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NATIONAL AVIATION UNIVERSITY

**Air Transportation Management Department**

PERMISSION TO DEFEND GRANTED  
Head of the Department

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“ \_\_\_\_\_ ” \_\_\_\_\_ 2020

**MASTER THESIS**  
**(EXPLANATORY NOTES)**

**Theme:** “Strategy of Regional Airfields of Civil Aviation of Ukraine Development”

**Done by:** Korynevskia Tetiana, FTML 202Ma

**Supervisor:** Ivannikova V.Yu., PhD, Associate professor

**Standards Inspector:** Yuliia V. Shevchenko, PhD in Economic, Associate professor

Kyiv 2020

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ  
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Кафедра організації авіаційних перевезень

ДОПУСТИТИ ДО ЗАХИСТУ  
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**ДИПЛОМНА РОБОТА**  
**(ПОЯСНЮВАЛЬНА ЗАПИСКА)**

**ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «МАГІСТР»**

**Тема:** “Стратегія розвитку регіональних аеродромів цивільної авіації України”

**Виконавець:** Кориневська Тетяна, ФТМЛ 202Ма

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Київ 2020

**NATIONAL AVIATION UNIVERSITY**

Faculty of Transport Management and Logistics

Air Transportation Management Department

Major (specialty): 275 “Air Transportation Technology”

APPROVED BY

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“ ”

2020

**TASK**

**for completion the Master thesis**

Korynevskya Tetiana Borysivna

1. Theme of the Master thesis entitled “Strategy of Regional Airfields of Civil Aviation of Ukraine Development” was approved by a decree of the Rector’s order № 2026/CT. of October 16, 2020.
2. Terms of thesis performance: from 05.10.2020 to 31.12.2020
3. Initial data required for writing the bachelor thesis: overall information about Ukrainian airlines; passenger and cargo traffic of Boryspil International Airport; passenger and cargo traffic of Kyiv International Airport; analysis of the Borodyanka aerodrome; analysis of the fleet of low-cost airline Flynas.
4. Content of the explanatory notes: basic information about airfields; Ukrainian airports evolution; business development strategies; analysis of the air transport system in Kyiv avian node; dynamics of passenger and cargo traffic; the efficiency of air transport system of Ukraine; establishment of the new regional airport in Kyiv region; calculation of the economy efficiency of the new airport; Borodyanka International Airport facilities development; suggested airline, routes and fleet for the airport;

5. List of the mandatory graphic materials: Timeline of the first aerodromes construction; Classification of the aerodromes according to the runway length; Classification of the aerodromes according to the runway width; Basic elements of the aerodrome; Impact of Covid-19 on passenger traffic during period Jan.-Aug. 2020; The share of Ukrainian leading airports in the total volume of passenger air traffic; The process of strategic planning; Geographical and administrative data of the aerodrome; The physical characteristics of Borodyanka aerodrome taxiways; Business model of low-cost airlines; Impact of the Covid-19 on the air transport mode (Jan.-Jul.); Quantity of flights before Covid-19 presence; Quantity of flights after Covid-19 presence; The list of impacts that COVID-19 will have on the airline industry; The number of scheduled passengers boarded by the global airline industry in millions, 2004-2021; Impact of Covid-19 on aviation in Ukraine, 2014-2020 Jan.-Sep.; Dynamics of passenger traffic in Ukraine, 2005-2019; Dynamics of transferred cargo in Ukraine, 2005-2019; General scheme of research database organization for analysis of demand volumes for air transportation; Dependence of passenger air traffic on GDP per capita (data for 2005-2019); Boryspil International Airport map; SWOT analysis of Boryspil International Airport; Igor Sikorsky Kyiv International Airport map; SWOT-analysis of Igor Sikorsky Kyiv Airport; Forecasting long-term demand model for air transportation; General structure of Passenger forecasting model; Analysis of the most probable factors influencing the projected volumes of air traffic at Borodyanka airport; The structure of SWOT analysis; SWOT analysis application diagram; SWOT analysis of Borodyanka International Airport; Passenger and cargo traffic statistics in Kyiv Airport, 2010-2019; Passenger and cargo traffic statistics in Boryspil airport; Passenger and cargo traffic statistics in Kyiv Aviation Node, 2010-2019; Passenger traffic statistics forecast (linear trend line); Passenger traffic statistics forecast (an exponential trend line); Passenger traffic statistics forecast (logarithmic trend line); Passenger traffic statistics forecast (power trend line); Passenger traffic statistics of Kyiv air node, passengers; Polynomial coefficients for passenger traffic forecast; Passenger traffic forecast in Kyiv avian node; Diagram of passenger traffic forecast in Kyiv avian node,

passengers; Cargo traffic statistics of Kyiv air node, tons; Polynomial coefficients for cargo traffic forecast; Freight traffic forecast in Kyiv avian node; Diagram of cargo traffic forecast in Kyiv avian node, tons; Passenger traffic statistics of Kyiv air node, passengers; Polynomial coefficients for passenger traffic forecast; Passenger traffic forecast considering data of 2020 in Kyiv avian node; Freight traffic forecast in Kyiv avian node; Diagram of cargo traffic forecast considering data of 2020, tons; Comparative analysis of passenger traffic forecast in Kyiv avian node, passengers; Comparative analysis of freight traffic forecast in Kyiv avian node, tons; Predicted passenger traffic of the main airports in Kyiv region; The share of funds reception between government and investor; Dynamics of the revenues and costs of airport Boryspil; The net revenues of the airport Boryspil, 2014-2019; Approximate net earnings of Borodyanka airport; the fleet of Flynas;

#### 6. Planning calendar

| №  | Assignment  | Deadline for completion | Mark on completion |
|----|---|-------------------------|--------------------|
| 1. | Collection and processing of statistical data                         | 05.10.2020              | done               |
| 2. | Writing of the theoretical part                                       | 16.10.2020              | done               |
| 2. | Writing of the analytical part  | 26.10.2020              | done               |
| 3. | Writing of the design part  | 16.11.2020              | done               |
| 4. | Writing of the introduction and summary                               | 26.11.2020              | done               |
| 5. | Execution of the explanatory note, graphic materials and presentation | 02.12.2020              | done               |

7. Given date of the task: October 05, 2020

Supervisor of the bachelor thesis:  
Task was accepted for completion:

Dr. Ivannikova V.Yu  
Korynevskaya T.B.

## REPORT

Explanatory note to the diploma project “Strategy of Ukrainian regional civil aviation airfield development” consists of 112 pages, 39 figures, 26 tables, 24 sources used.

*Key words:* AIRLINE, STRATEGY, REGIONAL AIRPORT, CREATION OF THE NEW AIRPORT, ANTONOV, BORYSPIL AIRPORT, KYIV AIRPORT, INVESTATION, .

*Object of study:* development of aviation industry, passenger, cargo and mail air transportation in Ukraine.

*Subject of study:* the investigation of strategy of Ukrainian regional civil aviation airfield development in order to improve the situation with aviation industry in our country.

*Purpose of thesis:* definition of Ukrainian aviation threats and weaknesses; main problem determination and suggestion of the way in which it could be fixed; proposal to create the new airport – Borodyanka International airport; the mechanism and the main steps of airport establishment; assessment of the main advantages of the new airport construction; performance evaluation of the new airport creation.

*The master’s thesis actuality:* through the execution of master’s diploma thesis, an establishment of the Borodyanka international Airport on the base of Borodyanka airfield was proposed in order to develop and expand an aviation industry of Ukraine as the main hub of Europe. Also the creation of state airport will help to handle the future passenger and cargo traffic.

*Recommendations:* the following data and calculations of the master’s thesis can be used in further research and can be proposed as an important question-motion to the government of Ukraine.

# CONTENTS

|  |    |
|--|----|
| LIST OF SYMBOLS.....   | 9  |
| INTRODUCTION.....  | 10 |
| 1. THEORETICAL PART.....   | 13 |
| 1.1. The fundamentals of Ukrainian aviation development.....               | 14 |
| 1.1.1. The first airfields construction in Kyiv region.....                | 15 |
| 1.1.2. Civil aviation establishment in Ukraine.....                        | 16 |
| 1.2. Airfields. Basic information.....                                     | 18 |
| 1.3. Ukrainian aviation market situation.....                              | 22 |
| 1.3.1. Ukrainian airports evolution.....                                   | 24 |
| 1.3.2. The airports development current problems assesment in Kyiv region. | 25 |
| 1.4. Business development strategies and their types.....                  | 27 |
| 1.5. History and basic information of Borodyanka airfield evolution.....   | 30 |
| 1.6. Basic information of low-cost airlines.....                           | 33 |
| 2. ANALYTICAL PART.....  | 36 |
| 2.1. Analysis of the air transport system of Ukraine.....                  | 37 |
| 2.1.1. The current status of aviation in Ukraine.....                      | 37 |
| 2.1.2. Dynamics of passengers and cargo turnover in Ukraine.....           | 44 |
| 2.1.3. Demand assesment for air transportation in Ukraine.....             | 46 |
| 2.2. Contemporary state of Kiev aviation node.....                         | 49 |
| 2.3. Forecasting methodology of the air transportation development.....    | 56 |
| 2.4. Borodyanka airport establishment.....                                 | 58 |
| 2.4.1. Practicability of Borodyanka airport creation.....                  | 59 |
| 2.4.2. Strategic vision of the aerodrome development.....                  | 60 |

|        |  |     |
|--------|--|-----|
| 2.4.3. | Factors analysis influencing the airport construction and development.                     | 62  |
| 2.4.4. | SWOT analysis of Borodyanka airport.   | 64  |
| 2.4.5. | Positive impact of Borodyanka airport creation on aviation overall in Ukraine.             | 68  |
| 3.     | DESIGN PART.   | 71  |
| 3.1.   | Forecast of Kyiv air traffic node development.   | 72  |
| 3.2.   | Application of the game theory models for analysis of market interactions of the airports. | 87  |
| 3.3.   | Determination of passenger traffic of Borodyanka airport.                                  | 90  |
| 3.4.   | Calculation of Borodyanka passenger terminal area.   | 92  |
| 3.5.   | Investment calculation of the Borodyanka airport development.                              | 95  |
| 3.6.   | Estimation of economic efficiency of investments.  | 99  |
| 3.7.   | Locating of the new airline on the territory of Borodyanka airport.                        | 102 |
|        | CONCLUSIONS.   | 104 |
|        | REFERENCCES.   | 108 |
|        | APPENDICES.  | 110 |



## **LIST OF SYMBOLS**

IATA – International Aviation Transport Association

ICAO – International Civil Aviation Organization

UIA – Ukraine International Airlines

USD – United States dollars

ATC – Air Traffic Control

SAA – State Aviation Administration

UAH – Ukraine Hryvnia

NC – National Carrier

SE – State Enterprise

GDP – Gross Domestic Product

LCC – Low Cost Carrier

US – United States

EU – European Union

UAE – United Arab Emirates

IA – The Investment Association

# ***INTRODUCTION***

|  |                   |  |  |                    |                     |       |        |   |
|--|-------------------|--|--|--------------------|---------------------|-------|--------|---|
| Air Transportation Management Department |                   |  |  | NAU.20.03.86 001EN |                     |       |        |   |
| Done by:                                 | Korynevskaya T.B. |  |  | INTRODUCTION       | Letter              | Sheet | Sheets |   |
| Supervisor                               | Ivannikova V.Yu.  |  |  |                    |                     | D     | 10     | 2 |
| Standards Inspector                      | Shevchenko Yu.V.  |  |  |                    | FTML 275 OII- 202Ma |       |        |   |
| Head of the Department                   | Shevchuk D.O.     |  |  |                    |                     |       |        |   |

Air transport is one of the most important factors influencing the development of the economy of each country. Due to the process of providing communication between the remote countries and regions of the world, it stimulates the foreign economic cooperation growth, promotes an international trade, creates a lot of jobs, encourages and facilitates international tourism.

Air transport development in the conditions of world globalization of the economy is an important element of Ukraine's integration into the modern system of international economic relations. Also, it plays a significant role in solving socio-economic problems and improving the quality of country's population life. The aviation industry belongs to the strategically important, basic sectors of the Ukrainian economy, but today the existing potential is not efficiently used, and the airline industry itself is under the growing manifestations influence of the systemic crisis.

In Ukraine there are the following negative factors, which determine the weak development of air transportation today:

- low level of technologies and standards of the air transportation services on which this business is based abroad;
- absence of system of agencies that form the market of freight sales;
- absence of competent technology for passing customs formalities at airports, due to which the time of passage of goods through customs is many times higher than the accepted norms in other countries.

In the general scheme of air routes, Ukraine has a very advantageous position on one of the busiest routes between Western Europe and the Far East, which accounts for about 20% of world air traffic, and this direction is one of the fastest growing.

IA (UK), using a forecast of potential revenues of Ukrainian airlines, using pairs of endpoints, including European cities, on routes between Europe and South Asia, found that 1,078 flights by foreign airlines could operate weekly through the airspace of Ukraine.

According to the above said information, as well as the strategic position of Ukraine, it is advisable to create an international complex on its territory to provide air transportation. This is confirmed by numerous statements and proposals of foreign brokerage and forwarding companies engaged in the transportation of goods and passengers, expressed in business negotiations with the Ministry of Transport of Ukraine and airports.

In order to have a positive impact on the overall economy situation in Ukraine, the modern, highly efficient airport should be created on the basis of one of the current airfields – Borodyanka airfield. Consequently, its set up will extend economic and financial indicators, increase deductions to budgets and funds of the state, create new job opportunities, and improve social standards and guarantees.

At the following Master thesis the object of study is the best way how to develop and improve the overall aviation industry, passenger, cargo and mail air transportation in our country.

For this Master thesis a lot of methods of study were used: analysis, classification, observation and comparison of forecasts comprising data of 2020 and excluding it.

