MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF TRANSPORT, MANAGEMENT AND LOGISTICS
DEPARTMENT OF ORGANIZATION OF AVIATION WORKS AND SERVICES

PERMISSION TO DEFEND GRANTED
Head of the Department
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«____» _____2023 p.

**QUALIFICATION PAPER**
**(EXPLANATORY NOTES)**
GRADUATE DEGREE OF EDUCATION
"MASTER"
SPECIALITY 275 “TRANSPORT TECHNOLOGIES (BY AIR)”
SPECIALIZATION 275.04 “TRANSPORT TECHNOLOGIES (BY AIR)”
EDUCATIONAL PROFESSIONAL PROGRAM "MULTIMODAL TRANSPORT AND LOGISTICS"

**Topic: «Organization of cargo transportation in the multimodal transport network»**

Done by: __Yeshchenko Elvira Stanislavivna, MT-205Ma _
(recipient, group, surname, first name, patronymic)

Head: Klymenko Viktoriia Viktorivna, PhD in Economics, Associate Professor
(academic degree, academic title, surname, first name, patronymic)

Standards Inspector: _____ _Viktor E. Osmak_____
(signature) (surname, first name, patronymic)

Kyiv – 2023

NATIONAL AVIATION UNIVERSITY

Faculty of Transport, Management and Logistics
Department of Organization of Aviation Works and Services
Specialty 275 "Transport technologies (by air)"
Specialization 275.04 "Transport technologies (by air)"
Educational professional program: "Multimodal transport and logistics"

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**TASK**
**of completion the qualification paper**
Yeshchenko Elvira Stanislavivna
(full name of the graduate)

1. The topic of the qualification paper entitled: “Organization of cargo transportation in the multimodal transport network" was approved by a decree of the Rector of September 01, 2023 order No.111/ст.

2. Term performance of qualification paper is 01.09.2023 – 25.12.2023.

3. Initial data required for writing the qualification paper: statistical data of the socio-economic and transport environments of Ukraine, production and financial report of the LLC FTP.

4. Content of the explanatory note to the qualification paper: evaluation of the degree of development of the transport network of Ukraine and the peculiarities of its components in the multimodal transportation system, general characteristics of the FTP LLC, analysis of financial and economic activity of the FTP LLC, peculiarities of interaction of transport modes in multimodal systems, optimization of last-mile logistics using drone transportation, optimization of the transportation process using smart contracts.

5. List of mandatory graphic (illustrated) material: graphical representation of economic and statistical indicators in the form of tables, graphs and charts.

6. Planning calendar

| № | Assignment | Deadline for completion | Mark on completion |
|---|---|---|---|
| 1. | Collection and processing of statistical data | 01.09.2023 - 30.09.2023 | done |
| 2. | Writing of the analytical part | 20.09.2023 - 10.10.2023 | done |
| 3. | Writing of the design part | 11.10.2023 - 30.10.2023 | done |
| 4. | Writing of the introduction and summary | 01.11.2023 - 25.11.2023. | done |
| 5. | Execution of the explanatory note, graphic matters and the presentation | 01.12.2023 - 20.12.2023. | done |

7. Consultants from individual sections

| Section | Consultant (position, P.I.B.) | Date, signature | |
|---|---|---|---|
| | | Issued the task | I accepted the task |
| 1. Theoretical part | Klymenko V.V. | 12.09.2023 | 19.09.2023. |
| 2. Analytical part | Klymenko V.V. | 05.10.2023. | 12.10.2023. |
| 3. Project part | Klymenko V.V. | 29.10.2023 | 12.11.2023. |

8. Given date of the task: 29.08.2023

Supervisor of the qualification paper: _____ __Klymenko V.V.__
(signature) (surname, first name, patronymic)

Task was accepted for completion:_____ ___Yeshchenko E.S _
(signature) (surname, first name, patronymic)

# ABSTRACT

The explanatory notes to the qualification paper on the theme “Organization of cargo transportation in the multimodal transport network” comprises of 108 pages, 36 tables, 38 figures and 43 references.

KEY WORDS: TRANSPORT NETWORK, CARGO, MULTIMODAL TRANSPORTATION, INVESTMENT PROJECT, OPTIMIZATION, BLOCKCHAIN, ARTIFICIAL INTELLIGENCE, DRONE, SMART CONTRACT.

The object of the research is organization of cargo transportation in the multimodal transport network.

The subject of the research is efficiency of the organization of cargo transportation in the multimodal transport network on the basis of FTP LLC and directions of its improvement.

The purpose of the research is analysis of the organization of cargo transportation within a multimodal transport network on the basis of the FTP LLC and development of approaches directed at improvement of performance indicators of the company and organization of transportation process as a whole.

The relevance of the qualification paper is based on the concern that studying of organization of cargo transportation in the multimodal transport network is pivotal for achieving operational efficiency, reducing costs, mitigating risks, complying with regulations, fostering innovation, and contributing to sustainable and resilient supply chains in a globalized and interconnected world.

Scientific novelty of qualification paper is based on the fact that scientists have not yet sufficiently investigated the approaches of integration of unmanned aerial vehicles into the logistics chain as well as facilitation of transportation processes using blockchain technologies.

Methods of research are theoretical, such as analysis, synthesis, systematization, comparison, and empirical, such as calculation of technical and economic parameters and graphical analysis.

The material base of this qualification paper is recommended to be used for the further researches, the educational process and for the professional practical implementation by LLC FTP in order to improve their production and financial results.

## LIST OF CONVENTIONAL SIGNS, ABBREVIATIONS AND TERMS

UAV - Unmanned Aerial Vehicle

VAT – Value Added Tax

AI – Artificial Intelligence

IoT – Internet of Things

MTO – Multimodal Transport Operator

LLC – Limited Liability Company

COVID-19 – Coronavirus Disease 2019

TSW – Temporary Storage Warehouse

EDI – Electronic Data Interchange

EORI – Economic Operators Registration and Identification number

NPV – Net Present Value

IRR – Internal Rate of Return

**CONTENTS**

# INTRODUCTION

**Relevance of the research.** Research on the organization of cargo transportation within a multimodal transport network plays a pivotal role in enhancing efficiency, reducing costs, mitigating risks, and fostering sustainable and resilient supply chains, thereby benefiting various stakeholders in the logistics and transportation industry.

The level and speed of the integration of technology in logistics and transportation is rather high. This involves leveraging innovations like IoT, blockchain, AI, use of unmanned aerial vehicles and data analytics to enhance efficiency, track shipments, and optimize routes. Though the speed of modernization and adoption of new technologies in Ukraine is low (especially in war time), a company that works with global logistics market needs to keep up with the time and follow trends in order to be able to provide high-quality services and stay competitive.

In addition, research in this area can have a substantial economic impact by improving trade facilitation, reducing transportation costs, and boosting economic growth through efficient cargo movement. It contributes to strengthening global trade networks and enhances supply chain resilience by diversifying transportation options and reducing dependency on a single transport mode.

**The purpose of this work** is analysis of the organization of cargo transportation within a multimodal transport network on the basis of the FTP LLC and development of approaches directed at improvement of performance indicators of the company and organization of transportation process as a whole.

It is needed to perform the following tasks for this purpose accomplishment:

– describe the essence of the transportation network and evaluate the degree of development of the transport network of Ukraine;

– assess the development of the transport network as a factor determining the efficiency of the multimodal cargo transportation system;

– provide general characteristics of the FTP LLC;

– monitor and evaluate the main production and financial indicators of FTP LLC;

– determine the optimal way to organize last-mile delivery using unmanned aerial vehicles;

– improve and simplify organization of multimodal cargo transportation with the use of smart contracts.

**The object of research** is organization of cargo transportation in the multimodal transport network.

**The subject of research** is efficiency of the organization of cargo transportation in the multimodal transport network on the basis of FTP LLC and directions of its improvement.

**Methods of research.** The following methods were used to solve the established tasks: theoretical, such as analysis, synthesis, systematization, comparison, and empirical, such as calculation of technical and economic parameters and graphical analysis.

The scientific works of such scholars as Klymenko V.V., Novalska N.I., Sokolova O.Ye., Hans-Joachim Schramm and others deal with the issues of organizational principles of multimodal transportation in international connection, integration of transport into multimodal systems, conceptual basis for the formation of a multimodal cargo transportation system. It includes concepts of logistics flows, multimodal transport system, efficiency, technological aspect of multimodal transportation, productivity, etc. [1-4].

However, the scientists have not yet sufficiently investigated the approaches of integration of unmanned aerial vehicles into the logistics chain as well as facilitation of transportation processes using blockchain technologies.

**Approbation of the obtained results.** The qualification paper results are recommended for use by logistics companies, such as FTP LLC in order to improve their production and financial results (Annex F).

# CHAPTER 1
# CHARACTERISTICS OF THE TRANSPORT NETWORK IN TERMS OF ITS FORMATION AND DEVELOPMENT IN MULTIMODAL CARGO TRANSPORTATION SYSTEMS

## 1.1. Evaluation of the degree of development of the transport network of Ukraine and the peculiarities of its components in the multimodal transportation system

A transport network typically refers to the interconnected system of nodes (centers or locations where goods are loaded and unloaded) linked by routes (roads, railways, air routes, etc.) that facilitate the movement of people and goods. It consist of railways and highways, inland waterways, navigable canals and locks, overhead lines, pipelines, sea and river ports, railway stations, airfields and airports, pumping stations, piers, transshipment bases, access roads of industrial enterprises for transportation to highways. Transport networks can vary widely in scale and complexity, ranging from local road systems to global networks of air and sea routes, depending on the specific context and needs [5].

A well-designed and integrated transport network is crucial for economic development, social inclusion, and environmental sustainability. It can reduce congestion, lower transportation costs, improve accessibility, and reduce the environmental impact of transportation through measures like supporting cleaner energy sources and introduction of alternative transportation methods.

Transport networks are typically planned and managed by government authorities and agencies at various levels, as well as private sector entities in some cases. They involve a complex interplay of infrastructure development, maintenance, regulations, and technology to ensure that people and goods can move efficiently and safely.

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Transport networks have several key characteristics that define their structure and operation (Fig.1.1).

The coefficient of nonlinearity is the ratio of the distance along the transport network to the distance along the air line between the two points [6].

Increasing the coefficient of nonlinearity leads to an increase in the distance of movement, and, consequently, the cost of passenger time, as well as exceeding the mileage of rolling stock, which leads to increased costs of transportation.

Network density can be determined as the number of links per unit area or the total network length divided by the area it covers. It may indicate state of economic prosperity: the greater the density and the better the index, the more advance a country is. When it is utilized properly, network density can yield increase in efficiency and save cost [7].

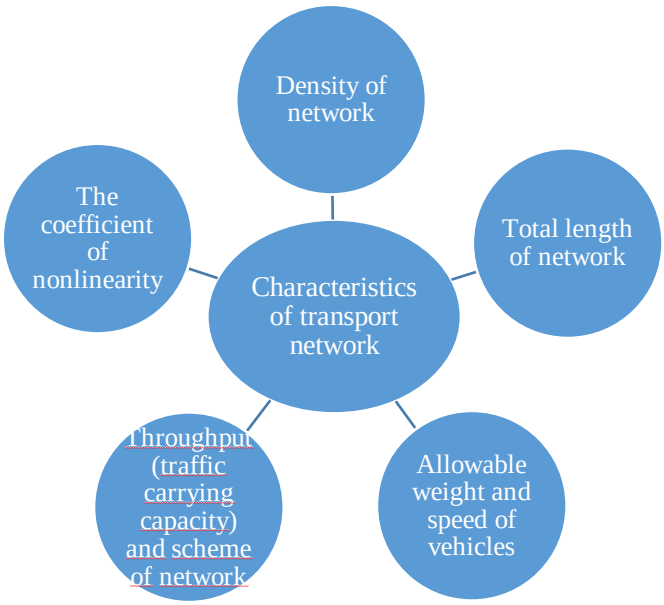



Fig.1.1. Characteristics of transport network

*Source: developed by the author on the basis of research*

Throughput and capacity of a transport network refers to its ability to handle a specific volume of traffic or passengers [8]. Adequate capacity planning is essential to prevent congestion and bottlenecks.

These characteristics are interrelated and may vary depending on the specific type of transport network, its geographic location, and its intended purpose.

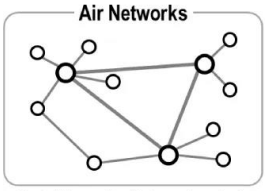
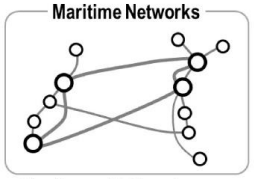
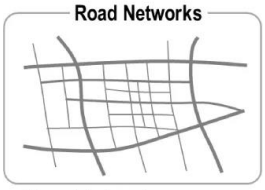
Transport network must meet the following requirements:

- large objects of attraction (industrial enterprises and zones, transport hubs of modes of transport, cultural objects of urban importance) must be connected with residential areas and between themselves, if possible, the shortest distances;
- transport lines must correspond to the direction of passenger and cargo traffic, and their length must correspond to the area of the city and the number of operated rolling stock;
- the capacity of the transport network shall ensure the passage of the expected number of vehicles and reserve lines shall be provided in the event of a traffic stop on each of the sections of the transport network.

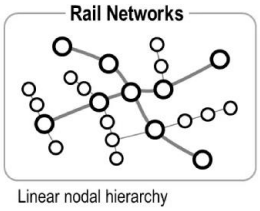
The configurations of transportation networks vary depending on the modality they represent. The main types of transport network are presented in the table 1.1.

*Table 1.1.*

Major types of transport network

| Type of transport network | Scheme of transport network | Description of transport network |
|---|---|---|
| Air networks |  Nodal hierarchy (hub-and-spoke) | These networks are often nodal hierarchies arranged in a hub-and-spoke fashion, emphasizing that nodes, or airports, constitute the fundamental components of air networks. A node's significance is often determined by the volume of traffic it manages as well as its degree of connectivity. A hierarchy of flows exists, with short-distance feeders at the regional level and inter-hubs at the worldwide level. Air transportation networks are particularly susceptible to interruptions at big hubs because to its high degree of hubbing. |
| Maritime networks |  Circuitous nodal hierarchy | Such networks form a ring node hierarchy, which implies that services are typically organized along a chain of nodes (ports) with inter-span services returning to the originating port. While point-to-point services mirror bulk transport, container transport is organized between deep-sea services and feeder services, with transhipment hubs acting as interface points. The vulnerability of maritime networks has different considerations. Disruption at a hub will mainly affect the maritime transport network, while disruption at a gateway will mainly affect the hinterland. |
| Road networks |  Hierarchical meshes | Such networks are hierarchical grids, each serving a different scale. They do not have visible nodes but rather fixed paths of known capacity. While the interstate highway system is designed to connect a country or a large area, local streets only connect nearby activities within a larger framework. Due to its grid structure, the road network is not susceptible to disruptions, unless these disruptions are large-scale or impact strategic connectors such as bridges or tunnels. Highly connected road networks can be disrupted if high-level connections are closed, forcing traffic to switch to lower-level connections that may not be able to handle the load. |

*Ending of the table 1.1*

| Type of transport network | Scheme of transport network | Description of transport network |
|---|---|---|
| Rail networks |  | Such networks form a linear node hierarchy with nodes linked to multimodal stations, railway stations, and public transit stations.<br>Due to the fixed nature of routes and their capacity, they are allocated periods of use during which units are grouped for circulation. While linear rail networks are susceptible to disruption, complex rail and transit networks have a mesh structure, making them more resilient. |

*Source: developed by the author on the basis of the information [5].*

Basic schemes of the transport network depending on the layout include radial, radial-circular, triangular, rectangular, rectangular-diagonal and free (combined) schemes (Fig.1.2).

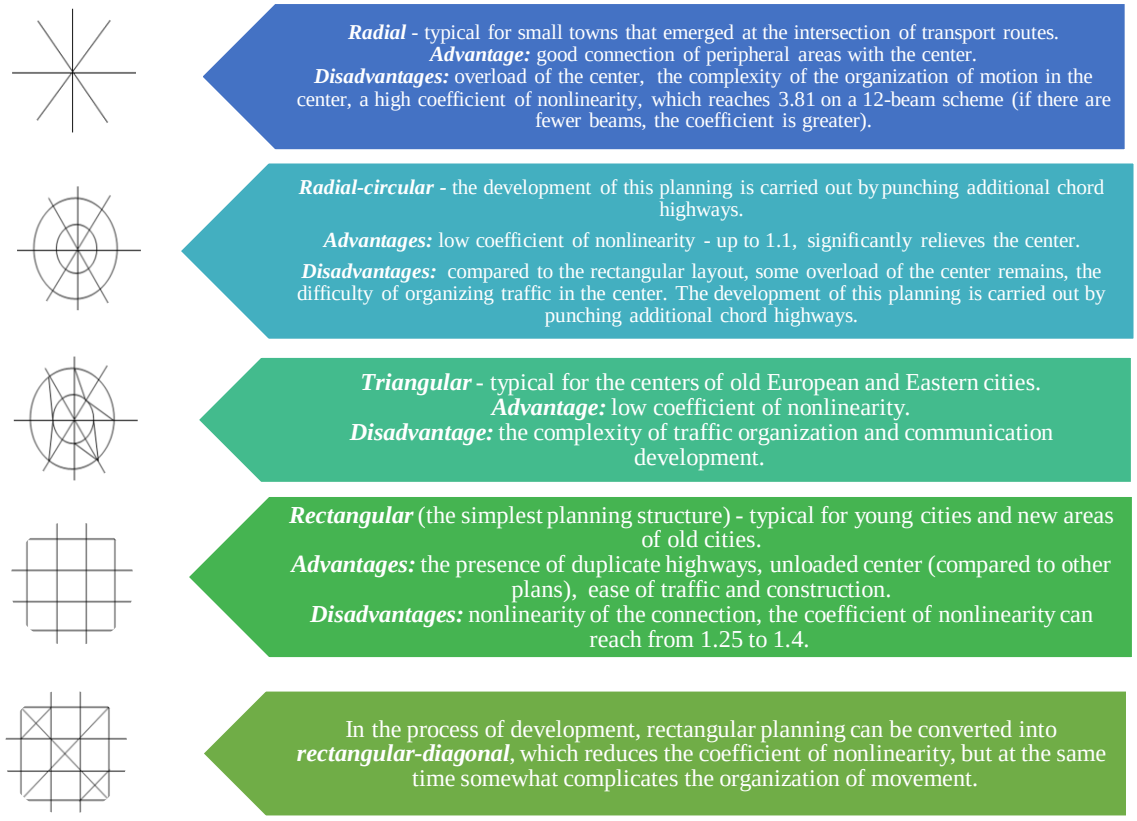



Fig.1.2. Basic schemes of the transport network: depending on the layout

*Source: developed by the author on the basis of information [5]*

The most common - free (combined) planning is a combination of the above transport schemes. With free planning, a lot depends on how well the individual parts are combined. In some cases, this planning is most appropriate (reliefs, rivers, etc.). The coefficient of nonlinearity is approximately 1.1.

In the scientific literature, the study of the scientific principles, construction and organization of multimodal transport systems is given a prominent place by both domestic and foreign authors. In particular, a multimodal transport system is considered both in terms of its components and purpose, and in terms of the peculiarities of organizing multimodal transportation of goods, as well as the composition of participants in such a system. Per Rodrigue J.-P. A multimodal transport system integrates different geographical scales from global to local, consisting of a set of gateways and hubs where regional and local transport networks converge [5].

Bielli, M., Boulmakoul, A., & Mouncif, H. state that a multimodal transport system is a combination of all transportation participants and types of transportation systems, operated by means of different systems [9].

Dewitt, W., & Clinger, J. define multimodal transport system as the use of two or more modes of transport involved in the movement of people or goods from origin to destination [10].

Pawan Kumar, S.S.Jain, S.Y. Kulkarni, M. Parida state that multimodal transportation system involves the use of several types of transport for safe, convenient and efficient transportation [11].

Sokolova O. defines multimodal transportation system as an integrated and interconnected transportation system aimed at accelerating, reducing the cost and simplifying technological procedures along the entire door-to-door delivery chain, provided that all links in the transportation process are interconnected in an organizational and technological manner. The multimodal cargo transportation system is based on the internal integration of various modes of transport and other participants in the transportation process, which interact with each other and perform their part of the work within the framework of contractual relations and in the presence of a single management body - the "main link" [3].

Per the Law of Ukraine multimodal transportation is transportation of goods by two or more modes of transport on the basis of a multimodal transportation agreement carried out under a multimodal transportation document [12].

Multimodal transport systems are integrated systems that include at least two modes of transport, sections of different types of connections (roads, railways, airlines and waterways), transport hubs where different modes of transport interact directly, as well as real-time information switching systems and integrated electronic document management and payment systems. Integration takes place on the basis of common standards and a single information environment both within the country and its regions and in international traffic. Multimodality refers to transport infrastructure, vehicles, freight units and management systems. The main concept of multimodality is transfer and transit. Multimodality is characterized by the presence of points that connect networks of different modes of transport into one large integrated network, and where cargo is transferred from one mode to another.

The main property of a multimodal transport system, like any system, is integrity and unity, which is achieved through certain interconnections and interactions of its constituent elements. The constituent elements of a multimodal transport system are:

- logistics flows;
- technical means of transport;
- participants;
- regulatory system.

A successfully integrated transport system involves not only the combination and interaction of all its participants, the creation of a single legal and information field for transportation, but also the coordination of technical and operational characteristics of vehicles, infrastructure facilities, transport equipment, and containers; coordination and optimization of schedules, development of contact schedules for various types of transport, shippers and consignees, etc.

Integration in multimodal transport systems also involves [13]:

- integrated planning;
- integrated infrastructure;
- integrated operations (Fig.1.3).

Integrated transportation planning in multimodal systems includes estimation of demand volumes on routes, distribution of demand by modes of transport, taking into account the elasticity of demand; assessment of the potential of each route and line; development of long-term route strategies by direction, calculation of the potential for the development of route networks; planning the transfer of cargo flows from one type of transport to another, taking into account competition between carriers, the formation of a multimodal transport hub system; forecasting the technical capabilities, capacities and capacity of each individual transport infrastructure facility; planning the development of enterprises participating in the transportation process, the integration of carriers, agents, and forwarders into international networks; planning investments in the development of multimodal transport system infrastructure.

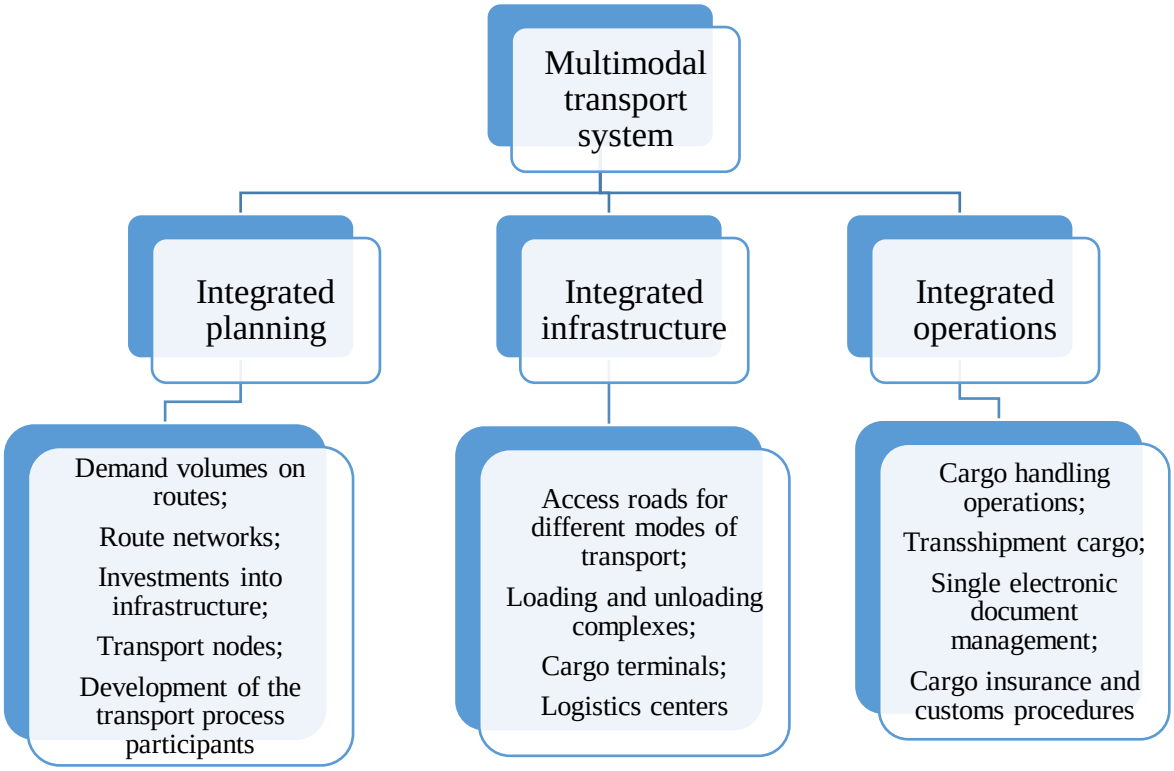



Fig.1.3. Integration in multimodal systems

*Source: developed by the author on the basis of information [13]*

The integrated infrastructure in multimodal systems provides for an uninterrupted connection of different modes of transport, which is ensured by the availability of access roads for different modes of transport, loading and unloading complexes, cargo terminals and warehouse complexes with logistics centers for the management and distribution of

cargo flows. A transport hub is a direct point of connection and interaction between different modes of transport, and the implementation of multimodal transportation on logistics principles on a national and international scale. A multimodal transport hub may include railway stations and railways connecting these stations, seaports and river ports, airports, railway stations, highways, and terminal and intermediate facilities of main pipelines.

