SETAM") [41].

May 27, 2017 The Cabinet of Ministers of Ukraine has approved Ministry of Justice State Agency proposition for Electronic Governance implementation of measures aimed to implement the Blockchain data storage and protection system in the work of the State Register of Real Estate Rights and SETAM [41].

On June 16, 2017, a Memorandum of Understanding and Cooperation was signed between The Ministry of Justice of Ukraine, the Ministry of Agrarian Policy and Food of Ukraine, State Agency for Electronic Governance of Ukraine, Transparency International Ukraine and Bitfuri Holding BV (hereinafter - Memorandum) for forming and maintaining land cadastre and other state registers based on blockchain technology [54]. The signing of the Memorandum is a necessity introduction of this technology as a mechanism for preventing corruption, promoting state transparency information resources, creating a favorable environment for information development in Ukraine, improving the dialogue between business, citizens and government, improving investment climate for the development and support of innovative technologies, as well as increasing public confidence in public services in Ukraine.

For practical implementation of the Memorandum provisions and implementation of digital transformations in Ukraine the following is envisaged: the use of blockchains for the formation and maintenance of priority state electronic information resources state registers and the state land cadastre, to

ensure protection against manipulation both internally and externally; introduction of electronic services for citizens and businesses using blockchain technology; implementation of electronic auctions based on this technology for the sake of ensuring a high level of transparency and confidence in the realization of public and private assets; formation of open and transparent architecture of state electronic information resources and state land cadastre based on blockchain technology; developing a blockchain development methodology in the public sector [54].

On September the 6th, 2017, the first electronic auction was conducted using the Blockchain technology [46] in the "Electronic auction of seized property" system.

The mechanism of operation of this technology is as follows: information supplied to the system is stored on several servers and placed on a public server. So everyone can watch the bidding process in real time without the risk of data loss. You can check the information about each step of the auction by copying the transaction hash code and pasting it in the appropriate field at www.blockchain.gov.ua. The system therefore issues a complete list of bids: volume, size, date (when the bid was made) [39].

On September the 3rd, 2017, 24202 auctions were conducted using blockchain, including 4471 successful ones. Total sales amounted to UAH 692 million. All auction bids have been hashed and saved [50].

The state land cadastre became the second project in the public sector of Ukraine, where blockchain technology has been applied since September 2017 [40]. Information about each operation performed, which happens in the cadastre, gets into a chain blocks according to a given algorithm. From now on, every document certifying ownership of land, supported by a QR code that encrypts everything location, size and owner information specific land plot. Using the code you can identify the authenticity of one or the other document and just verify the information in the registry. The cadastre will be able to make changes to the

cadaster specialists. To identify people who can change land information in the inventory, an electronic signature or bank ID is used.

Initially using blockchain technology in the field of registration of land contracts there is a likelihood of problems with the initial identification of land owners, as the information entered in the blockchain registry itself is not accurate. Blockchain guarantees the immutability of data, not their truth, because of this system can only be used to test or provide extracts as to whether it is a forgery. However, the accuracy of the data presented in such an extract cannot be verified [53].

Therefore, for the transition of the state system to blockchain technology is important to develop legally verified and border-controlled mechanism for transferring offline data to state registers. Effective work depends first and foremost on accuracy filling in the registers of citizens, real estate, companies. The point is that there is no support for data integrity in situations of accidental failures or attacks, nor prevention Data manipulation is not a major challenge for public IT systems. The real one danger is in the practice of registering deliberately unreliable data. It is obvious that here the blockchain service is powerless. It is just a tool [48].

In the Blockchain and Property in 2018: At the End of the Beginning Study, Michael Grazhlai and Christopher Mellon, given the level corruption in Ukraine and a lengthy registration process ownership, state: "If representatives of domestic authorities expect the blockchain – or any other technology will become a panacea, then they will may well be disappointed" [49]. Despite this, analysts have identified "reasons for caution optimistic that this project will work effectively": implementing blockchain technology in Ukraine is carried out by Bitfury company which already has relevant practice (in the field of land registration rights in Georgia); Ukraine has only recently introduced the land cadastre that is required to organize and place in the registry with blockchain; in Ukraine there are many programmers who can contribute improving government work in the e-government

system; the government of Ukraine plans to introduce technology blockchain in various spheres of public relations [49].

In addition to the practices discussed above, the use of blockchain technology in the public domain relations, in Ukraine is planned to introduce information and telecommunication support systems management decision-making and automation administrative processes (including the use of advanced geoinformation technologies, Internet of things, data processing technologies Big Data and Blockchain, in different volumes spheres of public relations: health care (creating basic medical registers, such as healthcare providers, medicines, institutions; introduction of electronic medical patient and electronic prescription cards; development integrated medical information systems for automation of basic processes of work of establishments health care, including the registry, doctors, laboratories, diagnosis, reporting, management, funding); ecology and natural resources (introduction of environmental monitoring system; introduction of electronic integrated permits in the field of ecology and natural resources; introduction of electronic water balance system of Ukraine); social protection (implementation of a single state register of social sphere and integration of existing disparate databases; introduction of electronic hospital; introduction of automation of data validation during destination assistance, benefits and other types social assistance; introduction of electronic employment contracts); elections (development and implementation of an information system for holding electoral process in electronic form) [45]. However, it is not yet known when these tools of electronic government are going to be put into practice.

When using blockchain as a modern technology for distributed data processing, in particular in the fields of state regulation and state registration of information, sooner or later there will be certainly need to solve a number of problems of a legal nature: the issue of state responsibility for the functioning of the system (in the case of classical blockchain technology no one controls the whole system) ; issues of incentives to support the functioning of the system by users; issues of information security (first of all from loss and distortion and

provision of long-term (practically lifelong) storage in open for use state). In any case, the implementation of distributed data processing technologies for management purposes the state will need considerable updating of the legislation and solving of very serious legal problems [43].

In Ukraine, there are attempts to legalize existing legal relationships in the field of blockchain technology. For example, on the 6th October, 2017, a draft law on cryptocurrency circulation in Ukraine was registered in the Parliament, the purpose of which is to regulate legal relations regarding the circulation, storage, possession, use and conduct of operations using cryptocurrency in Ukraine. This bill made the first attempt at the legislative level to define the concept of blockchain, namely: defined the terms "blockchain system" - a decentralized public register of all conducted cryptocurrency transactions conducted by the subject of cryptocurrency transactions, "blockchain system user" - any physical person, entrepreneur or legal entity, which, through its own and/or leased technical equipment, supports the blockchain system's performance, conducts cryptocurrency transactions and protects the blockchain system [44]. However, this project is general, contains only terminological definitions and superficially defines the status and procedure of conducting transactions with cryptocurrencies, not blockchain technology. Other domestic legislative initiatives on the legal status of cryptocurrencies have not identified the blockchain issue at all.

To conclude the practice of using blockchain technology in the fields of data logging, storage and processing demonstrates significant advantages over traditional information technologies. Blockchain provides highly effective mechanisms to protect the integrity and accessibility of information and allows you to create fully decentralized systems. Integration of blockchain-based solutions into e-governance enables you to transform, optimize and even automate administrative procedures in the public and municipal sectors in areas such as property rights registration, functioning of registers of documents (diplomas, certificates, licenses), migration control, identification of the person and other e-government services.

However, at the present stage, they need legal regulation: the legal status of the blockchain technology, the issues of storage, possession, use and conduct of transactions using this technology, the legal status of those responsible subjects for its functioning, the order of access to information in the system, the relations between the owners information and the system owner (between the system owner and the user), the conditions for processing information in the system, ensuring the protection of information in the system.

Further expanding the scope of blockchain technology in public relations will contribute to reducing the number of civil servants, eliminating corruption factors, de-bureaucratization of administrative services, and creating a favorable environment for improvement investment climate for the development and support of innovative technologies, as well as improving the dialogue between business, citizens and government in Ukraine.

Conclusions to the theoretical part

Thus, blockchain is a distributed registry technology that is a blockchain in strict sequence. This technology was first implemented in digital currency bitcoin, and then began to be used in many other areas.

Blockchain can be public and private. A public or public protocol is one that can be read by any user who is authorized to transact. At the same time, private makes blockchain centralized, and all the rights to carry out such operations belong to one organization. In this case, a large audience can only look at the data, and only trusted nodes can manage the databases and other applications.

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2. ANALYTICAL PART

Air Transportation Management Department				NAU 20.09.38.200 EN			
Researcher	Yarosh O.S.			ANALYTICAL PART	Letter	Sheet	Sheets
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Normative Supervisor	Shevchenko Yu.V.				FTML 275 ОІТ-202Ма		
Head of the Department	Yun G.M.						

2.1. Application of blockchain technology in the aviation sphere

Information collection and distribution by outdated system is a huge issue the aviation industry. With globalization reaching never before seen levels, the systems which exchange data are very outdated, timely and insecure. This is very concerning when we take into account that for the last 20 years there is nearly a 170% increase in outbound trips in the United States alone.

This is very good news for blockchain technology since it aligns perfectly with the characteristics of the aviation industry. The potential to streamline data sharing among information silos in airports will allow for the creation of a secure travel experience.

The aerospace industry is large, dynamic, and interconnected — and rapidly growing. Approximately 40,000 aircraft can reach demand for new commercial aircraft over the next 20 years. When aircraft manufacturing, operating, and service companies grow, they are pursuing AI, 3D printing, and other capabilities, innovations, and resources to allow them to optimize performance. Blockchain is another cutting-edge technology that should be considered. Having a more accurate view of the configuration and maintenance history of an aircraft could help to reduce costs and losses, increase the availability of assets and increase the value of aircraft in the secondary market and at the end of leases, and improve the productivity of workers.

Growing industries are the product of ever-changing modern technology and its application. With rising customer demand in the service industry, finding the right balance between customer demand and supply is becoming increasingly important.

Besides making transactions safe blockchain has a wide range of applications in the industry. Aviation blockchain can ease many functions such as flight operations, tracking, servicing and overhaul of repairs, etc. Similar to the blockchain, when applied to these areas, conventional technologies are

unsuccessful because they lack the elements of reliability, accountability and security that Blockchain provides.

Below there are presented possible Blockchain use-cases in the aviation industry [55]:

1. Identity Management - Identities of individuals can be forged and used to accomplish fraudulent and terrorist activities. Blockchain solves this problem by validating identities with the help of biometrics. Once an identity is validated and stored on a blockchain, it is almost impossible to make changes to it as the network is highly protected and decentralized. This would also result in eliminating the use of paper passports and human-errors in the process of checking.
2. Ticketing through tokenization - Currently, airplane tickets are either paper-based or electronic passes. With the implementation of Blockchain, the need for using paper tickets can be fully eliminated and the e-tickets can be tokenized through smart contracts. Tokenized tickets can have their own set of business logic and terms associated with them such as the process of selling tickets and their usage in the value chain in real time efficiently and securely. This will also allow people to purchase tickets from different partners globally.
3. Security - Privacy of information is crucial for industries as many people place their trust by sharing their personal details for better functioning of the systems. Passenger records, as well as crew information of airlines, need to be kept secure as any mishap can lead to dangerous outcomes and misuse of identities. Blockchain technology along with a security wrapper creates a safe medium to share this data reliably through authorities. Aeron.com is one of the most successful companies working in this sector.
4. Loyalty Points - Loyalty points and schemes when tokenized through blockchain can provide immediate value to the users as it would be possible to use them instantly in real-time. Moreover, these loyalty points can be used more broadly through a partner community. Points replacing the role of currency will allow travelers to save time and make payments with better ease.

5. Maintenance- Maintenance logs keep regulating between manufacturers, traders, service providers, and airlines. These take up a lot of time and are prone to errors if entries go wrong at any point. Blockchain technology can remove the need for complex databases and paper binders and enable airlines to manage a single record of provenance that would be instantly available to all the authorized people. With this, maintenance events could be set priorly and this information would be available on the aircraft maintenance record which will save time, improve maintenance and ensure safety.

Possible Blockchain use-cases in the aviation industry are represented on the Figure 2.1.