The need for passenger terminal area for certain functional spaces at certain stages of airport development has been determined. This is reflected in the master plan of Borodyanka, which will be a plan for the development of the necessary areas. Stages of development of areas demonstrate the need to increase them and problematic aspects of the Borodyanka International Airport development.

Surely, for beginning plenty of money is needed. But, for my opinion, investors would be interested in (approximately amount of money which is needed for start is calculated at the 3-nd part of the Master thesis, p - 95).

1. ***THEORETICAL PART***

|  |                   |  |  |                    |                     |       |        |    |
|--|-------------------|--|--|--------------------|---------------------|-------|--------|----|
| Air Transportation Management Department |                   |  |  | NAU.20.03.86 002EN |                     |       |        |    |
| Done by:                                 | Korynevskaya T.B. |  |  | THEORETICAL PART   | Letter              | Sheet | Sheets |    |
| Supervisor                               | Ivannikova V.Yu.  |  |  |                    |                     | D     | 13     | 22 |
| Standards Inspector                      | Shevchenko Yu.V.  |  |  |                    | FTML 275 OII- 202Ma |       |        |    |
| Head of the Department                   | Shevchuk D.O.     |  |  |                    |                     |       |        |    |

## **1.1. The fundamentals of Ukrainian aviation development**

Aviation is one of the youngest branches of technology. In Latin, "Avia" means "Bird". From ancient times people envied birds, but only from the end of the 19th century they were able to rise into the air. The subject of aviation is admittedly one of extreme difficulty. Henson's flying machine, designed in 1843, was the earliest attempt at aviation on a great scale. The progress made by all these experiments at aviation had naturally created widespread interest, both as a matter of sport and also as indicating a new departure in the possibilities of machines of war.

The scientific and technological revolution, which began in the mid-1940s, in aviation was marked by the advent of the era of jet technology, the emergence of supersonic airliners and wide-body aircraft, the use of information technology, automated control systems. Composite materials, more powerful and economical engines, innovations in aerodynamics, radio and lighting engineering, electronics, and avionics began to be used in aircraft construction.

In 1952, Antonov Experimental Design Bureau began work in Kyiv, where a series of classic aircraft was created, from the multi-purpose An-2 to the An-225 and An-178 (see AN). Gas turbine engines were manufactured in Ukraine at JSC "Motor Sich". Increased attention began to be paid to aviation safety, the creation of simulators for pilots, and so on. Jets, which reached speeds of up to 800 km / h, became the basis of military and civil aviation. With the release on the airline of the world's first passenger jet comfortable multi-seat airliners (British De Havilland Comet DH-106 (1952), American Boeing 707 (1954), Soviet Tu-104 (1955), French Caravelle-1 (1955), etc.) mass passenger air transportation began[1].

In the following decades, a new generation of aircraft appeared, among which the most popular were passenger trunk Boeing-747 (USA) of various modifications.

In the 1980s, transport aviation was enriched by giant aircraft created at the State Enterprise "Antonov" - An-124 "Ruslan" (1982, length - 69.1 m, payload up to 150 tons) and the largest and most powerful aircraft in the world An-225 "Dream" (1988, length 84 m, load capacity over 250 tons), which still successfully fly on all continents.

### 1.1.1. The first airfields construction in Kyiv region

The first main airports in Kyiv region were: Antonov, Boryspil, Brovary and Kyiv. Also some airfields are located there: Svyatoshin, Chayka and Borodyanka.

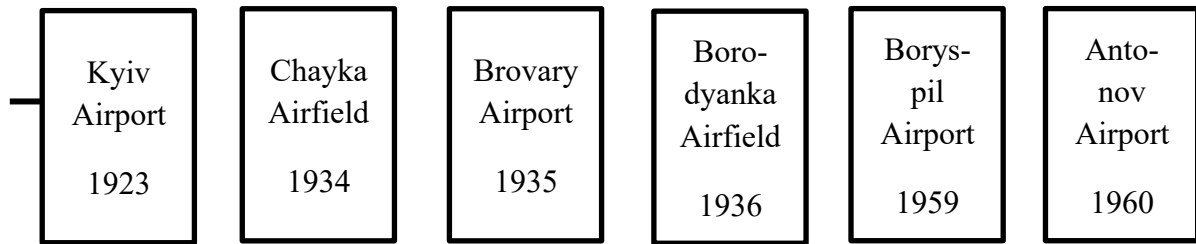


Fig. 1.1. Timeline of the first airdromes construction

Antonov is an international airport located 25 km north-west of Kiev (Ukraine), 2 km from the town. The airfield is used by both civil (Antonov Airlines) and experimental aviation (testing of aircraft manufactured and repaired by Antonov ASTC is carried out here). Until the early 2000s it was called Gostomel. Construction of the airport began in 1959. Commercial cargo operations at the airport began in 1989 with the first attempts at demilitarizing and commercializing of the Antonov Design Bureau. The airport is used by the Antonov Airlines, as well as by other interested cargo carriers. The following facilities and services are available on site: transshipping (air-to-auto; air-to-railway), storage capacities, border control and customs, aircraft maintenance.

Boryspil Airport is the largest international airport in terms of traffic in Ukraine. On 22 June 1959, the Council of Ministers of the Ukrainian SSR ordered the establishment of regular civil air traffic to the then military airfield near Boryspil. On 7 July 1959, the new airport (named Kyiv-Tsentralnyi) received its first scheduled flight. It was Aeroflot's Tupolev Tu-104 en route from Moscow, carrying 100 passengers and about 1,600 kg of cargo. The first routes served were Moscow–Kyiv–Moscow and Leningrad–Kyiv–Leningrad.

Brovary airport - an airport existed near the city of Brovary in the mid. of XX. In the period from 1935 to 1941 it was the main airport serving the city of Kiev and the nearest areas of the Ukrainian SSR. It was destroyed (the terminal buildings) by the Germans on June 25, 1941.

Zhuliany Airport (Igor Sikorsky Kyiv International Airport) is one of the two passenger airports of the Ukrainian capital Kyiv. The airport is known since 1923 as a military airfield that was co-used by the "Ukrpovitroshlyakh" ("Ukrainian Society of Air Communications") which in 1934 was completely integrated into Aeroflot as the latter's regional administration. The airport terminal was built only after World War II in 1949. Until the 1960s, Zhuliany was the only passenger airport serving Kyiv. In 1959, the larger Boryspil International Airport was built near the city of Boryspil, gradually replacing Zhuliany as the main airport serving Kyiv. Since that time the old "Kyiv" airport became commonly known just as "Zhuliany" and was used for Soviet domestic flights only[2].

Sviatoshyn Airfield, formerly known as Svyatoshino, is an industrial airfield in Kyiv, Ukraine, located 11 km northwest of city center. It is a part of the Antonov Serial Production Plant.

On April 1934 the Kiev Aeroclub was formed at the airfield. Airfield "Chaika" is an airfield located 10 km from Kiev. It is a part of the Chaika sports complex. The airfield begins its work in the warm season and ends with the onset of cold weather. An aero club is based at the airfield, training for sportsmen-parachutists and training of beginners under program, training flights on airplanes and gliders are held. Also, flights on sightseeing tours over Kiev and the surrounding area are carried out from the airfield.

In 1936, a military airfield was built in the village of Borodyanka, Kiev region. After the commissioning of the airfield in the city of Uzin, the Borodyanka airfield began to be used as a reserve airfield for strategic aviation.

### **1.1.2. Civil aviation establishment in Ukraine**

A new, independent period of development of the Ukrainian civil aviation industry began after the proclamation of Ukraine's state independence in 1991 and its election to a market economy policy. The previous stage of development in the former USSR is rich in achievements related to civil aviation, which Ukraine began to develop in the early twentieth century. Back in 1923, the Ukravozdukhput airline



was established in Ukraine. High performance of its work became the basis for the merger of "Ukravozdukhput" with the Russian "Dobrolyot".

A new era in the history of civil aviation in Ukraine began with the creation of a state body regulating aviation activities – Ukraviatsia, in October 1992, which coincided with the beginning of market relations in civil aviation. Freedom was given to initiative, to the creation of new national airlines of various forms of ownership. Due to this, the aviation of Ukraine managed to avoid a complete collapse in the conditions of a sharp drop in the volume of traffic on the domestic market, a limited legal field for international flights.

In September 1992, Ukraine became a member of ICAO, in May 1993 adopted its own Air Code and established air connections with many countries around the world. As part of the general administrative reform in Ukraine, the beginning of which coincided with Ukraine's accession to the European Civil Aviation Conference on December 15, 1999, the civil aviation management system has been gradually reformed, as reflected in Air Code on May 19, 2011.

The biggest problem was that Ukraine did not have an airline capable of competing with foreign carriers. Intergovernmental agreements on air transportation have enabled Ukraine to conduct direct international air transportation on its own. These agreements provided for equal working conditions for carriers of both parties. But Ukrainian carriers could not compete with airlines such as Lufthansa, Air France and others. It was necessary to create a Ukrainian airline that would meet international standards. It was Ukraine International Airlines (UIA).

The State Aviation Service of Ukraine is a central executive body, the activities of which are directed and coordinated by the Cabinet of Ministers of Ukraine through the Vice Prime Minister of Ukraine - Minister of Infrastructure of Ukraine. The State Aviation Service of Ukraine is part of the system of executive bodies and ensures the implementation of state policy in the field of civil aviation.

The main tasks of the State Aviation Service are:

- making proposals on the formation of state policy in the field of civil aviation and the use of airspace;

- implementation of state policy in the field of civil aviation and use of airspace;
- implementation of state control and supervision over the safety of civil aviation;

European integration is a strategic priority for Ukraine, and the National Program for Ukraine's Integration into the European Union (EU) has already been developed and approved. The chosen path involves many changes in all areas, including civil aviation[3].

## **1.2. Airfields. Basic information**

Aerodrome (airfield) is a specially prepared land or water surface areas, with facilities and equipment that provide takeoff, landing, accommodation and maintenance of aircraft.

In formal terminology, as defined by the International Civil Aviation Organization (ICAO), an aerodrome is "A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft."

An aerodrome is a location from which aircraft flight operations take place, regardless of whether they involve cargo, passengers, or neither. Aerodromes include small general aviation airfields, large commercial airports, and military airbases. The term airport may imply a certain stature that an aerodrome may not have achieved. That is to say, all airports are aerodromes, but not all aerodromes are airports. Usage of the term 'aerodrome' remains more common in the UK and Commonwealth nations, and is conversely almost unknown in American English. A water aerodrome is an area of open water used regularly by seaplanes or amphibious aircraft for landing and taking off. According to the International Civil Aviation Organization an aerodrome is "A defined area on land or water intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft."

According to the Rules of State Aviation Administration of Ukraine, "Aerodrome is a section of land or water surface with equipment, buildings and structures, which is equipped for takeoff, landing, taxiing, parking and maintenance of aircraft".

Classification of aerodromes:

- by equipment they are divided into permanent and temporary;
- according to the technical characteristics of the runways – for classes;
- civil aerodromes (for the carriage of civilian passengers and cargo, part of the airports) are divided:

1. Route - for air flights;
2. Educational - for training and coaching of cadets of flight schools;
3. Factory - for testing aircraft after repair at aircraft repair plants;
4. To perform aviation work.
5. Experimental (for testing aircraft at aircraft plants and landfills)

- state aerodromes are classified as following:

1. Military (for solving tasks of a defensive nature, carrying out combat duty, transfer of troops, etc.);

2. Training (for training of flight, navigating and technical structure of military aviation);

3. Sports (for training and demonstration flights on airplanes, helicopters, hang gliders, gliders, parachute jumps);

- private airfields and aerodromes.

Civilian airfields (aerodromes) are deployed at civilian airfields, military units of the Ministry of Defense and other law enforcement agencies are deployed at military airfields. The organizations testing aircrafts, research institutions are stationed at experimental airfields[4].

According to ICAO Annex 14, each civil aerodrome is provided with a code consisting of two indicators: the runway length index number (table 1.1) and the

runway width index letter (according to the wingspan and the width of the outer main gear wheel span).

*Table 1.1*

**Classification of the aerodromes according to the runway length**

| <b>Code Number</b> | <b>Referential runway length</b> | <b>Aircraft examples</b>                 |
|--------------------|----------------------------------|--|
| <b>1</b>           | < 800 m                          | De Havilland Canada DHC-6/Piper PA-31    |
| <b>2</b>           | 800 m, but < 1200 m              | ATR42/Bombardier Dash 8 Q300             |
| <b>3</b>           | 1200 m, but < 1800 m             | Saab 340/Bombardier Regional Jet CRJ-200 |
| <b>4</b>           | > 1800 m                         | Boeing 737-700/Airbus A-320              |

*Table 1.2*

**Classification of the aerodromes according to the runway width**

| <b>Code Letter</b> | <b>Wingspan</b>  | <b>Wheel-base width</b> | <b>Aircraft examples</b>                           |
|--------------------|------------------|-------------------------|--|
| <b>A</b>           | < 15 m           | < 4,5 m                 | Piper PA-31/Cessna 404 titan                       |
| <b>B</b>           | 15 m, but < 24 m | 4,5 m, but < 6 m        | Bombardier Regional Jet CRJ-200/De Havilland DHC-6 |
| <b>C</b>           | 24 m, but < 36 m | 6 m, but < 9 m          | Boeing 737—700/Airbus A-320/Embraer ERJ 190—100    |
| <b>D</b>           | 36 m, but < 52 m | 9 m, but < 14 m         | B767/Airbus A-310                                  |
| <b>E</b>           | 52 m, but < 65 m | 9 m, but < 14 m         | B777/B787 series/A330                              |
| <b>F</b>           | 65 m, but < 80 m | 14 m, but < 16 m        | Boeing 747-8/Airbus A-380-800                      |

The classification of Ukrainian aerodromes and the types of relevant aircrafts are determined in accordance with the SAA and ICAO standards.