Integrated operations within multimodal transportation systems involve coordinating infrastructure and planning to ensure uninterrupted communication between modes of transportation. This subsystem includes cargo handling operations, transshipment cargo, collecting and processing orders from customers, notifying about the arrival and departure of goods, informing about the location of cargo and vehicles, maintaining a single electronic document management, organization of settlements with organization of settlements with the use of a single through tariff, cargo and technical means.

The main principles of multimodal transport system functioning is shown in the fig.1.4.

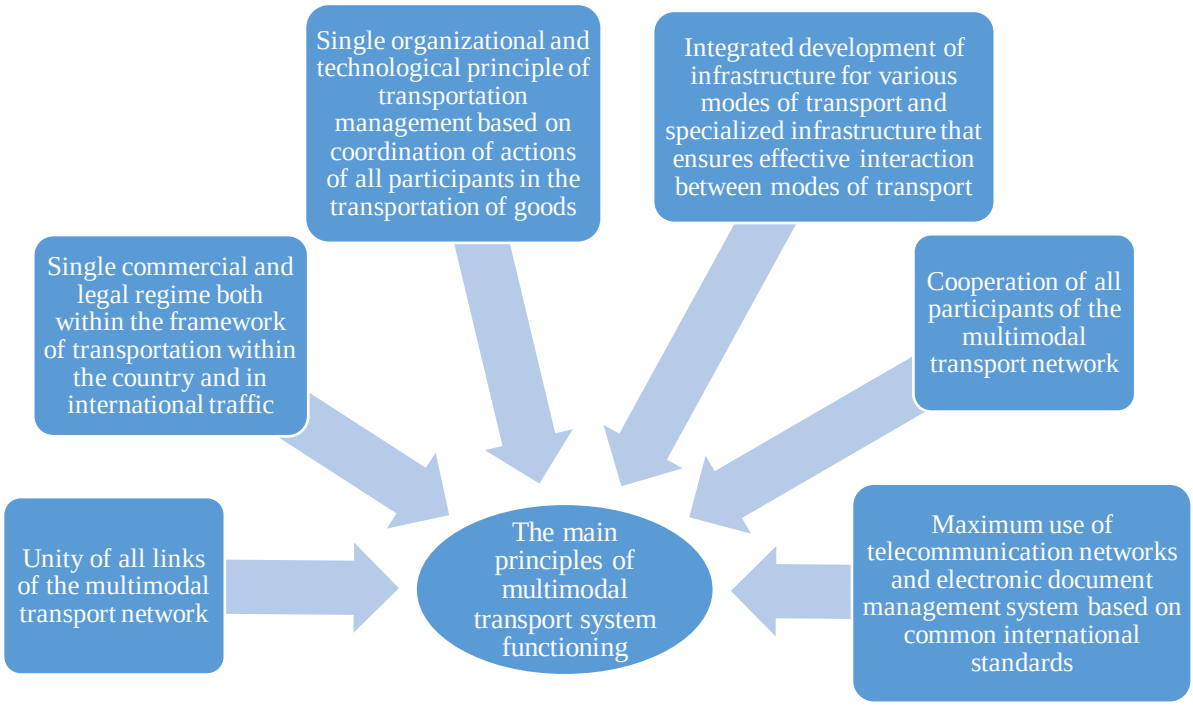



Fig.1.4. The main principles of multimodal transport system functioning

*Source: developed by the author on the basis of research*

Ensuring the efficiency of multimodal transport systems is a complex task that

includes:

- determination of the effects of organizing and carrying out cargo transportation (in particular, economic, scientific and technical, organizational, social and environmental) and their correlation with the costs incurred;

- forming a system of economic security of multimodal systems, which involves analyzing internal and external threats and risks, developing indicators for assessing the state of the multimodal system and planning measures to eliminate and minimize identified threats (risks).

Ensuring conditions for the efficient development of multimodal freight transportation systems is possible, on the one hand, on the basis of the development of legislative, financial, credit, tax and other factors of the external environment in which freight carriers and their partners operate. On the other hand, it is necessary to fundamentally improve the activities of logistics companies themselves to provide the most complete package of services to cargo owners.

The efficiency of the transportation system is an important factor in economic development. Transport is an industry that is at the intersection of the manufacturing and service sectors. It does not create any material assets, but provides transportation of goods and passengers, developing links between enterprises, industries, and regions. That is why the transport sector is an important component of the Ukrainian economy. The efficient functioning of the state transport system and its inclusion in the global transport network will help to increase the volume of international transportation, which is extremely important for improving the competitiveness of domestic transport. It is necessary to choose a rational technological scheme for multimodal cargo transportation.

Ukraine's transportation system consists of different types of transport. Each of them has its own specifics. All types of transport must be interconnected and work in a coordinated manner to ensure the country's economy. The total transport network of Ukraine includes 21.6 thousand km of railways, 166.1 thousand km of paved roads, 4.8 thousand km of main oil pipelines, 40.1 thousand km of gas pipelines and 1.0 thousand km of ammonia pipelines, 2.1 thousand km of operational river shipping routes with access to the Azov and Black Seas [14].

Rail transport is one of the main modes of transportation for cargo and passengers. It carries out a significant volume of domestic and export-import transportation.

Road transport transports various goods and passengers mainly over short and medium distances.

Pipeline transportation plays an important role in the movement of oil and oil products, as well as natural gas. The oil pipeline network is less dense. Local oil pipelines are short and transport oil from production sites to refineries.

River and sea transport together make up the water transport of Ukraine. River transport mainly carries out domestic transportation of goods and, to a small extent, international transportation. The most important navigable artery is the Dnipro River and its tributaries, the Desna and Pripyat. International transportation is carried out mainly along the Danube River, which connects Ukraine with many European countries. Maritime transport plays an important role in export-import and cabotage transportation.

In terms of cargo transportation, air transport ranks last in Ukraine's transportation system. It is the youngest mode of transport that performs important functions in Ukraine's relations with other countries. It primarily transports passengers, as well as mail and perishable goods. One of the main indicators of transport performance is transportation volume - the amount of cargo transported by a particular mode of transport. Table 1.2 shows the dynamics of cargo transportation by different modes of transportation in 2020-2021.

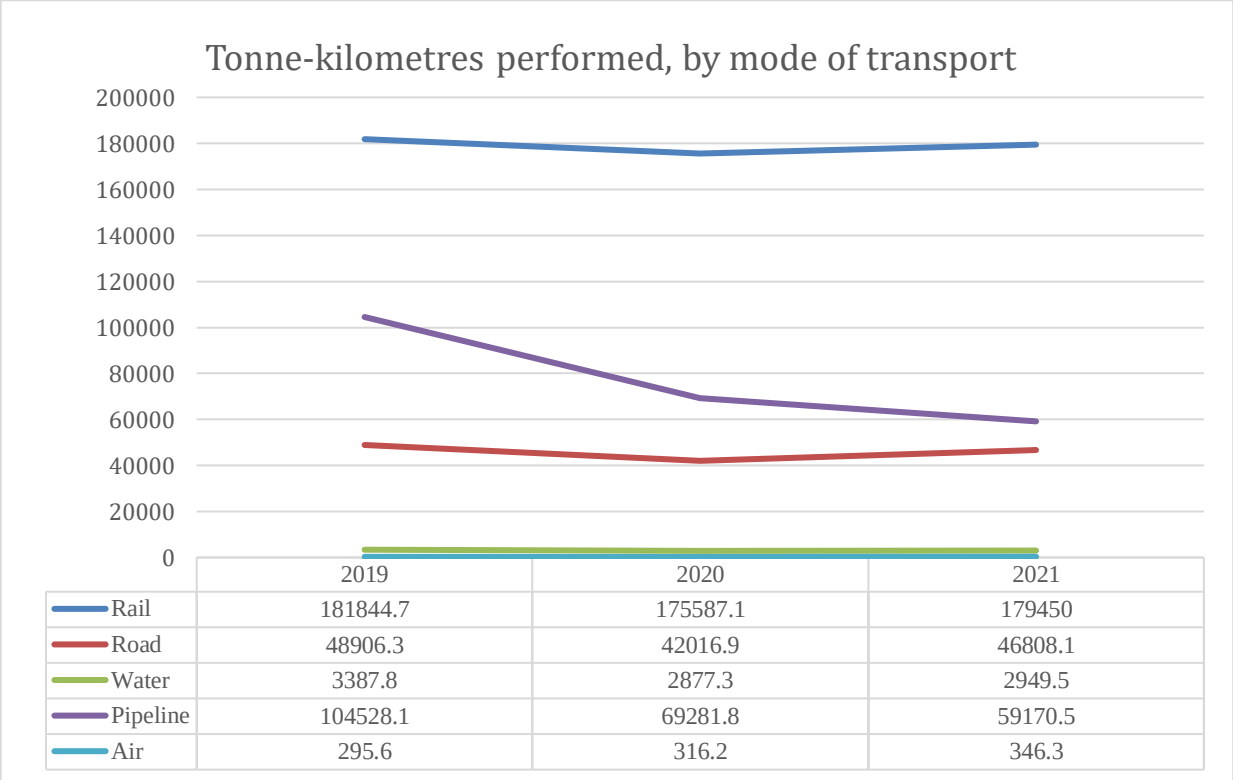
*Table 1.2*

Volume of freight traffic by type of transport, 2020-2021

| Transport | Volume of freight traffic in 2020, mln.t | Volume of freight traffic in 2021, mln.t |
|---|---|---|
| Rail | 305.5 | 314.3 |
| Road | 191.4 | 224 |
| Water | 5.6 | 5.3 |
| Pipeline | 97.5 | 77.6 |
| Air | 0.1 | 0.1 |
| *Total* | *600.1* | *621.3* |

*Source: developed by the author on the basis of information [15].*

Another indicator of transport activity is freight turnover. Cargo turnover is the total volume of freight transportation work, which is equal to the sum of the products of the transported cargo and the transportation distance for each consignment (measured in ton-kilometers or ton-miles for maritime transport). The dynamics of freight turnover by type of transport in Ukraine is shown in fig.1.5.




| | 2019 | 2020 | 2021 |
|---|---|---|---|
| Rail | 181844.7 | 175587.1 | 179450 |
| Road | 48906.3 | 42016.9 | 46808.1 |
| Water | 3387.8 | 2877.3 | 2949.5 |
| Pipeline | 104528.1 | 69281.8 | 59170.5 |
| Air | 295.6 | 316.2 | 346.3 |

Fig.1.5. Freight turnover, by mode of transport, 2019-2021, mln.tkm

*Source: developed by the author on the basis of information [16].*

The third indicator is the share of transport modes in freight transportation. It characterizes the level of territorial concentration of production and the dynamics of its change. The ratio of transport modes in freight transportation is determined by the composition of cargo-forming industries and the degree of territorial concentration of production. The distribution of freight turnover by individual modes of transport in Ukraine is shown in fig.1.6.

If we look at the ratio of modes of transport in Western countries, it is as follows: in general, rail transport accounts for 25%, road transport - 40%, and the remaining 35% - inland waterway, sea cabotage and pipeline transport. In the CIS and Eastern European

countries, railways dominate cargo turnover, accounting for about 60% on average, while road freight transport accounts for only 9%. In Ukraine, in 2021, as in previous years, rail transport accounted for the largest share in the structure of freight turnover (62%, Fig.1.6). This is the main mode of transportation that moves massive cargo for industry, construction, and the agricultural sector. The main cargo-forming industries in the rail transport segment have always been the fuel and energy complex (mines, power plants and oil refining), the mining and metallurgical complex (ore, coke, metallurgy) and construction (sand, gravel, cement).

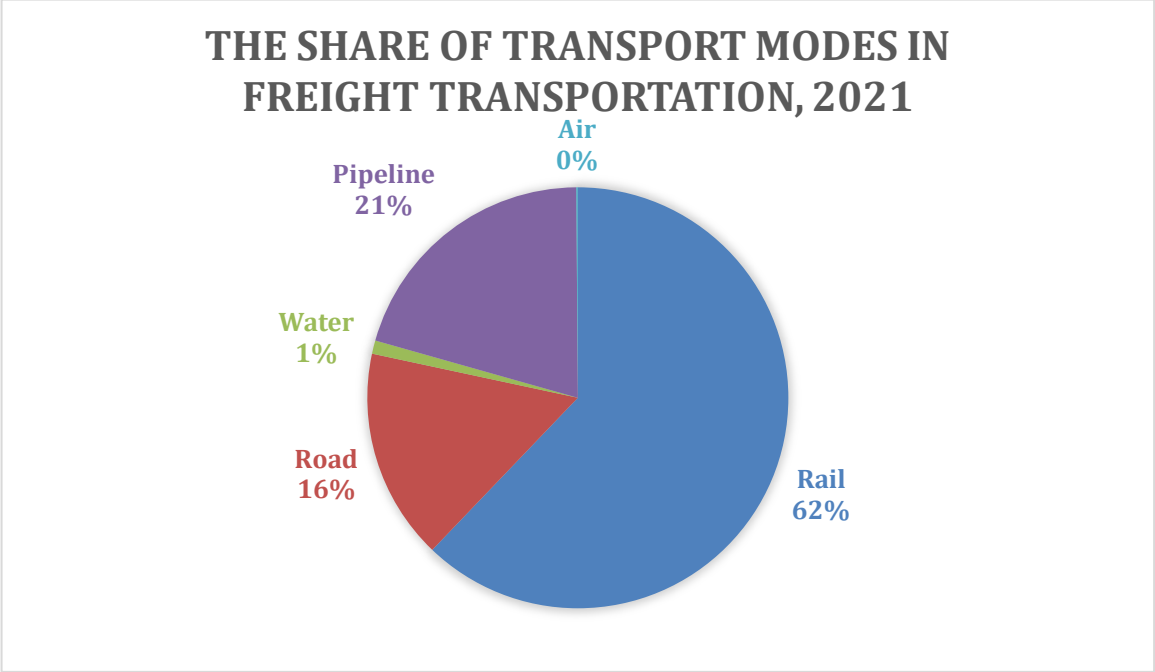



Fig.1.6. The share of transport modes in freight transportation, 2021

*Source: developed by the author on the basis of research.*

In the structure of total cargo turnover, road transport accounts for 16%, water transport for 1%, and the share of pipeline transport is rapidly decreasing to 21% (Fig.1.6).

In Ukraine, road transport primarily transports goods for own use over short distances. Commercial transportation is carried out by specialized trucking companies. In the river transport segment, the main cargo-forming sectors are construction and mining and metals. Despite the great potential of river transport, it is used by no more than 10%, and its share is insignificant and does not exceed 1%.

The lack of adequate infrastructure development for multimodal transportation in Ukraine's transportation system today makes it less competitive and makes it more difficult

for Ukrainian goods to enter the international transportation market. In particular, there are limits on the market for rail container transportation, a lack of multimodal transportation terminals, an imperfect regulatory framework for multimodal transportation, a lack of state support for multimodal transportation and the development of transportation and logistics infrastructure, and an unfriendly environment for investment in multimodal transportation [17].

The field of multimodal transportation using containers in Ukraine is at the initial stage of development, and the volume of such transportation does not exceed 1% per year. In terms of this indicator, Ukraine lags behind EU member states and other developed countries by 20-30 times and is ranked 85th in the world in terms of competitiveness and 66th in terms of logistics efficiency. High transportation costs account for about 40% of the total cost of production [18].

### 1.2. Peculiarities of interaction of transport modes in multimodal systems

International multimodal transportation is a complex transportation and logistics process that involves determining the optimal route (based on certain criteria), selecting and justifying an efficient way to perform the transportation process, controlling each stage of transportation, organizing interaction between certain types of transport and cargo transshipment points, preparing the necessary supporting documents, taking into account numerous risk factors, etc. Therefore, it should be noted that this type of transportation is one of the most difficult ways to deliver goods in terms of organization.

The use of one or another mode of transport and their combination vary depending on the territorial location. Any multimodal transportation requires the adoption of certain forms of interaction between modes of transport, so its organization requires the comprehensive development of all modes of transport, as well as terminal and storage facilities, customs infrastructure, information and telecommunication technologies and insurance support of cargo.

Multimodal transportations are usually organized by large, often international transport firms at large distances between consignors and consignees.

The organization of multimodal transportation is based on the interaction of participants involved in the transportation of goods (Fig.1.7).

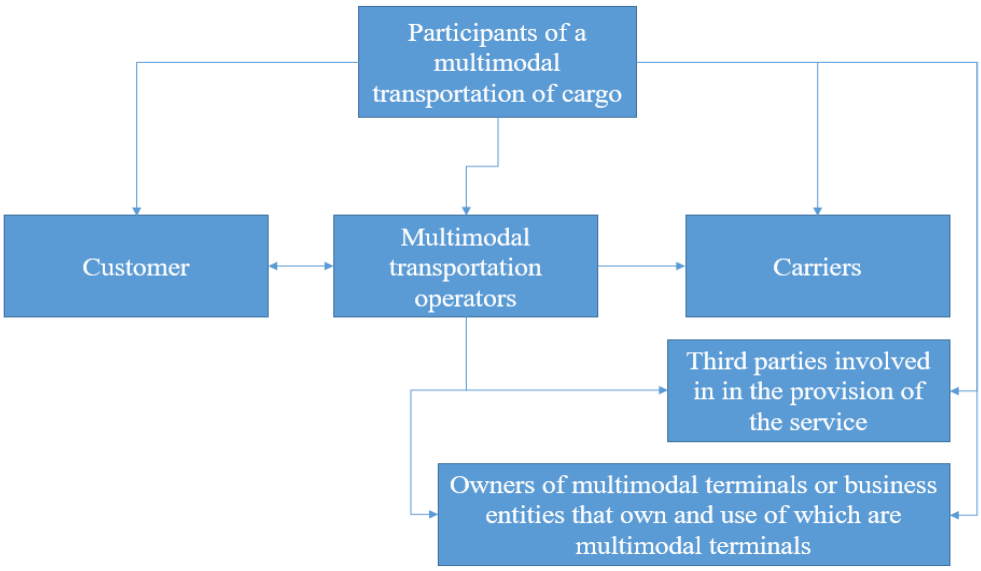



Fig.1.7. Interaction of participants involved in multimodal transportation

*Source: developed by the author on the basis of research*

The main feature of the organization of multimodal transport is the need for a single operator who can monitor the entire transport process. The operator issues a single transportation document, which allows the consignor to deal not with several representatives of different modes of transport forming a multimodal transport system, and only one operator and monitors the schedule of cargo, its safety, security delivery, as well as the consistency of the transshipment from one mode of transport to another [19]. The scheme of options for the organization of multimodal transportation is shown in fig.1.8.

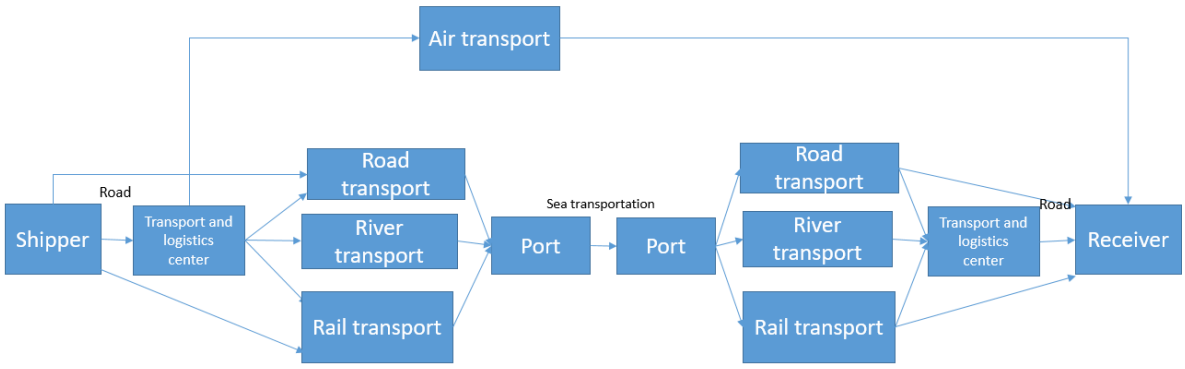



Fig.1.8. Scheme of multimodal transport connections

*Source: developed by the author on the basis of research.*

The freight forwarder responsible for the entire multimodal transportation process is called a universal operator. As a rule, the participation of two or more modes of transport is coordinated and controlled by the operator. Between the operator and the cargo owner is a contract with the execution of supporting documents, which follow the cargo throughout the process of delivery. The definition of "MT document" includes negotiable, non-negotiable transport documents as well as the case where the paper document has been replaced by electronic data interchange messages [20]. The operator acts as a representative of the shipper and the legal entity responsible for the entire process of cargo movement and quotes the through rate tariff. On the basis of the customer's instructions and on his behalf and at his expense, the operator organizes the transportation, cargo handling and controls the entire process. With each subcontractor operator enters into a contract, which specifies the time and place of receipt of cargo. In international transportation such contracts are based on Incoterms rules.

The operator begins his work with the client's application by choosing the route, means of transportation and technologies of transportation (Fig.1.9.). After that begins work on drafting contracts with individual performers on various issues, one of the main ones is the issue of calculating the prime rate of the tariff. Based on market monitoring and comparison of rates, as well as the individual capabilities of subcontractors choose the option to deliver the cargo. Then the operator informs the client about the main characteristics of transportation. The operator documents any risks associated with the delivery of cargo.

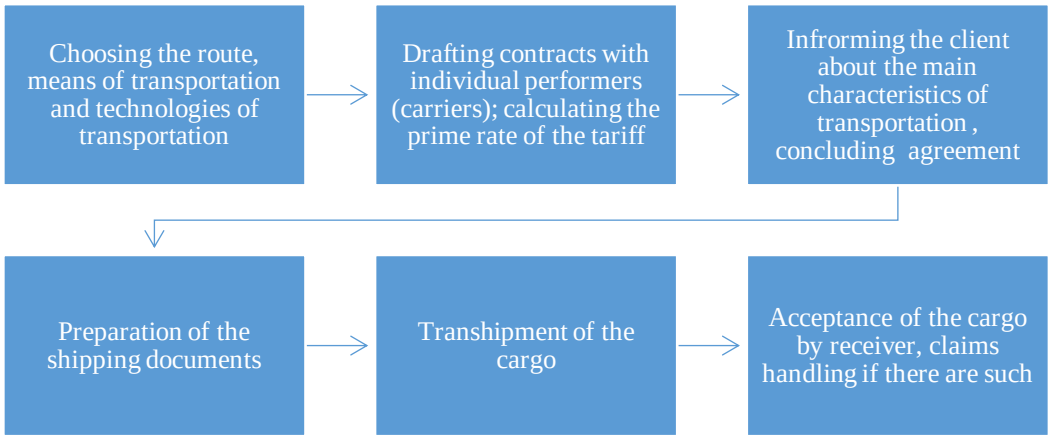



Fig.1.9. The main stages of multimodal transportation

*Source: developed by the author on the basis of research.*

After agreement with the sender operator prepares shipping documents, as well as in the process of transportation, customs declarations, insurance documents, commercial and other acts of damage to goods or vehicles, breaking seals, etc. Carriage charges and fees are also calculated. The operator informs cargo owners about the movement of cargo and handles claims.

The operator's duties require knowledge of laws and regulations, international agreements and conventions on transport, optimization methods for the efficiency of the transport process, principles of tariffs, benefits, discounts in various modes of transport, basics of cargo management, ecology and traffic safety norms, information support systems and risk insurance, etc.

The issue of optimizing transportation processes is relevant for modern society, as people always strive to find the best solution in any field of activity. Determining the optimal routes for multimodal transportation will help to fulfill the order for cargo transportation in a timely manner and at minimal cost.

By modeling the multimodal transportation process, MTO tries to find an optimal plan that offers the best use of existing conditions to ensure the maximum possible economic effect (e.g., fast delivery at minimum cost). In practice, as a rule, the efficiency of the multimodal transportation process is evaluated not by one, but by several criteria simultaneously. Some of them are maximized, while others are minimized.

In the organizational aspect of multimodal transportation, the issue of determining a single through tariff rate is important. According to international experience, the value of the through rate may vary depending on whether the MTO owns vehicles. MTOs that own their own vehicles - Carrier-MTOs, are interested in loading them, although this may not always minimize costs, but will give better opportunities to charge marginal costs in case of incomplete loading of vehicles. MTOs that do not own their own transport - Non-Carrier-MTOs, consider several possible transportation options according to certain criteria. When determining the size of the tariff, they take into account the place of departure and destination, possible route options. The tariff should be attractive to the customer to a certain extent, both in terms of cost and delivery time, since the customer's requirement is not always the criterion of minimum time and minimum cost.

The global experience of forming a pass-through tariff shows that it is based on the following: the cost of cargo transportation by the types of transport involved in the transportation process (actual carriers); the cost of basic and related services provided at transport terminals and customs; the cost of MTO liability insurance; and the planned profit of the MTO (Fig.1.10).


Fig.1.10. Components of the trough rate

*Source: developed by the author on the basis of research*.

The technological aspect of multimodal transportation involves preparing cargo for transportation, delivering it to the terminal, performing loading and unloading operations, warehousing, the transportation process itself, and ensuring the interaction of transport. Detailed coordination of technological processes is an important task in the process of multimodal transportation. The process of interaction consists in synchronizing and coordinating the technological modes of transport. This process is carried out already at the project development stage and continues during the operational regulation of transport processes. During the formation of a technological system of cargo delivery, technical, technological, economic, organizational, commercial and legal issues that need to be resolved to ensure efficient cargo transportation are mutually agreed upon. For example, when determining technological issues related to the choice of types and brands of vehicles, technical capabilities are taken into account, namely the compliance of the carrying capacity of vehicles with the volume of cargo to be transported. There is also a risk of loss of material assets as a result of the transfer of cargo from one mode of transport to another. Therefore, nowadays, the transportation of goods in containers, the use of removable body technology, trailer and containerized cargo transportation systems are increasingly preferred.