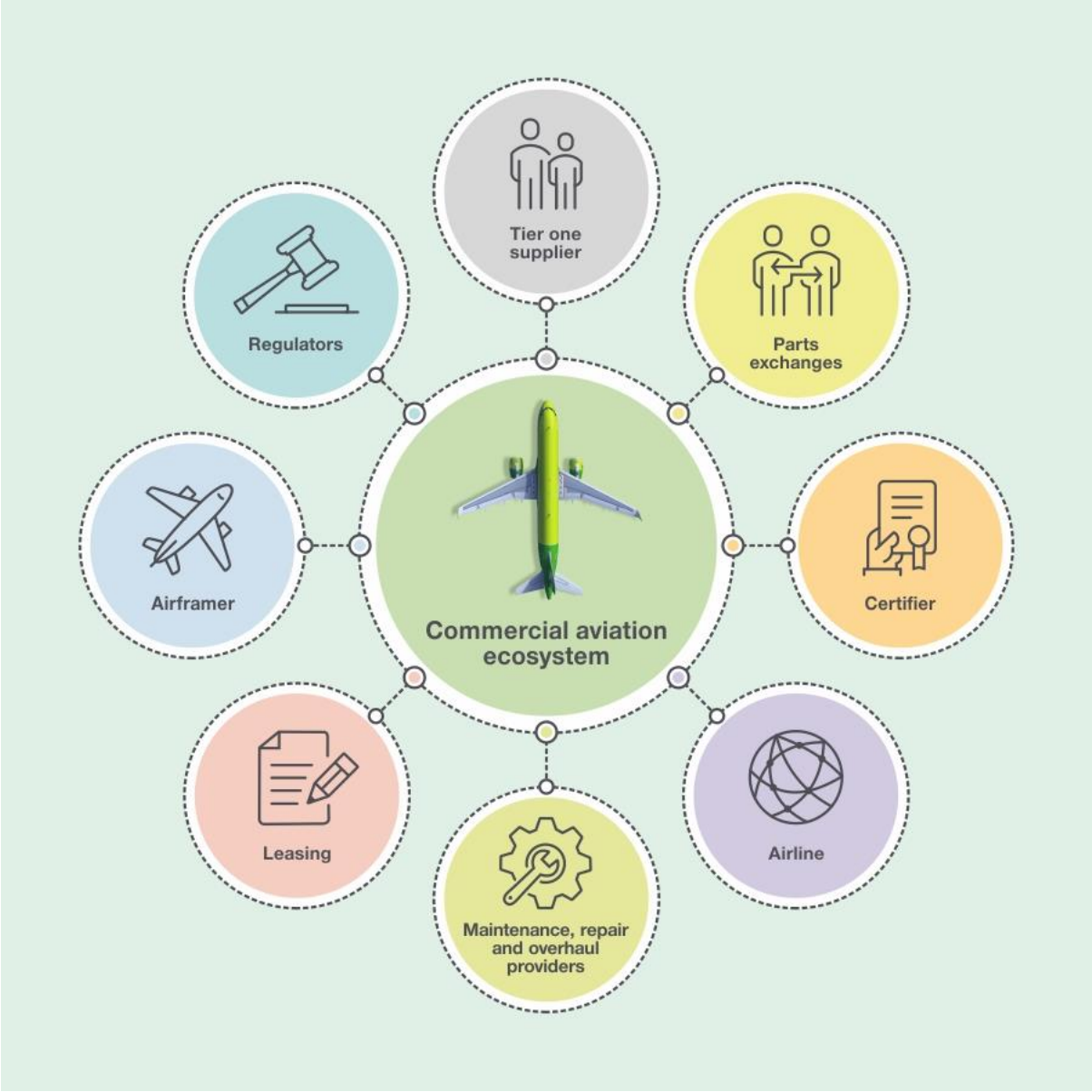

Fig.2.1. Possible Blockchain use-cases in the aviation industry

Europe’s biggest airline, Lufthansa Industry Solutions, was seeking potential applications of blockchain technology and wanted to create industrial standards for its use. The solution they came up with is the Blockchain for Aviation initiative. Lufthansa is also partnering up with Eurowings, Australian Airlines, Brussels Airlines and the Swiss-based, non-profit Winding Tree, which relies on blockchain to operate a decentralized travel distribution network to ensure travel is more cost effective for both customers and providers [56].

More cost effective solutions would be of great benefit to world economy since the world’s airlines annually carry over 3 billion passengers and contribute with over $660 billion to the global GDP. The aviation industry requires airlines to be both flexible and systematic in order to compete, because the efficiency of their chain of operations determines their bottom line [56].

The aviation industry needs modernization in all fields. Data security is paramount to airports. The second a passenger arrives to the time of departure, requires airports to collect and transfer an incredible amount of data. The process is complicated even more when travel plans are changed so frequently. Another issue is the different software used in different airports. This makes data transfer timely and annoying for both sides.

SITA, the technology specialist of airport communication and information has used the Ethereum protocol to battle the problem of corresponding flight delays in different airports. The lab designed Flightchain, which was tasked with tracking over a million flight changes between Geneva Airport, Heathrow and Miami Airport. The results are suggesting that smart contracts are very effective at meditating conflicting data. The only downside is they require strict governance and additional oversight [57].

S7, which is the biggest airline in Russia, partnered up with Alfa Bank in launching a blockchain protocol for issuing tickets. The protocol is built on the Ethereum blockchain and allows for smart contracts to be used to exchange data between contradicting parties. This will reduce the settlement time between ticket sellers and the airlines rom 2 weeks to a little over 20 seconds.

The blockchain startup AERON reports that about 57% of the incidents in aviation are the fault of a human error. The startup created a mobile app which records and verifies the pilot's qualifications and is bound to decrease incidents due to poor record keeping or performance. All of the pilot data is stored in digital form. Additionally, company is working on a global database aimed at storing aircraft and pilot information as well as flight schools. These innovations are aimed more towards private flights and respectfully pilots.

The aviation industry will make incredible use of blockchain tech's ability to quickly go through conflicting data and verify the consistence of information. Customer experience will also greatly be enhanced in regards to time and cost efficiency. It's only a matter of time before all major global industries make use of this technology and save $ billions in the process.

The current systems landscape in the airline industry is archaic and siloed, which hinders the fast and seamless exchange of data within the intertwined and complicated ecosystem of industry players. Blockchain can address these problems. Its shared nature—built on a decentralized approach to data management, security, and information exchange—can sharply improve speed, transparency, and responsiveness. This saves substantial time and money and paves the way for new business models. With blockchain, airlines can:

— Automate repetitive processes and payments. The ability to create smart contracts—electronic agreements that self-execute according to predefined rules—is generating strong interest in the airline industry. A wide range of transactions can be set up this way, including billing among airlines, billing between travel agents and airlines, determining loyalty settlements, purchasing travel insurance, and paying airport and authority taxes, fees, and charges.

— Improve the customer experience. Most airlines are focusing their blockchain efforts here. When members of an airline's loyalty program travel on a partner airline, reconciling the miles or points flown and getting those credits correctly applied to the customer's account can be difficult, error prone, and time-consuming. Smart contracts can simplify and automate the process among

airlines, minimize the risk of error, and increase customer satisfaction. Many applications designed to strengthen customer loyalty are emerging. Singapore Airlines has developed a digital wallet that allows customers to use frequent-flyer miles at participating retail merchants, and Cathay Pacific Airways' loyalty app lets partners and members use their rewards almost immediately, nearly in real time. SITA Lab is testing a blockchain application that would allow passengers to create tokens on their devices that would be accepted across airports and borders.

— Simplify revenue accounting and payment reconciliation. When a ticket is sold, airlines often have to deal with multiple players—such as GDSs, travel agents, or other airlines—and sensitive booking data must be shared. This also gives rise to a complex web of revenues and payments that must be reconciled. Today, airlines rely on IATA, which sets industry standards and acts as a payment clearing-house: the association's billing settlement plan handles payments between travel agents and airlines, and its clearing-house solution handles interline billing among the airlines themselves. Blockchain could automate and streamline these settlement processes, keep booking data secure, eliminate disputes, and do away with heavy reconciliation work.

— Reduce dependence on intermediaries and reallocate industry value. Airlines have become highly dependent on a handful of third parties that consolidate much of the industry's decision power—and charge substantial fees and commissions for their services. GDSs distribute available tickets to travel agents, who sell the tickets to individuals and businesses. The top three GDSs control 99% of the market for indirect ticket sales. Online travel agents account for most airline bookings. By reducing these third-party costs, blockchain can increase revenues among network members. Air France–KLM, Air Canada, Lufthansa, and Air New Zealand have partnered with Winding Tree to develop a blockchain app that will allow consumers to access tickets directly from the airlines. In an initiative backed by Russia's largest commercial bank, S7

Airlines is using blockchain to sell and issue tickets, as well as to insure faster payments between airlines and travel agents.

— Track components, luggage, and shipments. Given the industry's focus on safety, knowing the source and ensuring the quality of all the components, parts, and other materials that make up an aircraft are critical. In MRO, the complex value chain—which involves manufacturers, component resellers, airlines, service providers, and regulatory authorities—can make getting information on the origin and journey of components a challenge. Blockchain provides transparency throughout the value chain and an auditable record of the sources and histories of all parts and components. This traceability can also extend to baggage and high-value cargo shipments, which are handled by multiple players, including customers, airlines, transportation companies, airports, and local authorities.

— Improve ground operations and on-time departures. By capturing real-time data and tracking completed milestones on the detailed flight checklist, blockchain can help airlines coordinate the activities of all the crew members and service providers—such as cleaners, baggage handlers, catering providers, and airport ground crews—that the companies depend on for on-time departures and identify the source of any delay.

Blockchain is still a fairly young technology whose full potential has yet to emerge. Current challenges—including performance speed and the best way to approach platform and technology governance—are still being resolved. In the meantime, airlines must explore a wide variety of applications and prioritize those that deliver the most business value from a shared data platform. Two models show promise:

1. Apply the technology to a closed, private network of players to create a competitive advantage. The payoff of this approach comes from greater efficiencies and the added profits gained by taking business away from other members of the industry ecosystem. Larger industry players are in a particularly

good position to lead the development and adoption of these blockchain platforms.

2. Apply the technology more broadly across the industry ecosystem through a public or public-permissioned blockchain. In this model, industry players agree to share data (often guided by business rules and a specific governance) and reap the benefits of applications that leverage this shared data to create value. Consortia, alliances, and regulation could enable this type of blockchain platform.

Many observers believe that forming a consortium of partners to run a blockchain is the best way to unlock the technology's real benefits, although this shared approach is more challenging to coordinate. Because power isn't consolidated in a single company, governance is more equally distributed, which goes a long way toward overcoming the trust barrier—and enhancing the sharing of information. The airline industry is already well positioned for this approach, given the established alliances and joint ventures among players. For instance, Air France is one of 20 airlines in the SkyTeam alliance, which draws on the flights and connectivity of its member network to offer customers a more seamless travel experience. Similarly, many airlines form joint ventures so that their customers have more options than they would with a single carrier. And across the industry as a whole, airlines have long shared the trusted services of IATA.

Airlines ought to build on this foundation of cooperation and extend it to blockchain technology, which will require broad-based discussion and agreement among industry players and major changes to industry standards. No airline can go it alone given these industry dynamics—no matter how brilliant a proposed solution. What's more, a trusted governance structure must be in charge of making key blockchain decisions in a fair and reasoned manner, so that no members of the consortium feel disenfranchised. The best approach may be to start small, testing the waters with existing joint ventures and then scaling up as needed.

Finally, the industry should consider how combining blockchain with technologies such as predictive analytics, robotics, and the internet of things (IoT)

can create even greater power and synergies. For instance, in industries where health and safety are primary concerns—such as airlines, food, and pharmaceuticals—the combination of blockchain and IoT can improve quality assurance and proof of provenance throughout the supply chain. As with any new technology, the potential for disruption isn't always immediately apparent. Forward-looking airlines that use blockchain and other digital technologies to fundamentally rethink how they do business will gain the greatest benefits.

The value of blockchain

Blockchain is highly secure. Blockchain applications can be designed to offer encryption (which protects data when it is stored) and the protocol Transport Layer Security (which protects data while it is being transferred). This provides a high level of data security at any given time.

Blockchain is tamper-proof. Since the blockchain is distributed across several computers and not contained in a single central location, information cannot be changed from a single computer and does not have a single point of failure. This principle, known as immutability, makes the data more trustworthy.

Blockchain is compatible with every data format. Airlines are striving to establish common data exchange standards. Today, though, many different data formats still exist. Blockchain circumvents this issue, since an Application Programming Interface (API) can connect any data source in any format to the blockchain [55].

By creating a neutral layer above the existing data, blockchain delivers a common, visible version of the current information.

Blockchain is future-proof. As organisations leverage new technologies, the ability to plug in APIs and parse any data format will be a competitive advantage. Smart wearables, connected devices, and cognitive computing generate masses of data in various formats—but they will all be compatible with blockchain.

Who benefits from blockchain?

All participants in the business ecosystem will benefit from blockchain to some extent. However, the value they can realistically expect to gain depends on

their role and contribution. For best results, individual incentives and shared value in the blockchain eco- system should be mapped out early in the process [55].

- Manufacturers

Manufacturers stand to benefit the most from blockchain. Ultimately, it is their cargo that gets shipped quicker and more efficiently, resulting in reduced lead times and higher volumes shipped for the same cost.

- Shippers

As shippers are usually unable to track their shipments end-to-end, they are highly dependent on the rest of the network. The ability to locate containers and cargo more easily would be highly beneficial for them. Consequently, they are likely to become paying participants in the blockchain business network.

- Air carriers

Carriers stand to gain considerable value from blockchain. They will achieve a more efficient and lean supply chain as well as greater visibility in the overall shipment process. Moreover, blockchain enables carriers to offer new products and services and the added simplicity encourages initiatives to develop blockchain applications for the industry.

- Consumers

Consumers are increasingly demanding real-time visibility into the delivery of their goods. Carriers, together with IBM, are making efforts to develop blockchain applications to address customers concerns and improve satisfaction.

- Existing communities

The blockchain business network can draw value from existing data sharing communities, by including them in the loop and collaborating instead of trying to replace them. Existing communities that can add value to blockchain solutions are TradeLens, IBM Watson Supply Chain, Food TrustTM, airport communities and data sharing platforms.

- International Air Transport Association and blockchain

The International Air Transport Association (IATA) is striving for a standardised digital ecosystem, in which data is transparent and can be easily

exchanged. Their vision, known as One Record, is designed to link the air cargo systems of tomorrow together.

Blockchain directly addresses these requirements and will be compatible with the new One Record standard as soon as it is implemented.

2.1.1. Blockchain technology implementation challenges

Despite the huge potential, manufacturability and advanced technology of distributed ledgers, organizations will have to face certain problems when implementing this system. Any transformation that occurs in the organization is a great stress for her. Therefore, it is often recommended that they be carried out gradually (step by step) so as not to cause stressful situations for the company that could adversely affect its activities.

Simplicity is the key to security.

Due to the complex coding mechanisms and the fact that the blockchain database is stored simultaneously on many computers, the blockchain is considered practically invulnerable to attackers. In order to hack into the system, computing equipment of tremendous power is required. From this point of view, the blockchain certainly outperforms systems with centralized control. However, if the client wants to modify or modify the system on his own and change the code, it may become less secure.

Performance issues.

Due to the fact that the volume of the blockchain database is constantly growing, in the future there may be an acute problem of data storage and access speed to them. This is especially important for organizations where the speed of the transaction is of paramount importance - banks and other financial organizations.

Premature implementation.

Blockchain is currently under development, due to which the system is not yet sufficiently reliable. Many users are critical of the blockchain, as they are not

sure about the quality of the technology itself and the stability of the services they will receive. Given that the work of the blockchain is based on the involvement of numerous users, its viability and success as a market initiative largely depends on the level of trust in the system.