The aerodrome includes the following elements (aerodrome objects):

- surfaces (artificial, soil or water) intended for landing, take-off, movement, parking of aircraft, movement of ground transport on the territory of the aerodrome;
- soil elements of the aerodrome;
- air traffic service facilities;
- means of communication, navigation and surveillance;
- visual means of flight support;

- facilities and means of emergency rescue and fire support, aviation security, meteorological services, aerodrome electricity supply;
- structures and networks of utilities that ensure the operation of aerodrome facilities.

The decision on the joint use of the aerodrome shall be made by the executive body to whose sphere of management the aerodrome belongs, or the owner of the aerodrome and the authorized body for civil aviation.

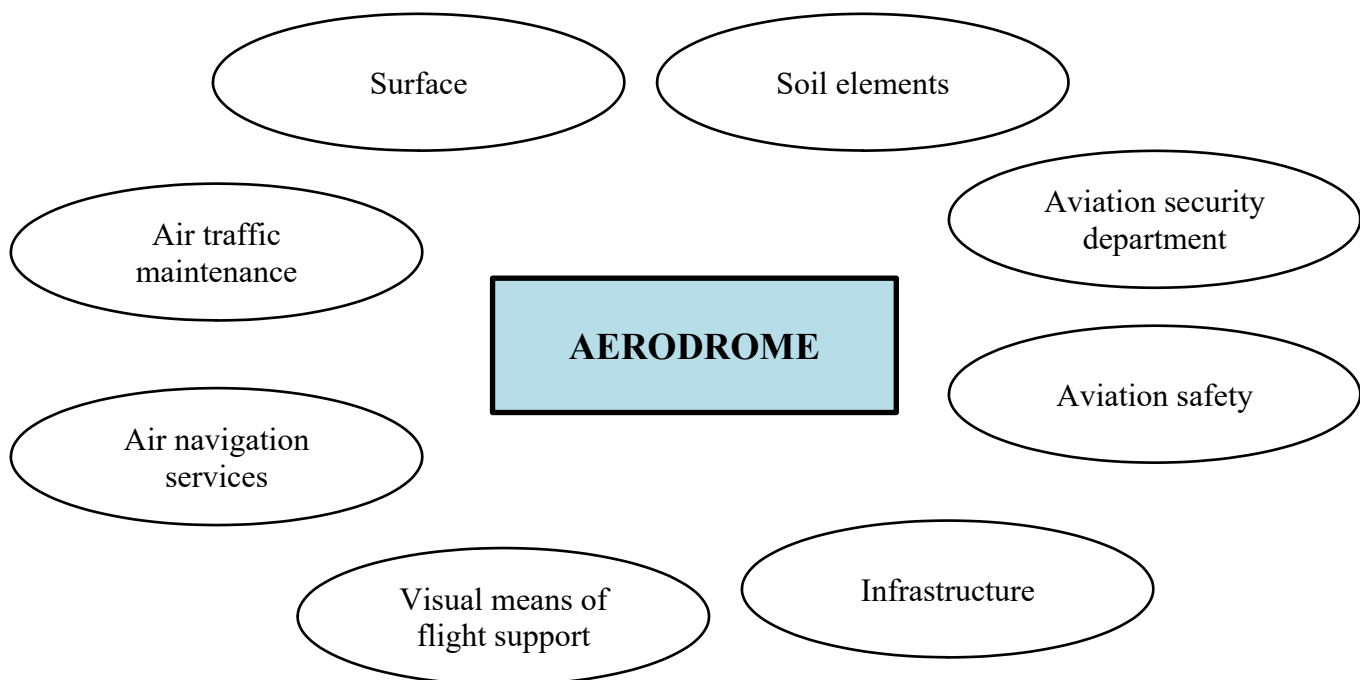


Fig. 1.2. Basic elements of the aerodrome

The objective of each airport is to support its mission and vision through the operation, maintenance, and development of airport services and infrastructure that is accountable to its constituents, provides appropriate airport facilities, and supports compatible business uses and development. The following goals further define and clarify airport accountability, facilities and business [5].

The main mission of the airport: compatible with the mission and vision of the airport, encouraging economic growth that is specific and targeted, encourages revenue-generating activities that are competitively priced, fostering partnerships, promoting tourism, responding to the demands of dynamically changing economic influences and aviation technologies, addressing the needs of general aviation users.

### **1.3. Ukrainian aviation market situation**

Civil aviation in the context of globalization of the world economy is an important element of Ukraine's integration into the modern system of international economic relations. In addition, it is of great importance for solving socio-economic problems and improving the quality of life of the country's population. The aviation industry is one of the basic, strategically important sectors of Ukraine's economy, but currently the available potential is not used enough, and the aviation industry itself is under the influence of the growing manifestations of the systemic crisis. Therefore, the analysis of the current state and trends in the development of the aviation industry of Ukraine, identifying the causes of the situation, as well as making proposals for possible improvement are quite relevant.

According to statistics for the first 9 months of 2019, 153.9 thousand aircraft were serviced by Ukrainian airports, which is 11.4 percent more than in the same period last year. At the same time, passenger traffic through the airports of Ukraine increased by 18.8 percent and amounted to 18,510.2 thousand people. Mail and cargo flows increased by 1.7 percent and amounted to 42.3 thousand tons.

From January to September 2020, the volume of passenger traffic of Ukrainian airlines decreased compared to the same period last year by 64.7% and amounted to 3769.8 thousand people, including international - by 65.4% and amounted to 3380 thousand people.

The COVID-19 pandemic has significantly affected aviation - since February 2020, and especially in the spring, airlines have significantly reduced the number of flights or stopped flights altogether. Due to the decision of governments to impose quarantine, close flights and ban or restrict entry, the crisis caused by the pandemic became the deepest for aviation since World War II. In April 2020, the number of flights (compared to April 2019) in the world fell by 80%, and in Europe - by 90%.

Unfortunately, because of COVID-19 passenger traffic through the airports of Ukraine decreased by 62.9% and amounted to 6857.5 thousand people (fig.1.3.), including in international traffic - by 63.7% and amounted to 6063.6 thousand people in 2020 [6].

During January-September 2020, Ukrainian airlines performed 33.5 thousand commercial flights (a decrease compared to the same period last year - by 58%), including international - 26.7 thousand (reduction - by 60.1%).

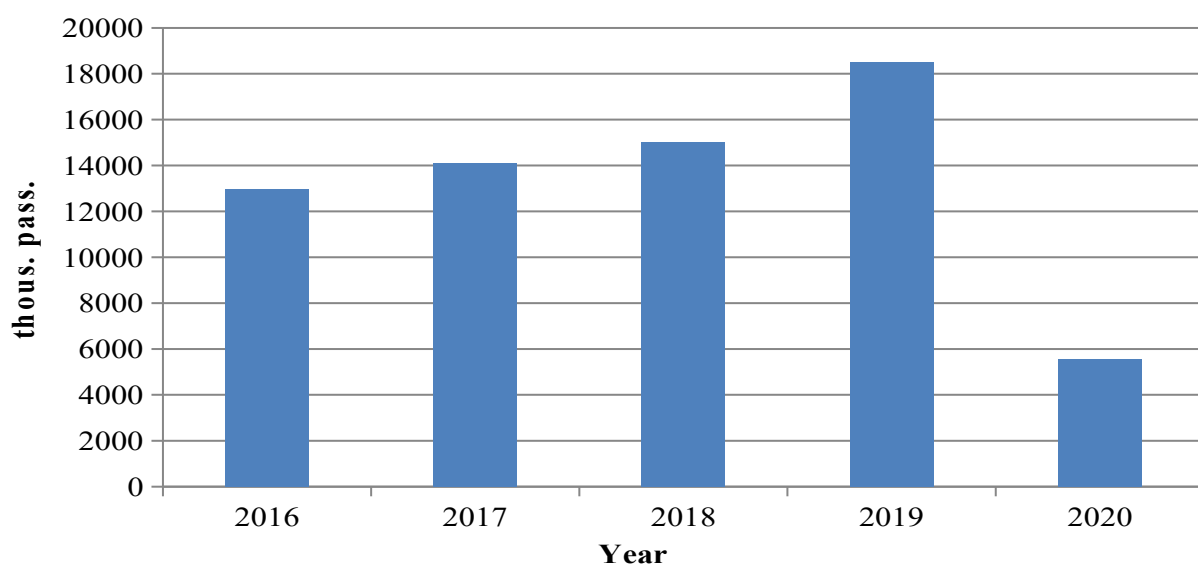


Fig. 1.3. Impact of COVID-19 on passenger traffic during period Jan.- Aug. 2020

After the beginning of the pandemic on the planes before and from the directions of the greatest spread of the virus, the crew began to wear masks, at airports and on board planes passengers are measured temperature, passengers are given antibacterial wipes, and before / after flights aircraft cabins are additionally disinfected. Airlines that continue to operate during quarantine have begun to block medium seats so that there is at least one empty seat between passengers. Fearing the spread of the virus through food, some carriers stopped cooking hot meals on board. Passengers are offered pre-packaged sandwiches and snacks.

It is difficult to calculate how much the already implemented and future precautionary measures may cost for Ukrainian airlines. After all, the real level of their profits is a trade secret. Most of our carriers declare losses publicly. For example, UIA loses 2-3 billion UAH every year. And only this year the company expected to enter a profitable business.

According to experts, at best, the profitability of Ukrainian airlines will return to the previous values - from 2 to 4% (although in the last 4-5 years it exceeded 6%, on some flights reaching even 20). Now this benefit will have to be forgotten - both due to a significant reduction in the number of flights, and due to incomplete occupancy of liners [7].

### **1.3.1. Ukrainian airports evolution**

In 1991 there were almost 50 civilian airports in Ukraine, as well as a large number of air bases and runways. During the years of Independence, most of these resorts were partially lost (abandoned for various reasons).

All aviation infrastructure of Ukraine is supervised and regulated by the State Aviation Service of Ukraine (until 2010 the State Aviation Administration of Ukraine). The service issues certificates for all airports in the country and keeps a registry of all aircraft.

According to the State Aviation Administration official data, in total, commercial flights of domestic and foreign airlines in 2019 served 19 Ukrainian airports and airfields. At the same time, about 98 percent of passenger traffic. And almost all mail and cargo flows are concentrated in 7 major airports (Borispil, Igor Sikorsky Kyiv, Lviv, Odessa, Kharkiv, Zaporozhye and Dnepropetrovsk).



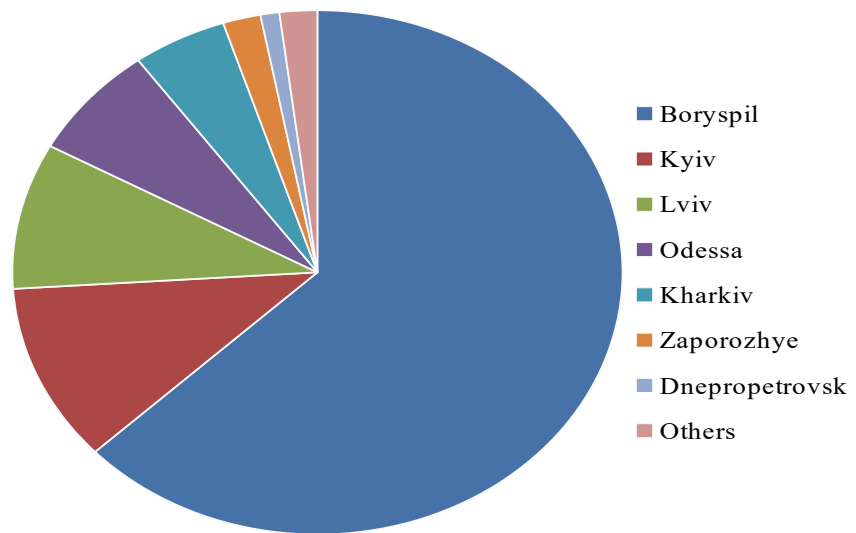


Fig. 1.4 The share of Ukrainian leading airports in the total volume of passenger air traffic

According to the fig. 1.3.1.1 the biggest of them are Borisopil and Kyiv airports.

### 1.3.2. Assessment of current problems of the airports development in Kyiv region

On the territory of the Kyiv aviation hub there are several operating airfields of civil aviation - Boryspil, Igor Sikorsky Kyiv, Kyiv (Antonov), Uzyn, Borodyanka, Vasylykiv, Sviatoshyn. The largest of them, which have a significant impact on the development of passenger and cargo air transport in the Kyiv region and the state as a whole, are Boryspil and Kyiv International Airports (fig. 1.3.1.1).

Boryspil International Airport is the largest international passenger airport, providing about 60 percent of all air passenger traffic in the country and is a base for

leading Ukrainian airlines. This airport is the only international hub airport in Ukraine.

According to the analysis of demand and calculations conducted by the leading consulting company Airport Consulting Vienna, it is projected that in 2045 the airport will serve about 54 million passengers a year. At the same time, the capacity of access roads will be completely exhausted and there will be a need to create a new transport infrastructure. In addition, the growing volume of passenger traffic in the next 10 years will force the administration of Boryspil Airport to limit the growing demand of citizens for air transportation. And these are the main problems of this airline.

Igor Sikorsky Kyiv International Airport is the second largest international passenger airport in Ukraine and at the Kyiv Air Hub, located within the Zhulyany district of the capital, 8 km southwest of Kyiv city center. The airport has undergone significant development in preparation for the Euro-2012 championship. In particular, a new international terminal "A" has been opened for international flights.

Kyiv International Airport operates about 2,500 flights monthly, and almost 2 million passengers are served annually. However, over the past year, there has been a reduction in passenger traffic at the airport by 6.9 percent [8].

The location of the airport within the city doesn't allow developing its infrastructure, with an increase in air traffic in the near future.