For multimodal transportation, it is important to have large transportation hubs with the most complete service to serve the transportation process. As a rule, they are located in

large cities. Multimodal transportation has changed the technology of the transportation process. Thus, the development of the contrailer system led to the creation of a new technology. The maintenance of small railway stations with loading and unloading infrastructure is expensive. Warehouses and various equipment occupy a large territory, which, in case of small volumes of freight handling, is not reasonable to maintain. It is more profitable to close them, shifting the cargo flow to hubs (terminals). The use of piggyback technology will reduce the number of small railway stations, as the vehicle can be used on a short section of the route to the consignee.

In the maritime transport small consignments are transported by "feeder" technology. Feeder transportation is the transportation of cargo in small batches in various directions from a large port (terminal) or a vehicle, such as a lighter carrier.

The organization of international multimodal transport requires the presence of transportation control points at the borders of states.

In the EU countries, where the Schengen Agreement has been signed, mandatory controls at the borders between these states have been abolished, which has accelerated the passage of vehicles. Border control stations work in a specially allocated and guarded area, on which there are places of border control with in-depth control of documents, preliminary detention of persons, weight and size control, inspection and detention of vehicles, canine service premises. There are also laboratories for examination of goods and things. There is also a temporary storage warehouse (TSW) necessary to clarify the data on the cargo recipient or the cargo itself. Parking lots of vehicles with dangerous or radioactive cargoes are allocated as independent ones.

In order to reduce terminal costs, these transport infrastructure facilities are introducing terminal innovations, such as information management systems based on electronic data interchange (EDI), which significantly speed up information processing and accelerate the process of multimodal transportation of goods. Automation of work at transport terminals increases their productivity, although it requires significant capital expenditures at the initial stage. The economic side of innovation is that reducing terminal costs significantly affects multimodal cargo transportation tariffs, international trade in

general, the development of the transport system, and changes in competition between modes of transport [21].

The effectiveness of multimodal systems primarily depends on their organization. It should be noted that multimodal transportation systems are a complex process of organizing cargo transportation, which includes stages shown in the figure 1.11.

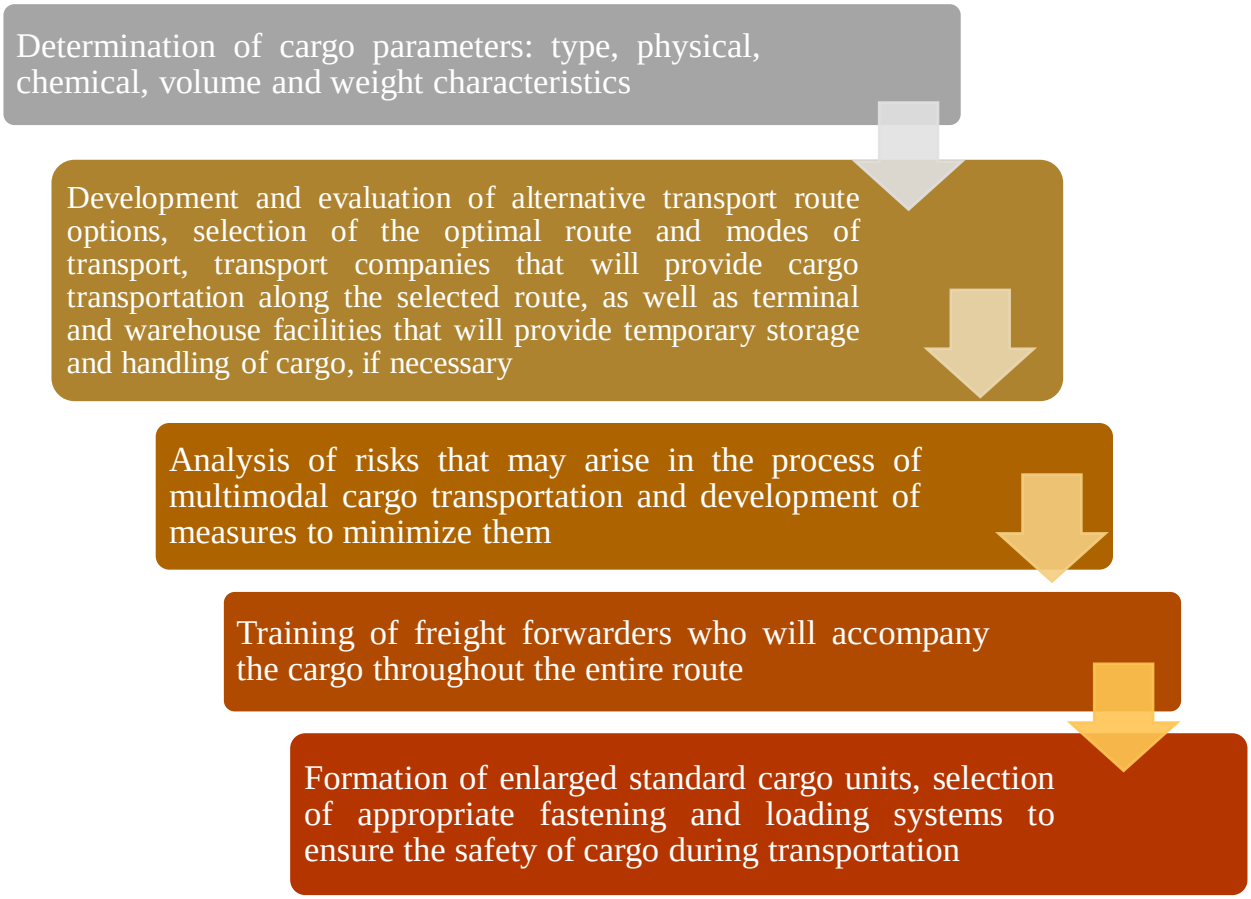



Fig.1.11. Algorithm of organizing multimodal transportation

*Source: developed by the author on the basis of research.*

In view of this, the effectiveness of multimodal systems should be assessed from the following points of view:

- the organization of the cargo transportation process itself;
- the construction and operation of a multimodal transport network;
- the activities of each participant in the delivery chain: the multimodal transportation operator, which acts as a guarantor of the contract for the delivery of cargo to the customer and bears full legal and financial responsibility for the entire organized process; carriers that directly deliver the cargo to a designated location, and terminal

and warehouse operators that ensure the transfer of cargo from one type of transport to another, as well as temporary storage of cargo.

Efficiency shows what effect is obtained compared to the costs incurred. We can distinguish the following types of effects from organization of the multimodal cargo transportation process: economic, scientific and technical, organizational, and social, environmental.

*Table 1.3*

The main types of effects from the multimodal cargo transportation

| Effect type | Effect description |
|---|---|
| Economic effect | Reflects the financial effect obtained from the use of material, financial, labor, natural and other resources in the process of transportation. The indicators of the effect are: transportation volumes and freight turnover, as well as financial results of the participants of multimodal transport systems. |
| Scientific and technical effect | Reflects the development of scientific, technical and technological sectors of the national economy that affect the transportation industry. The indicators of the effect are based on the use of new technologies for transportation, which ensures the reliability and speed of transportation, safety and security of cargo throughout the entire delivery chain. |
| Organizational effect | Characterizes the quality of construction and organization of the transport and technological system, the quality of the logistics system of transportation management, the reaction to organizational changes and changes in the external environment, and the process of making management decisions. The main indicators of the organizational effect include the efficiency of the management apparatus, reliability and optimality of management systems. |
| Social effect | Reflects the social results of the activities of participants in multimodal systems that contribute to meeting the needs of individuals and society (increasing employee well-being, improving the quality of life and working conditions, creating an atmosphere of security, and increasing labor productivity). The social effect is measured by such qualitative indicators as: the standard of living and income of employees; availability of jobs, the level of training and retraining of personnel, the level of social security, etc. |

*Ending of the Table 1.3*

| Effect type | Effect description |
|---|---|
| Environmental effect | Characterizes the introduction of environmentally friendly and resource-saving technologies in cargo transportation and operation of vehicles. The effect is assessed by the resource and energy intensity of the transportation service provision process, the level of emissions of various wastes into the environment, and level of impact of the transportation technologies used on transportation volumes and consumption of relevant resources. |

*Source: developed by the author on the basis of research.*

During transportation, the following are subject to risk: cargo, documentation, personnel, vehicles, transport communications and transport equipment. For example, cargo handling during transfer between modes can result in damage or loss if not properly secured or managed; it might be susceptible to theft or pilferage during various stages of transportation; due to the personnel incompetence documents might be incorrectly concluded, equipment might be incorrectly operated, etc. The ways to mitigate risks in multimodal transportation are shown in the figure 1.12.

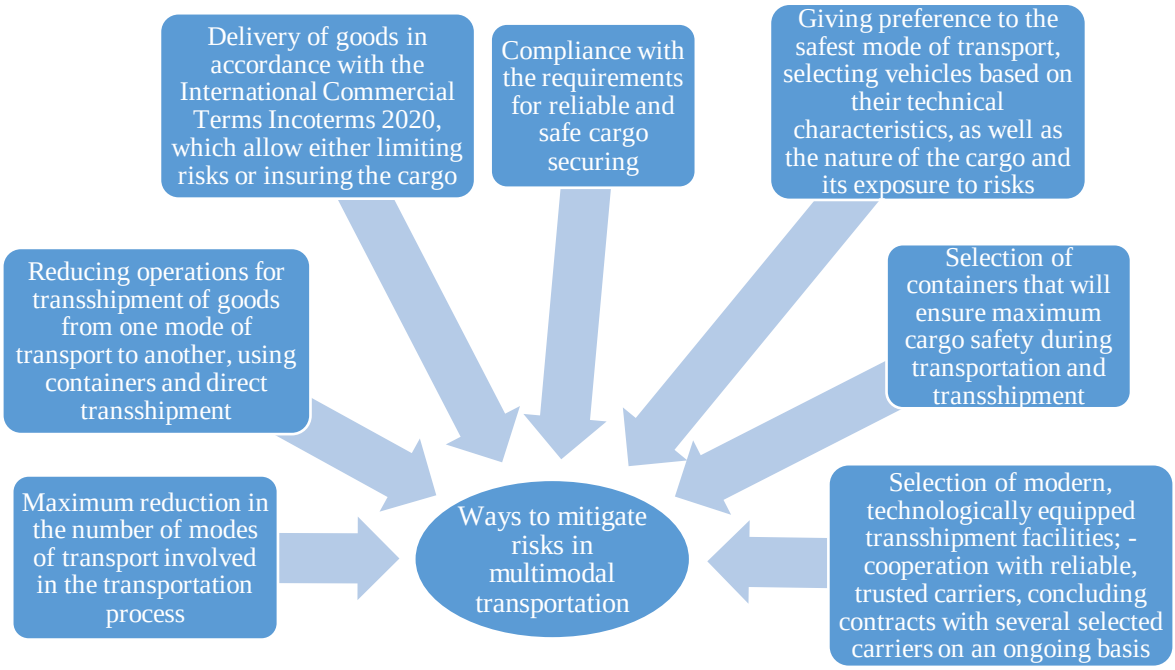



Fig.1.12. Ways to mitigate risks in multimodal transportation

*Source: developed by the author on the basis of research.*

At the same time, it should be noted that a balanced distribution of risks associated with multimodal cargo transportation can be ensured through mechanisms for coordinating the interests of all participants in multimodal systems: the state, multimodal system operators, cargo owners, carriers, etc. [22]. Such coordination is effectively implemented through public-private partnership mechanisms, in particular:

- contracts as an administrative agreement between public authorities and business (private partner) for the implementation of socially necessary multimodal transportation of goods;
- a concession, which provides for the authorities to grant a business the right to perform the functions stipulated in the contract for a certain period of time and vests it with the appropriate powers to ensure the effective functioning of the concession object; a concession always provides for the return of the subject matter of the contract to the public partner, while the ownership of the services remains with the private partner. Global practice shows that construction and reconstruction of transport infrastructure is financed through concession agreements;
- joint venture agreements, under which the governmental authority takes a permanent part in the administrative, economic and investment activities of the established joint venture participating in multimodal transportation of goods, depending on the share in the authorized or share capital.

**Conclusions on the first chapter**

Ukraine's transportation system has a low level of development of transport and logistics infrastructure to ensure the proper volume of multimodal transportation, which reduces its competitiveness and hinders the entry of Ukrainian products into the global transportation market. In particular, there is a lack of multimodal transportation terminals, no perfect regulatory framework for multimodal transportation, insufficient state support for multimodal transportation and the development of transport and logistics infrastructure, restrictions on the rail container transportation market, and no investment-friendly climate for the development of multimodal transportation.

Effective organization of cargo transportation in the multimodal transport network is possible on the basis of two main group of factors: internal and external. The logistics company needs to follow all the rules and regulations established for operation of each transport mode, constantly train its personnel to have a professional workforce, implement advanced technologies to provide the most complete package of services – this relies to internal factors. External factors for successful company operation includes development of legislative, financial, credit, tax and other factors of the external environment in which freight carriers and their partners operate.

Efficiently organizing cargo transportation within a multimodal transport network requires a holistic approach that integrates technology, collaboration, infrastructure development, risk management, and a customer-centric focus to ensure efficiency, reliability, and responsiveness to evolving logistical needs.

# CHAPTER 2
# ANALYSIS OF ORGANIZATION OF CARGO TRANSPORTATION IN THE MULTIMODAL TRANSPORT NETWORK ON THE BASIS OF FTP LLC

## 2.1. General characteristics of the FTP LLC

The FTP LLCis a logistics operator consisting of almost a hundred of talented and energetic people who quickly and efficiently organize the import and export of goods by any means of transport around the globe, provide customs, financial and contract logistics services.

The logistics company started its operations in 2011 (Fig.2.1), at that time it focused solely on providing freight forwarding services and opened two offices in Kyiv and Odesa, and in 2016 the company also opened its office in Poland, which allowed it to keep under constant operational control the transit cargoes passing through the seaports of Poland, as well as to ensure a high level of organization of road transportation of goods from Poland.

The founders and, accordingly, the top managers of the company are the people who invested their own efforts in the rapid development of the company and never stopped at the results achieved, which is confirmed by the national certificate received from the National Business Rating in 2014 in the nomination Industry Leader 2014 among small enterprises in terms of financial and economic activity "Investment Attractiveness" in its main activity.

In addition, the company gained membership in the world's largest association of independent freight forwarders - WCA (The World Cargo Alliance) in July in 2019. It should be noted that this alliance has more than 9,488 partners from 195 countries, which allows for exclusive access to the freight forwarders' database and maximum, unlimited opportunities in the field of international transportation, namely:

- the best possible tariff for cargo delivery by any type of transport;
- maximum level of comfort and security within the selected service;
- the ability to pick up cargo in the most difficult and remote areas of the globe.

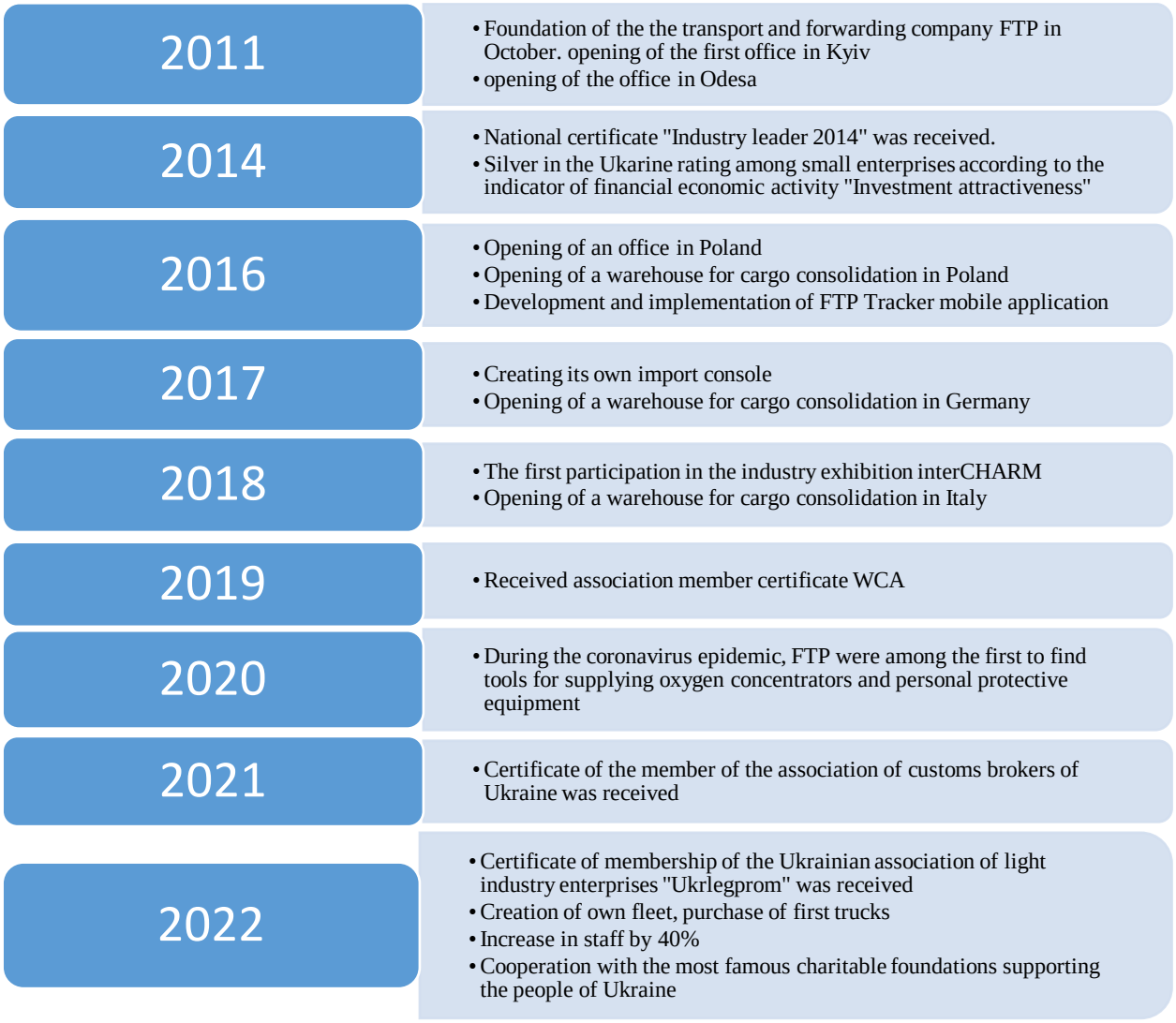



Fig.2.1. History of the LLC FTP

*Source: developed by the author on the basis of research.*

It should be noted that such membership is an indicator of the company's high level of service within international logistics, and only 14 logistics companies in Ukraine, headquartered in Kyiv and Odesa, have confirmed their quality of services in this international format.

The company has a standard line-functional structure (Fig.2.2). It is the most common type of bureaucratic structure, characterized by a large number of horizontal and vertical links and little involvement of lower management levels in decision-making. The head of the organization is directly subordinated to his or her deputies by function. The general manager has a linear influence on all participants in the structure, and the heads of functional departments provide functional assistance to the executors. Linear-functional management

structures are most effective where the management apparatus performs routine, often repeated and rarely changing tasks and functions [23]. However due to the relatively small and very friendly team, this structure helps the company to achieve the overall goals set by the top management without losses that usually arise from solving only local goals of individual departments.

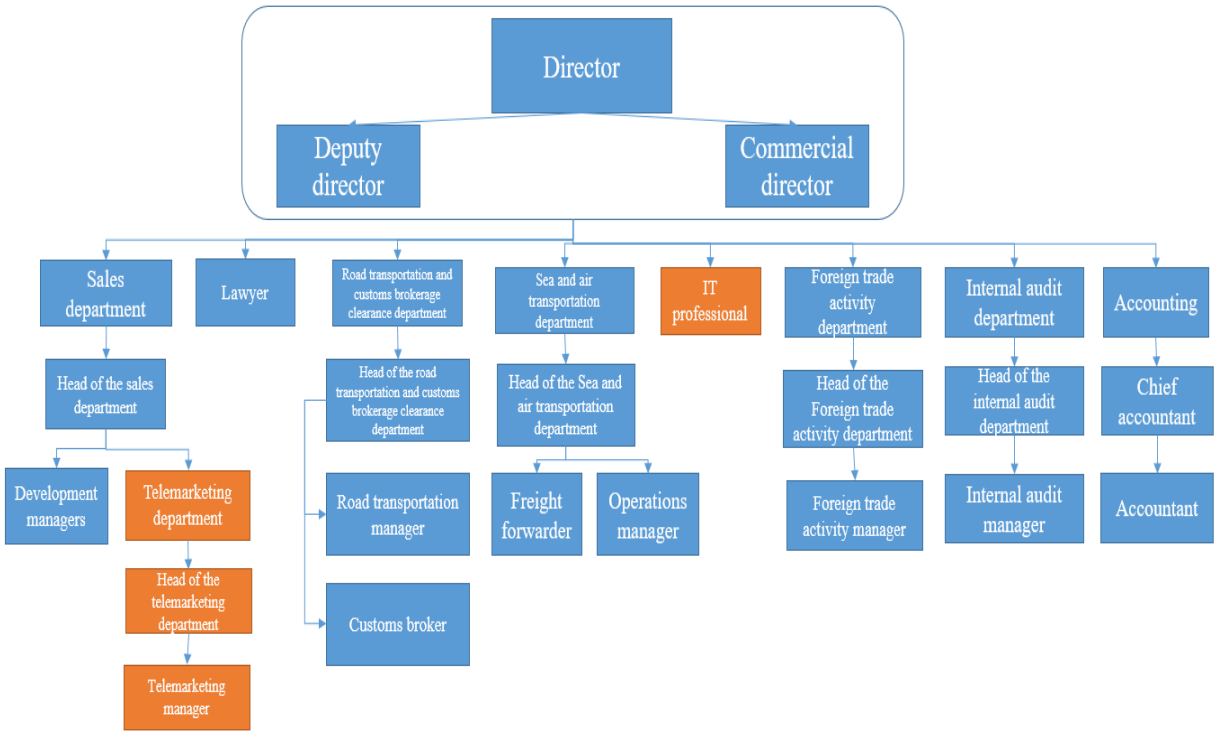



Fig.2.2. Structure of the LLC FTP

*Source: developed by the author on the basis of research.*

IT professional and Telemarketing department are being oursorced. It helps to concentrate all efforts on the core business. Outsourcing related business processes allows the company to focus on those operations that are efficiently performed by the employees and those that managements want to keep under its own control. Moreover outsourcing creates an opportunity to reduce auxiliary staff and attract highly qualified specialists to carry out core activities [24].

The company's services are divided into four main groups (Fig.2.3):

1. Customs Logistics

- ensuring the completion of all customs formalities in the export/import/transit mode with minimal involvement of the client in customs processes and with optimization

of the necessary types of control during customs clearance (tariffs, nomenclature, inspection, payments);

- protection of the client's interests at customs;
- sampling and obtaining laboratory reports;
- obtaining veterinary certificates for sale in Ukraine,
- certificates of origin and EUR 1;
- obtaining price expertise;
- accreditation of the company at the customs.

2. Financial Logistics

- management of the payments to the supplier
- movement of finances during the realization of foreign economic activity, which is an important part of logistics process and can significantly impact the final financial result
- participation in all the stages of the financial route, making it optimal and correct
- provision of financial consulting
- proceeding with expenses and income for foreign economic transactions

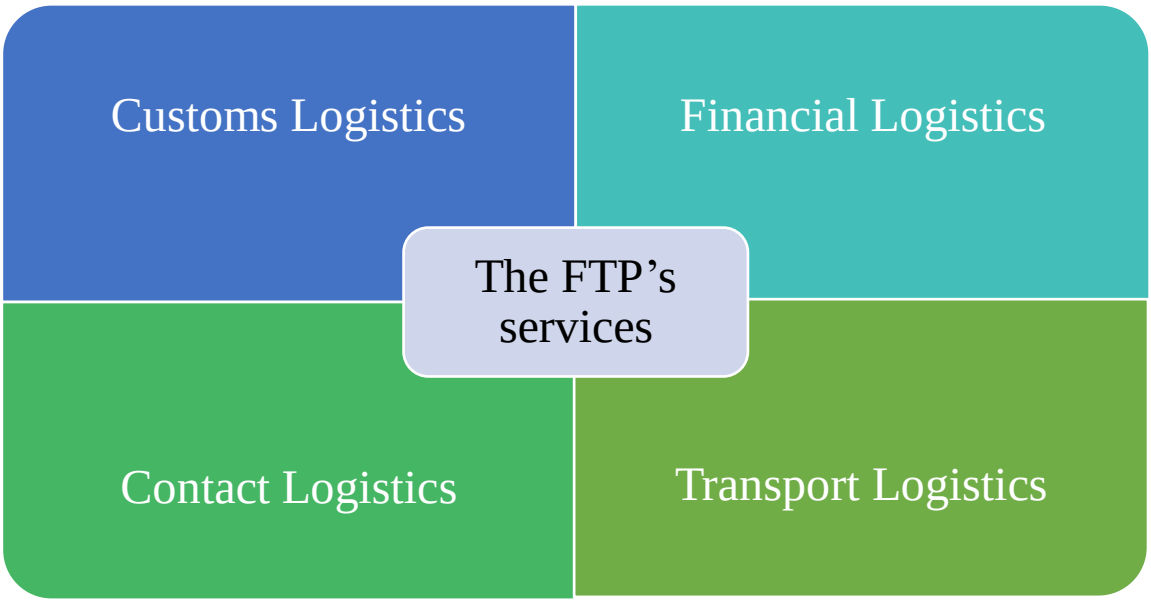



Fig.2.3. The FTP's services

*Source: developed by the author on the basis of information [25].*

3. Contract logistics

- realization of the outsourcing of the foreign trade department
- taking charge of work with suppliers
- provision of "turnkey" delivery
- provision of the commission agent services
- negotiation with suppliers on all the controversies connected to the documents and processes
- proceeding with foreign economic contracts

4. Transport Logistics:

- organization of door-to-door delivery of cargo by any mode of transport, as well as a combination of different modes of transport in the supply chain, taking into account compliance with the main logistics criteria;
- development of optimal routes according to the criteria of time or cost, as well as their combination depending on the client's wishes;
- organization of FTL or LTL cargo delivery with temperature control during transportation, if necessary;
- cargo insurance;
- cargo forwarding in seaports and airports;
- cargo tracking at all stages of delivery [25].