Jurisdiction.

If there is a problem in a normal banking transaction, the client knows that if the bank is guilty, he can sue him in accordance with the laws of his country. When using the blockchain, the situation becomes more complicated - it crosses the legal borders of different countries, since its nodes are dispersed throughout the world. Potentially, each transaction may fall under the jurisdiction of each region in which at least one blockchain node is located. At the same time, in the event of an erroneous or illegal transaction, it can be extremely difficult to find it inside the blockchain.

Responsibility.

One of the problems of the blockchain is the inability to control and stop the system, which entails certain risks of use. In this regard, the distribution of responsibility and risk control should be carefully agreed not only by suppliers, but also by all other participants in the system.

Intellectual property.

An important point in the conversation about the blockchain is the ownership of intellectual property (IP). Given the amount of investment and the potential financial profit from the blockchain, developers need to determine their strategy in relation to IP: suppliers will most likely want to take every opportunity to maximize their profit from the blockchain. Perhaps the terms of the contract related to IP will not differ from the terms of any other software development contract. Also, the conditions will depend on whether specific developments can provide the client with a competitive advantage and whether they can be sold in the future to other customers. The client may insist on ownership of such developments, or may simply purchase a license for a specified period or limit the supplier in the further sale of specific software to other clients.

Data confidentiality.

The transparency of transactions in the blockchain is little compatible with the needs of the private sector in the banking sector: using crypto addresses for identification is problematic, since none of the banks wants to provide competitors with accurate information about their transactions, and banking secrecy must be respected by law. It turns out that suppliers need to find way to keep balance between transparency and privacy, and developers think about blockchain protection technology.

The Blockchain technology in aviation sphere can be implemented in following sectors [55]:

- Frequent Flyer Points. Blockchain has the capability to significantly streamline the earning, spending, accounting and reconciliation of frequent flyer points by tokenizing these assets into becoming digital and pervasive. While the continuous rise of passenger load factors is good news, it makes it more difficult for airlines to facilitate the redeeming of points for tickets. In addition to the balance sheet liability issue, the process of earning, redeeming and exchanging points is ripe for innovation, in particular across alliances.
- Baggage, Cargo and Spare Parts. Blockchain facilitates tracking of the status and location of valuable assets such as passenger bags, cargo and aircraft spare parts in a very reliable and immutable manner as these assets change custody. This provides an opportunity to enhance visibility and transparency as these type of items move across the value chain. These new capabilities could potentially unlock new product development areas, support the streamlining of the process and equip the providers to deal with disruptions.
- Distribution and Payment. Blockchain allows airlines, travel agents, and others across the distribution space to better collaborate while co-delivering travel products and services. The anticipated changes could expand the distribution reach of all parties involved, and increase the

efficiency of how travel products and services are aggregated. It also has the capability to move payment towards being more transparent, real-time and low-cost.

- Passenger and Crew Identity Management. Blockchain could streamline the identity management of passengers, enhancing the experience, protecting privacy, and also enabling airlines and the wider value chain to do business in digital environments.
- Smart Contracts across the Travel Value Chain. Airlines and other actors across the value chain trade products and services and spend significant efforts on contracts, execution of contracts, monitoring the fulfillment stage, reconciliation, invoicing and settlement. All these efforts can either be eliminated or considerably simplified leveraging the concept of Smart Contracts. Smart Contracts could be programmed to be self-executable, triggered by neutral data sources and pre-defined conditions.

Is blockchain data “proprietary”?

If we talk about the legal component of this issue, the information itself does not fall under the category of ownership. However, data collection may be protected by intellectual property rights. According to the "Law on Personal Data", before selling or using personal data, the client will have to obtain consent from interested parties.

Decentralized Autonomous Organizations (DAOs)

DAO - these are Internet objects that perform a series of actions according to the rules enclosed in them during encoding. DAOs are used in the blockchain to record transactions and implement smart contracts - algorithms that allow you to exchange assets without resorting to the services of intermediaries. DAOs are part of the legal system, but it is not clear what legal status to assign to them.

Exit.

Can a client independently exit the blockchain when the contract expires? Mostly, it depends on the decision of the user himself and on the amount of

information that he stores in the blockchain. Also, if the client does not have his own copy of the data, he will need help in transferring it [34].

Performance and scalability.

The problems of limiting the performance and scalability of the system are interconnected, and this connection is very close. These are collective concepts that are more accurately expressed in throughput, that is, in the number of transactions performed per second, and in the time required to confirm the transaction and enter it into the blockchain. A distributed system most often has less bandwidth than a system with one control center, since making changes in this case takes longer. It is necessary to distribute data among all participants, and they must reach a consensus on the information available: the decision is made not in one place, but in several. These delays lead to an increase in the response time of the accounting system.

Excessive data.

The problem of storing excess data also imposes additional restrictions. After all, everyone who participates in the management of such a system must have a copy database of this system, which is constantly updated. In the case of traditional centralization, such a volume is not necessary.

Governance.

Development within the framework of one company is a centralized development, which has its own idea and direction. There is a formed vector that does not provide for freedom of proposals for improving the network. Any updates are censored by a narrow circle of persons involved in the development of the rules of the system. Increasing the level of influence of system participants on its state and freedom in proposals for updates to the rules can have unexpected and extremely serious consequences for this company if the changes are contrary to its interests.

For a properly applied decentralized accounting system, the democratization of change management is beneficial. The larger and more open the community that argues and offers solutions, the more opportunities there are for valuable

improvements: if the majority supports the improvement, it will be added to the update. Thus, everyone has the opportunity to offer their own updates and openly discuss its advantages and disadvantages. However, collective management is always more complicated than sole management. The decision in such a system is always made slower, since participants need time to agree. It is precisely because people are not inclined to quickly reach unanimity that delays occur.

Shared responsibility.

On the path to the practical implementation of decentralized technologies, a special stand is the unpreparedness of the public worldview for accepting the consequences of a decentralized approach. Unreadiness consists in the fact that we are used to seeing a specific person who is responsible for something. This happens in a centralized management system that has become traditional for us.

When you are served in a certain organization, in case of misunderstanding, you call the employees of this organization and find out what is the matter. For example, when you purchased a car, and after a week it stopped starting up, you call the company where you bought it and seek a refund ... Or you don’t, and then you go to a court that will satisfy your requirements in law, forcing the company to return the money and compensate you for the damage. In any case, you find the "extreme", that is, the one who is responsible for the decision. And if in the case of the managing center since responsibility is clearly defined, in the case of a distributed system, responsibility takes on a somewhat vague meaning. Here it is more appropriate to replace “responsibility” with “risk”, because it is the risks that the participants bear. The guarantee of the correct operation of the system is the rules by which it operates, and they are known to all participants. Everyone can check the actions of others for compliance with the rules of the protocol. These risks lie either in the behavior of the users themselves, or in vulnerabilities through which you can influence the rules: attacks on the same protocol. In the latter case, a decentralized system is much more stable than a centralized one. In a decentralized system, not a single person, including a developer, is able to make changes individually. Therefore, no court can implement a decision, all the more

contrary to the rules of the protocol. To change the state of the system, you need the consent of most participants and the absence of contradictions to the rules. Here we need a different model of the legislative approach, so that the situation is clear in the context of the legal field: we need new legal models and, possibly, the legislative framework. With the help of it, it is possible to regulate the existence of such systems where, until a certain point, the creators of this system are obligated to ensure safety and compliance with certain requirements, and after it the responsibility passes to the side of the user who agrees with the rules and accepts possible risks.

The complexity of updating the protocol

Another important feature of decentralized systems is the approach to updates. When a proposal appears to improve the rules of the system, it can meet both unanimous acceptance and disagreement among the participants. In other words, we observe the problem of governance in action. If these disagreements are quite serious, then the matter may end with a fork, that is, the separation of the blockchain and the emergence of a new system based on the old one, but with different rules. This was the case with Bitcoin in 2017 when its fork, Bitcoin Cash, appeared. It was proposed to increase the block size in the Bitcoin network from 1 MB to 8 MB in order to increase throughput. The participants who supported it updated their software and began to work according to the new rules. Thus, two systems turned out: Bitcoin, whose participants continued to work according to the old rules, and Bitcoin Cash, whose blocks already had a size of 8 MB. Here it is worth recalling Ethereum. In 2016, attackers stole 70 million dollars invested in the development of one project that was developed on the Ethereum platform. The development team decided to intervene and forked, where they rolled back the system and revoked the smart contracts that were involved in the abduction. As a result, all funds returned to the balance of the project. But not everyone appreciated this move positively. Opponents of the fork continued to work in the old system, calling it Ethereum Classic, and those who supported the rollback began to work in the new system - Ethereum.

2.1.2. SWOT analysis

It should be recognized that today blockchain technology is still at the beginning of its path. Before deciding on the implementation of blockchain technology in your organizational environment, you should carefully analyze all the advantages and disadvantages. To do this, we propose to create a table of SWOT analysis.

After analyzing all aspects of the blockchain technology, the positive and negative sides, opportunities and threats, we can formulate a number of proposals that help to reduce the impact of negative aspects and strengthen the positive.

The problem of undesirable centralization is directly related to the insufficient (or complete absence) regulation of cryptocurrency mining in the legal field and the potential increase in block size. Increasing the block size to the maximum permissible values will lead to the fact that only large organizations will be able to provide enough space for data, computing power, network bandwidth, and the nodes of small operators will be discarded. However, it is worth noting that such a problem can be characteristic only if the block sizes increase and only in open systems.

It is not possible to analyze the potential conflict of interests with the current regulatory requirements, since even existing systems violate the data protection regulations. Much closer attention should be paid to what prospects blockchain technology opens up.

Today, in most cases, the user does not control what data he provides to various online systems. Search engines collect information about users based on their search queries, use microphones built into the devices to offer ads in the future, using keywords spoken by the user, and this is at best. The blockchain offers users to choose what information they would like to make publicly available.

Table 2.1.

SWOT matrix of blockchain technology

Strengths	**Weaknesses**
Efficiency; Facilitates the exchange of information; Secure encryption and protection against unauthorized access to data; Eliminates centralization; There is no possibility of changing data without the knowledge of other participants in the blockchain.	Scalability issues: too many transactions (congestion), however there are several solutions to this problem; Undesirable centralization (mining pools, mining farms); Quantum computers (in the future) will be able to decrypt data; Fast-changing digital environment;
Opportunities	**Threats**
Provides a platform for Big Data and analytical research; Gets the user control over their data; Provides the ability to create an open economic system; Automation of most processes of concluding and fulfilling obligations using smart contracts; A significant reduction in uneven pricing due to the openness of the system; The ability to refuse the services of a "trusted third party", companies whose sole purpose is to mediate in a transaction (Uber, Airbnb)	The rules of business often change, there is no blockchain; The blockchain system is not modular. The old encryption module cannot be easily replaced; Potentially contrary to existing regulatory approaches, such as GDRP (European General Data Protection Regulation).

2.2. Statistics in the field of air transport

Up-to-date information on key performance indicators of the aviation industry for January-November 2019 is provided down below.

In January-November 2019, the volume of passenger transportation of Ukrainian airlines increased by 10.2% compared to the corresponding period of the last year and amounted to 12867.3 thousand people, incl. international - by 10.5% and amounted to 11,792.9 thousand people.

Passenger traffic through the airports of Ukraine increased by 18.7% and amounted to 22576.0 thousand people, incl. in the international connection - by 20% and amounted to 20404.2 thousand people.

During January-November 2019, Ukrainian airlines performed 95.7 thousand commercial flights (an increase of 3.1% over the same period last year), incl. international - 80.5 thousand (an increase of 3.1%).

Between January and September 2019, 29 domestic airlines operated passenger and freight services, which totaled 79.7 thousand commercial flights (against 77.1 thousand in the same period last year) [58].

Table 2.2.

The results of Ukraine aviation industry activity for 9 months of 2019

	Units measurement	**Total**			**including international**		
		9 mon. 2018p.	**9 mon. 2019p.**	**% 19/18**	**9 mon. 2018p.**	**9 mon. 2019p.**	**% 19/18**
Airlines activity							
Number of transported passangers	thsd. people	9677,6	10664,5	110,2	8859,4	9781,0	110,4

Continuation of the Table 2.2

including on regular lines	-„-	6031,6	6508,2	107,9	5221,0	5632,6	107,9
Passenger-kilometers completed	bll.pass.km.	19,7	23,2	117,8	19,3	22,8	118,1
including on regular lines	-„-	11,9	13,8	116,0	11,5	13,4	116,5
Cargo and mail transported	thsd. tons	70,1	68,2	97,3	69,9	67,9	97,1
including on regular lines	-„-	16,1	15,0	93,2	15,9	14,9	93,7
Ton-kilometers completed (freight + mail)	Mln.tkm	245,8	222,6	90,6	245,7	222,4	90,5
including on regular lines	-„-	69,3	72,6	104,8	69,2	72,6	104,9
Commercial flights completed	thousands	77,1	79,7	103,4	64,8	67,0	103,4
including on regular lines	-„-	51,3	52,0	101,4	40,3	40,6	100,7
Activity of airports							
Aircraft sent and arrived	thsd. units	138,1	153,9	111,4	110,2	124,3	112,8
including on regular lines	-„-	105,1	117,5	111,8	83,5	95,4	114,3
Passenger traffic	thsd.people	15582,5	18510,2	118,8	13929,7	16726,8	120,1
including on regular lines	-„-	11877,7	14318,1	120,5	10249,3	12558,4	122,5
Postloads	thsd.tons	41,6	42,3	101,7	40,7	41,2	101,2
including on regular lines	-„-	37,8	38,2	101,1	36,9	37,3	101,1

2.2.1. Airlines activity. Passenger transportation

This year, the passenger air transport market continues to show positive dynamics.