Sikorsky Kyiv International Airport has resumed operations on June 22 after COVID-19 detection. The mayor of the capital Vitaliy Klitschko announced this during an online press conference, answering questions from the media.

Due to the forced suspension of passenger traffic, the airport suffers great losses. The company loses almost 27 million UAH every month. For Klitschko opinion, therefore, today there are 3 options for solving the problems of Kyiv Airport so that it can fully resume its work:

- The first option is to reduce costs and lay off some employees. But this is the worst option that will not solve the company's problems.

- The second option is to increase revenues by setting minimum fixed rates for air services and enshrining them at the legislative level. This decision must be made by the Cabinet of Ministers.

- The third option – it is necessary to distribute passenger traffic at the Kiev air hub between the airports "Boryspil" and "Kyiv". This approach, according to experts, will help to quickly restore the aviation industry after quarantine. And this decision must also be approved by the government.

The main difficulty the Kyiv airport faced after the international flights opening was not only insufficient passenger traffic, but also insufficient number of flights - there are almost none. The airport planned to reach 30% of the pre-quarantine volume by the end of the month, but now has an average of 3-4 flights (up to seven flights) per day. Airport doesn't cover even the minimum income for maintenance - both for infrastructure and for the payment of the minimum wage to employees. It should be noted that, according to the State Aviation Administration, in 2019 the airport had a passenger flow of about 2.17 million, or more than 7 thousand people a day.

The borders with other European countries were formally opened, but in fact we can see four carriers that have resumed regular flights. They have a very low frequency and they carry very few passengers. As an example, flights "Kiev - Frankfurt", which in 2019 were performed three times a day, and now - three times a week.

#### **1.4. Business development strategies and their types**

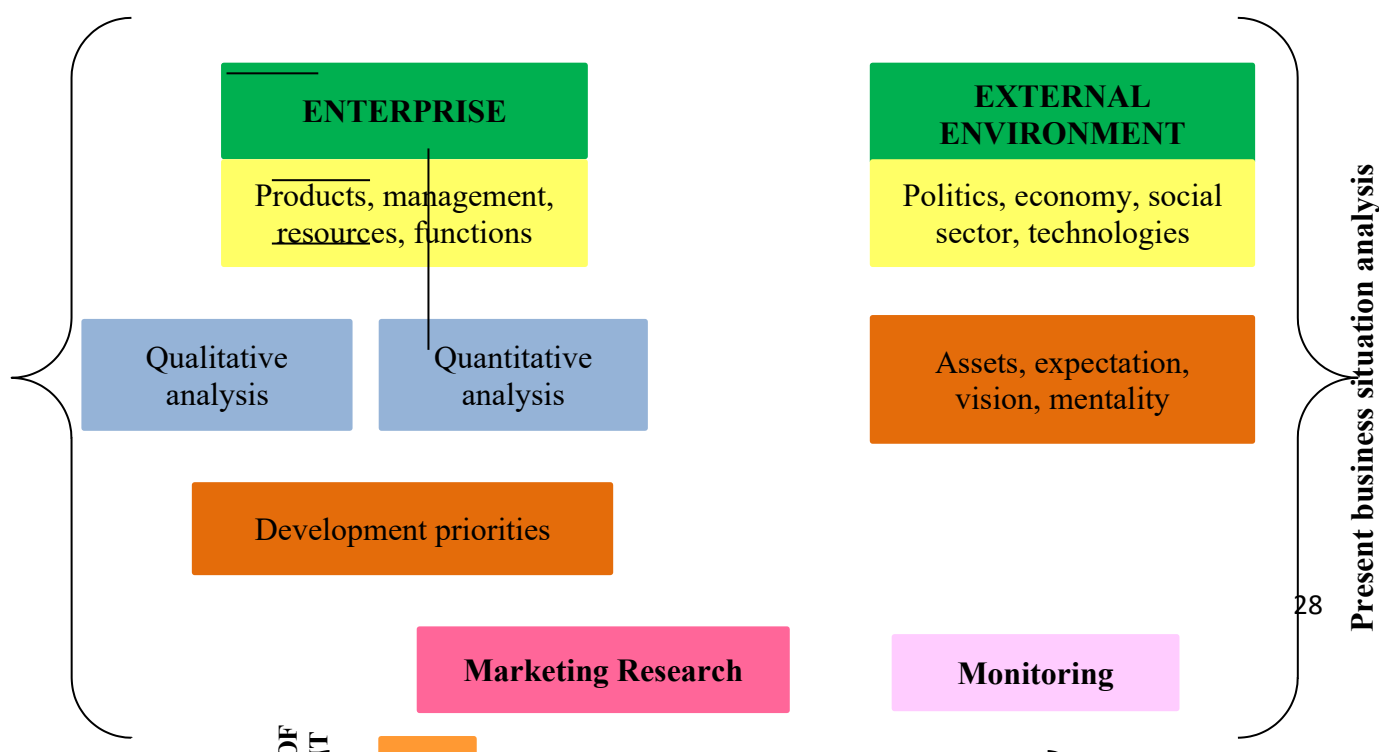
The strategy is a generalized model of actions needed to achieve long-term goals. The term "strategy" (from the Greek words stratos – army, and ago – to lead) translates as "the art of the commander."

Strategic planning is the development of a strategy through a formalized procedure, which is described by stages and techniques. This procedure is aimed at building both a model of the future ("as desired") and a program of transition from the current state to this model. Strategic planning is the most modern method of strategic management and the most highly intelligent and expensive stage of

management in general. A strategic plan is a voluminous document where the future is painted for the manager according to a certain stencil and with the appropriate level of detail.

Strategic planning sets promising areas of enterprise development, determines the main types of its activities, allows you to integrate marketing, design, production and financial activities into a single system. The strategic plan ensures the adaptation of the enterprise to the external environment, to the allocation of resources and internal coordination of activities in order to identify strengths and weaknesses. The strategic plan for large enterprises is usually long-term. But the time period of a strategic plan for companies may be different and what is long-term for one company may be short-term for another. Strategic planning in enterprises should be aimed at their long-term development, achieving high rates of economic growth. Development is a process in which the opportunities and desires of the enterprise to satisfy the desires and needs of consumers increase. Thus, strategic planning should provide the necessary economic growth and the desired level of development of the enterprise for the long term [9].

The process of strategic planning consists of three stages: analysis of today's business situation, development of tomorrow's business model and development of a development program (fig. 1.5).



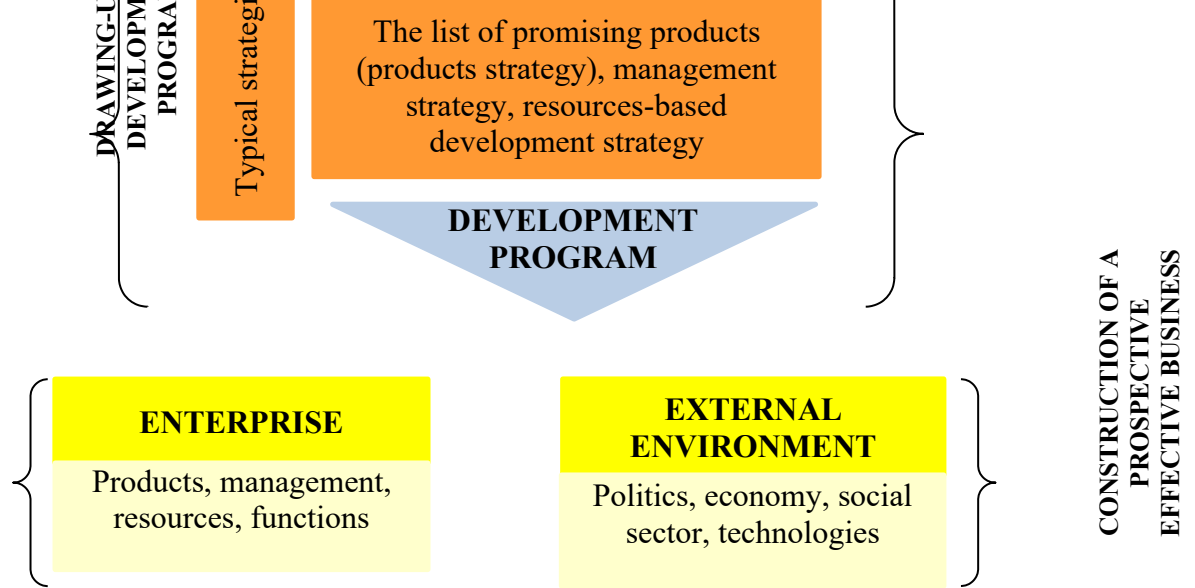


Fig. 1.5 The process of strategic planning

However, there is no single strategy. Business theory and practice have developed many strategic approaches to doing business. This diversity is due to the specific conditions in which the business is conducted, a set of external and internal factors, trends in the industry, the nature of the business goals and a number of other factors.

All types of strategies in the business world can be combined into three groups:

- offensive, or breakthrough strategy;
- defense, or survival strategy;
- reducing and changing business type strategy.

Offensive strategies are usually based on scientific discoveries and inventions, designed to occupy a leading position in the market or industry. However, they require significant financial costs, have a high degree of risk, but if successful give high results.

Defense strategy, or survival strategy, involves maintaining the firm's existing market share and maintaining its market position. This strategy is chosen by a firm that has a satisfactory market position or insufficient funds to conduct an active

offensive strategy. The firm is afraid to conduct the latter due to the undesirable response of measures of strong competitors or orders of measures from the state.

However, this type of strategy is quite dangerous and requires the most careful attention from the firm to issues of scientific and technological progress and the actions of competing firms. The firm may be on the verge of collapse and will be forced to withdraw from the market, as unnoticed inventions of competitors will reduce their production costs and undermine the position of the defending company.

The strategy of reduction and change of business types is used in situations when the firm needs regrouping of forces after a long period of growth or when it is necessary to increase efficiency during recessions and cardinal changes in economy (structural adjustment, etc.) [10].

Each of them has many options depending on the specific conditions of the firm. Multi-purpose strategies that combine elements of each group are also possible.

It is clear that more attractive is the offensive strategy, or breakthrough strategy, which aims to gain a certain market share, and often to take a leading position in a new market or in a new industry.

In practice, companies can simultaneously implement not one but several strategies. This is especially common in diversified companies.

### **1.5. History and basic information of Borodyanka airfield evolution**

Borodyanka airfield was built in 1936 as a military one. After the aerodrome commissioning in Uzyn, Borodyanka aerodrome began to be used as a reserve aerodrome for strategic aviation. From the end of 1970 to 1990, the reserved land was not used by anyone. In 1993, as part of the strategy for the development of general aviation in Ukraine, aerodrome received a land plot of the aerodrome for permanent use. In the same year, Borodyanka aerodrome was entered into the State

Register of Civil Aerodromes of Ukraine as Class D aerodrome and certified in accordance with all the conditions of the Air Code of Ukraine.

For more than 20 years of modern history of Borodyanka airfield, Joint Stock Company “AC” has created an integrated complex for servicing the needs of civil aviation on the basis of the former reserve military airfield. With the help of Borodyanka airfield, aviation enterprises of various forms of ownership carry out huge volumes of work, including: transport-connecting, aviation-chemical, aerial photography, protection of forests and oil refineries, patrol control and monitoring of mobile networks. And all this is done in terms of ensuring the highest level of flight safety.

The staff of Borodyanka Airport is about 130 highly professional specialists in the field of service and aviation security. The material and technical base of the aerodrome has been significantly modernized and continues to be modernized. Aircraft hangars, repair shops, warehouses, fuel and lubricants warehouses, new administrative buildings were built and put into operation.

Administratively, the territory of Borodyanka airfield is located within the Bucha district of Kyiv region of Ukraine. Borodyanka Airport is located 35 km northwest of Kyiv and 2 km east of Borodyanka urban-type settlement (table 1.3).

It has a favorable geographical position in terms of the organization of medium-haul and transcontinental air connections, as well as providing the complex with other types of transport communications.

Borodyanka Airport is located 70 km from the main air gate of Ukraine to Boryspil International Airport. Therefore, direct control communication between Boryspil and Borodyanka airports will provide operational air traffic control in case of unforeseen situations at one of the aerodromes.

*Table 1.3*

**Geographical and administrative data of the aerodrome**

| <b>Indicator</b>               | <b>Range</b>           |
|--------------------------------|------------------------|
| ICAO code                      | UKKB                   |
| IATA code                      | -                      |
| Aerodrome location coordinates | 503957.19N 0295600.83E |

|  |  |
|--|--|
| Direction and distance from settlements    | 35 km northwest of Kyiv, 2 km east of Borodyanka |
| Aerodrome altitude / estimated temperature | 149,2 m/490 ft/ 23,6 °C                          |
| Magnetic declination                       | 4° E   |
| Exceeding the thresholds                   | 102° – 149,2 m/490 ft;<br>282° – 145,6 m/478 ft  |
| Type of permitted flights                  | VFR  |

The runway of Borodyanka airfield has a ground cover of 1400 meters long and 75 meters wide. Data on the physical characteristics of taxiways are given in Table 1.4 There is no light signaling system at the aerodrome to indicate the exact landing trajectory or any other light signaling system.

*Table 1.4*

**The physical characteristics of Borodyanka aerodrome taxiways**

| <b>Taxiways, aircraft parking area</b> | <b>Width</b> | <b>Type of runway surface</b> | <b>Strength</b>                             |
|--|--------------|-------------------------------|---|
| Taxiway №1                             | 30 m         | soft surface                  | Class 4 aircrafts, helicopters of all types |
| Taxiway №2                             | 30 m         | soft surface                  | Class 4 aircrafts, helicopters of all types |

According to the certificate of the State Aviation Administration of Ukraine № АІІ 09-03 dated March 21, 2019, Borodyanka Airport meets the Ukrainian legislation requirements on civil aviation and is suitable for receiving index 1 aircraft (code 3B) and helicopters of all types. The owner and operator of the aerodrome is PJSC "AS". Aerodrome class - D. The level of required fire protection corresponds to 3 categories [11].