Transport logistics services cover the types of cargo transportation such as sea, rail, air, road, and intermodal transportation.

Among the most popular orders is the delivery of goods by road. The advantages of such transportation are:

- the speed and extensive network of highways combined with the optimal cost of delivery of goods, both from Europe and the CIS countries;
- the ability to organize door-to-door delivery with delivery times ranging from three to seven days;
- ability to organize delivery by road for any type of cargo, including liquid, bulk, dangerous, and temperature sensitive.

The logistics company offers sea freight transportation for any cargo to destinations in China, the United States, India, Korea, Israel, Spain and Turkey. Depending on the distance, delivery times range from 10 to 40 days, while delays related to weather conditions and the operation of transit ports may also affect the duration of cargo delivery by sea. The most frequently used ports for sea transportation in the company's practice are Chornomorsk and Odesa (Ukraine), Shanghai, Ningbo and Hong Kong (China), Gdynia and Gdansk (Poland), Klaipeda (Lithuania), Riga (Latvia), Constanta (Romania) and Hamburg (Germany).

The logistics company's experts cover nearly the whole planet through the ports of China, Central, Southeast, East, West, and Southwest Asia, Europe, Australia, and ports on the coastlines of North and South America. They also have vast experience in planning maritime transportation. To ensure the largest volume of cargo traffic serviced by the logistics company through the seaports of Ukraine - Odesa and Chornomorsk, the logistics company has a separate division in Odesa, which ensures continuous work on servicing the client's cargo in the optimal time and at the optimal cost.

For the delivery of expensive, high-margin or perishable goods in international traffic, the FTP specialists may suggest using air transport, as it will provide the fastest delivery over long distances, namely from one to five days from anywhere in the world). It should be noted that the delivery time itself will be significantly affected by the availability of direct flights on the required route, as well as the availability of free space in the cargo compartments of aircraft. Most often, this type of transportation is chosen by customers who need a high level of turnover of their goods and in case of urgent delivery of goods. Since the bulk of air cargo is transported through Boryspil Airport, the company has an office at the cargo terminal, which makes it possible to organize the delivery of cargo from the airport as soon as possible, taking into account the completion of all necessary formalities at the airport.

To ensure low cost of transportation over long distances, as well as taking into account the significant weight of the cargo, especially for bulk and bulk cargo, as well as oversized and heavy cargo, the FTP team offers services for organizing rail transportation, with the

average delivery time ranging from 7 to 21 days, which is influenced by both the length of the route and the number of transit stations.

Containerized transportation is one of the most popular types of transportation. Containers can transport a very large variety of goods ranging from food grains or food products to machinery. Shipping containers are indivisible units and each registered container has a unique identification number making it easy to track and trace it during a voyage. Delivery is mostly organized by 20- and 40-foot containers via intermodal routes, and the company's managers can provide door-to-door delivery. However, there are some disadvantages of the containers usage:

- empty containers are needed to be available where there is demand; consequently, empties (empty containers) have to be relocated in a timely manner to the desired locations. Containers that arrive with cargo are unloaded and eventually moved to the designated stack for empty containers at their destination;
- containers take up a lot of room, whether they are filled with goods or are empty. For containers to enter and exit terminals, there needs to be ample room for stacking [26];
- the complexity of the container layout on the ground and in the modes (containerships and double-stack trains) necessitates periodic restacking, which adds to the terminal operators' expenses and time [27].

To make tracking parcels and cargoes much more convenient, an application FTP Tracker was developed. Using the free FTP Tracker program, you can track more than 50 courier and postal services, air and sea carriers, freight forwarders, keep track of the proper closing of EU export and transit declarations, and look up the EORI numbers of European counterparties.

Along with many other carriers, the application supports Nova Pochta, UkrPochta, Delivery, and Meest Express. The IT specialists have implemented support for Air Cargo (such as Belavia, Emirates, LOT Cargo, Turkish Airlines, Lufthansa Cargo, China Airlines and many others), moving containers (such as ZIM, Maersk Line, Emirates Shipping Line), checking the correct closing of export and transit declarations of the EU.

Full list of the capabilities of the application is shown in the fig.2.4.

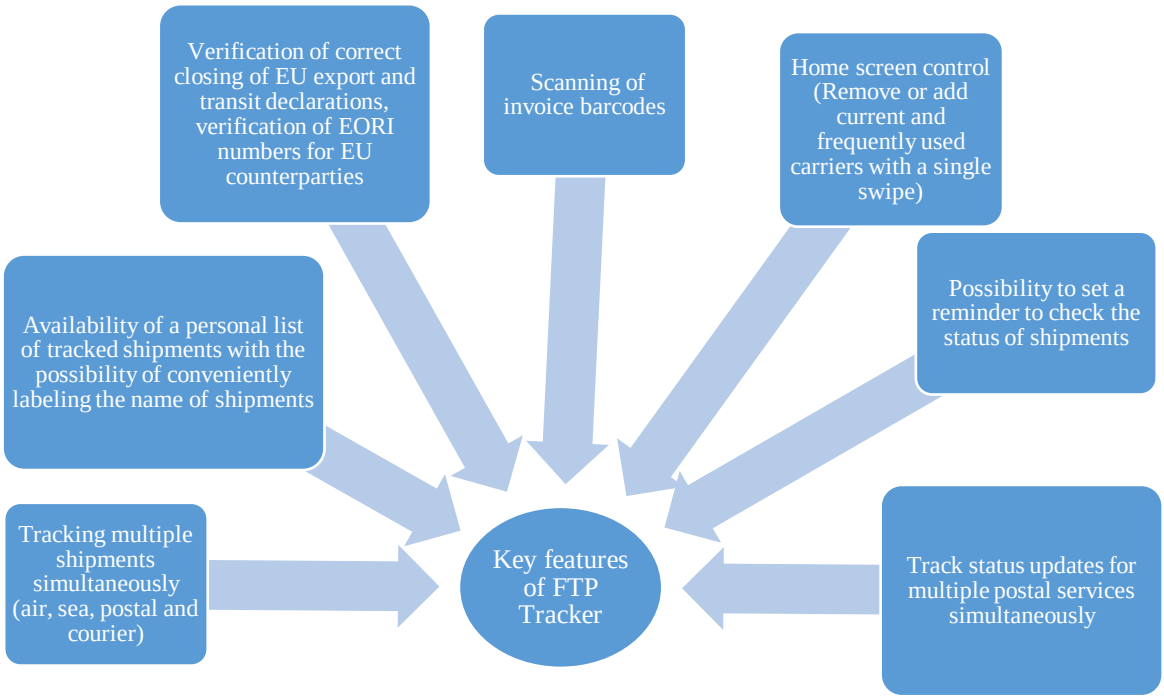



Fig.2.4. Key features of FTP Tracker

*Source: developed by the author on the basis of research.*

You just have to select the appropriate service, insert your shipment number for tracking or scan the barcode and give it a name for easy information. You will then have all the information you need about your shipment always at your fingertips. You can also put a notification to receive a reminder to check the status of your tracked shipments.

Let us consider the activity of the company in terms of its strengths, weaknesses, opportunities for development and threats and conduct SWOT-analysis (Table 2.1).

Based on the table some conclusions can be drawn. The main strengths of FTP LLC are ability to organize delivery of valuable, dangerous, temperature-sensitive goods using road, sea, rail, road transport modes and their combination.

If we are considering weaknesses of the company, first of all it is inability to offer competitive rates due to the high transportation cost of road carriers and absence of the developed fleet of trucks. Moreover, the company needs to set up relations with higher number of railway carriers.

*Table 2.1*

SWOT-analysis of the LLC FTP

| Strengths | Weaknesses |
|---|---|
| 1. Good reputation, member of different cargo transportation associations.<br>2. Ability to organize cargo delivery using road, sea, rail, road transport modes and their combination.<br>3. Established strong relations both with Ukrainian and global road, sea and air carriers.<br>4. The company has own tracking application.<br>5. Experience in transportation valuable, dangerous, cargo that needs to be carried under specific temperature regime.<br>6. Presence of the warehouses for cargo consolidation in Germany, Italy, Poland | 1. Lack of strong relationships with providers of railway transportation.<br>2. Inability to offer competitive rates due to the high transportation cost of road carriers.<br>3. Small fleet of trucks.<br>4. Not as fast level of usage of modern technologies as can be observed in global competitors. |
| **Opportunities** | **Threats** |
| 1.Attraction of new customers due to the competitors might not be able to face multiple obstacles that the war brings.<br>2.Due to the high level of diversification of the services provided the company might still keep strengthening its position on the market<br>3.Implementation of modern IT technologies would lead to optimized and simpler process of transportation.<br>4. Possible after-war transportation infrastructure rebuilding.<br>5. European integration of Ukraine, including transport sector.<br>6. Investment attraction and government support into logistics sector to rebuild the economy of Ukraine. | 1. Lower numbers of orders because of military action in Ukraine.<br>2. Destroyed transport infrastructure due to the military actions.<br>3. Loss of valuable personnel as a result of mass migration in response to military action.<br>4. Weak Ukrainian economy caused by protracted and exhausting hostilities on the territory of the country.<br>5. A high level of bureaucracy and corruption may be an impediment to the company's growth. |

*Source: developed by the author on the basis of research.*

One of the weightiest opportunities is attraction of new customers as the competitors might not be able to face multiple obstacles that the war brings. From the beginning of the war FTP has already managed to increase its customers base by 30%.

However the war brings also the main threat for the company – lower number of orders available and loss of valuable personnel as a result of mass migration in response to military action.

## 2.2 Analysis of financial and economic activity of the FTP LLC

For many years of experience, the company successfully organized transportation of different goods among which there are medical goods, vehicles and drones. The full list of products that are transported by FTP is shown in the fig.2.5. The most popular imported goods that the logistics company's specialists work with are medical products, the experience of which was gained by the company's specialists before the pandemic (for example, with such companies as: "Evolutis-Ukraine, Euromedproekt, Biomed Ltd, Renaissance Medical, Ecomed, Radunit).

Moreover, the company is specialized in fish and seafood transportation. FTP has become a partner of the Ukrainian Importers of Fish and Seafood Association, UIFSA. Cooperation with such a partner helps to understand in more detail the intricacies of organizing the import of fish products and to defend the interests of business clients-importers when processing such goods in Ukraine.

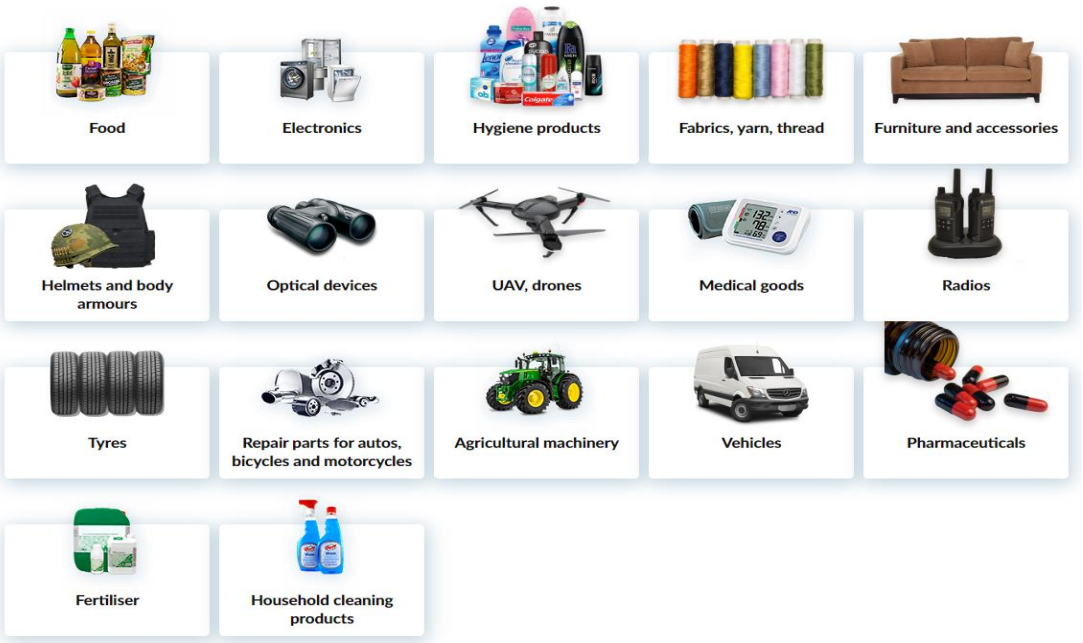



Fig.2.5. The critical imports goods FTP handles

*Source: developed by the author on the basis of information [28].*

Since FTP provides services by various types of transport, it connects different parts of the globe and does not have a specific geographic segment that it operates in: cargo deliveries are made from China, South Korea, the United States and Canada Poland, Spain, Hungary etc. It has a network of agents that transfers freight with different types of challenges anywhere in the world for this reason.

Let us take a closer look at the countries FTP cooperates with (Fig.2.6). The main geographical segment of the company's freight forwarding activities belongs to China - 25% and Western Europe (Germany and Poland - 15% each). In addition, large share of goods is transported by Turkey (7%), the Netherlands and Slovakia (5% each). Less competition is felt for cargo flows from the Middle East and Southeast Asian countries, but it should be noted that cargo flows from these countries are much smaller and therefore less competitive.

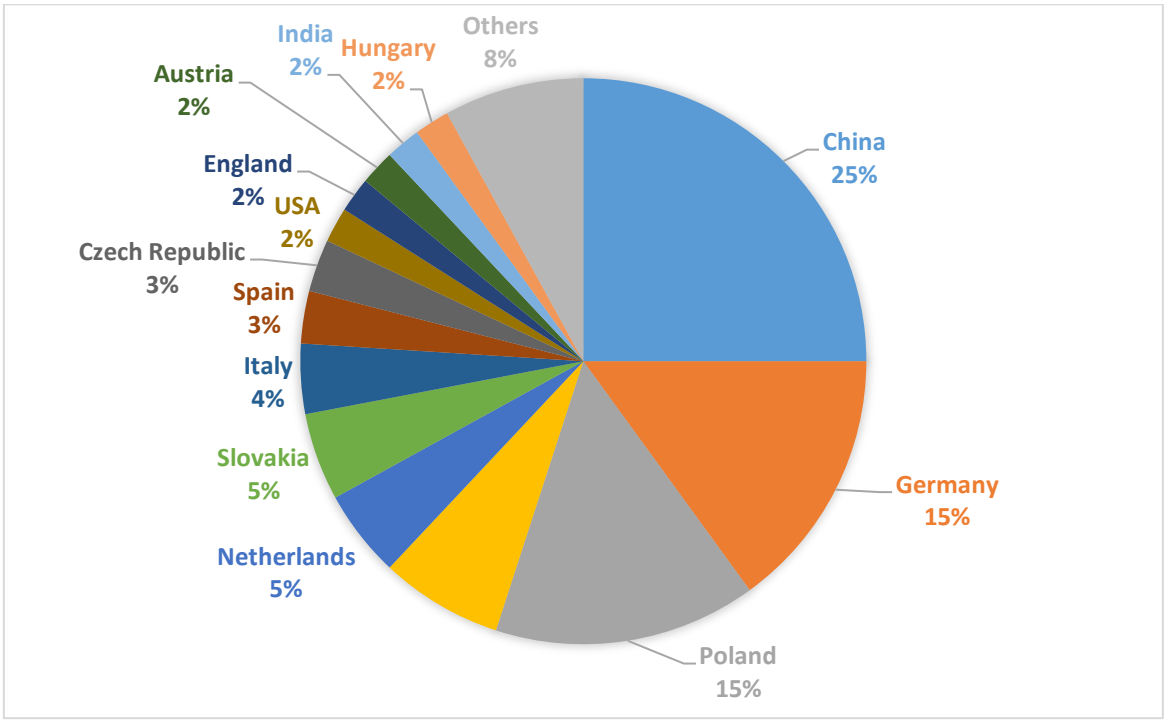



Fig.2.6. Countries FTP cooperates with

*Source: developed by the author on the basis of research.*

Now let us consider the volume of order processed (Table 2.2) and its dynamics over the past years (Fig.2.7).

As we can see in the period of 2017-2019, the number of services provided was constantly increasing. However, in 2020 the number of order significantly increased because of the COVID-2019 pandemic.

*Table 2.2*

Volumes of the orders processed by FTP, 2017-2022

| Type of services/Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Road transportation | 310 | 460 | 950 | 730 | 913 | 921 |
| Air transportation | 28 | 36 | 88 | 19 | 35 | 30 |
| Sea Transportation | 150 | 232 | 408 | 198 | 282 | 293 |
| Brokerage services | 1185 | 1715 | 1809 | 1264 | 1582 | 1604 |
| Total | 1670 | 2443 | 3255 | 2211 | 2812 | 2848 |

*Source: developed by the author on the basis of research.*

During the hostilities on the territory of Ukraine the FTP LLC was able to adapt to the new market of transportation. Due to the wide range of services available and ability to carry various goods the company has attracted new clients and even increased the number of customers by 30% while most competitors lost ground since the beginning of the war.

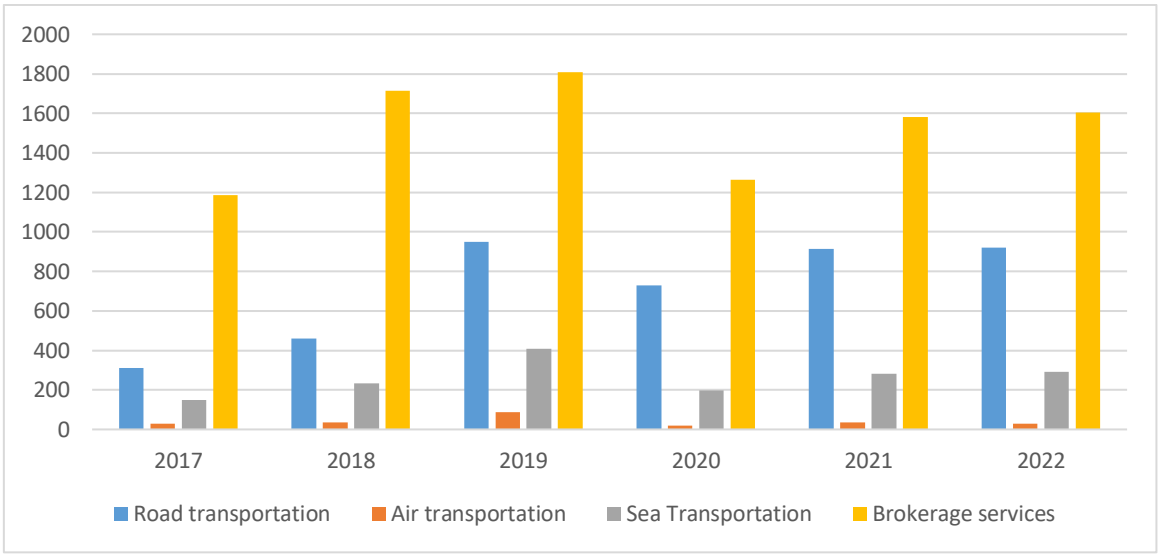



Fig.2.7. Dynamics of the FTP's orders processed by different departments, 2017-2022

*Source: developed by the author on the basis of research.*

The research shows that the most in-demand services are primarily customs clearing (brokerage) services. This statistic can be easily explained by the fact that brokerage services are typically offered in conjunction with other logistics services to arrange the delivery of goods in import/export and transit traffic. Rarely the company's experts are asked to provide only customs clearance services. As a result, from the perspective of freight forwarding, the majority of deliveries are performed by land and sea, with only a small number by air.

Over the last years, there has been a considerable growth in the number of orders for complex services including the use of road and sea transport in the development of multimodal transportation. Intermodal transportation, which combines rail and road transportation, is a novel service, but statistics reveal that the proportion of deliveries made under this intermodal system is still very modest. Although gradually the financial advantages are starting to prevail and some clients are testing this delivery option, taking into account the reduction in time for such delivery at almost moderate costs compared to sea transportation.

Fig.2.8 shows the distribution of shares by all freight forwarding services, taking into account the cargo flows. The shares of imports and exports are distributed 84% to 11%, which is natural due to the national trend of imports exceeding exports in Ukraine and growth of e-commerce. Share of transit transportation between third countries is just 5%.

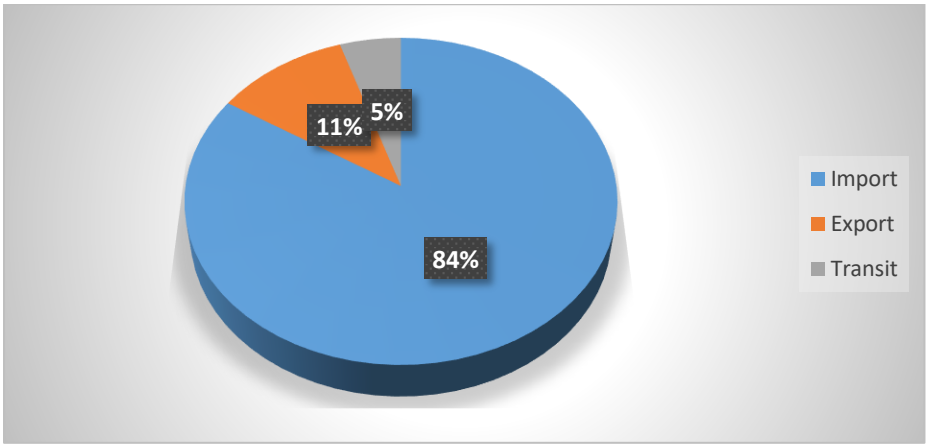



Fig.2.8. Distribution of shares by all freight forwarding services, taking into account the cargo flows

*Source: developed by the author on the basis of research.*

Though in 2022 the company started working on creation of its own fleet and purchased a few trucks it still needs to involves carriers from the outside. FTP uses both global and Ukrainian carrier services providers as well as small Ukrainian companies in the form of limited liability companies and individual entrepreneurs (Fig.2.9).

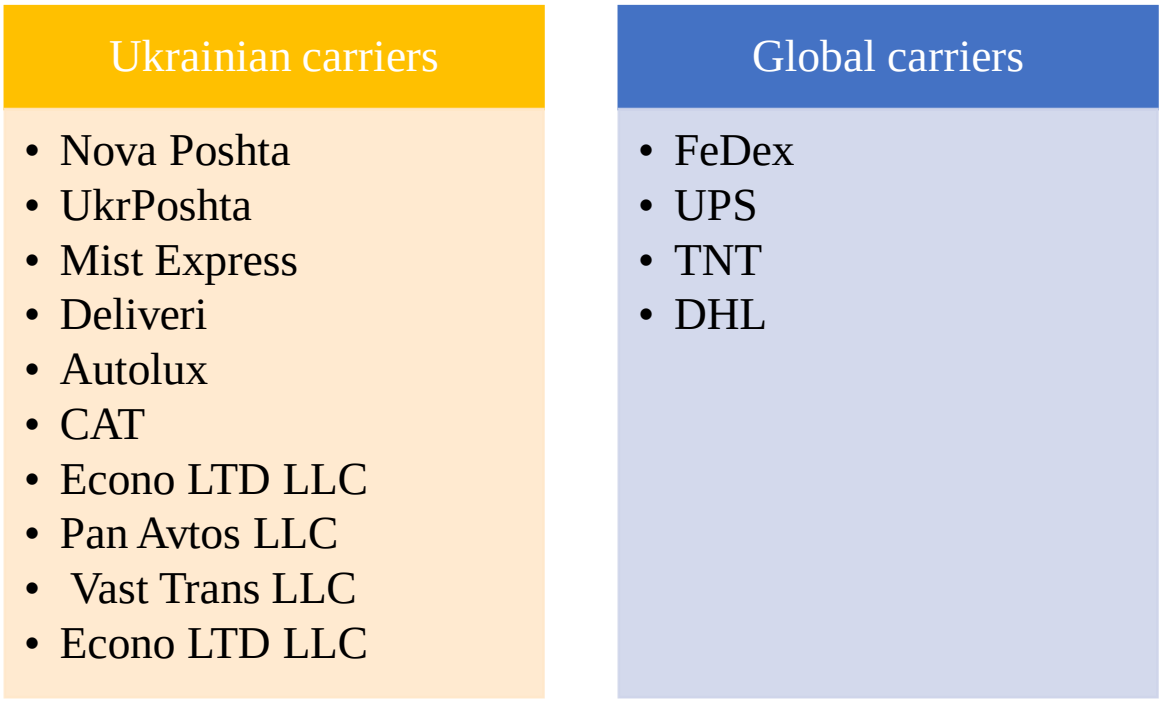



Fig.2.9. Ukrainian and global carriers FTP cooperates with

*Source: developed by the author on the basis of research.*

The largest share of groupage cargo delivery is carried out by such companies as Nova Poshta, UkrPoshta, Deliveri, Autolux, Mist Express and CAT, while among the road carriers working in partnership with FTP at the level of FTL delivery in international and domestic transportation, first of all, we can distinguish such carriers such as Pan Avtos, Vast Trans, Econo LTD (Fig.2.10).