According to the results of 9 months of 2019, the volume of passenger transportation of Ukrainian airlines increased not only in comparison with the

same period of 2018 (by 10.2 percent), but also exceeded the level of the previous 2017 as a whole (by 1 percent), and amounted to 10664.5 thousand. Male [59].

During the reporting period, passenger traffic was carried out 18 domestic airlines, among which the International Airlines of Ukraine is traditionally the leader (increasing the volume of 4.1 percent). At the same time, significant volumes of passenger transportation were performed by Azur Air Ukraine airlines (by 48.1 percent growth), Skyap (by 4.3 times) and Wind rose (by 10.8 percent)). It should also be noted that the fifth position was taken by Bukovyna Airlines, which has been performing passenger services since November last year. For the 9 months of 2019, the five largest passenger airlines mentioned above have carried 10331.5 thousand people, which is almost 97 percent of the total volume of passenger transportation of Ukrainian airlines [59].

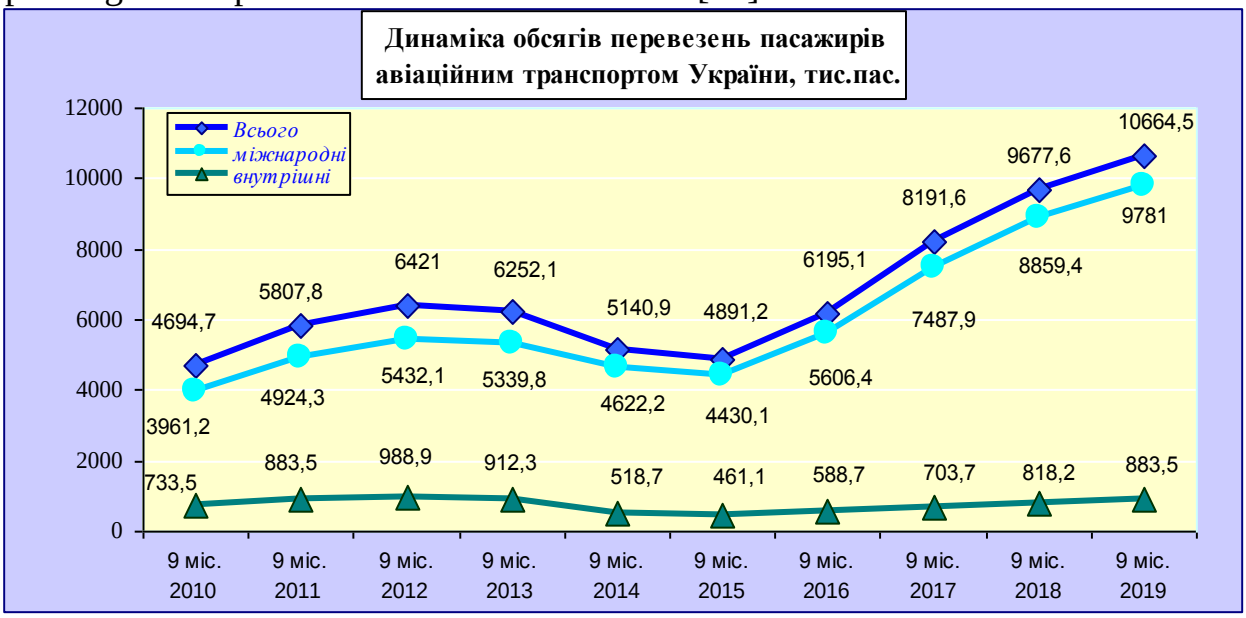

Fig. 2.2. Dynamics of passenger traffic by Ukrainian aviation

International scheduled flights

During January - September 2019, international scheduled passenger services operated according to the approved timetable

10 domestic airlines to 45 countries. During this period, Ukrainian airlines began operating flights on nine new international routes that combined air services:

- Kherson with Burgas;
- Zaporozhye with Barcelona;
- The Dnieper with Bodrum;

- Odessa from Rimini;
- Kharkiv with Paris, Sharjah and Rimini;
- Boryspil with the cities of Sanya and Catania.

In the first nine months of 2019, the number of passengers who used the services of Ukrainian companies increased by 7.9 percent and amounted to

5632.6 thousand people, with the average percentage of passenger loading of international scheduled flights of Ukrainian airlines increased by 1.9 percentage points to 81.2%.

At the same time, there was an expansion of activity in the Ukrainian market of foreign airlines using services of 6,935.9 thousand passengers, which is by 38.1 percent higher than in 9 months of 2018 and is 55.2 percent in the total volume of regular passenger transportation between Ukraine and countries around the world. This year, foreign airlines operated flights on 15 new routes:

- from Bremen, Billun and Genoa to Kiev (Zhuliany);
- from Manchester, Paphos, Dublin and Bodrum to Kiev (Boryspil);
- from Copenhagen and Riga to Lviv;
- from Milan, Krakow and Baku to Kharkiv;
- from Rome, Baku and Krakow to Odessa.

In general, regular passenger transportation to Ukraine was performed 39 foreign airlines (including three new ones) from 36 countries [59].

International irregular flights

In the first nine months of 2019, there has been a significant increase (up 14 percent) in such a segment of the market as international flights on an irregular basis. During this period, 4148.4 thousand passengers were transported to 16 Ukrainian airlines. At the same time, almost 97 percent of such flights were made by the five leaders mentioned above.

Domestic scheduled flights

Regular domestic passenger services between 11 cities of Ukraine were performed by four domestic airlines, including Ukraine International Airlines, Motor Sich, Wind Rose and Skyap. For 9 months of 2019 scheduled flights within

Ukraine carried 875.6 thousand passengers, which is 8 percent more than that carried over the same period last year. At the same time, the average occupancy rate of passenger seats on domestic scheduled flights of Ukrainian airlines was 79% (against 79.5% for the 9 months of 2018).

2.2.2. Cargo and mail transportation

For the period from January to September 2019, the volume of cargo and mail transportation by air transport of Ukraine decreased by 2.7 percent compared to the corresponding period of the last year and amounted to 68.2 thousand tons.

Cargo and mail transport were performed by 20 domestic airlines. The leaders of cargo transportation are ATP of SE "Antonov", airlines "International Airlines of Ukraine", "ZetAvia", "Maximus Airways" and "Yuzhmashavia". The aforementioned airlines accounted for 84 percent of the total cargo and mail traffic in the reporting period. It should be noted that most of the freight has traditionally been charter flights to other countries within the framework of UN humanitarian and peacekeeping programs, as well as under contracts and agreements with other customers.

2.2.3. Airport activities

According to statistics, for the 9 months of 2019, 153.9 thousand aircraft were served by Ukrainian airports 11.4 percent more compared to the same period last year. At the same time, passenger traffic through Ukrainian airports increased by 18,8 percent and made 18510,2 thousand people. Shipping volumes increased by 1.7 percent to 42.3 thousand tons.

In total, domestic and foreign commercial flights served 19 Ukrainian airports and airfields. At the same time, about 98 percent of passenger traffic is concentrated at 7 major airports (Boryspil, Kiev (Zhuliany), Odessa, Lviv, Kharkiv, Zaporozhye and Dnipropetrovsk) [58].

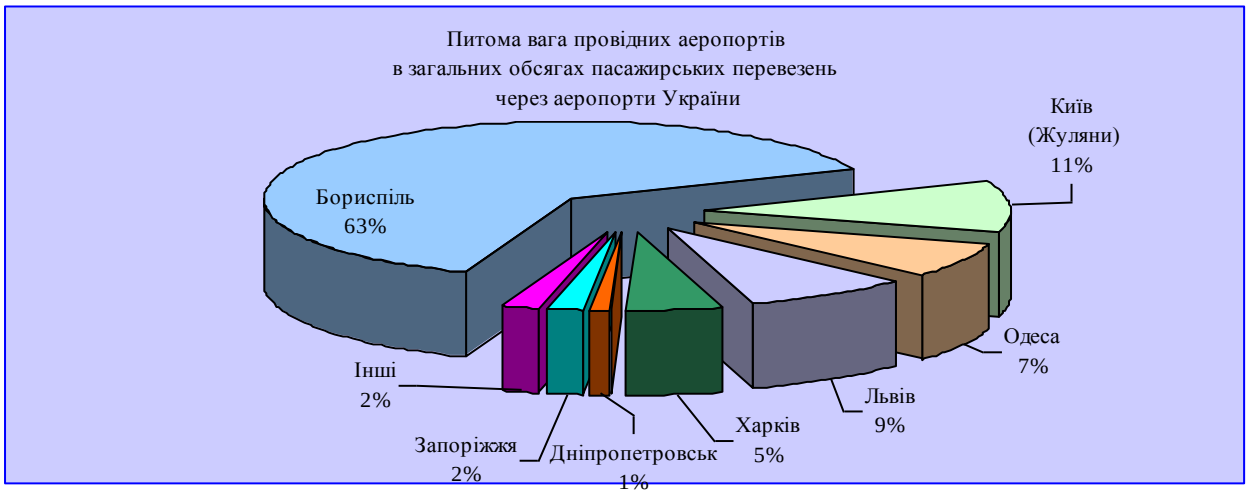

Fig.2.3. Share of leading airports in total passenger traffic through Ukrainian airports

Significant increase in the number of passengers served compared to the same period last year was recorded at the following airports: Lviv - by 38.7 percent, Kharkiv - by 33.4 percent, Boryspil – by 22.5 percent, Dnipropetrovsk by 14.3 percent, Odessa by 13.8 percent and Zaporizhzhia by 13 percent. At the same time in the capital's airport Kiev (Zhuliany) experienced a decrease in passenger traffic (7.2 percent).

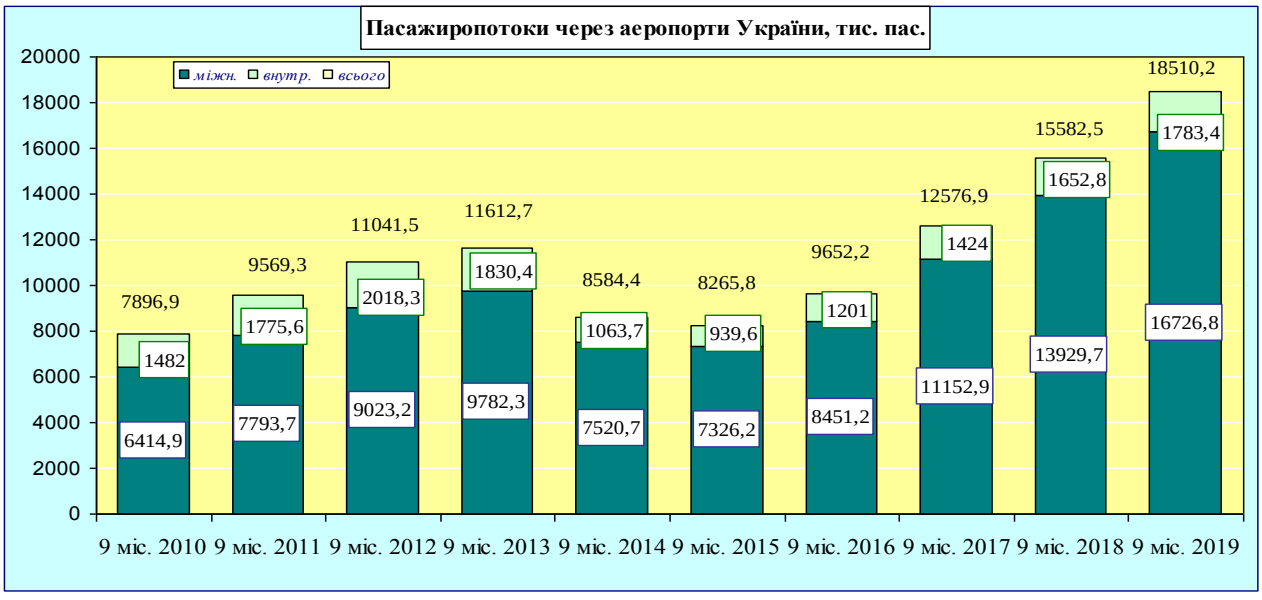

Fig.2.4. Passenger traffic through the airports of Ukraine

The use of aviation in economic sectors. For 9 months of 2019 aviation enterprises processed 359.6 thousand hectares of agricultural area, flight during the performance of aviation works in the economic sectors amounted to 6.1 thousand

hours (for 9 months of 2018 - 543.6 thousand hectares and 8.7 thousand hours respectively).

Service of air traffic of Ukraine. SE “UkSATSE” during the reporting period serviced 260.4 thousand flights against 232.3 thousand for 9 months of 2018. The number of flights operated by aircraft and helicopters of Ukrainian airlines increased by 3.6 percent, and by foreign airlines - by 16.8 percent [58, 59]

2.3. General characteristics of the Boryspil International Airport

Boryspil International Kyiv Airport (IATA: KBP, ICAO: UKBB) is one of the two international passenger airports serving Kyiv, the capital of Ukraine, and the largest airport in the country, being the main international gateway.

Today Boryspil International Airport (MA) is Ukraine's largest player in the market of passenger and cargo air transportation. It provides transportation for more than 68% of passengers (Fig. 1.1.), Which in quantitative terms reaches 8 million passengers.