At present, Borodyanka airfield, according to the rules of visual flights, is a permanent platform for training, educational, sports and other types of flights for 4th class aircraft (up to 10 tons), including ultra-light and light aircraft, as well as helicopters of all classes.

Borodyanka airport is one of the most famous and popular aeroclubs in the Kyiv region. On the territory of the airfield there is a drop zone "DZBoro", where



parachute jumps for beginners and professionals, competitions in parachute disciplines are carried out.

Parachute club at Borodyanka airfield has existed since 1991. The staff of the aeroclub consists of experienced instructors and parachutists. Jumps from a height of up to 4200 meters are available on the Dzboro drop zone. More than 10,000 parachute jumps are performed on the DZBoro drop zone each season. In addition, the International Festival of Masters of Aircraft Modeling "Aeroshok" is held on the territory of Borodyanka Airport, which also includes many events aimed at promoting aviation sports.

In May-June 2019, the Ukrainian Geodetic Research and Production Enterprise performed engineering and geological surveys on part of the territory of Borodyanka Airport. A feature of the engineering-geological structure of the aerodrome location is the presence of sandy loams subsidence.

Soil conditions of the site, depending on the sagging possibility from its own weight belong to the first type of subsidence. Hydrogeological conditions of the horizon are characterized by the presence of groundwater at depths 2.2 - 5.0 m.

Thus, the western part of the aerodrome, taking into account the high level of groundwater and the amplitude of fluctuations in its level, belongs to the floodplains [12].

According to the conclusion of the Research and Production Enterprise "Ukrainian Geodetic Company", taking into account the location of the aerodrome on the territory, which is composed of heterogeneous soils with a high level of groundwater, engineering protection of the territory is necessary.

## **1.6. Basic information of low-cost airlines**

Low Cost carrier is a carrier that provides services at minimum rates and with minimal free service. The first successful company known as low cost was American Pacific Southwest Airlines. The historic flight of the first flight with ticket prices was several times cheaper than its competitors on May 6, 1947.

The first budget airlines in the European market were the Irish Ryanair and the British EasyJet, founded in the 90s. Their rapid growth was due to the creation of the EU and the subsequent deregulation of European airspace - airlines were given the right to fly between the countries of the European Union without the need to obtain special permits

In the last 10 years alone, more than 100 new low-cost airlines have appeared in the world, and the share of low-cost passengers has grown from 13% to 29% of the world's total passenger traffic. Many classic airlines under the pressure of competition have also changed their business models, becoming airline discounters. For example, UIA launched low-cost tariffs in 2017.

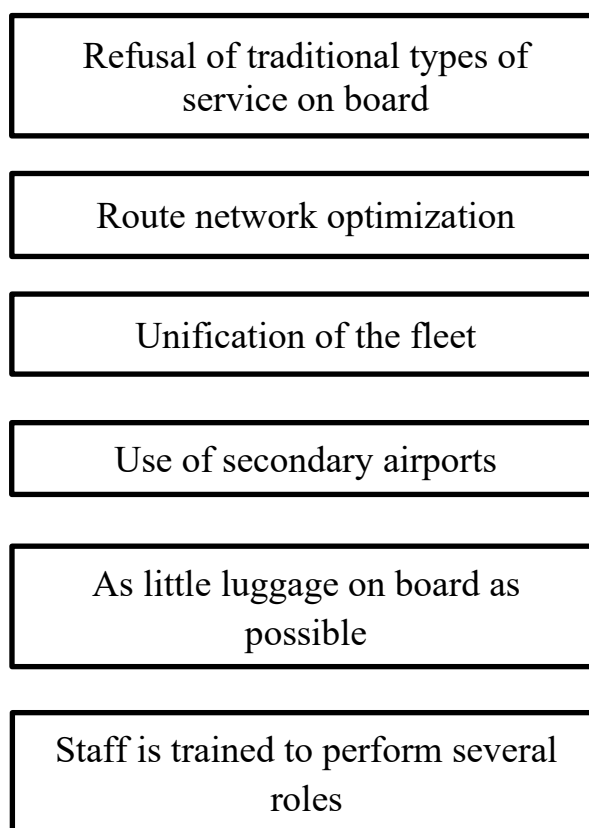


Fig. 1.6. Business model of low-cost airlines

The basic low-cost model provides the following (fig.1.6.):

- Refusal of traditional types of service on board. Low-cost carriers do not have a division of the cabin into classes, more spacious layout of the cabin (not folding, narrower seats, less distance between the backs of the seats), which usually

allows you to take on board more passengers. Paid meals, luggage transportation and choice of seats.

- Route network optimization: high-frequency point-to-point routes and downtime reduction. Low-cost companies mainly focus on short and medium distances - an average of up to 2000 km.

- Unification of the fleet - aircraft of the same model with one class of service (without business and premium economy classes) are used. This saves on maintenance staff. In addition, airlines try to use boards not older than 10 years to save money on maintenance.

- Use of secondary airports. Since the traditional ticket includes the cost of airport fees, often quite high, the use of secondary airports can reduce this cost item, and downtime at the airport is also reduced. Turning time on a budget airline is 25 minutes. The fewer aircraft on the ground, the less it costs. Sometimes you can see that passengers enter the door of the plane, and the others only have time to leave the arriving passengers - this is a clear example of saving downtime.

- The "as little luggage on board" approach not only reduces the takeoff weight of the aircraft, which gives less fuel consumption, but also reduces the service time of the aircraft on the ground, and non-folding seats and the lack of rear pockets on the seats in Ryanair - time to clean the cabin. All this together allows airlines to ensure the rapid turnover of aircraft on the ground. So Wizz Air and Ryanair aircraft perform an average of 5 flights a day.

In 2018, after analyzing the reviews of travelers from around the world, Skytrax named the low-cost carrier Air Asia from Malaysia the best budget airline in the world. In second place was the Norwegian carrier Norwegian Air, in third place - the American JetBlue, followed by the British EasyJet and Virgin America from the United States.

Ryanair uses only Boeing 737, and Wizz Air - Airbus A320 and A321. New boards will cost more, but with active maintenance will be much cheaper. Moreover, when ordering large batches of aircraft, the airline receives a good discount from the

manufacturer, and after a few years of use, the aircraft can be sold at a still good price.

The price of low-cost tickets for a particular route is much larger than that of regular airlines. It depends on the time before departure, demand and competition on the route. Unlike regular airlines, low-cost carriers rarely offer cheap tickets more than 3 months before departure. This is due to the desire to maintain flexibility in planning the route grid for a long period. This is due to the fact that it is much easier to cancel a flight for which 5 tickets have been sold than a flight for which 50 tickets have been sold, so they stimulate demand only 3 months before departure, when the flight schedule is more stable.

Advantages of low-cost airlines:

- Cheaper
- Cheap parking (they usually fly to smaller airports. This means that parking is going to be significantly cheaper)
- Sightseeing

Disadvantages of low-cost airlines:

- Service (is less than you will get from a traditional airline);
- Distance airport-city
- Extra costs

2. ***ANALYTICAL PART***

|  |                   |  |  |                    |                     |       |        |    |
|--|-------------------|--|--|--------------------|---------------------|-------|--------|----|
| Air Transportation Management Department |                   |  |  | NAU.20.03.86 003EN |                     |       |        |    |
| Done by:                                 | Korynevskaya T.B. |  |  | ANALYTICAL PART    | Letter              | Sheet | Sheets |    |
| Supervisor                               | Ivannikova V.Yu.  |  |  |                    |                     | D     | 36     | 34 |
| Standards Inspector                      | Shevchenko Yu.V.  |  |  |                    | FTML 275 OII- 202Ma |       |        |    |
| Head of the Department                   | Shevchuk D.O.     |  |  |                    |                     |       |        |    |

## **2.1. Analysis of the air transport system of Ukraine**

### **2.1.1. The current status of aviation in Ukraine**

Air transport occupies an important place in the country's transport system, plays a significant role in ensuring international transport links. Ukraine is one of the countries that have a full cycle of design, production and operation of aircraft. In terms of integration of Ukraine's transport system into the European space, the state pays great attention to the development of air transport, including airport reconstruction, support of the airline, support of aircraft production, introduction of modern information technologies, development of external relations, harmonization of aviation legislation.

On July 19, 2017 by a resolution of the Cabinet of Ministers of Ukraine, the State Aviation Concern Antonov was liquidated, as all three companies that made up the concern left it in 2016 and were included in the concern Ukroboronprom.

The state system of airspace use of Ukraine includes executive bodies that ensure the implementation of state policy in the field of Ukrainian airspace use, organizations and enterprises entrusted with the functions of air traffic, radio, aeronautical and meteorological support of aviation, preparation and publication of regulations, documents on air navigation, as well as training of specialists in the field of airspace use and their medical certification.

SE "Antonov" is in a protracted crisis. From 2016 to 2018, the company did not produce even a single serial aircraft; representatives of the company stated that this situation has developed, among other things, due to the severing of ties with Russia. The president of the Antonov company, Alexander Donets, noted that the company has only one valid firm contract – for the supply of 10 An-178 aircraft to the Azerbaijani Silk Way.

In January 2019, the Minister of the Ministry of Internal Affairs of Ukraine Arsen Avakov announced the purchase of 13 aircraft of Ukrainian production for the needs of the Ministry of Internal Affairs.

The transport sector has an important role in the social and economic development of the country, and the transport system has also been developed to

change the economy, to promote the competitiveness of the national economy and the health of the population.

Today, the transport sector of Ukraine's economy as a whole meets only the basic needs of the economy and the population in transportation. The level of safety, quality and efficiency of passenger and cargo transportation, energy efficiency, man-made load on the environment do not meet modern requirements. According to the International Civil Aviation Organization (ICAO), the relative indicators of the level of flight safety in Ukraine are much worse than the global average. There is a lag in the development of transport infrastructure, transport and logistics technologies, multimodal transportation and the level of containerization, which causes a high share of transport costs in the cost of production [13].

To increase the efficiency of the transport system, a program of comprehensive renewal and modernization of transport is needed, which will include a set of measures for regulatory support and the creation of a favorable investment climate, taking into account budgetary and non-budgetary sources of investment. The transport strategy also proposes a number of structural reforms in transport.

The unsatisfactory state of the domestic innovative and high-tech component of the air transport industry is explained by:

- insufficient level of investment;
- low level of tariffs for socially significant passenger traffic;
- limited funding from state and local budgets;
- lack of funds for simple reproduction of fixed assets due to underestimation of their value and insufficient level of depreciation;
  - lack of investment in concessions,
  - lack of public-private partnership;
  - imperfection of leasing mechanisms.

Unfortunately, in 2020 COVID-19 changed situation for the worse (table 2.1.) According to the IATA forecast, by the end of 2020, the passenger traffic of

Ukrainian airports may decrease by 55% compared to 2019. About 69% of the fleet registered in our country does not fly – this is slightly higher than the world average.

Table 2.1.

**Impact of the COVID-19 on the air transport mode (Jan.-Jul.)**

| Year | Passenger transportation, mln.passengers | Reduction, % | Cargo transportation, thous. tons | Reduction, % |
|------|--|--------------|-----------------------------------|--------------|
| 2019 | 4,06                                     | -            | 107                               | -            |
| 2020 | 2,4                                      | -69%         | 100                               | -7%          |

However, behind these numbers lie others, more gloomy ones. In Ukraine the loss indicators of airlines will amount to about \$ 1.3 billion, and more than 80 thousand jobs. In general, this is about \$ 1 billion of the country's GDP with a minus sign.



Fig. 2.1. Quantity of flights before COVID-19 presence



Fig.

2.2.

Quantity of flights after COVID-19 presence



The Kyiv airport has emptied even more. In the archival data of Flightradar24 on some days there is no regular flight from the airports "Zhulyany" and "Boryspil".

The COVID-19 pandemic has had a significant impact on the aviation industry due to travel restrictions and a slump in demand among travellers. Significant reductions in passenger numbers have resulted in flights being cancelled or planes flying empty between airports, which in turn massively reduced revenues for airlines and forced many airlines to lay off employees or declare bankruptcy.

ICAO, using ADS-B Flight aware data and the ICAO Enterprise Data Management (EDM), has worked jointly with the Directorate General of Civil Aviation (DGCA) of Turkey to develop interactive dashboards to monitor four aspects of the impact of COVID-19 on the civil aviation.

- Operational impact: impact on the number of flights, seats offered, for passenger and cargo flights segmented into international and domestic operations;
- Economic impact: impact on the revenues of air carriers, airports and air navigation service provider (ANSPs);
- Aircraft utilization: aircraft utilization and grounded aircraft by aircraft category;
- Country-pair traffic: level of flights at the country-pair level on weekly basis.

The impact of COVID-19 on Airline Industry is different. For example, the effects from SARS, financial crisis are short term shock, most shocks are localized or regionalized (they aren't global) and limited impact (no major change to long term growth pattern). But COVID consequences are different: cannot adjust network to avoid affected markets; slow creation of cure / vaccine / treatment; IATA predicts a return to growth and a doubling of passenger journeys to over 8bn globally by 2039 (Table 2.1.1.2).

The COVID-19 pandemic has significantly affected aviation - since February 2020, and especially in the spring, airlines have significantly reduced the number of flights or stopped flights altogether (fig. 2.2.). Due to the decision of governments to

impose quarantine, close flights and ban or restrict entry, the crisis caused by the pandemic became the deepest for aviation since World War II.