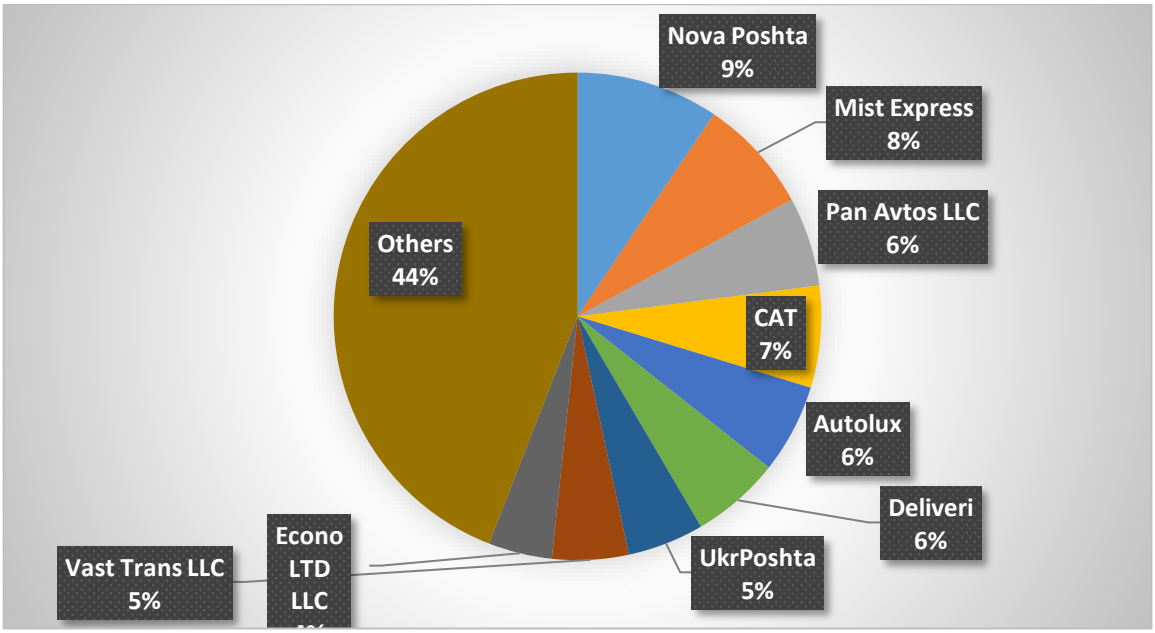



Fig.2.10. Top of the road carriers FTP works with

*Source: developed by the author on the basis of research.*

Considering the partnership between FTP and sea lines (Fig.11) we can see that the largest share of cargo is transported using such carriers as Maersk, ZIM, Yang Ming and Safmarine. The largest volumes of imported cargo by these sea lines come mainly from China, Taiwan, India, the United States, Vietnam, Thailand, Bangladesh (around 80%), the smallest share (less than 5%) - from Africa, the UAE, North and South America, as well as Western Europe and Turkey.

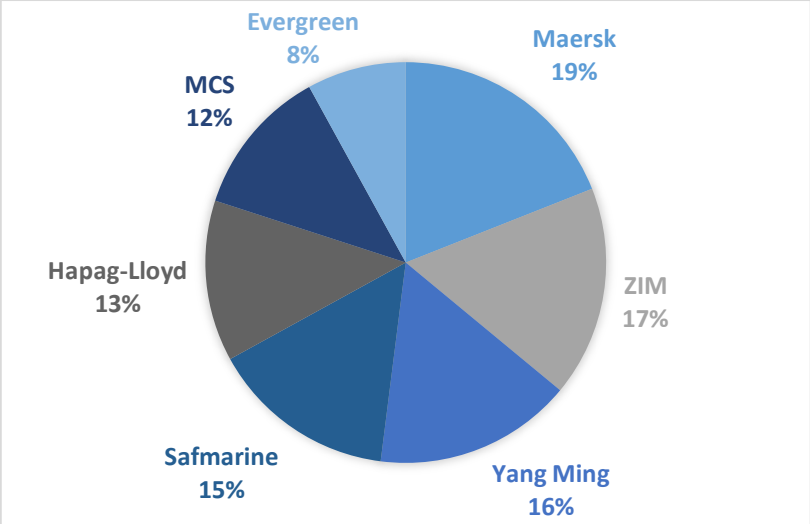



Fig.2.11. Shares of cargo transported by sea lines

*Source: developed by the author on the basis of research.*

When we analyse cooperation of the FTP LLC with airlines we can notice that the company works both with Ukrainian and foreign carriers (Fig.2.12). There is a strong coordination with Ukraine's UIA, which is linked to the best pricing schedule for air cargo delivery, both on its own and in accordance with agreements with other airlines. Additionally, Turkish Airlines is another airline that FTP frequently uses. This is largely because of Turkish Airlines' highly established internal flight network and competitive pricing. Other European businesses may also claim of an established network, but less favorable rates, thus FTP only uses their services when there are no other superior-quality and most affordable alternatives for air cargo transportation.

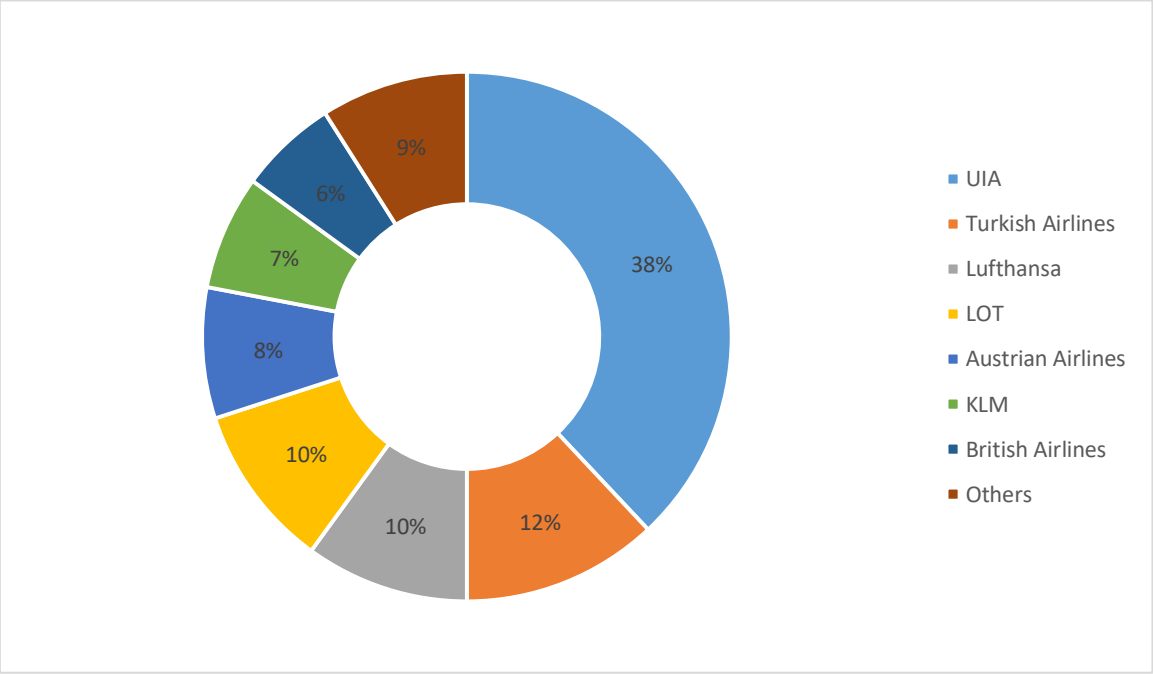



Fig.2.12. Shares of cargo transported by airlines

*Source: developed by the author on the basis of research.*

Over the past four years, the import mode of customer service has prevailed, while the share of logistics services in the organization of supply chains has been growing intermodal scheme, which is rated by customers as the most convenient, as it has such advantages as the possibility of reduced attention to the packaging of goods, as the container provides additional reliable packaging of cargo, and reduces the time for loading and unloading operations at transshipment ports.

Let us consider the dynamics of the two main financial indicators of the company – net income and net profit in 2018-2021 (Fig.2.13).

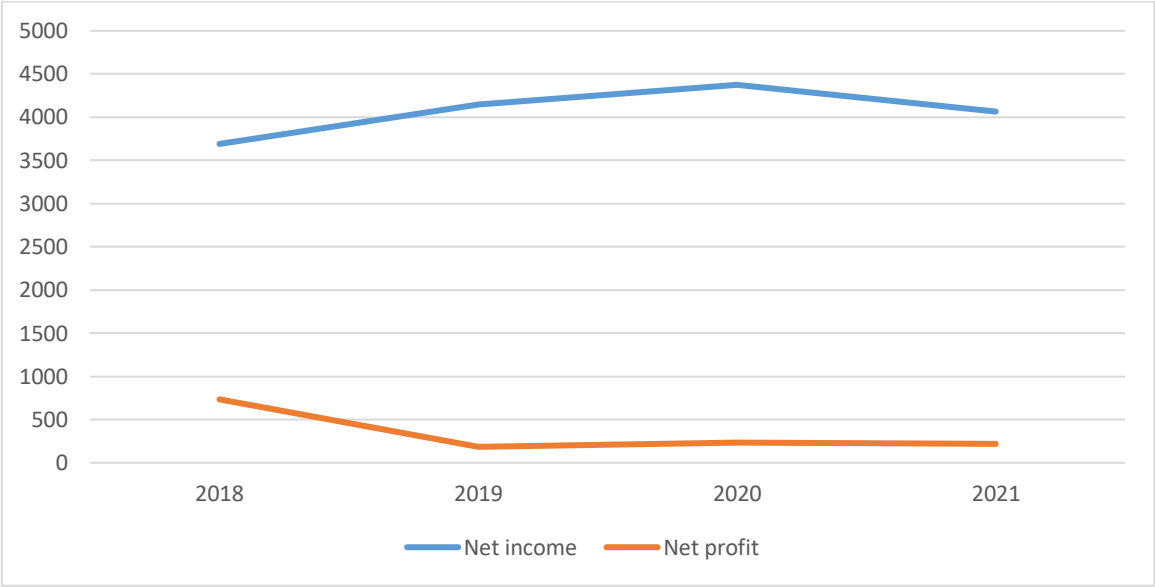



Fig.2.13. Dynamics of the main financial results of the LLC FTP, thousand UAH

*Source: developed by the author on the basis of research.*

We can observe the highest net profit in 2018. In 2017 the company decided to choose new strategy and involve new customers by taking part in the international exhibition of transport and logistics and in specialized exhibitions of the company's target segments. As a result FTP found new partners and contractors, expanded the list of countries in which it can provide its services and attracted new clients. All of the previously mentioned factors lead to the outstanding financial results in 2018.

In 2019-2021 with the further growth of gross income, due to the significant increase in expenses a strong decrease in net profit can be observed comparing to 2018. These results are related to the expansion of the range of services, namely the provision of storage capacity for its customers. Moreover, COVID-19 brought negative impact on transportation industry. A lot of restrictions were put in place to minimize the spread of the virus pandemic. Transportation revenues dropped significantly, therefore, transport workers' wages were deducted, other transport workers were laid off, and some transport companies closed due to bankruptcy. However FTP specialists found the way to overcome appeared obstacles and

were among the first to find tools for supplying oxygen concentrators and personal protective equipment. As a result, the company has stable financial results in 2020-2021.

**Conclusions on the second chapter**

FTP LLC was founded in 2011 and over these years the company has managed to recommend themselves as a reliable logistics operator that organizes door-to-door delivery of cargo by any mode of transport, as well as a combination of different modes of transport in the supply chain, taking into account compliance with the main logistics criteria.

The analysis of the FTP statistics shows that the most popular service for many years remains the provision of customs brokerage services, while the direction of intermodal transportation is also developing, as well as as well as consulting services on foreign trade in certain markets. Due to the national trend of imports exceeding exports in Ukraine and growth of e-commerce FTP is approached by importers. The main geographical segment of the company's freight forwarding activities belongs to China, Germany and Poland.

The company shows quite stable financial results over the past years despite multiple obstacles including COVID-19 pandemic.

In addition, FTP LLC was able to adjust to the changing transportation market during the hostilities on the territory of Ukraine. The company has increased the number of customers by 30% while most competitors have lost ground since the start of the war sue to the wide range of services offered and ability to transport varied items.

Though the company has begun creation of its own fleet, it still needs to buy many trucks in order to fulfil a significant share of the orders on their own. In addition, it will not be superfluous for the management to reduce transportation costs by reviewing the available road carriers and choosing the most cost-efficient ones. The main reason for the above measures is high transportation rates of the current carriers; this circumstance negatively influences the company’s competitiveness. Besides FTP needs to establish closer relations with railroad services providers so it will be able to offer rail transportation solutions on a regular basis.

# CHAPTER 3
# DIRECTIONS FOR IMPROVING THE PROCESS OF ORGANIZATION OF CARGO TRANSPORTATION IN THE MULTIMODAL TRANSPORT NETWORK OF LLC FTP

## 3.1. Optimization of last-mile logistics using drone transportation

The FTP LLC is a stable logistics company with a ten-year experience in the transportation industry. However having conducted SWOT-analysis we can state that one of its weaknesses is inability to offer competitive rates due to the high transportation cost of road carriers. Partially this problem can be solved by the introduction of drone delivery.

Drone delivery is a method of transporting various goods (food, medicine, etc.) using commercial drones. Most solutions offered today are based on a configuration with two or more rotors. The delivery box is placed in a compartment located at the bottom of the copter or attached to the drone itself using a mounting mechanism. After delivery, the customer receives the package either by removing it from a cable lowered from a hovering drone (which eliminates the need for landing), or by picking it up after the UAV lands). Drones are becoming increasingly integrated into multimodal transportation systems, offering unique advantages in terms of efficiency, speed, and accessibility [29].

Drones as a means of transporting goods have many advantages (Fig.3.1), including:

- Logistics efficiency. Traditional delivery is tied to roads. Trucks often have to travel dozens of extra kilometers to bring cargo from a warehouse to even close destinations. In addition, they can get stuck in traffic jams. Drones don't have these limitations - they can directly get from point A to point B, making transportation much more efficient.

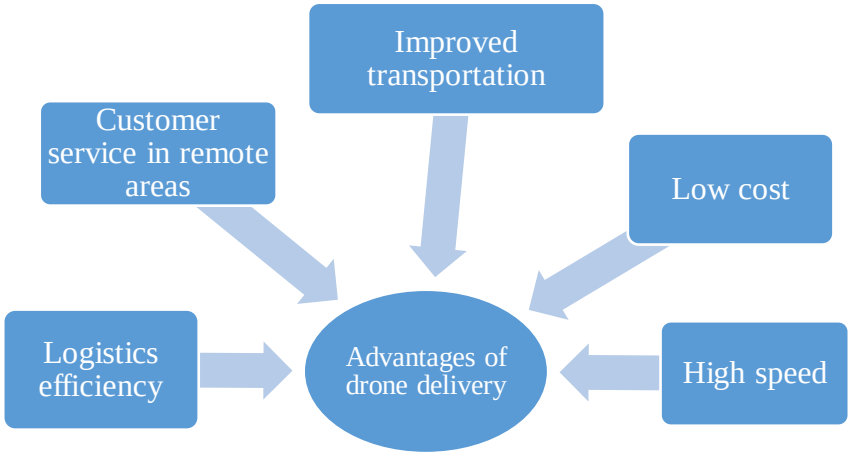



Fig.3.1. Advantages of drone delivery

*Source: developed by the author on the basis of research*.

- Customer service in remote areas. In areas with poor road infrastructure, delivery takes a lot of time. In some cases, weather can ruin plans. Drones, on the other hand, can easily fly over roadless areas.
- Relatively high speed. Drone delivery is most correctly compared to airmail - shipments are delivered quickly and without obstacles. The speed of transportation can exceed traditional delivery methods by times.
- Improved transportation. According to retail giant Amazon, most commercial shipments weigh less than 2 kilograms. Today, such goods take up space in trucks. If all light parcels started being sent by drones, it would significantly relieve transportation and reduce the number of vans and lorries on the roads. This would benefit passenger transportation and, of course, the environment - drones powered by electricity produce no emissions.
- Low cost. Using drone delivery is much cheaper for companies than helicopter transportation. Drones are also more cost-effective than standard delivery methods, which involve a lot of human resources. Drones only require high costs when the technology is introduced, while the cost of employee salaries can only increase over time.

In the context of multimodal transportation, which involves using multiple modes of transport in a coordinated manner, drones serve as an additional component.

Fig.3.2 shows how drones fit into multimodal transportation.

## Last-Mile Delivery

- Drones excel in covering short distances efficiently, making them ideal for last-mile delivery. In a multimodal system, they complement other transportation modes like trucks, ships, or trains by handling the final leg of delivery from a transportation hub to the destination. This reduces congestion and expedites delivery times.

## Emergency Response

- Drones play a crucial role in emergency situations by quickly delivering medical supplies, food, or equipment to areas that might be inaccessible to traditional vehicles. In multimodal systems, they can seamlessly integrate with other emergency response mechanisms to provide swift aid.

## Data Collection and Monitoring

- Drones equipped with various sensors and cameras can gather real-time data and monitor transportation infrastructure, traffic flow, and road conditions. This data helps optimize the use of other transportation modes, making the overall system more efficient.

## Traffic Management

- Drones can aid in traffic management by providing aerial views of traffic patterns, allowing authorities to make informed decisions in managing congestion and improving transportation flow.

## Intermodal Connectivity

- Drones can bridge the gap between different transportation modes. For instance, a drone could transport a package from a cargo ship to a distribution center or from a train station to a remote area where trucks might have difficulty reaching.

## Future Integration

- As technology advances, there are discussions about integrating drones with larger modes of transportation, like air taxis or autonomous flying vehicles. This could potentially create a more interconnected and efficient transportation network.

Fig.3.2. Usage of drones in multimodal transportation

*Source: developed by the author on the basis of research.*

In multimodal transportation, the key is seamless integration and coordination between various transportation modes, and drones offer a versatile and agile option to enhance these systems. However, their widespread adoption still faces regulatory, safety, and logistical challenges that need to be addressed for optimal integration into multimodal transportation networks.

Some of the significant hurdles include:

Regulatory Framework: Regulations surrounding drone operations vary widely across different regions and countries. Obtaining the necessary permits and approvals for drone flights, especially in urban or densely populated areas, can be complex. Harmonizing regulations to ensure safety while allowing innovation is crucial.

Safety Concerns: Safety remains a primary concern, especially when drones share airspace with manned aircraft. Ensuring collision avoidance systems, robust communication protocols, and adherence to safety standards is essential to gain public trust and regulatory approval.

Airspace Management: Integrating drones into existing airspace systems without disrupting manned flights poses a challenge. Developing systems for efficient traffic management and creating dedicated drone corridors or airspace zones is critical.

Technology Limitations: Despite advancements, drones still face limitations in terms of battery life, payload capacity, and range. Improvements in battery technology, flight endurance, and the ability to carry heavier payloads are necessary to enhance their utility in transportation.

Reliability and Redundancy: Ensuring the reliability and redundancy of drone systems is crucial for their adoption in transportation. Fail-safes, backup systems, and mechanisms to handle emergencies need to be robust to maintain operational integrity.

Infrastructure: Building infrastructure to support drone operations, such as landing pads, charging stations, and maintenance facilities, requires investment and planning. Integrating these into existing transportation networks can be challenging.

Data Security and Privacy: Drones gather a vast amount of data through sensors and cameras. Ensuring the security of this data and addressing privacy concerns is important, especially in scenarios involving sensitive information or surveillance.

Operational Challenges: Factors such as weather conditions, environmental hazards, and the need for skilled operators can impact drone operations. Overcoming these challenges to ensure consistent and reliable performance is necessary [31-32].

Addressing these challenges requires collaboration among governments, regulatory bodies, industry stakeholders, and the public. Efforts in research, technological

advancements, policy development, and community engagement are essential to facilitate the safe and effective integration of drones into transportation systems.

Despite some difficulties associates of the organization of drone delivery recent news from the US confirms that active activity in this new field can bring big profits. For example, the company Flirtey, which from the very beginning made drone delivery its main focus, in a few years turned from a small startup into a large company with a capitalization of more than $100 million [32].

Zipline is another American company specializing in drone delivery. Its priority is working with non-profit organizations to deliver medical supplies. In 2016, Zipline became known for its vaccine transportation project in Rwanda. Today, the company is developing a partnership with Intermountain Healthcare Foundation and delivering prescription drugs to patients in need in Utah [33].

IT giants have created dedicated drone delivery divisions as well. Amazon Air expects drones to become the primary method of delivering goods to customers "in the coming years" [34]. Google's Wing service is known to be actively developing grocery delivery. Platforms for launching drones are created on the empty roofs of shopping centers. Since drones need much less time for delivery than couriers, customers have a chance to order even ice cream and receive it unmelted [35].

Choosing the right drone for your cargo transportation needs can be a daunting task. With the increasing number of drones on the market, it is important to understand the characteristics and capabilities of each type of drone to make the best decision. Here are some tips to choose the right drone for the cargo transportation needs (Fig.3.3).

The first step is to estimate the payload of the drone. This will determine the size of the drone you need. The larger the payload, the larger the drone. You also need to consider the distance the drone will need to travel, as well as any obstacles or other risks that may be encountered along the way.

The next step is to research the different types of drones available. There are several different types of drones, including fixed-wing, multi-rotor, and hybrid models. Each type of drone has its own unique capabilities and features, so it's important to understand the

differences between them and determine which one is best suited for your specific cargo transportation needs.

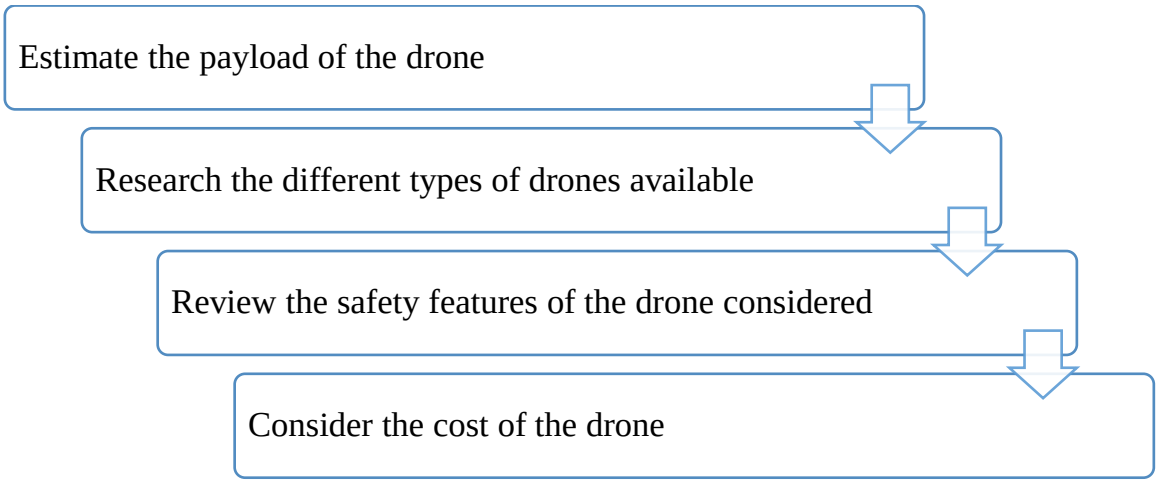



Fig.3.3 Algorithm of choosing a drone for transportation

*Source: developed by the author on the basis of information [36].*

You should also consider the safety features of the drone considered. This includes features such as obstacle avoidance, automatic flight paths, and automatic landing capabilities. These features will help ensure the safety of your shipment and can also reduce the risk of damage or loss.

Finally, you should consider the cost of the drone. Some drones are more expensive than others, so it's important to compare prices and features to find the best deal. Additionally, you should also consider the cost of maintenance and repairs as they can quickly add up over time.

Following the steps above two alternative concepts (A and B) were developed, the main difference is in the need for credit resources and size/payload of drones used (Table 3.1).

*Table 3.1*

Peculiarities of the investment projects

| | Project A | Project B |
|---|---|---|
| Drone model | Reactive Drone Hybryd RDHC20 | Reactive Drone Hybryd RDHC5 |
| Appearance of the drone |  |  |
| Needed quantity | 10 units | 10 units |
| Necessary financial resources | 166.2 thousand dollars | 97.3 thousand dollars |
| The life cycle of the project | 6 years | 6 years |
| Tariff for service in the first year | 1.5 USD/km | 1.3 USD/km |
| Estimated revenue for the last year of the project's life cycle | 251.56 thousand dollars | 212.04 thousand dollars |

*Source: developed by the author on the basis of research.*

The main characteristics of the drones are shown in the table 3.2.

*Table 3.2*

The main characteristics of Reactive Drone Hybryd RDHC20 and of Reactive Drone Hybryd RDHC5

| | Reactive Drone Hybryd RDHC20 | Reactive Drone Hybryd RDHC5 |
|---|---|---|
| Maximum load | 25 kg | 7 kg |
| Flight distance | With a load of 20 kg - up to 60 km, with a load of 25 kg - up to 40 km. | With a load of 5 kg - up to 100 km, with a load of 7 kg - up to 70 km. |
| Flight speed | Up to 15 m/s | Up to 12 m/s |
| Flight altitude | Up to 1000 meters | |

*Ending of the table 3.2*

| | Reactive Drone Hybryd RDHC20 | Reactive Drone Hybryd RDHC5 |
|---|---|---|
| Fuel Type | A mixture of A95 gasoline and 2DT engine oil, 7.5 kW gasoline hybrid unit. | A mixture of A95 gasoline and 2DT engine oil, 2.4 kW gasoline hybrid unit. |
| Working dimensions | 2430 * 2430 * 550 mm | 1650 * 1650 * 500 mm |
| Fuel consumption without load | 4 l/h | 2.2 l/h |
| Fuel consumption with load | 7 l/h | 3 l/h |
| The control system | Allows the drones to be manually controlled up to 15 km and receive telemetry and video signals up to 30 km away. It can be equipped with a second remote control on request. | |

*Source: developed by the author on the basis of information [38-39].*

In order to determine the most suitable drone for transportation we need to conduct feasibility study of investment projects, which should start with calculation of investment project parameters.