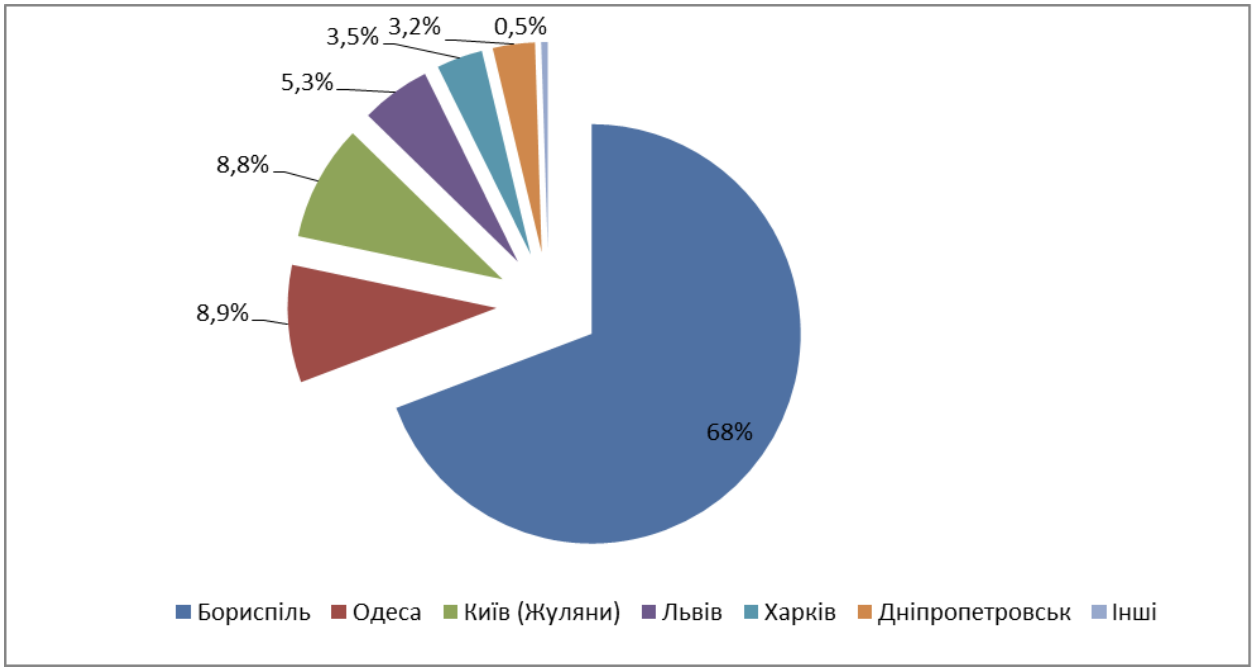

Fig.2.5. Share of Boryspil Airport in the structure of passenger transportation

It is located 6 kilometers west of the municipality of Boryspil and at 29 kilometers east of Kyiv downtown. Boryspil International Kyiv Airport is the main hub for the local carrier Ukraine International Airlines. Boryspil International Kyiv Airport is the largest passenger airport in Ukraine. Boryspil International Airport is a member of Airports Council International.

Boryspil International Airport occupies an area of more than 1000 hectares, about 200 production, administrative and auxiliary buildings and structures. Boryspil International Airport has two runways in length of 4,000 m and 3,500 m and four passenger terminals (D-terminal and F-operated, and the other two conserved). The main runway length of 4000 meters and a width of 60 meters allows to receive all types of aircrafts.

Boryspil International Airport has one operational passenger terminals (D), one cargo terminal (F) and a VIP terminal. The largely overcrowded former domestic Terminal A was closed on 15 September 2011, in favor of transferring all domestic operations to nearby Terminal B. In 2013, all domestic and international operations were transferred from Terminal B to Terminal D. Below we are going to consider the information about KBP terminals.

Terminal B, the original Soviet-constructed building, used to serve domestic and international flights. It has undergone an extensive, long-term reconstruction. The terminal hosted shops, cafes, travel agencies and banks, as well as offices of airlines and a business center. The ground floor features luggage storage, waiting-area, and check-in desks, whilst security and passport (immigration) control, the main departure lounge and the terminal's boarding gates are on the second floor. After passport control, passengers wait in the departure lounge where there is a business lounge, a number of cafes, restaurants and duty-free shops. There is free Wi-Fi access in the building. The terminal has two jetbridges and several bus-boarding stands. It is now used for charter flights for Hasidic Pilgrims participating in Rosh Hashanah kibbutz in Ukraine.

Terminal D, construction of which began on 24 March 2008, was opened on 28 May 2012 with an initial capacity of 3,100 passengers per hour. It received its first arrivals passengers on 29 May 2012.

Terminal D serves domestic and international flights. It is also a hub and a home base of Ukraine International Airlines. It has been designed to support an integrated system for monitoring and directing arriving and departing passengers; this has been ensured by implementing a scheme of movement based on the principle of multi-level zoning — departing passengers use the airport's upper floors, whilst those arriving and yet to pass through immigration are processed on a lower level. The ground and first floors are used for airside service and the sorting of baggage. Airside, the first floor is used for arrivals zone and baggage hall. The fourth floor is reserved for airlines' lounges. The terminal can be accessed from the airport's central access road for arrivals and in the same way but via a ramp for departures level. The building features both jetbridges and bus boarding stands and is equipped to handle wide-body aircraft such as Ukraine International Airlines' Boeing 777-200ERs.

The Ukrainian Border Guard and State Customs Service maintain control points for arriving and departing passengers (40 passport booths for arrivals and 28 for departures). The terminal has 11 gates equipped with jetways and additional 'bus gates'.

Terminal D regularly features Ukrainian art exhibitions by such notables as Maria Prymachenko and Yuriy Khimich, organised by the art fund "Artaniya".

Terminal F is a passenger terminal mostly used by low-cost carriers and was opened on 21 September 2010 as a home base for Ukraine International Airlines. Terminal F started handling regular flights as of 31 October 2010, with an initial capacity of 900 passengers/hour. The terminal is not equipped with jetways as it was originally meant to serve low-cost airlines. However, the higher level of service offered led to the transfer of many scheduled European and Asian carriers to the terminal.

The opening of Terminal F greatly reduced the overcrowding at Terminal B, which had previously been Boryspil's only operating international terminal. Upon opening of Terminal F and expansion/reconfiguration of Terminal B's airside departures to serve domestic flights, the airport was able to close the largely outdated domestic Terminal A.

Terminal used to serve UTair-Ukraine, airBaltic, Adria Airways, Armavia, Austrian Airlines, Belavia, British Airways, LOT Polish Airlines, Georgian Airways, Germanwings, Libyan Airlines, Lufthansa, Finnair, KLM, S7 Airlines, Turkish Airlines and others. All of them were transferred to Terminal D. Ukraine International Airlines transferred all of its regular flights to Terminal D on 30 May 2013 but UIA's charter flights stayed in Terminal F. It was expected that Terminal F would be also used for low-cost carriers. In October 2013, the terminal was used for charter flights and low-cost airlines; it serviced three or four, sometimes eight, flights a day. On 15 October airport management decided that terminal F will be used as a cargo terminal in the future. On 27 October 2013, all flights were transferred from terminal F to terminal D.

Terminal F was reopened on 31 March 2019, and is used as a passenger facility for low-cost carriers, especially Ryanair. The following airlines have confirmed their move to Terminal F: Ryanair, Laudamotion, Yanair, Bravo Airways, Iraqi Airways, SkyUp, Aigle Azur and Air Serbia.

Infrastructure of KBP

Boryspil airport has two runways, with the terminals occupying a center-field location.

The eastern No. 1 runway (36R-18L) built in 2001 serves majority of flights.

The western No. 2 runway (36L-18R).

In the long term, there are plans to build a third crosswind runway.

Boryspil International Airport infrastructure is represented on the figure 2.6

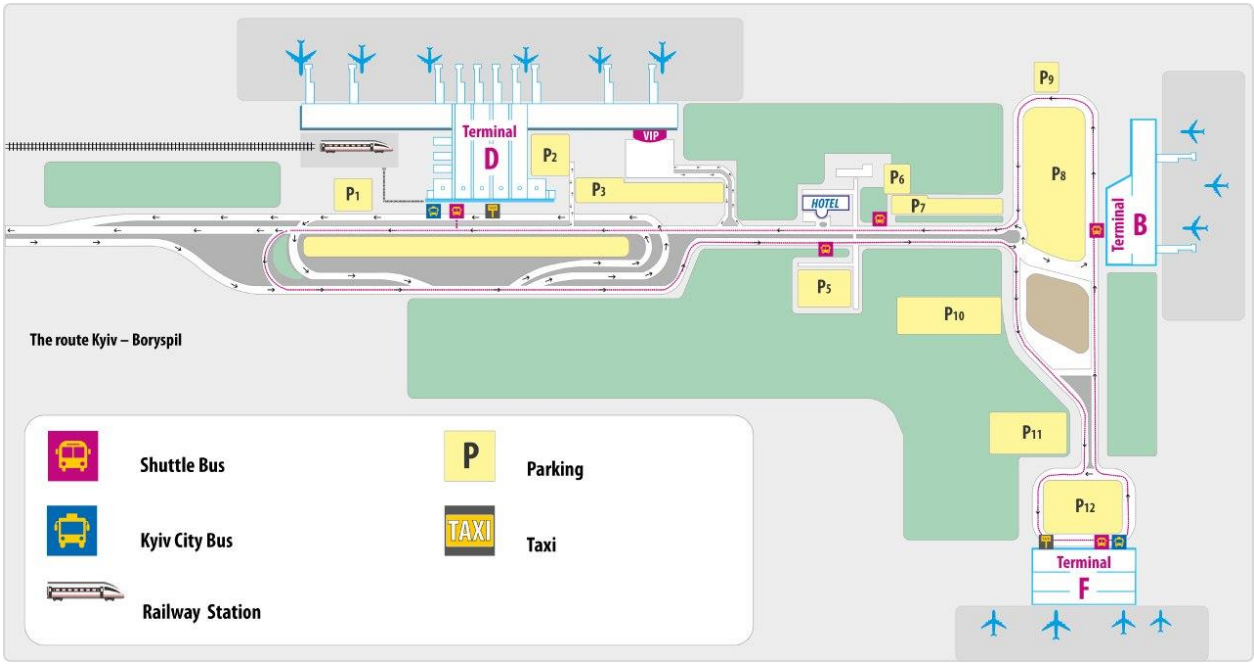

Fig. 2.6. Scheme of Boryspil International Airport

Short-stay car parking facilities at are provided in the immediate vicinity of terminals B and F, whilst long term parking facilities are in the vicinity of the airport's access road and 'station square'. In addition to these facilities, the airport is, in connection with the construction of Terminal D, building its first multi-storey car park; this will be a combined long- and short-stay car park.

Boryspil International Airport operates for the purpose of carrying out economic activity, the purpose of which is:

- obtaining profit from the airport's economic activities;
- ground and technical maintenance of aircraft of airlines used on domestic, interstate and international airlines;
- timely satisfaction of the demand for social and economic needs in the implementation of air transportation of passengers and goods;
- providing aviation security and flight safety.

The main goal of the Boryspil International Airport is to fight for the position of an international hub that will provide transfer services for passengers in the region from the Moscow aviation node in the north to Istanbul in the south.

To achieve the general goal, the airport must ensure the implementation of main factors of the strategy:

1. A strong base carrier that follows the hub strategy.
2. Flexible system of motivation of air carriers, aimed at developing new directions, long-distance program, transfer passenger traffic.
3. Development of the sphere of non-aeronautical activity.
4. Providing operational efficiency primarily in the service of transfer passengers, providing a minimum docking time. [60]

The Boryspil International Airport is a multi-disciplinary company that brings together more than 50 different services aimed at fulfilling the main functions of the airport: provision of services for passenger and airline flights, satisfaction of demand for freight transportation. The organizational structure of the airport includes services and departments for the provision of aviation security, technical, social and economic issues, central airport dispatching, accounting, personnel department, lawyers, etc. All structural subdivisions of the airport interact with each other and are elements of one system. For the proper functioning of the airport, coordinated and coordinated activities of all its structural units are necessary.

According to the strategy of Ukraine for integration into the EU, at the Boryspil International Airport in recent years, have been taken measures to improve the quality of services and increase production capacity in the light of the growing importance of airport, as the main air gateways of Ukraine and the base airport for the leading Ukrainian airlines. Boryspil International Airport operates an integrated management system, certified according to the standards of ISO 9001: 2000 and ISO 14001: 2004. Modern passenger and luggage maintenance equipment meets the requirements of the International Civil Aviation Organization (ICAO) for aviation security.

The audit team noted the special attention of the top management of the Boryspil International Airport to the process of systematic improvement of the company's operation and has identified a high level of competence in the field of quality management and environmental protection in the departments of the airport.

Boryspil airport has been a long-standing member of a number of international and national associations such as: the International Association International Council of Airports of the European Region‖, Association of Airports‖ of Civil Aviation, Association of Airports of Ukraine, Association of Hotel Associations and Hotels of Ukraine, Ukrainian Association of Quality, International Chamber of Commerce, IATA, others. Boryspil airport participates in the above-mentioned associations in order to create conditions for forming and spreading positive public opinion, enhancing the competitiveness of the enterprise in the foreign and domestic markets.

Boryspil is well located at the intersection of many air routes connecting Asia with Europe and America. More than 40 national and foreign airlines operate from Boryspil for the transportation of passengers and cargo on 80 regular routes around the world.

SWOT analysis (or SWOT matrix) is a strategic planning technique used to help a person or organization identify strengths, weaknesses, opportunities, and threats related to business competition or project planning. It is designed for use in the preliminary stages of decision-making processes and can be used as a tool for evaluation of the strategic position of a city or organization. It is intended to specify the objectives of the business venture or project and identify the internal and external factors that are favorable and unfavorable to achieving those objectives. Users of a SWOT analysis often ask and answer questions to generate meaningful information for each category to make the tool useful and identify their competitive advantage. SWOT has been described as the tried-and-true tool of strategic analysis,but has also been criticized for its limitations.

Below is a SWOT analysis of Boryspil Airport (Table 2.3.) Based on market analysis and airport development opportunities.

Table 2.3.