*Table 2.2.*

**The list of impacts that COVID-19 will have on the airline industry**

| <b>№</b> | <b>Short-term</b>  | <b>Mid-term</b>   | <b>Long-term</b>  |
|----------|--|---|---|
| <b>1</b> | Lots of airline failures. Over 40 airlines have failed so far this year – and more are set to come. State supported airlines least likely to fall. | Protectionism. After the beginning of the pandemic on the planes the crew began to wear masks, at airports and on board planes passengers are measured temperature, they are given antibacterial wipes, aircraft cabins are additionally disinfected. Airlines that continue to operate during quarantine have begun to block medium seats so that there is at least one empty seat between passengers. | Changes in factors of leisure travel demand. Driven by Low Cost Carriers, lower prices, increasing disposable income, emerging markets. These will be largely unaffected in the long run, but the economic impact on so many people will mean that the return to previous levels may take five years, which means that the 20-year-figure will be 5 years diluted   |
| <b>2</b> | A delayed return to growth in the leisure market. After lockdowns and staying at home for a long time, people want to go on holiday.               | Low yields. COVID-19 has led countries, economies and financial markets into uncharted territory, and uncertainty remains high. However, if restrictions can be lifted in the next few months, given levels of government support, we expect markets to recover a large part of the losses and spreads to meaningfully tighten again over the next 12 months.   | Changes in factors of business travel. Videoconferencing tech has got much better quickly and benefited from widespread broadband infrastructure. New technology has greatly substituted for travel, 5G will quicken this change. Small companies look to save money may travel less. Large companies will reduce inter-company travel and increase online maintenance of client base. Fewer numbers of employees sent to each client meeting. Further downgrading of travellers working for large companies (increase use of Premium Econ) |
| <b>3</b> | Fire sales.  | Excess capacity.  | -   |
| <b>4</b> | Change in demand drivers for business travel.  | -   | -   |

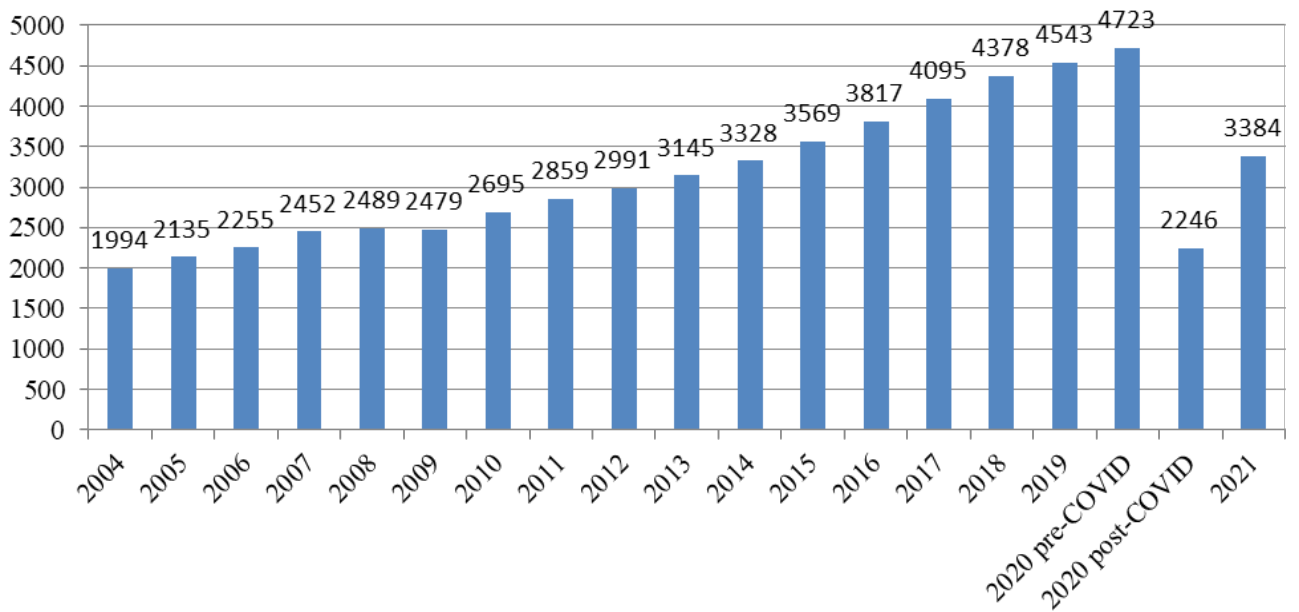


Fig.2.3. The number of scheduled passengers boarded by the global airline industry in millions, 2004-2021

The number of flights provided by UkSATSE with air navigation services in October 2020 is 13,041 flights, which is 56.4% less than in the corresponding period of 2019. At the same time, Ukrainian airlines performed 4,943 flights (49.6% less than in October last year), foreign airlines - 8,098 flights (-59.8%), according to the press service of UkSATSE.

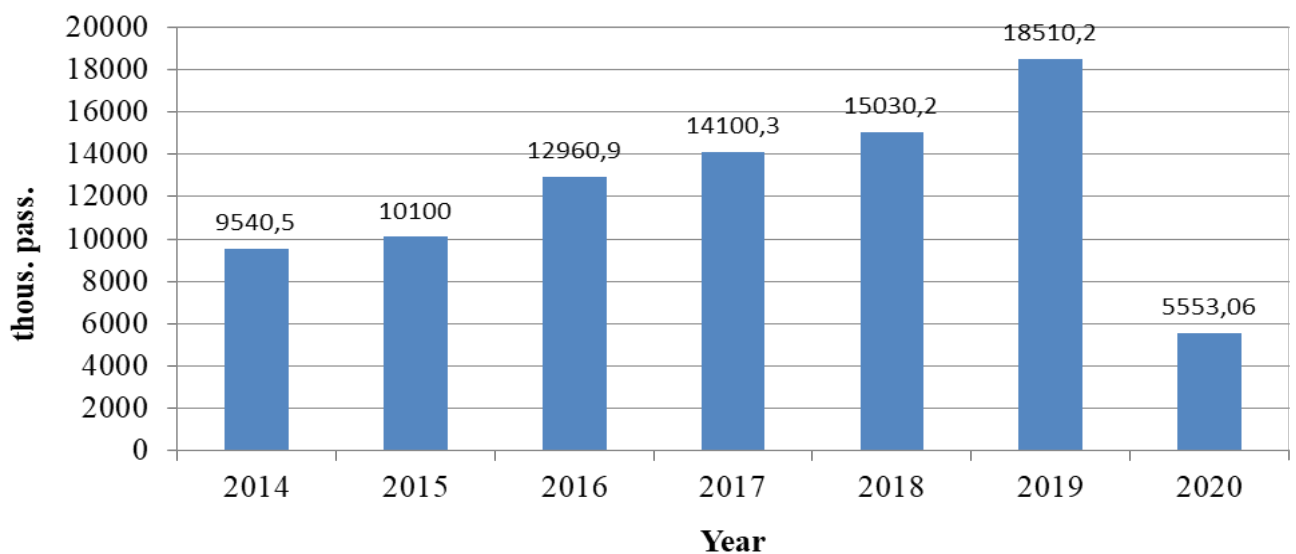


Fig. 2.4. Impact of COVID-19 on aviation in Ukraine, 2014-2020 Jan.- Sep.

It is noted that by type of flight air traffic is distributed as follows: 2260 flights performed in September - domestic (-15.7% compared to October 2019), 6250 - international (-56.8%), 4531 - transit (-64.6%) [14].

For our opinion, in spite of COVID negative influence, there is a positive impact of the pandemic on some of its elements. An important change could be the growing role of low-cost carriers due to declining demand for business class flights. The reason for this is the economic recession that will follow the pandemic and which will force people to look for cheaper alternatives in transport. Also the current situation will force airports to implement the best innovations that would otherwise take years. For example, airports are increasingly using biometric technology to identify passengers and not force them to touch different things or communicate with people on the premises. The same goes for automatic screening technologies, which can significantly speed up the process of queuing, and the new hygiene habits of the passengers themselves, acquired during the pandemic, can help make airports much cleaner in general.

Meanwhile, thanks to the efforts of domestic aircraft builders, Ukraine remains one of the seven countries with a full cycle of aircraft development. The aviation industry of Ukraine is the largest branch of the defense industry and mechanical engineering, a priority sector of the economy defined at the legislative level! Ukraine has the best transport aircraft production school in the world! Recent global trends show that developed countries are actively supporting the development of their domestic production, governments and heads of state care about this.

The aviation industry provides an economic multiplier effect for related sectors of the economy, connected by a single technological chain. Thus, according to various estimates, one job in the aviation industry stimulates the creation of 8 to 12 jobs in related industries, as well as additional jobs in infrastructure and services. Unfortunately, today the aviation industry is in a difficult situation without proper state support, contrary to international experience, which shows that each aviation

state helps its own aircraft construction, subsidizes (as evidenced, for example, the dispute between Boeing and Airbus in the WTO).

### **2.1.2. Dynamics of passengers and cargo turnover in Ukraine**

Passenger traffic is the movement of passengers in one direction of the route. Passenger traffic can be in forward or backward directions.

The passenger traffic is characterized by:

- power or tension, that is, the number of passengers that passes at a certain time on a given section of the route in one direction (by any mode of transport);
- the volume of passenger traffic, that is, the number of passengers carried by the considered mode of transport for a certain period of time (hour, day, month, year).

A characteristic feature of passenger flows is their unevenness, they change over time (hours, days, days of the week, seasons).

Information on the volume of air traffic in Ukraine is available on the websites of the State Statistics Committee (SCS) and the State Aviation Service (SAS) of Ukraine. The data presented on the official websites relate to the volume of traffic (number of passengers and cargo, passenger and tonne-kilometers) performed by enterprises registered in Ukraine. Although the source of data for the SCS is the Ministry of Infrastructure of Ukraine, to which the SAC is subordinated, the volumes of air traffic listed on the websites of the above-mentioned organizations differ slightly in some years.

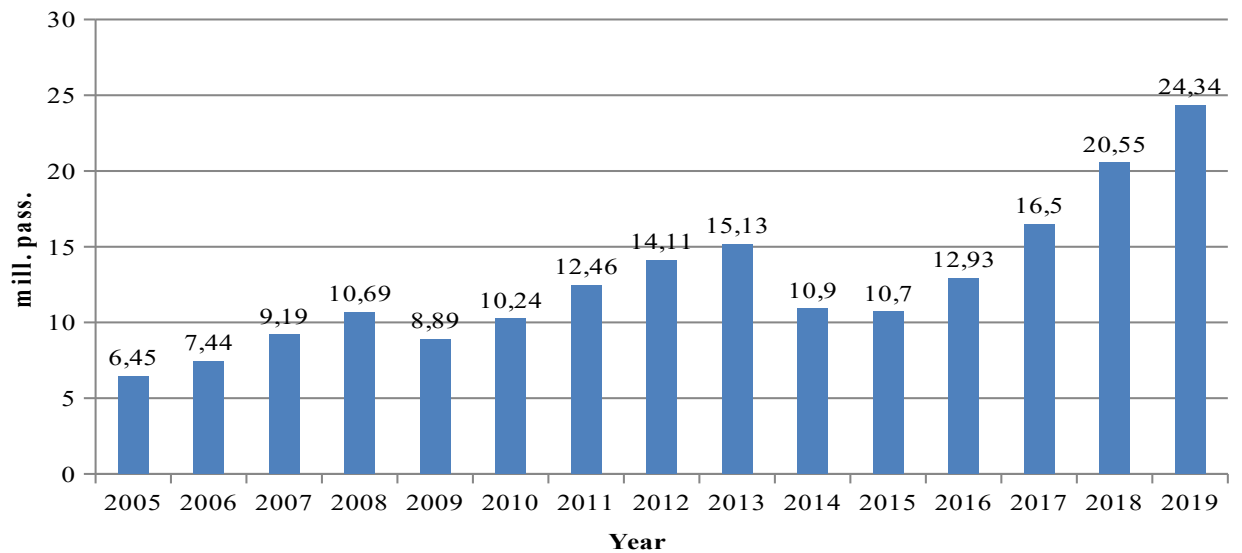


Fig. 2.5. Dynamics of passenger traffic in Ukraine, 2005-2019

According to the fig. 2.5., we can make a conclusion that dynamics of passenger traffic in Ukraine is very variable. Quantity of transported passengers in each country depends on economy situation, policy and level of technology development. Unfortunately, the War on the East of Ukraine in 2014 changed a situation for a worse. That's why a situation with passenger transportation within 2 next years (2014-2015) wasn't favorable. But, during the period 2016 - 2018, the passenger traffic of Ukrainian airports increased by 100%. If in 2015 it was approximately 11 million passengers, in 2018 this figure reached 20.5 million passengers and was growing further. 14 new airlines entered the Ukrainian market. The share of low-cost airlines in the message is almost 30%. In addition, more than 10 regional airports have been reopened [15].

The demand for flights from Ukraine clearly exceeds the existing supply. According to the State Border Service, in 2018, about 100 million people crossed the Ukrainian border in both directions, most of them by land transport. This means that each new airport serving international flights will have no problems with passenger traffic.

From Jan. to September 2020 in Ukraine because of COVID-19 the volumes of passenger traffic of airlines decreased compared to the same period last year by 64.7% and amounted to 3769.8 thousand people, including international - by 65.4% and amounted to 3380 thousand people.

Freight turnover refers to the amount of goods transported within one enterprise or a particular mode of transport, a particular industry and the state as a whole. It is customary to measure this indicator in ton-kilometers, but most often it is simply the total tonnage of the performed traffic. With regard to transportation carried out in a certain area and in the whole state, both units of measurement are used, and when assessing the activity of a transport facility or node, only the total weight of the transported in tons is used.

An open source is also the World Bank database, which publishes the total volume of airline traffic by country of registration.