Determination of cash flows by years of the investment project

Cash flows from projects A and B are calculated in the following order:

a)total revenues (benefits) for the project are defined as:

$$TR_t = T_{trt} Q_t, \quad (3.1)$$

where $T_{trt}$ – tariff for transportation in the $t^{th}$ year;

$Q_t$– the total distance travelled in the $t^{th}$ year.

$$Qt = n \cdot k \cdot 365 \cdot d, \quad (3.2)$$

where *n* – number of drones

*k* – average number of trips per day

*d* – average distance traveled by drone per trip

$$Q_{A1} = 10 \cdot 3 \cdot 365 \cdot 12 = 131.4 \text{ thousand km}$$

$$Q_{B1} = 10 \cdot 2 \cdot 365 \cdot 17.5 = 127.8 \text{ thousand km}$$

Currently average tariff of transportation by Reactive Drone Hybryd RDHC20 is 1.5 USD/km and 1.3 USD/km for Reactive Drone Hybryd RDHC5.

$$TR_{A1} = 131.4 \cdot 1.5 = 197.10 \text{ thousand USD}$$

$$TR_{B1} = 127.8 \cdot 1.3 = 166.14 \text{ thousand USD}$$

Using the data from Table 1.1, Table 1.3 - Table 1.4, the total income for the first year of project A and B is calculated. According to the same principle, taking into account the annual tariff increase of 5%, we calculate total revenues for other years. The result is shown in Table 3.3.

*Table 3.3*

Total project revenues

| TR | | |
|---|---|---|
| Year | Project A | Project B |
| 1st year | 197.10 | 166.14 |
| 2nd year | 206.96 | 174.45 |
| 3rd year | 217.30 | 183.17 |
| 4th year | 228.17 | 192.33 |
| 5th year | 239.58 | 201.94 |
| 6th year | 251.56 | 212.04 |

b) loan disbursements are calculated as follows:

- annual basic payment:

$$P_{cr} = \frac{ICOF}{n}, \quad (3.3)$$

where $ICOF$ – the total amount of capital investment received;

$n$ – term of investment project implementation.

- the amount of interest payments for the loan in the first year:

$$B_{ip1} = ICOF \cdot e, \quad (3.4)$$

where $e$ – the interest rate for using the loan.

- the amount of interest payments for the use of credit in the $t^{th}$ year (except the first year):

$$B_{ipt} = \Pi_{res.value t} \cdot e, \quad (3.5)$$

- residual value of the loan in the first year:

$$P_{res.\ value1} = ICOF - P_{cr} - B_{ip1}, \quad (3.6)$$

- residual value of the loan in the $t^{th}$ year (except the first year):

$$P_{res.value.t} = P_{res.value(t-1)} - P_{cr} - B_{ip(t-1)}, \quad (3.7)$$

- annual (total) loan disbursements in the $t^{th}$ year:

$$P_{cr,total t} = P_{cr} + B_{ip t}. \quad (3.8)$$

Since the FTP LLC is able to finance this project on its own, by attracting funds from the investor-owner of the company, receiving the loan is not appropriate, therefore, payments are not calculated.

c) total project costs are calculated for such components as:

- operating costs in the $t^{th}$ year:

$$OC_t = S_{Л.г.t} \cdot Q_t, \quad (3.9)$$

Using the data from Table 1.1 - Table 1.4, we calculate the operating costs for the first year for projects A and B:

$$OC_{A1} = 166.2 \cdot 0.1 = 16.62 \text{ thousand dollars}$$

$$OC_{B1} = 97.3 \cdot 0.1 = 9.73 \text{ thousand dollars}$$

According to the same principle, taking into account the annual growth of the indicator $Q_t$ by 1%, with the help of the MS Excel software, we will calculate the operating costs for other years. The result is shown in table 3.4.

*Table 3.4*

The result of the calculation of operating costs

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 16.62 | 9.73 |
| 2nd year | 18.28 | 10.70 |
| 3rd year | 19.94 | 11.68 |
| 4th year | 21.61 | 12.65 |
| 5th year | 23.27 | 13.62 |
| 6th year | 24.93 | 14.60 |

- fuel expenses in the $t^{th}$ year:

Fuel consumption is determined on the basis of consumption norms, that are set as following for the Reactive Drone Hybryd RDHC20: 4 l/h for empty drone, 7 l/h for loaded drone. Average speed of the drone is 12 m/s that equals 43 km/h. Therefore total time the drone is transporting a load is equal to 131,400 : 43 = 3,056h.

Thus, fuel consumption per 3,056 h of carriage is 21,392 liters of gasoline. Current cost of A95 gasoline is 1.54 USD/l. Therefore, fuel expenses for Reactive Drone Hybryd RDHC20 are $32,983. However, empty run amounts to a 75% of a loaded run. As a result 2,292 h the drone is operating without a load with fuel consumption 4 l/h. Fuel consumption per 2,292 h of operating is 9,168 liters of gasoline. Fuel expenses for empty run for Reactive Drone Hybryd RDHC20 are $14,118.7.

Total fuel expenses for Reactive Drone Hybryd RDHC20 are equal to:

$$C_{fA1} = 32{,}983 + 14{,}118.7 = 47{,}101.7 \text{ thousand dollars}$$

Consumption norms for the Reactive Drone Hybryd RDHC5 are 2.2 l/h for empty drone, 3 l/h for loaded drone. Average speed of the drone is 10 m/s that equals 36 km/h. Therefore total time the drone is transporting a load is equal to 127,800 : 36 = 3,550 h.

Thus, fuel consumption per 3,550 h of carriage is 10,650 liters of gasoline. Therefore, fuel expenses for Reactive Drone Hybryd RDHC20 are $16,401. Empty run amounts to a 75% of a loaded run. As a result 2,662.5 h the drone is operating without a load with fuel consumption 2.2 l/h. Fuel consumption per 2,662.5 h of operating is 5,857.5 liters of gasoline. Fuel expenses for empty run for Reactive Drone Hybryd RDHC5 are $9,020.6.

Total fuel expenses for Reactive Drone Hybryd RDHC5 are equal to:

$$C_{fB1} = 16{,}401 + 9{,}020.6 = 25{,}421.6 \text{ thousand dollars.}$$

Taking into account the annual diesel cost increase of 5%, we calculate total fuel expenses $C_f$ for other years. The result is shown in table 3.5.

*Table 3.5*

The result of the calculation of fuel costs

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 47.1 | 25.42 |
| 2nd year | 49.42 | 26.69 |
| 3rd year | 51.89 | 28.03 |
| 4th year | 54.48 | 29.43 |
| 5th year | 57.20 | 30.90 |
| 6th year | 60.06 | 32.44 |

- unexpected expenses in the $t^{th}$ year:

$$C_{непрt} = OC_t \cdot 10\%, \quad (3.10)$$

Using the data from Table 1.1 - Table 1.4, we calculate the unexpected costs for the first year for projects A and B:

$$C_{unexpA1} = 16.62 \cdot 0.1 = 1.66 \text{ thousand dollars}$$

$$C_{unexpB1} = 9.73 \cdot 0.1 = 0.97 \text{ thousand dollars}$$

According to the same principle, with the help of the MS Excel software, we calculate unexpected expenses for other years. The result is shown in table 3.6.

*Table 3.6*

The result of the calculation of unexpected costs

| | Value, million dollars | |
|---|---|---|
| | A | B |
| 1st year | 1.66 | 0.97 |
| 2nd year | 1.83 | 1.07 |
| 3rd year | 1.99 | 1.17 |
| 4th year | 2.16 | 1.26 |
| 5th year | 2.33 | 1.36 |
| 6th year | 2.49 | 1.46 |

- overhead costs in the $t^{th}$ year:

$$HC_t = OC_t \cdot 5\%. \quad (3.11)$$

Using the data from Table 1.1 - Table 1.4, we calculate the overhead costs for the first year for projects A and B:

$$HC_{A1} = 16.62 \cdot 0.05 = 0.83 \text{ thousand dollars}$$

$$HC_{B1} = 9.73 \cdot 0.05 = 0.49 \text{ thousand dollars}$$

According to the same principle, with the help of the MS Excel software, we calculate overhead expenses for other years. The result is shown in table 3.7.

*Table 3.7*

The result of the calculation of overhead costs

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 0.83 | 0.49 |
| 2nd year | 0.91 | 0.54 |
| 3rd year | 1.00 | 0.58 |
| 4th year | 1.08 | 0.63 |
| 5th year | 1.16 | 0.68 |
| 6th year | 1.25 | 0.73 |

- depreciation in the $t^{th}$ year are taken into account in the structure of total production costs based on the residual value of fixed assets of the transport and logistics company.

$$F_t = B_{initial t} \cdot AF_t, \qquad (3.12)$$

where $C_{initial t}$ – the initial cost of a group of fixed assets in the $t^{th}$ year;

$AF_t$ – the annual depreciation rate in the $t^{th}$ year (8%).

Using the data from Table 1.1 - Table 1.4, we calculate the depreciation deductions for the first year for projects A and B:

$$F_{A1} = 166.2 \cdot 0.1 = 16.62 \text{ thousand dollars}$$

$$F_{B1} = 97.3 \cdot 0.1 = 9.73 \text{ thousand dollars}$$

According to the same principle, with the help of the MS Excel software, we calculate depreciation deductions for other years. The result is shown in table 3.8.

*Table 3.8*

The result of the calculation of depreciation deductions

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 16.62 | 9.73 |
| 2nd year | 11.97 | 7.01 |
| 3rd year | 11.01 | 6.45 |
| 4th year | 10.13 | 5.93 |
| 5th year | 9.32 | 5.46 |
| 6th year | 8.57 | 5.80 |

- production costs in $t^{th}$ year are calculated as follows:

$$PC_t = OC_t + C_f + C_{unexpt} + HC_t + F_t. \quad (3.13)$$

The results of the production costs calculations are presented in table 3.9.

*Table 3.9*

The result of the calculation of production costs

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 82.80 | 46.34 |
| 2nd year | 82.41 | 46.01 |
| 3rd year | 85.83 | 47.90 |
| 4th year | 89.46 | 49.90 |
| 5th year | 93.28 | 52.02 |
| 6th year | 97.31 | 55.03 |

- the amount of value added tax (VAT) expenses in the $t^{th}$ year is determined depending on the established tariffs and the total volume of work performed in a certain billing period:

$$VAT_t = TR_t \cdot Q_t \cdot \gamma, \quad (3.14)$$

where $\gamma$ is the VAT rate (20%).

Using the data from Table 2.1, we calculate the amount of tax expenses for the first year for projects A and B:

$$VAT_{A1} = 197.1 \cdot 0.2 = 39.42 \text{ thousand dollars}$$

$$VAT_{B1} = 166.14 \cdot 0.2 = 33.23 \text{ thousand dollars}$$

According to the same principle, we calculate the amount of tax expenses for other years. The result is shown in table 3.10.

*Table 3.10*

The result of the calculation of the amount of value added tax

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 39.42 | 33.23 |
| 2nd year | 41.39 | 34.89 |
| 3rd year | 43.46 | 36.63 |
| 4th year | 45.63 | 38.47 |
| 5th year | 47.92 | 40.39 |
| 6th year | 50.31 | 42.41 |

- total project costs are calculated by such components as:

$$C_t = PC_t + VAT_t. \quad (3.15)$$

Using the data from Table 2.7 and Table 2.8, we calculate the total project costs for the first year for projects A and B:

$$C_{A1} = 82.8 + 39.42 = 122.22 \text{ thousand dollars}$$

$$C_{B1} = 46.34 + 33.23 = 79.57 \text{ thousand dollars}$$

According to the same principle, we calculate the total costs of the project for other years. The result is shown in table 3.11.

*Table 3.11*

The result of the calculation of the project total costs

| | Value, thousand dollars | |
|---|---|---|
| | A | B |
| 1st year | 122.22 | 79.57 |
| 2nd year | 123.80 | 80.90 |
| 3rd year | 129.29 | 84.53 |
| 4th year | 135.09 | 88.37 |
| 5th year | 141.20 | 92.41 |
| 6th year | 147.62 | 97.43 |

d) profit before tax in the t[th] year according to the project options is defined as:

$$\mathrm{PBT}_t = P_t - C_t. \qquad (3.16)$$

Using the data from Table 2.1 and Table 2.8, we will calculate the balance sheet profit for the first year under project A and B:

$$\mathrm{PBT}_{\mathrm{A1}} = 197.1 - 122.22 = 74.88 \text{ thousand dollars}$$

$$\mathrm{PBT}_{\mathrm{B1}} = 166.14 - 79.57 = 86.57 \text{ thousand dollars}$$

According to the same principle, we calculate the balance sheet profit for other years. The result is shown in table 3.12.

*Table 3.12*

Balance sheet profit

| $\mathrm{PBT}_t$ | | |
|---|---|---|
| Year | A | B |
| 1st year | 74.88 | 86.57 |
| 2nd year | 83.16 | 93.55 |
| 3rd year | 88.01 | 98.64 |
| 4th year | 93.08 | 103.96 |
| 5th year | 98.38 | 109.54 |
| 6th year | 103.94 | 114.61 |

e) income tax in the t[th] year is determined as follows:

$$\mathrm{IT}_t = \mathrm{PBT}_t \cdot m, \qquad (3.17)$$

where $m$ is the income tax rate (18%).

Using the data from Table 2.10, we calculate the income tax for the first year under projects A and B:

$$\mathrm{IT}_{\mathrm{A1}} = 74.88 \cdot 0.18 = 13.48 \text{ thousand dollars}$$

$$\mathrm{IT}_{\mathrm{Б1}} = 86.57 \cdot 0.18 = 15.58 \text{ thousand dollars}$$

According to the same principle, we calculate the income tax for other years. The result is shown in table 3.13.

*Table 3.13*

Income tax

| $IT_t$ | | |
|---|---|---|
| Year | Project A | Project B |
| 1st year | 13.48 | 15.58 |
| 2nd year | 14.97 | 16.84 |
| 3rd year | 15.84 | 17.75 |
| 4th year | 16.75 | 18.71 |
| 5th year | 17.71 | 19.72 |
| 6th year | 18.71 | 20.63 |

f) net profit in the $t^{th}$ year of the project is calculated as:

$$NP_t = PBT_t - IT_t. \quad (3.18)$$

Using the data from Table 2.10 and Table 2.11, we calculate the net profit for projects A and B (Table 3.14).

*Table 3.14*

Net profit

| $NP_t$ | | |
|---|---|---|
| Year | Project A | Project B |
| 1st year | 61.41 | 70.99 |
| 2nd year | 68.19 | 76.71 |
| 3rd year | 72.17 | 80.88 |
| 4th year | 76.32 | 85.25 |
| 5th year | 80.67 | 89.82 |
| 6th year | 85.23 | 93.98 |

The results of calculations of cash flow components for alternative investment projects are shown in the table (Annex B, C).

Calculation of criteria for the efficiency of the investment project of the transport and logistics company

The main criteria for assessing the effectiveness and making an informed decision on the implementation of investment projects include: net present value, profitability index, payback period, internal rate of return.

Below is a method of calculating the performance indicators of investment projects A and B.

*Net present (present) value NPV* is the difference between the amount of reduced (discounted) benefits and the amount of reduced (discounted) costs of the investment project.

The calculation of NPV in the case of a one-time investment costs at the zero step of the project is performed according to the formula

$$\text{NPV} = \sum_{t=0}^{n} \frac{\text{CIF}_t}{(1+i)^t} - \text{ICOF}, \quad (3.19)$$

$$\text{or NPV} = -\text{ICOF} + \sum_{t=1}^{n} \frac{(P_t - C_t - F_t)(1-m) + F_t}{(1+i)^t}, \quad (3.20)$$

where $\text{CIF}_t$ (cash inflows) - the amount of net cash inflow at certain intervals of the total period of operation of the investment project;

ICOF (initial cash outflows)- the amount of one-time (initial) investment costs for the implementation of the investment project, and- used comparison rate (discount rate),%;

t-step (year, period) of the project;

n- the total estimated period of operation of the project (years, months);

$P_t$ -the amount of income at certain intervals of the total period of operation of the investment project;

$C_t$ - the amount of costs at certain intervals of the total period of operation of the investment project;

$F_t$ - the amount of depreciation at certain intervals of the total period of operation of the investment project;

m - income tax rate,%.

Using the MS Ecxel software, we calculate the amount of net cash inflow for separate intervals of the total period of operation of the investment project, and then calculate the NPV for projects A and B. The results are presented in table 3.15 and table 3.16.

*Table 3.15*

Net present value, thousand USD (Project A)

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 201.34 | 111.89 |
| $CIF_t$ | | |
| 1 | 70.93 | 65.02 |
| 2 | 66.24 | 55.66 |
| 3 | 62.49 | 48.14 |
| 4 | 59.05 | 41.69 |
| 5 | 55.88 | 36.16 |
| 6 | 52.95 | 31.41 |

The method of internal rate of return (profitability) IRR is to determine the value of such a comparison rate (discount rate), at which the net present value of the project is zero.

This method requires information on the forecast of net income of the enterprise, and then find a discount rate at which the current value of the investment is equal to the current value of cash flows.

*Table 3.16*

Net present value, thousand USD (Project B)

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 288.63 | 194.31 |
| $CIF_t$ | | |
| 1 | 73.38 | 67.27 |
| 2 | 69.19 | 58.14 |
| 3 | 65.61 | 50.54 |
| 4 | 62.27 | 43.97 |
| 5 | 59.16 | 38.29 |
| 6 | 56.32 | 33.41 |

The method of internal rate of return (profitability) IRR is to determine the value of such a comparison rate (discount rate), at which the net present value of the project is zero.

This method requires information on the forecast of net income of the enterprise, and then find a discount rate at which the current value of the investment is equal to the current value of cash flows.

*IRR* for one-time investment costs is found by the equation:

$$\sum_{t=1}^{n} \frac{\text{CIF}_t}{(1+\text{IRR})^t} = \text{ICOF}. \qquad (3.21)$$

To determine the internal rate of return we use the methods of approximate calculations, one of which is the method of linear interpolation. To do this, with the help of preliminary calculations, two values of the discount rate are selected with discount rates $i_1 < i_2$ so that in the interval ($i_1$, $i_2$) the NPV function changes its value from "+" to "-».

Using the substitution method, it was determined that for project A $i_1$ = 43%, $i_2$ = 44%, and for project B $i_1$ = 84%, $i_2$ = 85%.

Using the MS Excel software, we calculate the NPV of projects A and B at the specified rates. The results are presented in table 3.17 and table 3.18.

*Table 3.17*

Net present value, thousand USD (Project A)

| Year | Rate value, % | |
|---|---|---|
| | 43 | 44 |
| NPV value | 2.699 | -0.344 |
| $CIF_t$ | | |
| 1 | 54.563 | 54.184 |
| 2 | 39.198 | 38.655 |
| 3 | 28.445 | 27.856 |
| 4 | 20.674 | 20.106 |
| 5 | 15.049 | 14.534 |
| 6 | 10.970 | 10.520 |

*Table 3.18*

Net present value, thousand USD (Project B)

| Year | Rate value, % | |
|---|---|---|
| | 84 | 85 |
| NPV value | 0.3575 | -0.7460 |
| $CIF_t$ | | |
| 1 | 43.869 | 43.632 |
| 2 | 24.728 | 24.461 |
| 3 | 14.018 | 13.792 |
| 4 | 7.954 | 7.784 |
| 5 | 4.517 | 4.397 |
| 6 | 2.571 | 2.489 |

The approximate value of IRR is found by the formula

$$\text{IRR} = i_1 + \frac{\text{NPV}_1}{\text{NPV}_1 - \text{NPV}_2}(i_2 - i_1), \qquad (3.22)$$

where $i_1$ -the value of the interest rate at which the estimated positive value of the net present value of the project ($NPV_1$) is obtained;

$i_2$- the value of the interest rate at which the estimated negative value of the net present value of the project ($NPV_2$) was obtained.

The accuracy of the calculations inversely depends on the proportional length of the interval ($i_1$, $i_2$). The highest accuracy is achieved when the interval length is minimal (equal to 1%), ie when $i_1$, $i_2$- nearest values.

With the help of the MS Excel software we calculate the internal rate of return for projects A and B.

$$IRR_{\text{A}} = 0.4389,$$

$$IRR_{\text{Б}} = 0.8432.$$

The next step is to find the internal rate of return using the graphical method. To do this, on the abscissa axis it is necessary to postpone the value of the discount rate and, and on the ordinate axis the value of the net present value of NPV. The point of intersection of the line NPV with the abscissa and will be the value of the internal rate of return IRR (Fig.3.4 and Fig.3.5).

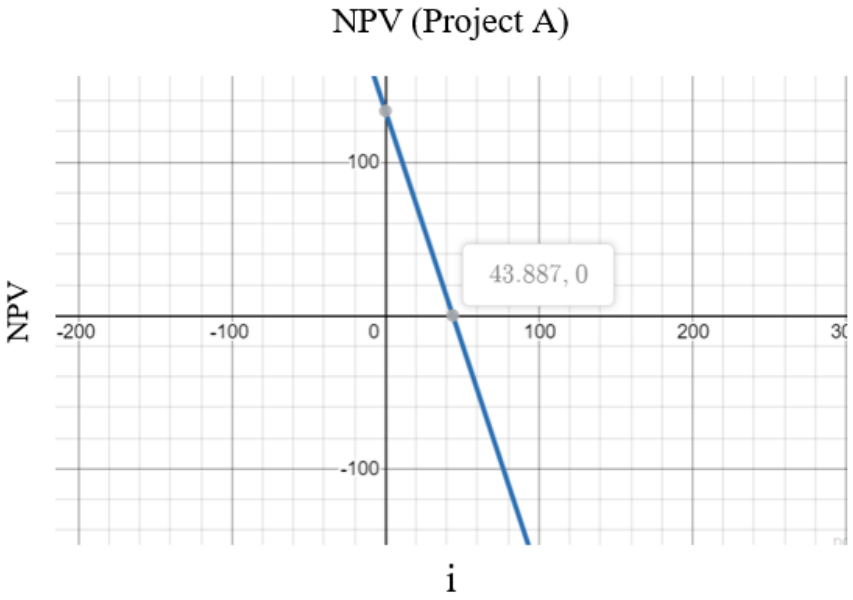



Fig.3.4. Graphical method of finding IRR values for project A

*Source: developed by the author on the basis of research.*

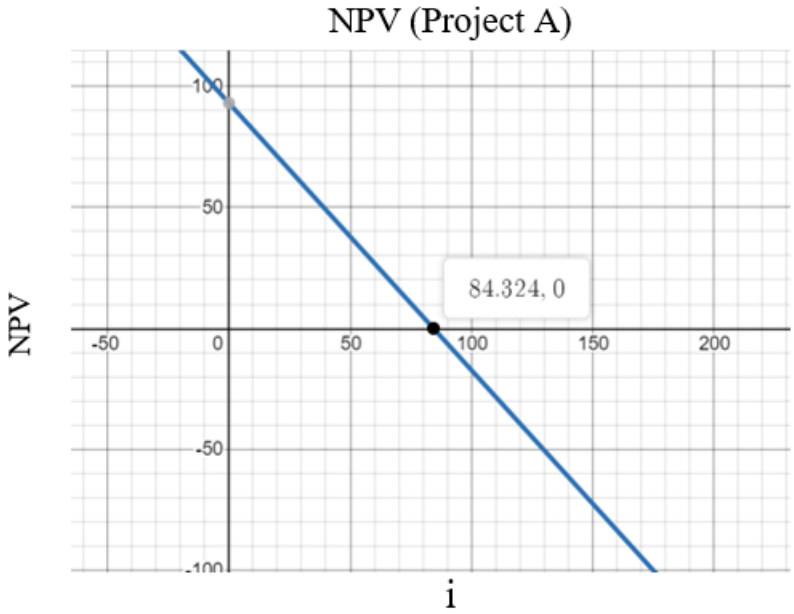



Fig.3.5. Graphical method of finding IRR values for project B

*Source: developed by the author on the basis of research.*

To calculate the relative effectiveness of investment projects use the method of the ratio of "benefits-costs ", which is calculated as the ratio of the amount of reduced benefits to the amount of reduced costs of the investment project. Criterion "benefits–costs" or profits – costs B / $C_{ratio}$ is a fraction of the separation of the discounted flow of benefits (income) to the discounted flow of costs and is calculated by the following formula:

$$BC_{\text{ratio}} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}. \qquad (3.23)$$

Using the MS Excel software and the values of Table 2.1 and Table 2.9, we calculate the criterion of "benefit-cost" for projects A and B. The result is presented in table 3.19 and table 3.20.

*Table 3.19*

The Benefit-to-Costs Ratio (i=10**)**

| | $B/C_{ratio}$ | | | | | |
|---|---|---|---|---|---|---|
| | i=10 | | | | | |
| Year | Project A | | Project B | | Project A | Project B |
| | Benefits | Costs | Benefits | Costs | | |
| 1 | 179.18 | 111.10 | 151.04 | 72.34 | 1.67 | 2.16 |
| 2 | 171.04 | 102.31 | 144.17 | 66.86 | | |
| 3 | 163.39 | 97.21 | 137.72 | 63.56 | | |
| 4 | 156.28 | 92.53 | 131.73 | 60.53 | | |
| 5 | 148.81 | 87.70 | 125.43 | 57.40 | | |
| 6 | 142.12 | 83.40 | 119.80 | 55.05 | | |

*Table 3.20*

The Benefit-to-Costs Ratio (i=20)

| | $B/C_{ratio}$ | | | | | |
|---|---|---|---|---|---|---|
| | i=20 | | | | | |
| Year | Project A | | Project B | | Project A | Project B |
| | Benefits | Costs | Benefits | Costs | | |
| 1 | 164.25 | 101.85 | 138.45 | 66.31 | 1.67 | 2.15 |
| 2 | 143.72 | 85.97 | 121.14 | 56.18 | | |
| 3 | 125.61 | 74.73 | 105.88 | 48.86 | | |
| 4 | 110.23 | 65.26 | 92.91 | 42.69 | | |
| 5 | 96.22 | 56.71 | 81.10 | 37.11 | | |
| 6 | 84.13 | 49.37 | 70.92 | 32.59 | | |

The next performance indicator to be determined is the Profitability index PI, which reflects the relative profitability of the project, or the discounted value of the project's cash flow per unit of investment.