SWOT analysis of Boryspil International Airport

Strengths	**Weaknesses**
1. Possibilities of the flight field (1 runway allows to serve long-distance flights). 2. Base airport for leading Ukrainian airlines. 3. There are opportunities for expanding the infrastructure without significant additional costs. 4. A large proportion of international air travel. 5. Availability of a network of transcontinental flights. 6. Monopoly position among airports in Ukraine, regarding long-haul flights.	1. High level of formalities when crossing the State border, which prevents the increase of transfer passenger traffic. 2. Not enough developed transfer infrastructure. 3. Relatively high cost of services provided by the airport. 4. Insufficient development of affordable commercial infrastructure. 5. Human factor (incompetence of airport staff). 6. Low level of aviation security. 7. The absence of a good connection to the «railway station-airport». 8. Low development of freight traffic.
Opportunities	**Threats**
1. Geographical position that facilitates the development of a network of routes. 2. Strengthening of position of the basic airline (increase of volumes of transportations and connecting flights). 3. Delayed demand for air transportation, which should be satisfied after the stabilization of the situation in the country. 4. The emergence of low-cost airlines.	1. Falling Ukraine's attractiveness for potential passengers as a result of hostilities, a complex socio-political situation in the country. 2. Economic crisis, falling consumer purchasing power; 3. More successful and dynamic development of competitive airports. 4. The growth of the national currency rate.

Based on the SWOT analysis, the following priority areas were identified:

- cooperation with airlines in the direction of opening new flights and preservation of existing routes with good slots for the purpose of restoring passenger traffic and increasing the percentage of transfer passenger traffic at the airport;
- increase of non-aviation activity revenues and measures aimed at increasing the level of service of passengers;
- development of infrastructure for servicing transfer passengers;
- enhancement of security measures;
- reduction of expenses, including reduction of the cost of services;
- improvement of personnel qualification level;
- approaching the profile of successful foreign airports without increasing debt burden (application of outsourcing). [61]

Domestic and international, charter and regular carriers are served at Boryspil Airport. Flight airlines represent all of the world's leading Airlines that operate flights that connect their base airports to the capital of Ukraine: Star Alliance (Lufthansa, Austrian, Turkish Airlines, LOT Polish Airlines); One World (British Airways, Royal Jordanian); Sky Team (KLM / Air France, CSA Czech Airlines). The airport also serves airlines that are not part of the above-mentioned alliances: Ukraine Airlines (Ukraine International Airlines, Dniproavia, Windrose); European airlines (Air Baltic, Estonian Airlines, Ellinair and others); airlines from other countries (El-Al, Air Arabia, Azerbaijan Airlines, Belavia Airlines, Air Astana). According to Yevgeniy Dyhne, Director of IA Boryspil, the development of the airport at the expense of the immediate coverage area is quite promising, since the city of Kyiv remains the main business and tourist center of the country. But it should be noted that development due to the immediate coverage area is limited in population, so the main promising potential of the airport lies in the development and attraction of transfer passengers from the extended coverage area.

2.3.1. Financial results and performance

Boryspil Airport is the first state-owned enterprise to transform a business model effectively and in a few years to become a stagnant and unprofitable European high-growth leader.

The “Hub” Airport Development Strategy, implemented since 2015, is aimed at attracting additional transfer passengers from foreign markets in conditions of low solvency of the majority of domestic passengers. Currently, the share of transfer passengers reaches almost 30% of the total passenger traffic of SE “Boryspil”. Attracting a large number of additional / transfer passengers reduces the cost of servicing one passenger. This has led to a reduction in the cost of the Company's services and an increase in its attractiveness to airlines and passengers. Thus, the Company, together with the airlines based in it, create an aviation product that is attractive in the Ukrainian and international markets. This strategy has ensured a significant increase in the number of passengers attracted by the Enterprise.

Between January and September 2019, Boryspil Airport served 11.6 million passengers, which is 22.5% more than in the same period last year.

In September 2019, Boryspil Airport served 1.7 million passengers, which is 27.6% more than in September last year.

It is noted that 1.5 million passengers used international flights (+ 29.3%), 97.2 thousand - domestic (+ 6.1%).

The number of flights in September 2019 at Boryspil Airport increased by 24.7% compared to September 2018 and amounted to 11 443. 10 292 flights were international (+ 28%), 1151 - domestic (+ 1.6%).

Kyiv International Airport Boryspil tops the rankings of the International Airports Council (ACI) in terms of passenger traffic growth in Europe among major airports. This was reported by the press service of Boryspil, citing an ACI report.

Thus, in July 2019, the passenger traffic of Boryspil increased by 27.6%. With the results of the second quarter - by 23.7%. In both ratings, the airport was ranked first among European airports serving between 10 and 25 million passengers. [60]

In total, more than 50 powerful international carriers operate flights to the airport.

Air carriers and passengers in the State Enterprise "Boryspil" attract, above all, the following:

- competitive cost of services of the Enterprise, provided with a transparent "Regulations on the application of reduction coefficients to airport charges",
- wide geography of the routes of SE “Borispol” - the Airport is among the 30 best airports in Europe by quality of connections according to ACI Europe 2018 data,
- high quality of service of the Enterprise - in the fall of 2018, the Airport was ranked among the 20 most punctual airports in Europe according to the Flightstats expert report, and in 2018 was ranked as the 3 leaders in Eastern Europe by quality according to SkyTrax rating.

Creation of the mentioned factors of the Company's attractiveness is ensured by the high quality of management of SE “Borispol” and professional implementation of the Company's strategy in 2015-2019.

In addition to the steady growth of the number of passengers served, Boryspil airport also provides growth of the serviced cargo (2018: 40.1 thousand tons, 2017: 36.9 thousand tons) and mail (2018: 8.7 thousand tons, 2017: 7.9 thousand t). The bulk of the cargo and mail are carried on passenger flights, but the Company has attracted several airlines that operate special cargo flights on cargo aircraft (Silk Way Airlines, European Air Transport DHL).

All airport revenues are divided into two types: revenues from aeronautical and non-aeronautical activities.

Aeronautical Revenues – Income derived from the use of airport aviation infrastructure and is essentially a fee for airlines for airport services. Aviation revenues include take-off services, boarding fees, passenger fees, etc.

Table 2.4.

Income plan for 2019 compared to previous years

Indicator	Fact 2017, ths. UAH	Fact 2018, ths. UAH	Plan 2019, ths. UAH	Growth 2019 to fact of 2017,%	Growth 2019 to fact of 2018,%
Net sales revenue, total:	3 870 048	4 151 633	4 501 215	16.3%	8.4%
Passenger fee	1 362 780	1 198 504	1 233 980	-9%	3%
Take-off/landing fee	658 227	709 624	747 779	14%	5%
Aviation security fee	537 157	701 858	804 163	50%	15%
Parking fee	28 418	23 748	29 887	5%	26%
Ground handling of aircraft	595 996	709 652	785 624	32%	11%
VIP-passengers services	79 596	108 272	118 050	48%	9%
Services for service of fuel and lubricants	60 259	74 031	80 000	33%	8%
Freight Terminal Services	32 279	37 652	40 050	24%	6%
% of revenue	389 856	437 344	490 332	26%	12%
Services for operating valuable goods	4 155	4 596	5 250	26%	14%
Connection services	33 096	37 969	38 200	15%	1%
Parking services	20 527	27 283	37 500	83%	37%
Hotel services	25 633	30 396	35 000	37%	15%
Heat production	7 616	9 790	9 800	29%	0.1%
Utilities	15 426	20 799	23 000	49%	11%
Other services	19 027	20 115	22 600	19%	12%

Non-aeronautical revenues – revenues derived from passenger-oriented services. They include income from lease of commercial space (shops, duty-free, press kiosks, flowers), catering services (restaurants, cafes) and accommodation (hotels at the airport), revenues from car parking, revenues from advertising, other income (slot machines, organization of massages and cosmetic cabinets, etc.).

Revenues from the operation of aviation transport infrastructure in 2019 has increased with respect to the fact of 2018 and 2017. Growth of the revenue part was due to:

— increase in the volume of air transportation through the airport;

— cancellation of the system of discounts to the passenger fee;

— changes in the price system for ground handling of aircraft.

One of the main indicators of the financial activity of the enterprise are expenses (Table 2.5.).

Table 2.5.

The structure of expenses of the Boryspil International Airport for 2017-2019

	Fact 2017, ths. UAH	**Fact 2018, ths. UAH**	**Plan 2019, ths. UAH**	**Growth 2019 to fact of 2017,%**	**Growth 2019 to fact of 2018,%**
Total expenses	1 982 252	2 379 176	3 342 049	68.6%	40.5%
Cost of realized services	1 350 288	1 774 770	2 579 272	91.0%	45.3%
Administrative expenses	95 627	152 965	217 141	127.1%	42.0%
Other operating expenses	209 761	77 767	86 341	-58.8%	11.0%
Selling expenses	5 503	9 587	12 009	118.2%	25.3%
Financial expenses	283 270	301 721	388 222	37.1%	28.7%
Other expenses	37 803	62 366	59 064	56.2%	-5.3%

According to the table, it can be concluded that the growth of expenses compared with the previous years by 68.6% and 40.5% is due to an increase in costs:

1. Cost of realized services increased by 45.3% or by 804.5 million UAH compared to the fact of 2018. The increase in costs is due to: an increase in transportation volumes by 14.5%; introduction to the production process of the additional terminal.

2. Administrative expenses are increased by 42.0% or by 64.2 million UAH in relation to the fact of 2018. Planned costs increase compared to plan 2018 for the following main articles:

- «Labor costs» and «Deductions for social measures». In general, the expenses under this article increase by 56.6% or by 54.0 million UAH, deductions for social measures increase accordingly by 60.9% or 7.5 million UAH.
- The expenses for salary of the head of the enterprise are planned in accordance with the terms of contract with general director of the enterprise.
- «Costs for consulting services» include the cost of services associated with the improvement of the management system.
- »Expenditures for advanced training and retraining» in the amount of 79 million UAH planned in accordance with the plan for training of employees.

3. Other operating expenses are planned to increase by 11.0% or UAH 8.6 million as compared to 2018. Transfer to the trade union, staff costs (study leave, average pay for the fulfillment of the state duty), calculated in accordance with the current legislation and requirements of the current collective agreement, estimated increase is proportional to the growth of average earnings.

4. Financial expenses increased by 28.7% compared to 2018. The financial plan for 2019 includes costs of servicing new loans, the purpose of which is to implement investment program of the enterprise, etc. [62]

Boryspil International Airport is actively developing as a hub and is investing more and more finance in the development of new and improvement of existing services. Every year the turnover of funds at the enterprise grows significantly, in comparison with the previous years, incomes and costs increase, airport infrastructure grows.

Elements of operating activities

According to Regulation (standard) of accounting "Expenses" are determined by the following economic elements of operating activities:

- material costs;
- costs of payment and deductions for social events;
- depreciation;
- Other operating expenses.

Down below the dynamics of operating cost in elements for 2017-2019 in thousands hryvnas is represented.

Table 2.6.

Dynamics of Operating Cost Elements for 2017-2019

	Fact 2017	Plan 2018	Forecasted 2018	Plan 2019	% of growth plan 2019 to the 2018 plan	Growth of plan 2019 to the 2018 plan	% growth of plan 2019 to the 2017p. plan	Growth of plan 2019 to the 2017	% growth of plan 2019p. To the foecasted 2018	Growth of plan 2019p to the forecasted 2018
Operating expenses, including	1 657 905	2 009 109	1 991 878	2 889 783	43.8%	880 674	74.3%	1 231 878	45.1%	897 905
Amortization	350 675	442 692	415 010	596 723	34.8%	154 031	70.2%	246 048	43.8%	181 713
Salary expenses	578 318	757 710	756 325	1 114 810	47.1%	357 100	92.8%	536 492	47.4%	358 485
Deductions for social events	125 444	156 385	156 442	228 759	46.3%	72 374	82.4%	103 315	46.2%	72 317
Material costs	232 883	346 785	359 816	501 374	44.6%	154 589	115.3%	268 491	39.3%	141 558
Other operating expenses	370 585	305 537	304 285	448 117	46.7%	142 580	20.9%	77 532	47.3%	143 832

Liquidity and Liabilities

According to the results of 2018, liquidity indices of SE “Boryspil” MA have increased rapidly due to an increase in current assets while reducing the volume of current liabilities. Enterprises' liquidity ratios are at a very high level (table 2.7.).

The value of the Company's current assets significantly exceeds its current liabilities - the net working capital of SE “MA Boryspil” increased to UAH 827 million, against UAH 36 million. at the beginning of this year.

Table 2.7.

Boryspil liquidity ratios

Indicator	**2014 year**	**2015 year**	**2016 year**	**2017 year**	**2018 year**
Current ratio	1,0	1,3	1,2	1,0	1,8
Quick ratio	0,9	1,2	1.1	0,9	1,6
Net working capital	-50	303	292	36	827

At the end of 2018, the National Authorized Rating Agency IBI-Rating upgraded the long-term credit rating of MA Boryspil to the maximum uaAAA level. The key factors for rating at the highest level were: sustainable improvement of financial results, implementation of effective debt policy and ensuring very high profitability. The uaAAA rated company has the highest creditworthiness compared to other Ukrainian enterprises.

Currently, Boryspil is the only non-financial sector enterprise in Ukraine with the highest credit rating - uaAAA.

Conclusions to the analytical part

The aviation industry needs modernization in all fields. Data security is paramount to airports. The aviation industry will make incredible use of blockchain tech’s ability to quickly go through conflicting data and verify the

consistence of information. Customer experience will also greatly be enhanced in regards to time and cost efficiency.

Blockchain technology positively affects the solution of key tasks of supply chain management, including the reliability, stability and flexibility of the supply chain. Entrepreneurs and authorities are constantly finding new ways and means of applying blockchain technology in the modern economic system. Blockchain in supply chain management is a technology that allows transactions between equal participants in a single network in the process of managing material, information, financial and service flows.

Summing up, it should be noted that a properly implemented blockchain technology can provide a transparent business model, stable infrastructure and audit accessibility. The business receives additional development prospects when involved in partnerships, as user confidence in such a system will increase.

However, on the way to realizing this idea there is a series of difficulties that need to be taken into account and overcome: the complexity of designing, setting up and maintaining a decentralized accounting system is usually much higher than for centralized alternatives.

Boryspil International Airport starts its counting since 1959, when it was decided to create a Boryspil International Airport for the civil aviation fleet «Kyiv» (Central) on the basis of a military airfield.