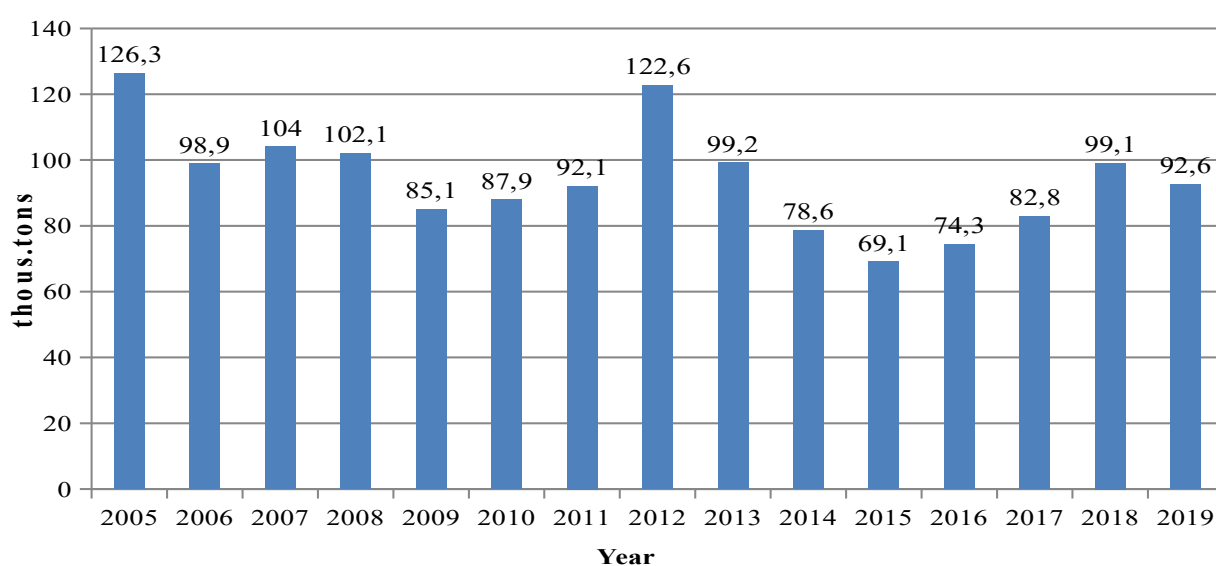


Fig. 2.6. Dynamics of transferred cargo in Ukraine, 2005-2019

As you can see at fig. 2.6., the largest drop of transported cargo was observed in 2014-2015. The causes of the crisis are well known to all. However, during 2016-2018, there has been a trend towards a recovery in freight traffic. Over the four months of 2020, 40% less cargo was transported by air mode of transport than in the same period last year.

### **2.1.3. Demand assessment for air transportation in Ukraine**

Demand is an economic principle referring to a consumer's desire to purchase goods and services and willingness to pay a price for a specific good or service. Holding all other factors constant, an increase in the price of a good or service will decrease the quantity demanded, and vice versa. Market demand is the total quantity demanded across all consumers in a market for a given good [16].

The study of demand for air transportation begins with the formation of a database. An example of such a database is the ICAO database, which is formed from the reports provided by airlines and airports of member states of this organization. The analysis of such data structure showed that in fact from ICAO it is possible to receive a database on volumes of demand for air transportation with a delay from one to two years. In addition, processing the data obtained from ICAO is not automated, so the analysis requires additional resources, including time to obtain a report in accordance with the relevant task or study.

But with regard to the analysis of the demand volume for air transportation of a particular country, the problem of updating and processing the database could be solved by involving the relevant IT. Typically, the country's aviation authorities formulate requirements for statistical reporting of airlines, organize the collection, storage and process obtained data, as is done in website of the US Bureau of Transportation Statistics. That is, today it is mandatory to collect and provide



statistical information by airlines to the relevant authorities, and therefore the formation of the necessary for full-fledged, different in purpose and strategic, tactical, operational areas of PBX research will not require additional resources from the system. The question is only to automate the receipt of data in real time and the formation of the necessary structure (fig. 2.7.).

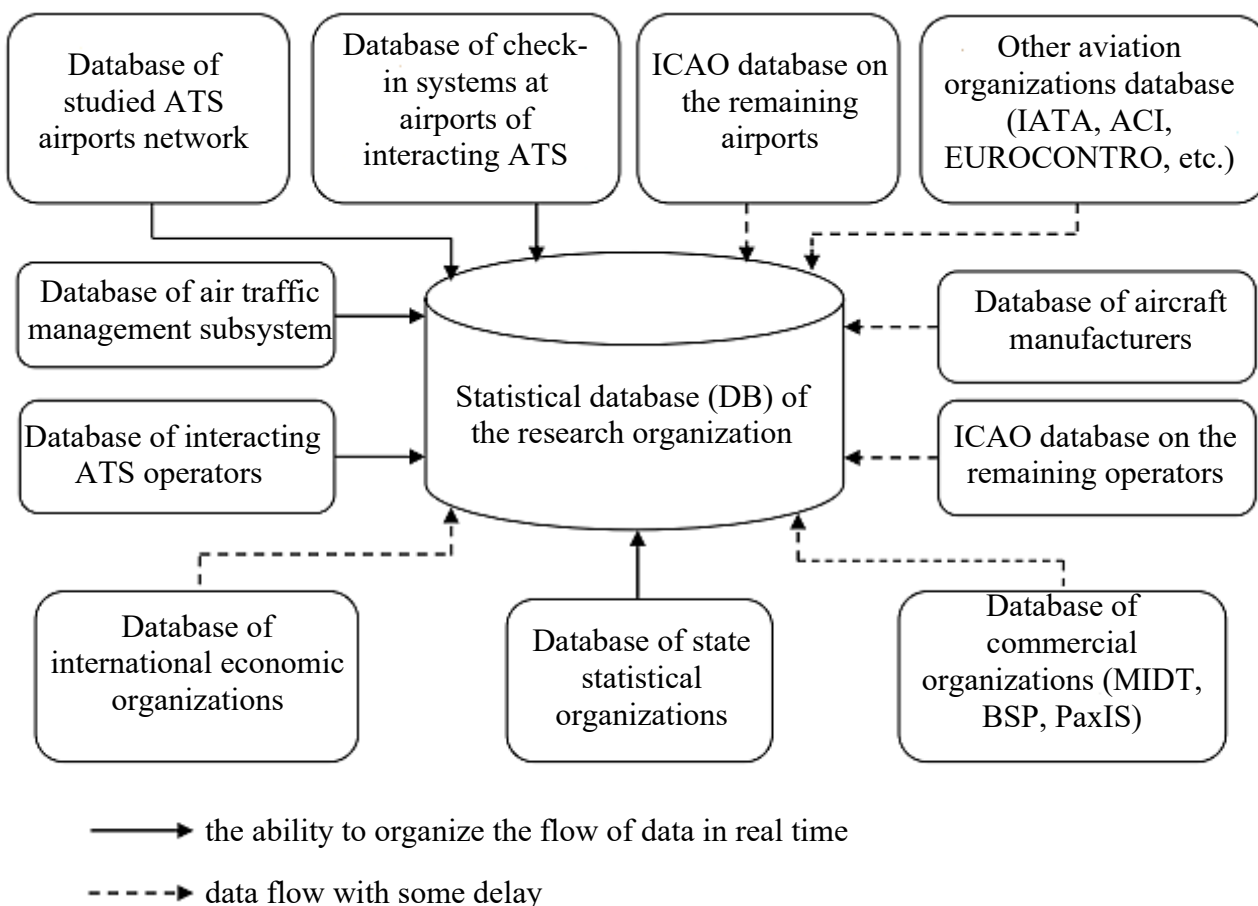


Fig. 2.7. General scheme of research database organization for analysis of demand volumes for air transportation

It is very important to organize a statistical base to expand the description of air transportation, which would allow studying information about the actual route flows, only the distance of the volume and voltage of the transfer. The source of this information may be the system of booking and sale of the system of registration of flows at airports. In addition, information can be obtained from the commercial source of the Market Information Data Tape (MIDT), which records data on passenger orders made through Global Distribution Systems (GDS) [17].

Political and, as a consequence, economic instability in Ukraine have led to a decrease in investment attractiveness and a lack of attraction of financial resources into the economy of the regions from outside.

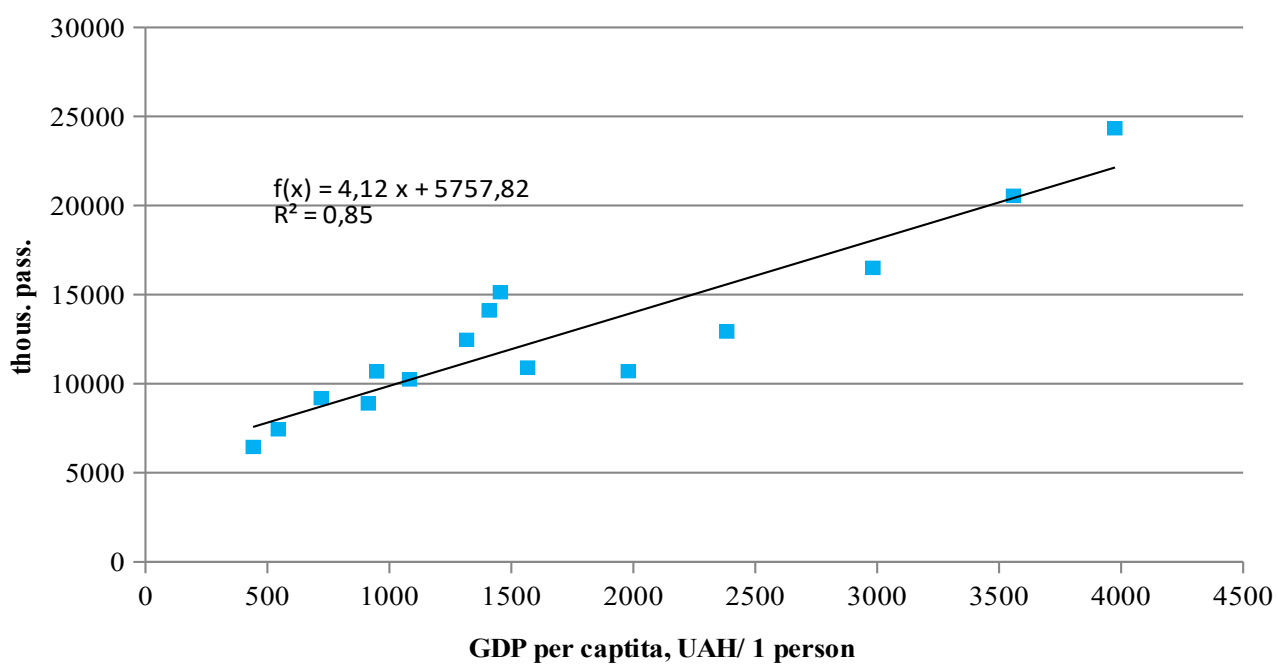


Fig. 2.8. Dependence of passenger air traffic on GDP per capita (data for 2005-2019)

The study of the development of air passenger traffic dependence on socio-economic factors (fig. 2.8.), showed a close correlation (the coefficient of determination of the linear trend is 0.95) between the volume of traffic and GDP per capita. Freight transportation of Ukrainian airlines doesn't dependent on GDP or

other socio-economic factors, which can be explained by the resource usage of Ukrainian freight airlines outside Ukraine.

## 2.2. Contemporary state of Kiev aviation node

Currently, there are several operating civil aviation airfields near the Kyiv aviation node - Boryspil, Kyiv (Zhulyany), Kyiv (Antonov), Uzyn, Borodyanka, Vasylkiv, Kyiv (Sviatoshyn).

Boryspil International Airport is the largest international passenger airport in Ukraine, providing about 60 percent of all air passenger traffic in the country and is a base for leading Ukrainian airlines. This airport is the only international hub airport in Ukraine.

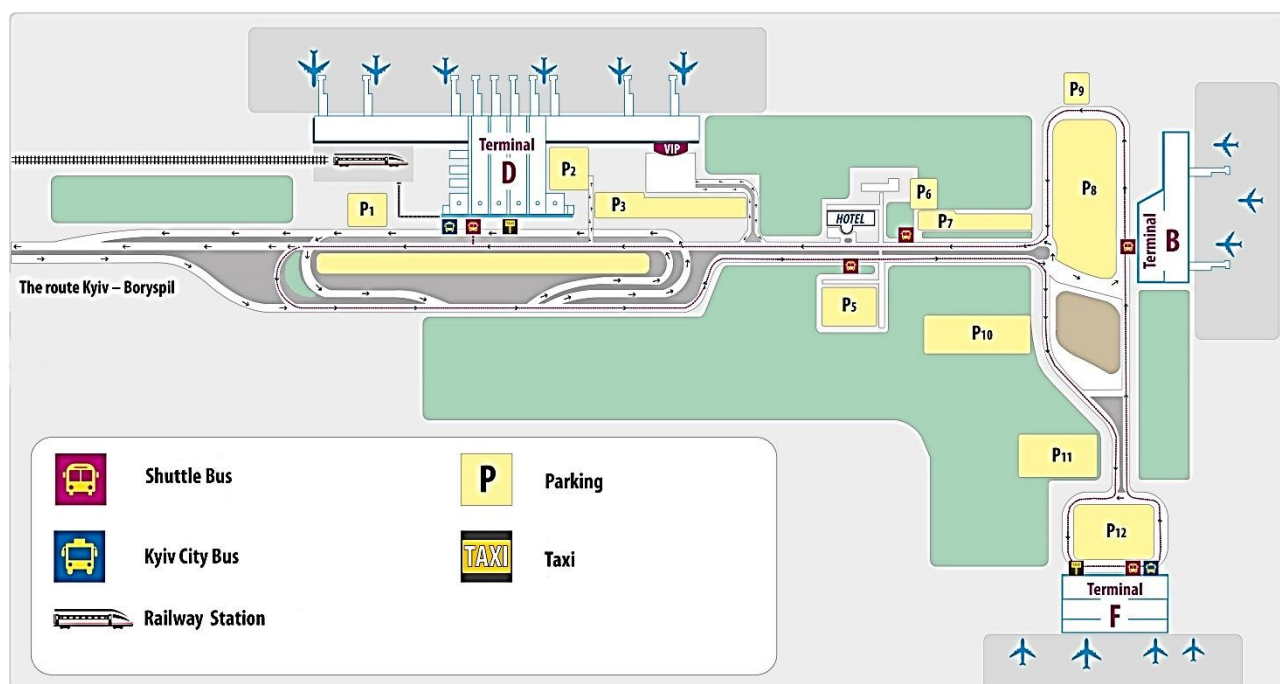


Fig. 2.9. Boryspil International Airport map

According to the analysis of demand and calculations conducted by the leading consulting company Airport Consulting Vienna GmbH, it is projected that in 2045 the airport will serve about 54 million passengers a year. At the same time, the capacity of access roads will be completely exhausted and there will be a need to create a new transport infrastructure. In addition, the growing volume of passenger

traffic in the next 10 years will force the administration of Boryspil Airport to limit the growing demand of citizens for air transportation.