The profitability index in the case of one-time investment costs for a real project is calculated by the formula:

$$\mathrm{PI} = \sum_{t=0}^{n} \frac{\mathrm{CIF}_t}{(1+i)^t} / \mathrm{ICOF}. \qquad (3.24)$$

The results of the profitability index are presented in table 3.21 and table 3.22.

*Table 3.21*

Profitability index, (project A)

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| PI value | 2.21 | 1.67 |
| $CIF_t$ | | |
| 1 | 70.93 | 65.02 |
| 2 | 66.24 | 55.66 |
| 3 | 62.49 | 48.14 |
| 4 | 59.05 | 41.69 |
| 5 | 55.88 | 36.16 |
| 6 | 52.95 | 31.41 |

*Table 3.22*

Profitability index, (project B)

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| PI value | 3.97 | 3.00 |
| $CIF_t$ | | |
| 1 | 73.38 | 67.27 |
| 2 | 69.19 | 58.14 |
| 3 | 65.61 | 50.54 |
| 4 | 62.27 | 43.97 |
| 5 | 59.16 | 38.29 |
| 6 | 56.32 | 33.41 |

One of the most common and understandable indicators for evaluating the effectiveness of an investment project is the payback period of the PP. This figure in the case of one-time investment costs for a real project is calculated by the following formula:

$$PP = ICOF / \left[\sum_{t=0}^{n} \frac{CIF_t}{(1+i)^t} / n\right]. \qquad (3.25)$$

The results of the profitability index are presented in table 3.23.

When assessing the payback period, it should be noted that it can be used to assess not only the efficiency of investment, but also to identify the level of investment risks associated with liquidity (the longer the project to full payback, the higher the level of investment risks).

The rules of work with the payback period indicator as a criterion for evaluating the efficiency of investment projects provide for the implementation to recommend those

investment projects that provide the shortest payback period. In our case, Project B should be implemented, because of the shortest payback period.

*Table 3.23*

Payback period

| PP | |
|---|---|
| i=10 | |
| Project A | Project B |
| 2.71 | 3.59 |
| i=20 | |
| Project A | Project B |
| 1.51 | 2.00 |

The results of calculations are shown in the table (Annex D, E).

Sensitivity analysis to identify the most dangerous factors in the implementation of the investment project.

To conduct a risk analysis, we choose three factors from the number of factors offered: production costs, production indicators, the amount of capital investment.

Sensitivity analysis involves the calculation of the base model based on the allowable values of the input variables of the project, for which the value of the net present value (NPV) is determined.

This value is the basis for comparison with the allowable possible changes that need to be analyzed.

The algorithm for sensitivity analysis involves:

- determination of critical variables that affect the value of net present value (NPV);
- estimating the impact of changes in one project variable (if all others remain unchanged) on the value of net present value;
- calculation of the impact of changes in the studied variable on the deviation of the obtained NPV value from the baseline (estimation of elasticity, sensitivity to changes in net present value from changes in the project variable);

- determination of the limit (critical) value of the variable and its possible permissible deviation from the baseline scenario of the project;
- calculating the sensitivity and critical value for each project variable and ranking them in descending order (the higher the sensitivity of the NPV, the more important the variable for the value of net present value, and therefore for the project).

Therefore, the essence of this method is to measure the sensitivity of the main result indicators of the project (NPV or IRR) to changes in a variable.

The calculation of the percentage change in NPV is carried out according to the formula:

$$\Delta NPV = \frac{NPV_н - NPV_б}{NPV_б} \times 100\%, \quad (3.26)$$

where $NPV_n$ is the new value of the net present value of the project when the indicator changes; $NPV_b$ is the base value of the net present value of the project.

As an indicator of the sensitivity of the project to changes in certain variables use the indicator of the elasticity of net present value (NPV), which is calculated as follows:

$$E = \frac{\%NPV}{\%X}, \quad (3.27)$$

where % NPV - percentage change in NPV;

% X - percentage change of variable (factor).

We calculate the updated values using the MS Excel software. The results are presented in table 3.24 - table 3.29.

*Table 3.24*

New values when changing production indicators (Project A)

**Net present value, thousand USD**

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 138.36 | 64.38 |
| $CIF_t$ | | |
| 1 | 59.18 | 54.25 |
| 2 | 55.02 | 46.24 |
| 3 | 51.78 | 39.89 |
| 4 | 48.83 | 34.47 |
| 5 | 46.12 | 29.85 |
| 6 | 43.63 | 25.89 |

**Percentage change in NPV when changing production indicators, %**

| Value, % | |
|---|---|
| 10 | 20 |
| -31.28 | -42.46 |

**Elasticity of NPV when changing production indicators**

| Value | |
|---|---|
| 10 | 20 |
| 3.13 | 4.25 |

*Table 3.25*

New values when changing production indicators (Project B)

**Net present value, thousand USD**

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 235.54 | 154.26 |
| $CIF_t$ | | |
| 1 | 63.47 | 58.18 |
| 2 | 59.73 | 50.19 |
| 3 | 56.58 | 43.58 |
| 4 | 53.66 | 37.89 |
| 5 | 50.93 | 32.96 |
| 6 | 48.47 | 28.76 |

**Percentage change in NPV when changing production indicators, %**

| Value, % | |
|---|---|
| 10 | 20 |
| -18.39 | -20.61 |

**Elasticity of NPV when changing production indicators**

| Value | |
|---|---|
| 10 | 20 |
| 1.84 | 2.06 |

*Table 3.26*

New values when changing capital investments (Project A)

**Net present value, thousand USD**

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 177.09 | 89.55 |
| $CIF_t$ | | |
| 1 | 69.51 | 63.72 |
| 2 | 65.02 | 54.63 |
| 3 | 61.25 | 47.17 |
| 4 | 57.80 | 40.81 |
| 5 | 54.63 | 35.36 |
| 6 | 51.72 | 30.68 |

**Percentage change in NPV when changing production indicators, %**

| Value, % | |
|---|---|
| 10 | 20 |
| -12.04 | -19.96 |

**Elasticity of NPV when changing production indicators**

| Value | |
|---|---|
| 10 | 20 |
| 1.20 | 2.00 |

*Table 3.27*

New values when changing capital investments (Project B)

**Net present value, thousand USD**

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 274.43 | 89.55 |
| $CIF_t$ | | |
| 1 | 72.55 | 66.50 |
| 2 | 68.47 | 57.53 |
| 3 | 64.88 | 49.97 |
| 4 | 61.54 | 43.45 |
| 5 | 58.43 | 37.82 |
| 6 | 55.60 | 32.99 |

**Percentage change in NPV when changing production indicators, %**

| Value, % | |
|---|---|
| 10 | 20 |
| -4.92 | -6.73 |

**Elasticity of NPV when changing production indicators**

| Value | |
|---|---|
| 10 | 20 |
| 0.49 | 0.67 |

*Table 3.28*

New values when changing fuel costs (Project A)

**Net present value, thousand USD**

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 182.54 | 97.71 |
| $CIF_t$ | | |
| 1 | 67.42 | 61.81 |
| 2 | 62.90 | 52.85 |
| 3 | 59.30 | 45.67 |
| 4 | 56.00 | 39.54 |
| 5 | 52.96 | 34.28 |
| 6 | 50.17 | 29.76 |

**Percentage change in NPV when changing production indicators, %**

| Value, % | |
|---|---|
| 10 | 20 |
| -9.33 | -12.67 |

**Elasticity of NPV when changing production indicators**

| Value | |
|---|---|
| 10 | 20 |
| 0.93 | 1.27 |

*Table 3.29*

New values when changing fuel costs (Project B)

**Net present value, thousand USD**

| Year | Rate value, % | |
|---|---|---|
| | 10 | 20 |
| NPV value | 278.48 | 186.65 |
| $CIF_t$ | | |
| 1 | 71.49 | 65.53 |
| 2 | 67.38 | 56.62 |
| 3 | 63.88 | 49.21 |
| 4 | 60.63 | 42.81 |
| 5 | 57.58 | 37.27 |
| 6 | 54.82 | 32.52 |

**Percentage change in NPV when changing production indicators, %**

| Value, % | |
|---|---|
| 10 | 20 |
| -3.52 | -3.94 |

**Elasticity of NPV when changing production indicators**

| Value | |
|---|---|
| 10 | 20 |
| 0.35 | 0.39 |

To assess the sensitivity of the investment project A and B to changes in selected indicators, the tables are compiled (Table 3.30-3.31).

*Table 3.30*

Sensitivity of an investment project to changes in factor impact, (project A**)**

| Name of factors | Factor change, % | NPV change, % | | Project sensitivity indicator, E | | Conclusion |
|---|---|---|---|---|---|---|
| Forecast production indicators | -10% | -31.28 | -42.46 | 3.13 | 4.25 | Dangerous factor of the project |
| Volume of capital investments | +10% | -12.04 | -19.96 | 1.20 | 2.00 | Dangerous factor of the project |
| Fuel costs | +10% | -9.33 | -12.67 | 0.93 | 1.27 | Dangerous factor of the project |

*Table 3.31*

Sensitivity of an investment project to changes in factor impact, (project B)

| Name of factors | Factor change, % | NPV change, % | | Project sensitivity indicator, E | | Conclusion |
|---|---|---|---|---|---|---|
| Forecast production indicators | -10% | -18.39 | -20.61 | 1.84 | 2.06 | Dangerous factor of the project |
| Volume of capital investments | +10% | -4.92 | -6.73 | 0.49 | 0.67 | Less dangerous factor of theproject |
| Fuel costs | +10% | -3.52 | -3.94 | 0.35 | 0.39 | Less dangerous factor of the project |

Conduction of the sensitivity analysis showed that both projects are highly dependent on change of production indicators. If the number of orders decreases by 10%, NPV decreases by 42.46% for the project A and by 20.61% for the project B (i=20%). Volume of capital investments and fuel costs do not have such a significant impact on the project's NPV as production indicators have, however it is dangerous factor for the project A and less dangerous factor for the project B. Fuel cost change is less dangerous factor for both projects. Therefore, we can say that project B is less sensitive to project variables change.

## 3.2. Optimization of the transportation process using smart contracts

FTP LLC organizes cargo delivery using road, sea, rail, road transport modes and their combination. The company works with a large number of Ukrainian and global carriers and is processing many documents every day.

According to experts in the logistics domain, about 10% of bills of lading contain incorrect data due to human or printing errors, and these can lead to legal disputes [39].

Trying to find more cost-effective carriers the company needs to start cooperation with new transportation services providers, as well as trying to increase clients' database FTP LLC might have an issue of mistrust of new participants of the supply chain and vice versa.

The above mentioned difficulties and many others can be partially resolved by using smart contracts. Smart contracts simplify and secure many of the processes in the logistics

industry, including agreement terms, fraud protection, record keeping, payments, cash flow, and more. They also save money, since they eliminate the need for any third-party processors.

Nick Szabo, an American computer scientist, is thought to have first used the term smart contract in an article in 1994. He defines a smart conract to be a computerized transaction protocol that executes the terms of a contract. The general objectives of smart-contract design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimise exceptions both malicious and accidental, and minimise the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitration and enforcement costs, and other transaction costs [40].

A smart contract is a self-executing, self-enforcing digital contract that is implemented using blockchain technology. It is essentially a computer program that runs on a blockchain, such as Ethereum, and automatically executes and enforces the terms and conditions of an agreement when predefined conditions are met. Smart contracts aim to eliminate the need for intermediaries, such as lawyers or banks, in the execution and enforcement of contracts, making transactions more efficient, transparent, and secure [41].

Traditional contract supposes two parties (for example, customer and freight forwarder) have to get into a contract and they utilize the services of a third party, whom they have to trust and get thee contract executed (Fig.3.6).

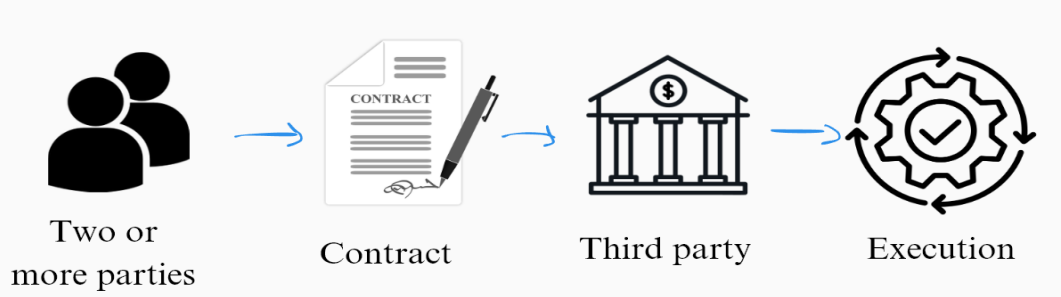



Fig.3.6. Traditional contract execution algorithm

*Source: developed by the author on the basis of research.*

With the introduction of smart contract and the technology which is evolving removes the dependency on such third party and automates the execution of such smart contracts (Fig.3.7).

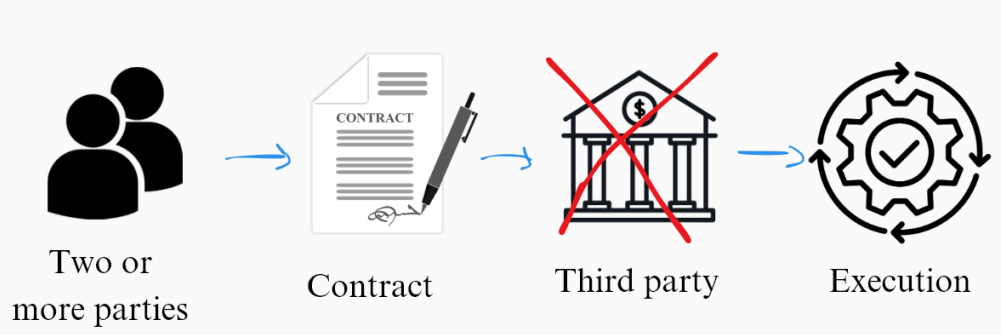



Fig.3.7. Smart contract execution algorithm

*Source: developed by the author on the basis of research*.

If to compare traditional and smart contract, in traditional contract we use to have government, lawyers, etc., in smart contract we do not need any third party. Other differences between mentioned types of contracts are shown in the Table 3.31.

*Table 3.31*

Comparison of traditional and smart contracts

| | Traditional contract | Smart contract |
|---|---|---|
| Form and Structure | These are written or oral agreements between parties, often documented on paper and governed by legal frameworks. They rely on legal language and enforcement through courts if disputes arise. | They are self-executing contracts written in code and stored on a blockchain. They encode the terms and conditions of an agreement and automatically execute actions when predefined conditions are met. |
| Execution and Automation | Require manual execution and enforcement by the involved parties or intermediaries. Fulfillment of contractual obligations depends on human intervention and trust in the legal system. | Execute automatically based on predefined conditions written in code. They eliminate the need for intermediaries and execute actions (like payments or transfers) without human intervention once conditions are met. |
| Trust and Security | Relies on trust in the legal system and the parties involved. Enforcement often requires legal intervention, and disputes may take time to resolve. | Built on blockchain technology, providing a high level of security through cryptography and decentralization. Once deployed, they are tamper-resistant and immutable. |
| Flexibility and Customization | Can be flexible in terms of language and negotiation but require human oversight for execution and amendments. | Are highly programmable but need careful coding for conditions. Once deployed, changes might be complex and require updates to the code. |

*Ending of the table 3.31*

| | Traditional contract | Smart contract |
|---|---|---|
| Cost and Efficiency | May involve administrative overheads, legal fees, and time delays in execution and enforcement. | Automate processes, reducing administrative costs and speeding up execution. However, initial development might require technical expertise. |
| Applicability | Widely used in various sectors but rely on manual enforcement and interpretation of terms. | Primarily used in blockchain-based applications, especially in sectors like finance, logistics, supply chain, and decentralized applications (DApps). |

*Source: developed by the author on the basis of information [39].*

Summing up the table above we can define such a key characteristics of smart contracts: self-executing, code-based, immutability, trust and security, decentralization (Fig.3.8).

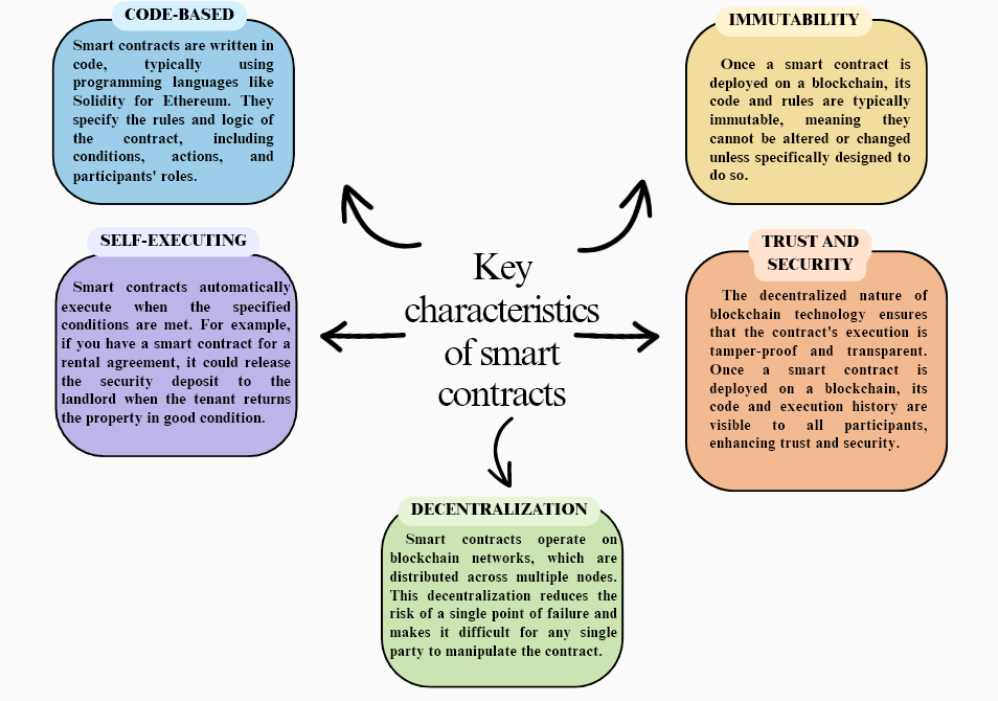



Fig.3.8. Key characteristics of smart contracts

*Source: developed by the author on the basis of the table 3.31.*

Smart contracts have a wide range of potential applications, including in finance (e.g., for automated payments and lending), supply chain management, healthcare (e.g., for managing patient records), voting systems, and more. They have the potential to revolutionize how agreements and transactions are conducted, offering greater efficiency

and transparency in various industries. However, it's important to note that the legal and regulatory status of smart contracts varies by jurisdiction, and not all contracts can be fully automated using this technology.

Smart contracts in logistics operate by leveraging blockchain technology to automate and enforce agreements between parties involved in the logistics process, such as shippers, carriers, suppliers, and customers. Here's a breakdown of how they work:

1. Blockchain Technology: Smart contracts are built on blockchain platforms like Ethereum, which allow for decentralized, secure, and transparent transactions.

2. Agreement Creation: Participants define the terms and conditions of their logistics agreement within the smart contract. These terms can include delivery schedules, payment conditions, penalties for delays, and more.

3. Automation: Once the terms are set, the smart contract automatically executes actions when predefined conditions are met. For instance, when a shipment reaches a particular location or milestone, the contract can trigger a payment release or notify the relevant parties.

4. Verification and Validation: Smart contracts rely on data inputs, often from IoT devices or external data sources, to verify the conditions. For logistics, this might include GPS data confirming the arrival of a shipment at a specific location or temperature sensors ensuring the preservation of perishable goods.

5. Transparency and Security: Blockchain's decentralized nature ensures that all involved parties can access the contract's terms and track the progress of the agreement. Once recorded on the blockchain, the contract becomes immutable, reducing the risk of tampering or disputes.

6. Cost and Time Efficiency: By automating processes, smart contracts can significantly reduce administrative costs and processing times. They minimize the need for intermediaries and manual oversight, streamlining the logistics workflow.

7. Resolution of Disputes: In case of disputes, the transparent and auditable nature of blockchain-based smart contracts can facilitate resolution by providing a clear record of the terms agreed upon and the actions taken.

8. Expansion and Integration: Smart contracts can integrate with other technologies, such as AI for predictive analytics or inventory management systems, to enhance efficiency and optimize logistics operations further.

Implementing smart contracts in logistics can revolutionize the industry by increasing transparency, reducing administrative burdens, enhancing security, and ultimately improving the overall efficiency of supply chain management.

Blockchain is seen as a revolutionary technology in the logistics and transportation industries. In order to implement blockchain technology for their marine container shipping business, Maersk has teamed up with the IBM firm. Concerns about the scalability and durability of blockchain technology are one of the implementation challenges [42]. The literature has seen a lot of recent activity around blockchain technology and its numerous applications and use cases, covering a range of topics such as how it will affect the economy, society, and ecology.

The distributed ledger or database of all events that are either carried out or shared by participating organizations is what makes up blockchain technology. Four characteristics set blockchain apart from its competitors: decentralization, immutability, security, transparency, auditability (Fig.3.9).

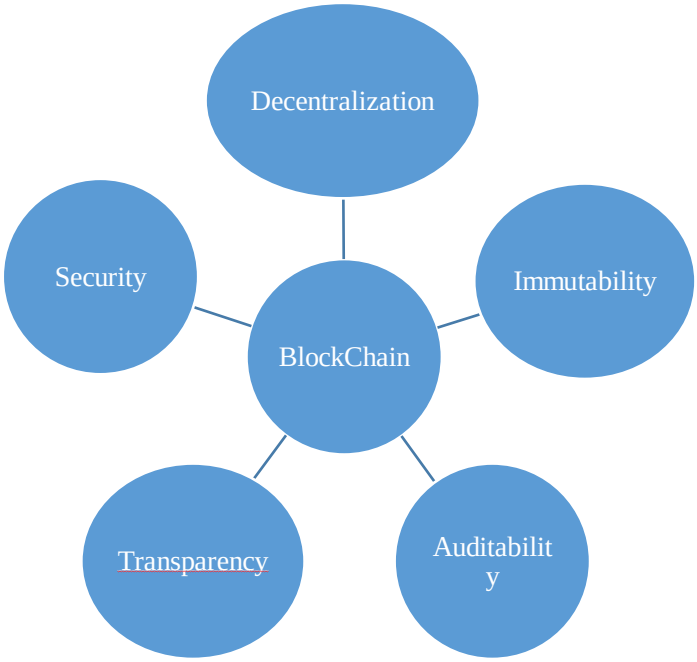



Fig.3.9. Blockchain features

*Source: developed by the author on the basis of research.*

At a higher level, a blockchain functions like this.

- An agent broadcasts a transaction to its peers on the network in order to record an occurrence.
- The transaction is accepted in accordance with the established rules that the participants in the blockchain have agreed to after it has been verified and audited by the majority of peers on the network.
- Multiple peers keep a record of the accepted transaction to increase dependability in the event of equipment or node failures and to guarantee the resilience of assaults.
- Usually, the transactions are arranged into blocks that are connected to one other by a hash function of their contents. This creates a chain of dependency between the blocks and becomes linked records.
- On every network node, an arbitrary contract might be implemented as a collection of instructions that, if certain requirements are satisfied, run on their own.

The interdependence of the blocks that make up a blockchain's structure is shown in Fig.3.10. Every block has a hash that was computed using the information in the block before it. Every block is therefore dependent upon every other block. Any modification made to one block will also affect the hash of the blocks that follow.

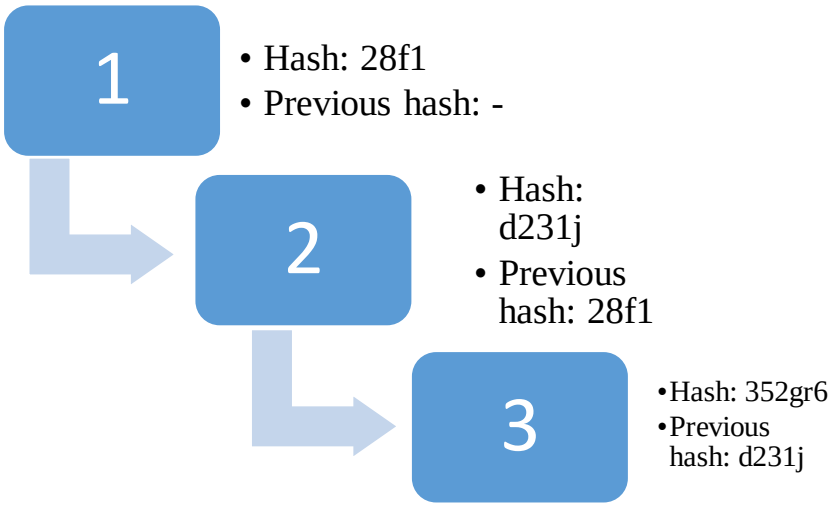



Fig.3.10. A blockchain's structure showing how each block depends on the one before it

*Source: developed by the author on the basis of information [43].*

In a similar vein, the auditability of the transactions is guaranteed by the timestamp data included in the blocks. A climate of mutual consent, trust, and security for the recorded data among the network's nodes is established by multiple copies of the transactions dispersed across a certain area. Two crucial features of a blockchain are decentralization and the veracity of the shared data. Information is freely accessible to the public and is decided upon by all parties involved. Furthermore, once a consensus is reached, it cannot be changed. Blockchain offers secrecy and transparency at the same time by using anonymity.

Public-key infrastructure methods and digital signatures can be used to secure access to parts of records. Records concerning the product's status, place of origin, kind, and standards may be found on the blockchain. Every physical instantiation of a product has a unique product identification on the blockchain. To verify the agreed-upon conditions, a smart contract may control the product's ownership transfer. Blockchain technology may highlight aspects of a product, like the:

1. Nature of the product
2. Quantity of the product
3. Location
4. Ownership of the product.

By doing away with the need for a centralized authority, blockchain may increase transparency across the whole logistical process, from the procurement of raw materials through manufacturing to the final sale of the product to the customer. Verifiable transactions and timestamps are logged with all of this data. As a result, blockchain makes it easier to transport goods and information via different blockchain phases. Customers are more confident in the product and believe it is worth more because of its transparency and unchangeability, which also improve consumer trust in the product.