Activities of all airports are connected not only with the servicing of passengers, but also with freight and mail services. State Enterprise Boryspil International Airport increases the volumes of transportation by various flights, regular, irregular and ordered. The annual growth in the number of flights led to an increase in passenger traffic and freight traffic.

Within the framework of Ukraine's matching the quality of goods and services to European standards strategy, Boryspil International Airport has been constantly working on improving the quality of services and expansion of production facilities taking into account all strategic needs of the airport during the last decade.

The total revenue from airport services consists of aeronautical and non-aeronautical activities. At Boryspil International Airport, the most powerful revenues are aviation revenues. However, the share of non-aviation revenue in the Ukrainian «air gates» is much lower than in the leading foreign airports.

Boryspil International Airport uses a system of information protection in which there are some flaws, and not all cells of the system are relevant today.

3. DESIGN PART

Air Transportation Management Department				*NAU 20.09.38.300 EN*			
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3.1. Blockchain implementation spheres

The commercial aviation industry is a highly complex space, where a large of number of entities are involved in the delivery of travel products and services, which is sometimes manifested in a single product from a customer perspective. These actors are often collaborating and partnering to be able to co-deliver value and meet the expectation of customers. From the moment passengers search online for an air ticket to the time they arrive at their destination, the airline is just one of around 26 business partners involved in the aviation chain.

Bockchain has enormous potential for improving the reliability and transparency of the supply chain, as well as for creating a chain in which it will be possible to track the goods up to their origin, check their originality, and make sure that all transport conditions are met. Another indisputable advantage of this technology is that it will significantly reduce the cost of document management, as well as simplify this procedure.

Which business challenges does blockchain help solve?

The main challenges blockchain helps to solve are represented in the Table.

Table 3.1.

Business challenges blockchain does help solve

Use case	How blockhain can help
Limited visibility Cargo changes hands multiple times on its path from manufacturer to consumer. However, no one can reliably track its whole journey. This means that neither the carrier nor the shipper has a complete overview of the end-to-end process.	Blockchain can allow for complete consolidation of air cargo records, with verification, in an effort to create an interconnected, decentralised network of information, optimize efficiency, and provide the option for data sharing. Blockchain is not a new ERP system. However, it can connect to existing Enterprise Resource Planning systems via APIs.

Continuation of the Table 3.1.

Damaged goods Fragile and perishable goods such as flowers or medicine require specific conditions to ensure quality upon arrival. Even a slight temperature drop might damage the goods, incurring costs for the airline. The lack of shared information, makes it hard to prevent and react to these kinds of incidents and causes disputes regarding liability.	Blockchain technology is the single source of truth and ensures that relevant and up-to-date information about the cargo is always readily available and can be acted upon.
Lost goods As stakeholders struggle to keep track of changes and complete the required documentation, cargo is sometimes delayed or disappears. Paper documentation can easily be lost and it is not unusual for cargo and documentation to be physically separated. Investigating what really happened is costly and time-consuming.	Blockchain provides a high level of visibility and transparency, enabling all ecosystem participants to keep track of cargo, where it is and its documentation. This significantly reduces the likelihood of goods going missing.
Workflow optimization Airlines receive confirmation of a booking 24–72 hours in advance. Until then, they have no details about the product or destination and are then left scrambling to execute the logistics.	Blockchain accelerates the exchange of information, thus giving airlines the necessary time to optimise their workflow.

Continuation of the Table 3.1.

Low cargo utilisation The average capacity utilisation across air cargo is only 44%4 as there is no utilisation overview and no marketplace for the available space. Current sales channels focus mostly on price and not utilisation.	Blockchain could facilitate the marketplace and provide the necessary data for a utilisation overview which updates in real-time, enabling air carriers to maximise their space—and revenues.
Disputes As each member of the supply chain ecosystem has their own version of what happened, this can create costly and time-consuming disputes.	Invoice disputes would occur less frequently and could be settled more smoothly, if everyone had a shared view of the truth.
Compliance Dangerous goods, such as lithium batteries, are subject to strict regulations. Air carriers must cooperate or run the risk of losing their operating licence and being shut down.	If the details of a booking come in at the last minute, it can be difficult to ensure compliance. As blockchain expediates the exchange of information and in general digitalises the compliance process, air carriers are better positioned to make the necessary compliance arrangements.

The current method of sending documents back and forth is inefficient and prone to errors. Frequently, the documentation does not progress at the same rate as the cargo, resulting in cargo being left behind while stakeholders launch a time-consuming investigation into what really happened.

This all causes errors, longer transaction times and inaccurate records—and even worse, it can lead to disputes and long-term lack of trust. Blockchain has the potential to solve many of these problems by creating a single source of truth.

3.1.1. Blockchain implementation algorithm at Boryspil airport

The blockchain platform implementation project will consist of the following actions:

1. Creation of a research group/department within the venture company;
2. Conducting research;
3. Attracting investment to sell the product;
4. Development of Dapp;
5. Development of smart contracts based on the developed Dapp;
6. Formation of an alliance of companies that want to join the system (manufacturers, suppliers, exporters, ports and terminals, sea carriers, government institutions, importers);
7. Technological equipment of companies in the alliance;
8. The widespread adoption of technology within the alliance;
9. Providing public access to consumers
10. Analysis of the results.

At the first stage of the project, it is necessary to develop the blockchain itself, as well as a series of smart contracts that will satisfy the requirements of the company in carrying out activities. Given the lack of extensive research in this area, as well as the lack of cases at the moment, the first thing the company will need to create a "department for the development and research of blockchain" within the company.

To study the possibility of applying the technology within the company, you will need:

- Logistics specialists;
- Specialists in data science and big data;

– Blockchain specialist;
– Application developers;
– Lawyer.

Considering the specifics of the platform being developed, experts from various areas of logistics will be required: a specialist in foreign economic activity, a specialist in working with customs authorities, an operational logistics specialist, a transport logistics specialist, and an information systems specialist. The average salary of a logistician in Ukraine is 162 000 UAH per year [63].

Since in order to draw up the necessary smart contracts, it will be necessary to analyze a huge amount of information, plus it will be necessary to study the market situation, take into account all the features that involve the analysis of big data. Given the volume of work, it will be necessary to attract 3 specialists in the field of Data Science and BigData. The average salary of a specialist in the field of big data analysis is 720 000 UAH per year [63].

Table 3.2.

The payroll of the design department

Specialist	**Quantity**	**Average salary/ year, thsd.UAH**	**Total thsd.UAH**
Logistics	4	162	810
Data Science and Big Data Specialists	3	720	2 160
Blockchain specialists	3	1 440	4 320
Application developers	2	792	1 584
Total	12	778.5	9 036

To implement the technical component of the project, blockchain specialists will be required: blockchain engineer - a core developer with experience in system programming in C / C ++, Go or Java. Blockchain developer —Analogue to a professional who writes a desktop application. Smart contracts developer - a

developer for smart contracts. The average developer salary in Europe is 1 440,000 UAH per year [63].

Also, application developers will need to create an intuitive platform that will facilitate the use of technology. Front-end and back-end developers will be required. The average salary in these areas is approximately 792 000 UAH per year [63].

Suppose research takes six months. This period should be enough to research the market, collect data and analyze them. Estimated cost of research is 4 518 000 UAH.

Total we get that the estimated research price of 10,120,320 UAH (9,036,000*1.12), where 12% are laid on deviations and additional costs. It is worth noting that the costs of research include the cost of creating the platform itself.

Since the system is focused on buyers and suppliers of goods, it is also worth deciding on the type of blockchain. Within the framework of this project, it is necessary that all participants in the logistics chain, except the end user, can enter information into the register. But at the same time, the end user must be able to view all the data inside the system. To do this, you should choose a closed public blockchain. This blockchain option allows all authorized users to record in the blockchain, and anyone can access the information. Thus, participants in the supply chain will be able to exchange information, and consumers will be able to receive all the necessary data in order to make decisions on the purchase of goods.

Blockchain 2.0 is also worth mentioning - this is a conditional name that users and developers have given to software based on blockchain technology. The initial blockchain was created under bitcoin and its main function was to perform electronic cash exchange. Although Satoshi Nakamoto has built into the system the ability to create escrow transactions, guarantee contracts, tripartite arbitration, multilateral signature, etc., which are essentially blockchain-based contracts, they still require a third party to regulate the conditions transactions and distribution of wealth. The task of smart contracts is that this distribution and regulation take

place without an intermediary. Thus, the so-called blockchain 2.0 technology appeared, which, unlike blockchain 1.0, is capable of not only making decentralized transactions, but also creating a decentralized market. It is this system that allows you to create smart contracts, smart assets, decentralized applications and decentralized autonomous organizations. It is also worth noting that blockchain 2.0 allows you to use any kind of digital assets inside the network except for cryptocurrency, which can be regulated by many rules and restrictions that are written in the code of the smart contract. At the same time, all the advantages of blockchain 1.0 (transparency, anonymity, security) are preserved. Thus, within the framework of this project, the only possible blockchain option would be blockchain 2.0 [64].

The next step will be directly developing the Dapp application. Dapp (decentralized application) is a decentralized application that should have the following characteristics:

.2. Fully open source. The application should be autonomous, not have a central server or organization that can manage the application;

.3. All data should be stored in cryptographic form in a distributed registry [65]

There are several options: you can develop your own blockchain, and then write a specific system of smart contracts based on it. The second option is to develop a Dapp based on an existing blockchain, such as Ethereum. The third option is to create a Dapp based on the Dapp of the second option, i.e. application on top of the application. For the third option, you must have protocols for your activities. This classification can be compared with operating systems and applications for these systems. The first option is essentially developing your own OS, like Windows or iOS. The second option is more like developing a program: text editor, accounting system, etc. The third option is specialized software solutions. In our case, it is most logical to use a ready-made blockchain and develop a Dapp based on it, since developing your own blockchain is too long and expensive. Plus, it takes time for the blockchain to become popular and can

generate the tokens necessary for work. Given that Ethereum currently exists, a platform specifically designed to create smart contracts, it would be logical to choose the second option. Plus, this option will allow you to create later your own ecosystem around the developed Dapp. On average, the development of Dapp applications costs from 500,000 UAH, but taking into account the scale of the project, as well as the complexity of the system, the estimated cost of development will be about 1,500,000 UAH.

It should be noted that Hyperledger fabric should be chosen as the main platform, since at the moment this platform is excellent for developing technologies in the supply chain field. Hyperledger is a blockchain controlled access platform. From a technical point of view, in this platform, each participant has a developed chain section in his company, but is deprived of access to parts of the network of other organizations. An example of the system is shown in Figure 3.1.

It can be seen from the diagram that each user has his own peer, which ensures the operation of the blockchain. Each user also has an application that allows you to interact with this system. And finally, the connecting links that provide interaction within the network (ordering service). In our case, these links will be smart contracts.

It is worth noting that tokens are not used in Hyperledger, which is an indisputable advantage under the current legislation, since the legal regulation regarding crypto has not yet been established. Somewhere it is approved and accepted, somewhere it is prohibited, but in some countries they are only trying to ban it.

The next step is to create smart contracts. At this point, you will need the information that the big data experts have received. Based on the analysis of statistical information obtained earlier during the company's operation, it will be possible to identify the main types of contracts with which the company and its closest partners work, which will create a template code. This code will be used to write a contract for a specific company.

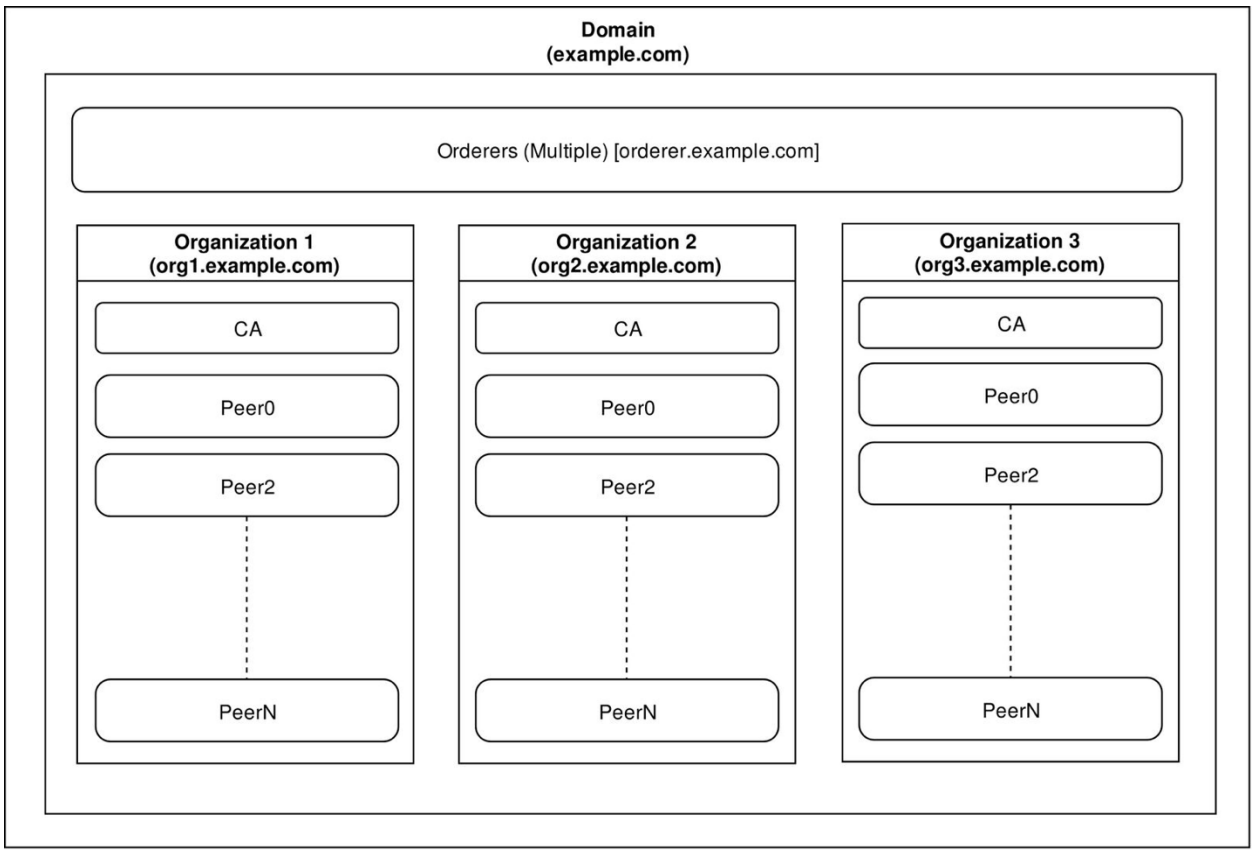

Figure 3.1. Scheme of building a system on the Hyperledger platform.

After the project is launched, it is worth forming an alliance of companies that will be members of the network. In fact, the more companies agree to join the alliance, the better it will be, as this will create healthy competition within the project, as well as significantly increase its effectiveness, since it depends on the number of participants how much this development will make sense.

The next step will be the technical equipment of the companies in the alliance. Or, even, it would be more correct to say - this will be a prerequisite for entry. Blockchain is a database, it needs eyes and ears, in other words, it requires the presence of channels through which information will enter the system.

It is necessary to label the goods using RFID tags, QR codes and NFC tags, which will allow automatic recording of the incoming product without human intervention, as, for example, with portal stationary readers that register all goods passed through them equipped with RFID -notes.

After the completion of the technical equipment of the participating companies of the alliance, in principle, there is nothing complicated. It is necessary to present the system to the general public, explain how to use it and after some

time analyze the results obtained in order to reveal the effectiveness of the system implementation.

From the expected results, we can assume:

• reduction in document costs, as well as a decrease in the number of paper escorts in general;

• Reducing the processing time of documents. Where previously it took several weeks to complete all the documentation, it may now take several minutes;

• Improving the control and accounting system. As a result, this will entail a reduction in the number of failures in the supply chain;

• Lower prices for the services provided in general;

• Increased global trade due to lower barriers within the supply chain.

3.1.2. Economic analysis of the system

To date, the cost of necessary trade documentation can be as high as 20% of the cost of actual transportation costs [66]. Boryspil Airport does not disclose its cost items in detail. The annual report provides information on general economic indicators, but it is impossible to find how much and what the airport spent specifically on. However, in our work, we can go from the opposite and calculate the minimum economic benefit that the airport will receive.

Since the main activity of the Boryspil airport is the organization of air passenger and freight traffic, we can assume that the cost of organizing air traffic services is at least 30% of operating expenses. According to the Table 2.6 operating expenses of Boryspil Airport for 2019, excluding social expenses, depreciation, interest and unusual expenses, were planned to be 2,064,301 UAH.

If we assume that the costs for the organization of air traffic services are not less than 30%, it turns out that the operating expenses for the organization of air services for 2019 were supposed to be 619,290.3 UAH.

Since in our case we are calculating the minimum possible benefit, it does not make sense to take the upper value. Suppose, on average, the cost of document

circulation is 10%. Then it turns out that in a year for the workflow the airport of Boryspil spends a minimum of 144,501.07 UAH.

As the system itself implies paperless operations, it can be said with certainty that there will be a 50% reduction in the cost of document circulation. Thus it turns out that Boryspil airport will be able to save a minimum of 72,250.535 UAH.

3.2. Recommendations on the use of blockchain technology

According to the research, the blockchain, originally used as a platform for cryptocurrency, should increase transaction transparency and reduce the risk of fraud in the analyzed airport. However, by November 2018, the turnover with the use of the blockchain is still too small to be able to say with certainty when its volume will reach a critical mass.

The main problem with using the blockchain is that cryptocurrency is not intended for physical transactions - it is impossible to track a physical object in the virtual world.

In addition, the introduction of new technologies should be accompanied by an agreement on terminology, and it is not yet clear whether, from an economic point of view, the transition to a blockchain platform is justified.

It is also unclear to what extent merchants are willing to accept a blockchain that can reduce an already insignificant share of profits. With the formation of platforms, the inefficiency of pricing and the uneven distribution of information that underlies intermediary deductions will disappear, and with they will dissolve and profit sellers.

At the same time, the use of blockchain can increase transparency of operations, create a more efficient and liquid market. Trading transactions will no longer be limited to bilateral agreements and will move to more flexible transactions based on electronic platforms between many sellers and buyers. The

wider the new technologies are introduced, the less the role of intermediaries will be, and it is not yet clear whether they will want to actively use the blockchain.

Blockchain will bring the greatest benefit in those areas of trade where the origin of the goods plays an important role. For example, this concerns the diamond trade. Since May 2018, De Beers has been using distributed ledger technology to track the most expensive diamonds from its place of production to a sales representative in order to rid the supply chain of fraudsters and illegal exploitation of deposits

Blockchain will become an effective tool in the commodity market only if everyone uses it. Occasional transactions in a distributed registry do not affect the overall picture.

Using the blockchain has its own advantages for the government - this technology facilitates the process of digitizing documentation and access to public services. Zigri noted that

Estonia already uses the blockchain in the e-Estonia program, which allows you to vote, keep medical records and pay taxes online. Blockchain technology allows Estonia to save up to 2% of GDP per year. The Dubai government, together with IBM and ConsenSys, is working on a pilot project that will cover the whole country. According to the plans of the companies, this project will simplify the verification of identification data and allow the digitization and tracking of medical records, wills and various contracts.

Blockchain changes the rules of the game. Thanks to this network, companies cannot work in isolation. At the center of any blockchain is a common book of records, and each member of the network owns an exact copy of it. Thus, all participants have an updated accounting book, which cannot be corrected without the knowledge of other network participants.

In order for the blockchain to fully realize its potential, it must be open and work on a generic technology with full interoperability. Blockchain helps save time in negotiations, reduces financial costs, eliminating the chain of intermediaries between the manufacturer and the consumer, and also reduces the

risk for both thanks to full open control. This opens up innumerable opportunities for using the blockchain [67-71]. Thus, according to the technological paradigm of the blockchain, data can be stored publicly and at the same time be safe. Data can be transmitted without a single center and intermediaries, while guaranteeing the fulfillment of obligations of the parties, and, most interestingly, the data has programmable value, which subsequently becomes market value. This is possible due to the cryptocurrency tool and smart contracts. They allow you to go from digital code to a tool of a market economy. Thanks to them, it becomes possible to digitize any asset in the real sector of the economy. However today the key a barrier to this is the discrepancy between legal institutions of the economy and the market potential of technology.

The modern financial system illustrates the interaction of these categories, in a simplified model it can be represented as a set of legal obligations between economic entities and a set of digital records fixing these obligations. The functioning of these institutions is managed within a single system of regulators, but the nature and mechanism of this regulation are different. In the framework of legal institutions, if the activities of entities violated the established rules, the consequences of the violation system to ensure compliance with these rules in the future. In the context of digital institutions, when a rule is violated (attempted to violate) a technical error occurs that does not allow an action to be taken in violation of the approved conditions. Thus, consistency is ensured by the digital code itself.

In the modern financial system, the function of managing and ensuring the consistency of actions to accepted standards is performed by the regulator at the expense of legal institutions, while digital institutions serve the tasks of their technical support. In the blockchain paradigm, digital institutions are the guarantor of the observance of rights, and legal institutions are entrusted with the task of legitimizing them.

Thus, the blockchain, implying the decentralization of the management system, demonstrates to us a situation where the work of economic entities can be

carried out on the basis of a digital code, while regulation shifts from legal institutions to digital ones. An important consequence of this is the reduction of administrative barriers, automation of reconciliation and approval procedures, openness and security of storage and circulation of information and digitized assets [72-75].

Since the information on the blockchain is stored in a decentralized manner, the creation of a centralized infrastructure is not required, which in itself allows organizations to save a huge amount of resources. Minimization of the costs of maintaining equipment operability is achieved by the fact that there is no central server as such: full and current copies of registries or databases are stored on numerous computers on this network. Such hosts are called nodes. All information on them is constantly synchronized, validated (checked) and supplemented when specified conditions are met. However such network design creates the need for economic incentives for node holders on the network.

It is advisable to introduce blockchain technology in operations with securities, clearing, crowdfunding, in property and ownership registers, decentralized data storage, when identifying users and clients, when using smart contracts, and also to confirm the relevance of identification data.

It may seem that blockchain technology is a priority only in the financial sector. Using this technology, any database can be implemented, and especially in the supply and aviation chains. With the combined use of blockchain technology in these areas, it is possible to refuse to provide supporting documents to many government bodies and authorities [76].

Despite all the advantages of the technology, today in the field of aviation there are no really working successful global projects on the blockchain. This may be due to the traditionalism inherent in the global financial system, the resistance with which many classical banking institutions met a new technology, seeing in it not an opportunity, but a competitor or even a potential alternative to themselves.

Conclusion to design part

In this chapter, an algorithm for implementing blockchain in Maersk's logistics chain was considered and implemented. The main labor units that will be needed in the course of work were listed, as well as a PHO. Further, on the basis of the analysis of media and literature sources, the estimated cost of developing the system was suggested. Since the blockchain theme is fairly new, there are no clear standards and rules in this area. Plus, since companies are just starting to implement these technologies and don't disclose their value, the price is approximate. As part of this project, a closed public blockchain will be implemented, which will be built on the Hyperledger fabric platform.

The estimated cost of Dapp development will be 1,500,000 UAH. The approximate cost of implementation of the whole project will be 11,620,320 UAH. Boryspil Airport will be able to save a minimum of 72,250,535 UAH annually on document circulation.

To summarize, it is worth saying that blockchain is not only a way to exchange financial transactions. In a broader sense, it is a distributed, secure database in which information cannot be faked, deleted, or modified with a “backward” number. Thanks to these properties, the blockchain brings a number of capabilities and services where the reliability and integrity of data, as well as speed and availability are important.

However, such a digital technology is not just a fantasy or the near future, it is already a fait accompli, and the success and development path depend on how quickly society and the state plunge into the world of new technologies. Unwanted and not seeking to change after global trends at least is worth paying attention to this young technology [40].

SUMMARY

Air Transportation Management Department				*NAU 20.09.38.002 EN*			
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In this paper, we considered blockchain technology and its impact on the aviation industry. During the study, it became clear that the scientific base has not yet been formed, there are no fundamental works in this area, and the technology itself is only just beginning to be studied and mastered by large companies and industry leaders.

Many experts believe that blockchain is the largest innovation that we are seeing today, comparable to the widespread digitalization of the economy. In technological terms (at the computational level), the blockchain is a decentralized registry of all transactions in a computer network.

Based on the consideration of the technological capabilities of the blockchain, the identification of its features and advantages, it can be concluded that the result of the introduction of blockchain technologies will be the automation of production and services, which will lead to the era of digital contracts and paperless transactions, significant resource savings. It is possible to find blockchain in almost any industry, among the areas in which projects have already been successfully implemented: financial and banking, healthcare, higher education, public administration, insurance, logistics, aviation and many others. However, when considering the possibility of using blockchain technologies in the aviation sphere, it is necessary to take into account and analyze such threats as: protecting and ensuring the confidentiality of information, large amounts of energy expended, low speed of transactions, data invariance - the problem of editing information, resistance to implementation (by intermediary companies and others), regulatory.

Due to the use of blockchain technologies, economic processes will be transformed. Moreover, in the future, blockchain can become the basis of the economy, which will create a decentralized, transparent financial system that intermediaries, predatory commissions, the state and corruption will not be able to influence. However, there are factors that impede the development of the blockchain economy, including: lack of a well-developed regulatory system, lack

of understanding or interest in blockchain, the use of cryptocurrencies as an accumulative or speculative asset, and others.

In recent years, transport logistics in the aviation sector has become one of the most significant and developing sectors of the economy. And blockchain technologies have great potential for optimizing costs, as well as the time associated with documentation and administrative processing of shipments. From the point of view of supply chain management, the blockchain allows one of the most difficult problems in the implementation of inter-organizational coordination to be solved: how to ensure the security (transparency) of information flow and the trust of counterparties of the supply chain.

The largest companies from the food and retail industries are not just testing, but are launching blockchain services to track the supply chain of products, among such companies: Walmart and Carrefour - retail giants. The main drivers are: reducing logistics costs throughout the supply chain, the safety of food products, the effectiveness of inventory management, competition for users with the help of new features related to the provision of reliable product information.

With the development of technology, the world is changing, which means that the business models of companies also need to change to meet the needs of the market and consumers. However, in the logistics sector in aviation, only a fifth of the companies are ready for changes and conduct research, introducing blockchain technologies in their activities, the rest of the companies prefer to wait, losing their potential competitive advantages.

The key problem that complicates the active use of blockchain technologies in logistics and supply chain management in the aviation industry is the difficulty or inability to evaluate the economic effect in absolute terms. Companies already using technologies are extremely cautious in disclosing information about losses, their volumes, facts of detected corruption cases, which leads to great difficulties in assessing the potential effects of the implementation of the blockchain.

However, even now it is safe to say that blockchain can increase the reliability and efficiency of the logistics chain in aviation. Firstly, the principle of

technology itself makes the supply chain more transparent, which increases the level of customer awareness, which in turn affects the awareness of the choice of goods or carrier, and also increases loyalty to the company, as the consumer understands that the company trusts him.

Secondly, the system is technologically arranged in such a way that the possibilities of manipulation in one's interests in it are much less than in the case of classical (paper) forms of contracts. It’s quite difficult to hack a blockchain, as this will require large computing power, which entail enormous costs. Plus, the system is designed in such a way that if it succeeds in hacking, the attacker can only return his money, but he will not be able to enrich himself indefinitely.

Thirdly, the technology of smart contracts can significantly reduce the costs of the document turnover, which can reach 20% of the total cost of transportation.

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