Creating a smart contract in logistics involves several steps and requires familiarity with blockchain technology and programming languages like Solidity (commonly used for Ethereum-based smart contracts). A simplified outline of the process is shown in the fig.3.11.

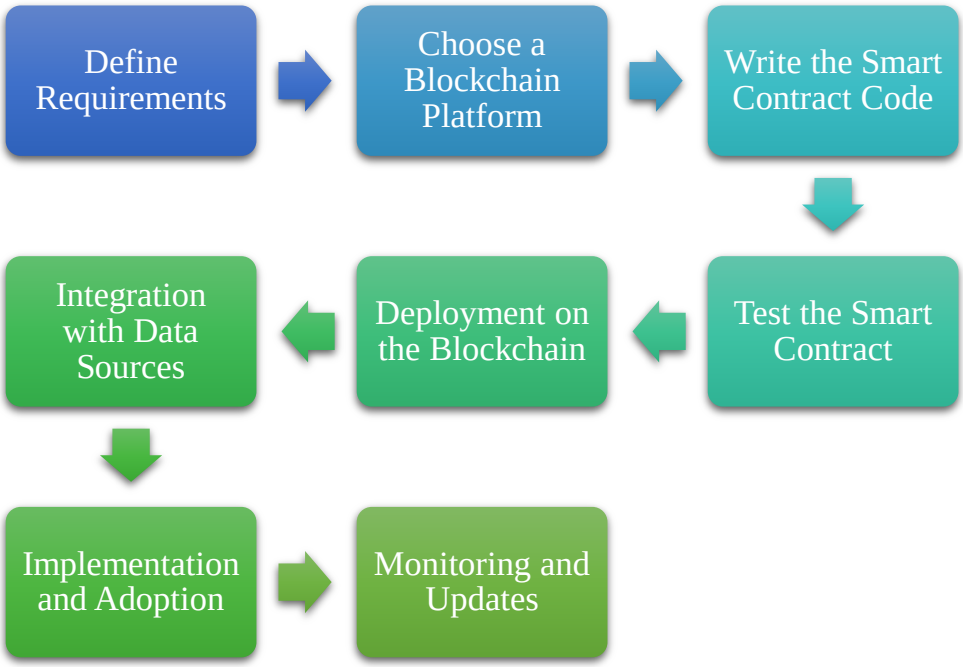



Fig.3.11. Algorithm for creating a smart contract

*Source: developed by the author on the basis of research.*

Define Requirements: Identify the specific logistics processes or agreements you want to automate using smart contracts. This could involve aspects like shipping, delivery, payment terms, and conditions for different parties involved.

Choose a Blockchain Platform: Select a suitable blockchain platform that supports smart contract development. Ethereum is a popular choice due to its robustness and support for smart contracts.

Write the Smart Contract Code: Utilize a programming language like Solidity to write the code for your smart contract. This involves defining the logic, conditions, and actions the contract will perform based on predefined triggers and inputs. The code should encapsulate the terms of the logistics agreement.

Test the Smart Contract: Use test environments (like Ethereum's testnets) to deploy and test your smart contract. This ensures that the contract behaves as intended and handles various scenarios correctly.

Deployment on the Blockchain: Once thoroughly tested, deploy the smart contract onto the mainnet or the live blockchain network. This step involves interacting with the

blockchain through tools like MetaMask or directly using development frameworks provided by the blockchain platform.

Integration with Data Sources: Integrate your smart contract with relevant data sources such as IoT devices, GPS systems, or other external sources that provide information needed to trigger the contract's actions. This could involve Oracle services that feed external data into the blockchain.

Implementation and Adoption: Start using the smart contract in your logistics processes. Ensure all involved parties understand and agree to the terms of the contract and are willing to participate in the automated process.

Monitoring and Updates: Regularly monitor the performance of the smart contract and make updates or improvements as needed. Blockchain allows for upgrades, but it's critical to consider the impact on existing contracts and data.

Creating smart contracts requires a deep understanding of blockchain technology, coding skills, and considerations for security and scalability. Additionally, legal and regulatory aspects should be considered when defining terms within the contract to ensure compliance with relevant laws. Consulting with blockchain developers and legal experts in logistics can be beneficial during the process.

Smart contracts in logistics offer several advantages by automating and streamlining various processes. Key achievements and benefits that can be realized through the implementation of smart contracts in logistics are represented in the fig.3.12.

By leveraging smart contracts, logistics companies can achieve operational efficiencies, reduce costs, enhance transparency, and create a more responsive and reliable supply chain ecosystem. The technology continues to evolve, opening up new possibilities for innovation in the logistics industry.


Fig.3.12. Achievements and benefits that can be realized through the implementation of smart contracts

*Source: developed by the author on the basis of research.*

While smart contracts offer numerous benefits, they also come with certain disadvantages and challenges. They are shown in the fig.3.13.

Addressing these challenges requires ongoing development, regulatory clarity, advancements in technology, and a deeper understanding of the implications and limitations of smart contracts. As the technology matures, efforts are being made to mitigate these disadvantages and enhance the capabilities and security of smart contracts in various industries.

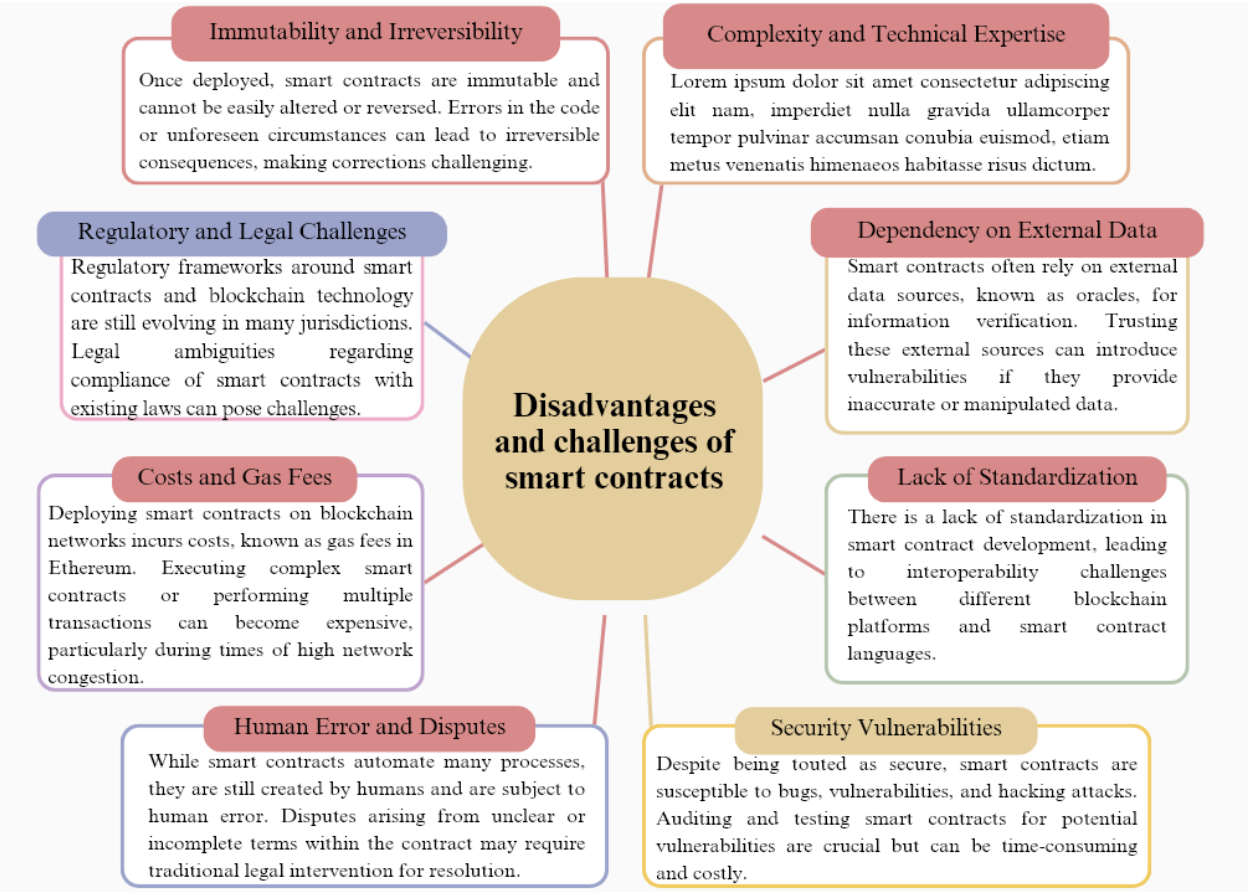



Fig.3.13. Disadvantages and challenges of smart contracts

*Source: developed by the author on the basis of research*.

Dealing with the disadvantages of smart contracts involves a combination of proactive measures, technological advancements, industry collaboration, and regulatory efforts. Here's how these challenges can be addressed:

1. Continuous Testing and Auditing: Thoroughly test smart contracts in various scenarios and conduct regular audits to identify and address vulnerabilities. Investing in security measures and bug bounty programs can help discover and resolve issues before deployment.
2. Improving Code Quality and Standards: Establishing best practices and standards for smart contract development can enhance code quality and reduce the likelihood of errors. Collaborative efforts within the developer community can lead to better practices and more secure coding frameworks.
3. Enhancing Security Measures: Implement additional security protocols, encryption methods, and authentication mechanisms within smart contracts to strengthen their

resilience against cyber threats. Utilizing formal verification tools can also help validate the correctness of the code.

4. Regulatory Compliance and Legal Clarity: Work with legal experts and regulatory bodies to navigate the legal landscape and ensure compliance with existing laws. Collaboration between blockchain developers, policymakers, and legal professionals is crucial to establishing clearer regulatory frameworks.
5. Scalability Solutions: Explore and implement scaling solutions such as sharding, layer 2 protocols, or improvements in blockchain infrastructure to address scalability issues. These advancements aim to increase transaction throughput without compromising security.
6. Oracles and Data Verification: Develop more reliable and decentralized oracle solutions to verify external data sources. Implementing multiple oracles and consensus mechanisms for data verification can enhance reliability.
7. Education and Skill Development: Focus on educating developers and stakeholders about smart contract development best practices, security measures, and risk management. Promoting knowledge sharing and training programs can improve the overall quality of smart contract implementations.
8. Interoperability and Standardization: Collaborate with industry players and standards organizations to establish interoperability standards and common protocols for smart contracts. This can facilitate seamless communication between different blockchain networks and platforms.
9. User-Friendly Interfaces and Tools: Develop user-friendly interfaces and tools that simplify the creation, deployment, and interaction with smart contracts. This can lower barriers to entry and encourage wider adoption.
10. Monitoring and Continuous Improvement: Continuously monitor the performance of deployed smart contracts and be prepared to update or improve them as technology evolves. Staying updated with advancements in the blockchain space is crucial to addressing emerging challenges.

## Conclusions on the third chapter

Summarizing the above information, we can say that drones are ideal for last-mile delivery. It is a cost effective and fast mode of transport, that can deliver the freight even to remote areas with poor infrastructure. Having compared two investment projects that are based on the use of Ukrainian drones - Reactive Drone Hybryd RDHC20 and Reactive Drone Hybryd RDHC5 we can conclude that integration of both models into logistics chain will lead to positive financial results. However, project that involves purchase and usage of Reactive Drone Hybryd RDHC5 has higher net present value, profitability index and internal rate of return, shorter payback period, Project B is more reliable in terms of sensitivity as well.

Smart contracts can address several challenges FTP LLC faces, improving efficiency, transparency, and reliability within the supply chain. Usage of smart contracts will automate paperwork, documentation, and verification processes, reducing manual errors and delays in customs clearance and freight handling; implement real-time tracking of shipments across multiple carriers and modes, providing transparency and visibility throughout the logistics process; execute payments automatically upon fulfillment of predefined conditions, such as delivery confirmation or milestones reached in the logistics chain, reducing delays and disputes. Smart contracts with predefined dispute resolution mechanisms might be implemented to automatically trigger actions or penalties in case of non-compliance with agreed terms. Addressing the disadvantages of smart contracts is an ongoing process that requires collaboration, innovation, and a commitment to enhancing the technology's capabilities while mitigating risks. By adopting these strategies, the reliability, security, and effectiveness of smart contracts in various industries, including logistics, can be significantly improved.

## CONCLUSIONS

Effective organization of cargo transportation in the multimodal transport network is possible on the basis of two main group of factors: internal and external. The logistics company needs to follow all the rules and regulations established for operation of each transport mode, constantly train its personnel to have a professional workforce, implement advanced technologies to provide the most complete package of services – this relies to internal factors. External factors for successful company operation includes development of legislative, financial, credit, tax and other factors of the external environment in which freight carriers and their partners operate.

Efficiently organizing cargo transportation within a multimodal transport network requires a holistic approach that integrates technology, collaboration, infrastructure development, risk management, and a customer-centric focus to ensure efficiency, reliability, and responsiveness to evolving logistical needs.

Having analysed Ukraine's transportation system we can say that it has a low level of development of transport and logistics infrastructure to ensure the proper volume of multimodal transportation, which reduces its competitiveness and hinders the entry of Ukrainian products into the global transportation market. In particular, there is a lack of multimodal transportation terminals, no perfect regulatory framework for multimodal transportation, insufficient state support for multimodal transportation and the development of transport and logistics infrastructure, restrictions on the rail container transportation market, and no investment-friendly climate for the development of multimodal transportation.

FTP LLC was founded in 2011 and over these years the company has managed to recommend themselves as a reliable logistics operator that organizes door-to-door delivery of cargo by any mode of transport, as well as a combination of different modes of transport in the supply chain, taking into account compliance with the main logistics criteria.

The analysis of the FTP statistics shows that the most popular service for many years remains the provision of customs brokerage services, while the direction of intermodal transportation is also developing, as well as as well as consulting services on foreign trade in certain markets. Due to the national trend of imports exceeding exports in Ukraine and growth of e-commerce FTP is approached by importers. The main geographical segment of the company's freight forwarding activities belongs to China, Germany and Poland.

The company shows quite stable financial results over the past years despite multiple obstacles including COVID-19 pandemic.

In addition, FTP LLC was able to adjust to the changing transportation market during the hostilities on the territory of Ukraine. The company has increased the number of customers by 30% while most competitors have lost ground since the start of the war sue to the wide range of services offered and ability to transport varied items.

Though the company has begun creation of its own fleet, it still needs to buy many trucks in order to fulfil a significant share of the orders on their own. In addition, it will not be superfluous for the management to reduce transportation costs by reviewing the available road carriers and choosing the most cost-efficient ones. The main reason for the above measures is high transportation rates of the current carriers; this circumstance negatively influences the company’s competitiveness. Besides FTP needs to establish closer relations with railroad services providers so it will be able to offer rail transportation solutions on a regular basis.

SWOT-analysis of the FTP LLC shows that one of its weaknesses is inability to offer competitive rates due to the high transportation cost of road carriers. Partially this problem can be solved by the introduction of drone delivery.

Summarizing the above information, we can say that drones are ideal for last-mile delivery. It is a cost effective and fast mode of transport, that can deliver the freight even to remote areas with poor infrastructure. Having compared two investment projects that are

based on the use of Ukrainian drones - Reactive Drone Hybryd RDHC20 and Reactive Drone Hybryd RDHC5 we can conclude that integration of both models into logistics chain will lead to positive financial results. However, project that involves purchase and usage of Reactive Drone Hybryd RDHC5 has higher net present value, profitability index and internal rate of return, shorter payback period, Project B is more reliable in terms of sensitivity as well.

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## ANNEXES

*Annex A*

*Table A.1*

Term of implementation of investment project options (n), year

| Term of implementation of investment project options (n) | |
|---|---|
| Project A | Project B |
| 6 | 6 |

*Table A.2*

Capital investments in the implementation of the investment project

| One-time capital investments in the implementation of the investment project, thousand dollars | |
|---|---|
| Project A | Project B |
| 166.2 | 97.3 |

*Table A.3*

Estimated value of total run with cargo

| | Cargo turnover, Thousand km | |
|---|---|---|
| Project A | 10 drones | 131.4 |
| Project B | 10 drones | 127.8 |

*Table A.4*

Tariff for service

| Project A | Project B |
|---|---|
| 1.3 | 1.1 |

*Annex B*

*Table B.1*

Results of calculations of income and expenses on the investment project (project A)

| Indicator | 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year |
|---|---|---|---|---|---|---|---|
| Forecast production (total run with cargo), thousand USD | 131.40 | 131.40 | 131.40 | 131.40 | 131.40 | 131.40 | 131.40 |
| Tariff for service without VAT, USD | 1.50 | 1.50 | 1.58 | 1.65 | 1.74 | 1.82 | 1.91 |
| Total project revenues, thousand USD | 197.10 | 197.10 | 206.96 | 217.30 | 228.17 | 239.58 | 251.56 |
| Operating costs, thousand USD | - | 16.62 | 18.28 | 19.94 | 21.61 | 23.27 | 24.93 |
| Fuel costs, thousand USD | - | 47.06 | 49.42 | 51.89 | 54.48 | 57.20 | 60.06 |
| Unexpected costs, thousand USD | - | 1.66 | 1.83 | 1.99 | 2.16 | 2.33 | 2.49 |
| Overhead, thousand USD | - | 0.83 | 0.91 | 1.00 | 1.08 | 1.16 | 1.25 |
| Depreciation deductions, thousand USD | - | 16.62 | 11.97 | 11.01 | 10.13 | 9.32 | 8.57 |
| Total production costs, thousand USD | - | 82.80 | 82.41 | 85.83 | 89.46 | 93.28 | 97.31 |
| VAT (20% rate), thousand USD | - | 39.42 | 41.39 | 43.46 | 45.63 | 47.92 | 50.31 |
| Total project costs, thousand USD | - | 122.22 | 123.80 | 129.29 | 135.09 | 141.20 | 147.62 |
| Balance sheet profit, thousand USD | - | 74.88 | 83.16 | 88.01 | 93.08 | 98.38 | 103.94 |
| Income tax (18%), thousand USD | - | 13.48 | 14.97 | 15.84 | 16.75 | 17.71 | 18.71 |
| Net profit, thousand USD | - | 61.41 | 68.19 | 72.17 | 76.32 | 80.67 | 85.23 |

*Annex C*

*Table C.1*

Results of calculations of income and expenses on the investment project (project B)

| Indicator | 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year |
|---|---|---|---|---|---|---|---|
| Forecast production figures (total run with cargo), thousand USD | 127.80 | 127.80 | 127.80 | 127.80 | 127.80 | 127.80 | 127.80 |
| Tariff for service without VAT, USD | 1.30 | 1.30 | 1.37 | 1.43 | 1.50 | 1.58 | 1.66 |
| Total project revenues, thousand USD | 166.14 | 166.14 | 174.45 | 183.17 | 192.33 | 201.94 | 212.04 |
| Operating costs, thousand USD | - | 9.73 | 10.70 | 11.68 | 12.65 | 13.62 | 14.60 |
| Fuel costs, thousand USD | - | 25.42 | 26.69 | 28.03 | 29.43 | 30.90 | 32.44 |
| Unexpected costs, thousand USD | - | 0.97 | 1.07 | 1.17 | 1.26 | 1.36 | 1.46 |
| Overhead, thousand USD | - | 0.49 | 0.54 | 0.58 | 0.63 | 0.68 | 0.73 |
| Depreciation deductions, thousand USD | - | 9.73 | 7.01 | 6.45 | 5.93 | 5.46 | 5.80 |
| Total production costs, thousand USD | - | 46.34 | 46.01 | 47.90 | 49.90 | 52.02 | 55.03 |
| VAT (20% rate), thousand USD | - | 33.23 | 34.89 | 36.63 | 38.47 | 40.39 | 42.41 |
| Total project costs, thousand USD | - | 79.57 | 80.90 | 84.53 | 88.37 | 92.41 | 97.43 |
| Balance sheet profit, thousand USD | - | 86.57 | 93.55 | 98.64 | 103.96 | 109.54 | 114.61 |
| Income tax (18%), thousand USD | - | 15.58 | 16.84 | 17.75 | 18.71 | 19.72 | 20.63 |
| Net profit, thousand USD | - | 70.99 | 76.71 | 80.88 | 85.25 | 89.82 | 93.98 |

*Annex D*

*Table D.1*

Results of calculations of investment project efficiency criteria (Project A)

| Indicator | 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year |
|---|---|---|---|---|---|---|---|
| ICOF invested capital, thousand USD | 166.2 | - | - | - | - | - | |
| Net profit on the project, thousand USD | - | 61.41 | 68.19 | 72.17 | 76.32 | 80.67 | 85.23 |
| Depreciation deductions, thousand USD | - | 16.62 | 11.97 | 11.01 | 10.13 | 9.32 | 8.57 |
| Cash flow on the project, CF thousand USD | - | 78.03 | 80.16 | 83.18 | 86.45 | 89.99 | 93.80 |
| i = 10% | | | | | | | |
| Discount factor | 1 | 1.1 | 1.21 | 1.33 | 1.46 | 1.61 | 1.77 |
| Discounted cash flow CFд., thousand USD | - | 70.93 | 66.24 | 62.49 | 59.05 | 55.88 | 52.95 |
| Accumulated CFд, thousand USD | 367.54 | | | | | | |
| Net present value of the project, thousand USD | 201.34 | | | | | | |
| Profitability index PI | 2.21 | | | | | | |
| "Benefits/Costs" $B/C_{ratio}$ | 1.67 | | | | | | |
| Payback period of the project PP, years | 2.71 | | | | | | |
| i = 20% | | | | | | | |
| Discount factor | 1 | 1.2 | 1.44 | 1.73 | 2.07 | 2.49 | 2.99 |
| Discounted cash flow CFд., thousand USD | - | 65.02 | 55.66 | 48.14 | 41.69 | 36.16 | 31.41 |
| Accumulated CFд, thousand USD | 215.23 | | | | | | |
| Net present value of the project, thousand USD | 49.03 | | | | | | |
| Profitability index PI | 1.30 | | | | | | |
| "Benefits/Costs" B/Cratio | 1.67 | | | | | | |
| Payback period of the project PP, years | 4.63 | | | | | | |
| Internal rate of return of the project (IRR,%) | 0.3077 | | | | | | |

*Annex E*

*Table E.1*

Results of calculations of investment project efficiency criteria (Project B)

| Indicator | 0 year | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year |
|---|---|---|---|---|---|---|---|
| ICOF invested capital, thousand USD | 97.30 | - | - | - | - | - | |
| Net profit on the project, thousand USD | - | 70.99 | 76.71 | 80.88 | 85.25 | 89.82 | 93.98 |
| Depreciation deductions, thousand USD | - | 9.73 | 7.01 | 6.45 | 5.93 | 5.46 | 5.80 |
| Cash flow on the project, CF thousand USD | - | 80.72 | 83.72 | 87.33 | 91.18 | 95.27 | 99.78 |
| i = 10% | | | | | | | |
| Discount factor | 1 | 1.1 | 1.21 | 1.33 | 1.46 | 1.61 | 1.77 |
| Discounted cash flow CFд., thousand USD | - | 73.38 | 69.19 | 65.61 | 62.27 | 59.16 | 56.32 |
| Accumulated CFд, thousand USD | 291.61 | | | | | | |
| Net present value of the project, thousand USD | 288.63 | | | | | | |
| Profitability index PI | 3.97 | | | | | | |
| "Benefits/Costs" $B/C_{ratio}$ | 2.16 | | | | | | |
| Payback period of the project PP, years | 1.51 | | | | | | |
| i = 20% | | | | | | | |
| Discount factor | 1 | 1.2 | 1.44 | 1.73 | 2.07 | 2.49 | 2.99 |
| Discounted cash flow CFд., thousand USD | - | 67.27 | 58.14 | 50.54 | 43.97 | 38.29 | 33.41 |
| Accumulated CFд, thousand USD | 220.08 | | | | | | |
| Net present value of the project, thousand USD | 194.31 | | | | | | |
| Profitability index PI | 3.00 | | | | | | |
| "Benefits/Costs" B/Cratio | 2.15 | | | | | | |
| Payback period of the project PP, years | 2.00 | | | | | | |
| Internal rate of return of the project (IRR,%) | 0.8432 | | | | | | |

*Annex F*

# Довідка про впровадження результатів дипломної роботи

Голові реорганізаційної комісії
Національного авіаційного університету
в.о. ректора
Володимиру ШУЛЬЗІ

ДОВІДКА ПРО ВПРОВАДЖЕННЯ
РЕЗУЛЬТАТІВ КВАЛІФІКАЦІЙНОЇ РОБОТИ

Виконана здобувачем вищої освіти факультету транспорту, менеджменту і логістики Національного авіаційного університету ОС «Магістр» за спеціальністю 275 «Транспортні технології (на повітряному транспорті)», спеціалізації 275.04 «на повітряному транспорт» освітньо-професійної програми «Мультимодальний транспорт і логістика» Єщенко Ельвірою Станіславівною кваліфікаційна робота на тему «Організація перевезень вантажів на мультимодальній транспортній мережі» має практичну значущість і рекомендована до впровадження у практику діяльності ТОВ «FTP». Зокрема, заслуговують на увагу наведені автором рекомендації щодо використання дронів для підвищення ефективності мультимодальних перевезень. Рекомендована до впровадження запропонована студенткою методика автоматизації процесів оформлення документів, відстеження вантажів у режимі реального часу між різними перевізниками та видами транспорту, автоматичного здійснення платежів при виконанні попередньо визначених умов, шляхом впровадження смарт контрактів.

Заступник директора ТОВ «FTP» Ситуленко К.В.