Boryspil Airport is the only airport of Ukraine, successfully competing with the large European hub airports. According to the Airports Council International (ACI EUROPE), in 2018 Boryspil was ranked first among the large European airports (top spot in the European Airports group, handling from 10 to 25 million passengers).

The Airport is a full member of the core international and national associations, such as Airports Council International Europe (Airports Council International; ACI EUROPE); Ukrainian Air Transport Association (UATA), Ukrainian Chamber of Commerce and Industry, Ukrainian Association for Quality, Transport Enterprise Employers Organization, Association of Taxpayers of Ukraine etc, and is guided by the standards and practices of the International Air Transport Association (IATA), International Civil Aviation Organization (ICAO). Boryspil is the largest and the busiest airport in Ukraine, providing most of air passenger traffic and much of cargo transportation [18].

Demand for the Airport services is maintained by the beneficial location at the intersection of numerous international transport routes (connecting Asia with Europe and America), proximity to the capital, availability of the modern infrastructure and introduction of the hub development strategy.

The Airport infrastructure includes two runways (4 km and 3.5 km long), allowing accommodation of all aircraft types, without limitations under weather and visibility conditions, as well as 2 full time operating terminals (D and F). Boryspil is the only airport in Ukraine, from which scheduled transcontinental flights are operated. Boryspil Airport is mainly intended for passenger traffic. The airport has two runways with an artificial surface of 4,000 meters and 3,500 meters. Currently, there is a need for complete reconstruction of the flight zone № 2, including runway-2 and related airport facilities, which is dictated by the unsatisfactory condition of airfield surfaces, artificial base, drainage system due to full

development of regulatory resource coatings and their long-term operation aircraft, which created a load on the coverage much greater than those for which they were designed. And these are the main problems of this airline.

Runways provide reception of aircraft of all types. Boryspil Airport aerodrome corresponds to class "A". DMA "Boryspil" occupies a dominant position in air transportation between airports of Ukraine.

At the table 2.3. it is possible to be accomplished with the SWOT analysis of airport Boryspil.

*Table 2.3.*

### **SWOT-analysis of Boryspil International Airport**

| <b>Strengths</b>   | <b>Weaknesses</b>   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Airfield capabilities (runway allows to serve long-haul flights).</li> <li>2. Base airport for leading Ukrainian airlines.</li> <li>3. There are opportunities to expand the infrastructure without significant additional costs.</li> <li>4. A large share of international air transportation.</li> <li>5. Availability of a transcontinental flights network.</li> <li>6. Monopoly position among the airports of Ukraine regarding the acceptance of long-haul flights.</li> <li>7. The presence of a high-speed connection "railway station - airport".</li> <li>8. Abolition of the visa regime with the countries of the European Union.</li> </ol> | <ol style="list-style-type: none"> <li>1. High level of formalities when crossing the state border, which prevents an increase in transfer passenger traffic.</li> <li>2. Insufficiently developed transfer infrastructure.</li> <li>3. Relatively high cost of services provided by the airport.</li> <li>4. Insufficient development of available commercial infrastructure (shops, food outlets, transport).</li> <li>5. Human factor (incompetence of airport staff).</li> <li>6. Low level of aviation security.</li> <li>7. Low development of air freight.</li> </ol>  |
| <b>Opportunities</b>   | <b>Threats</b>  |
| <ol style="list-style-type: none"> <li>1. Geographical location that contributes to the development of the network of routes.</li> <li>2. Strengthening the position of the base airline (increasing the volume of traffic and connecting flights).</li> <li>3. Signing of the Common Aviation Area (CAP) Agreement of Ukraine with EU countries.</li> <li>4. Deferred demand for air transportation, which should be met after the stabilization of the epidemiological and socio-political situation in the country.</li> <li>5. The emergence of low-cost airlines.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Falling attractiveness of Ukraine for potential passengers due to hostilities, difficult socio-political and the situation in the country.</li> <li>2. Economic crisis, falling purchasing power of the population.</li> <li>3. Rising prices for aviation fuel.</li> <li>4. More successful and dynamic development of competitors' airports.</li> <li>5. The growth of foreign exchange rates.</li> <li>6. Complication of the epidemic situation on the territory of Ukraine and in the world, in connection with the pandemic of acute respiratory disease COVID-19 caused by the coronavirus SARS-CoV-2/COVID-19, which led</li> </ol> |

to a sharp decline in demand for air transportation.

This airport is considered the most popular in Ukraine. In 2018 it has even become a leader among European airports in terms of passenger traffic growth. But the quality of service among 141 airports in the world is in seventh place from the end. Experts assess how timely ships arrive and depart, whether it is convenient for passengers at the airport, and what feedback they leave.

Igor Sikorsky Kyiv International Airport is the second largest international passenger airport in Ukraine and at the Kyiv air hub, located within the Zhulyany district of the capital, 8 km southwest of Kyiv city center. The airport has undergone significant development in preparation for the Euro-2012 championship. In particular, a new international terminal "A" has been opened for international flights. At Kyiv International Airport Igor Sikorsky approximately 2,500 flights are operated monthly and almost 2 million passengers are served annually. However, over the past years, there has been a reduction in passenger traffic at the airport by 6.9 percent.

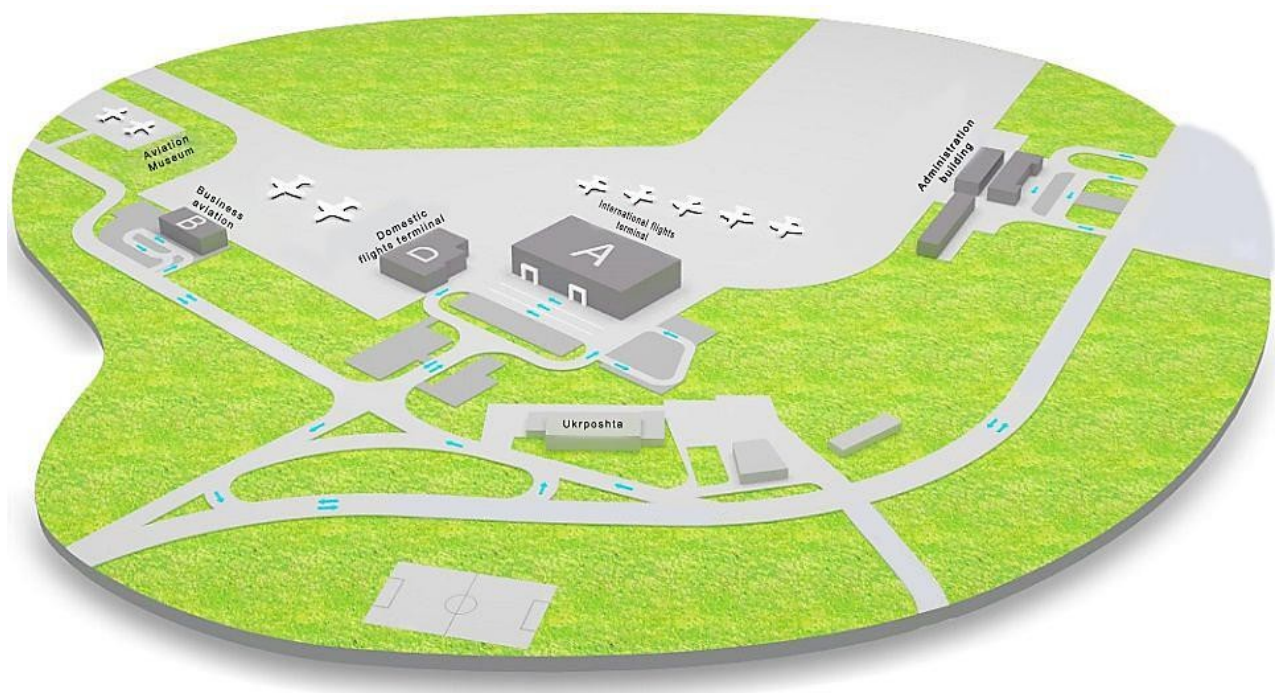


Fig. 2.10. Igor Sikorsky Kyiv International Airport map

There are three passenger terminals at Kyiv International Airport (fig. 2.10.): terminal "A". International flight service. Reception desks 1-18; terminal "B". Business terminal; terminal "D". Domestic flight service. Reception desks 1-12.

The location of the airport within the city doesn't allow developing its infrastructure, with an increase in air traffic in the near future. That is why the Kyiv air hub needs a third airport, which has free adjacent territories for further development. According to the results of the preliminary expert assessment, the optimal place for the construction of such an airport is the existing Borodyanka airport.

Analysis of the technical condition of the aerodrome and its equipment indicates the need for its modernization. In particular, the condition and bearing capacity of the aerodrome surface, the size of the runway and the RD do not meet the regulatory requirements for the operation of many types of aircraft and do not allow now to accept modern and promising 2nd class aircraft without restrictions. In addition, it is necessary to replace the light signal system, landing gear, radio navigation and air traffic control and meteorological equipment. The location of the airport, in terms of the existing residential buildings around it, and the above factors do not allow it to be considered as an option for the location of the center of air freight.

Kyiv International Airport is the second Ukrainian airport in terms of passenger traffic after Boryspil Airport (excluding temporarily occupied territories). It occupies an area of 265 hectares.

The only runway is 2310 m long and 45 m wide. In the first half of 2009, the reconstruction of the runway was completed. Due to the extension of the runway by 510 m, it became possible to receive heavier aircraft, including the Boeing 737 and Airbus A320. In August 2020, the airport will accept Jonika Airbus A321 aircraft.

The accumulation of problems was accompanied by the lack of any reaction and assistance from the government, the relevant ministry. The management of Kyiv International Airport emphasizes that it has repeatedly appealed to the authorities for help, but has not received a proper and timely response. As a result, Kyiv

International Airport (Zhulyany) will cut half of its 2,000 personnel due to the aviation crisis due to the pandemic in 2020.

At the table 2.4 it is possible to be accomplished with the SWOT analysis of Igor Sikorsky Kyiv Airport.

*Table 2.4*

### SWOT-analysis of Igor Sikorsky Kyiv Airport

| <b>Strengths</b>   | <b>Weaknesses</b>  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Base airport for low-cost foreign airlines.</li> <li>2. A large share of international air transportation.</li> <li>3. Low cost of services provided by the airport.</li> <li>4. The possibility of developing business aviation.</li> <li>5. Speed of registration procedures and, accordingly, increase of comfort for passengers.</li> <li>6. Abolition of the visa regime with EU countries</li> </ol> | <ol style="list-style-type: none"> <li>1. High level of formalities when crossing the state border, which prevents an increase in transfer passenger traffic.</li> <li>2. Insufficiently developed transfer infrastructure.</li> <li>3. Basement of most national carriers, which provide a significant amount of air traffic, at Boryspil Airport.</li> <li>4. Insufficient development of available commercial infrastructure (shops, food outlets).</li> <li>5. Human factor (incompetence of airport staff).</li> <li>6. Low level of aviation security.</li> <li>7. Low development of freight traffic.</li> <li>8. Flight field capabilities (runway does not allow to serve long-haul flights and accept all types of aircraft without restrictions).</li> <li>9. Lack of a network of transcontinental flights.</li> <li>10. Being within the city of Kyiv.</li> </ol> |
| <b>Opportunities</b>   | <b>Threats</b>   |
| <ol style="list-style-type: none"> <li>1. Geographical location that contributes to the development of the network of routes.</li> <li>2. Signing of the Agreement on SAP of Ukraine with EU countries.</li> <li>3. Deferred demand for air transportation, which should be met after the stabilization of the epidemiological and socio-political situation in the country.</li> <li>4. The emergence of new low-cost airlines.</li> </ol>          | <ol style="list-style-type: none"> <li>1. Falling attractiveness of Ukraine for potential passengers as a result of hostilities, the difficult socio-political situation in the country.</li> <li>2. Economic crisis, falling purchasing power of the population.</li> <li>3. Rising prices for aviation fuel.</li> <li>4. More successful and dynamic development of competitors' airports.</li> <li>5. The growth of foreign exchange rates.</li> <li>6. Complication of the epidemic situation on the territory of Ukraine and in the world, in connection with the pandemic of acute respiratory disease COVID-19 caused by the coronavirus SARS-CoV-2 COVID-19, which led to a sharp decline in demand for air transportation.</li> <li>7. Limited opportunities to expand the infrastructure, as the airport is "clamped" in the city.</li> </ol>                        |



Over the last decade, the volume of traffic through Kyiv Airport has significantly decreased and the airport has lost the volume of services in the Ukrainian and international air transportation markets [19].

Kyiv Airport (Antonov) is an integral structural unit of the state enterprise "Aviation Scientific and Technical Complex (ASTC). Antonov is currently the only airfield in Ukraine designed for a full cycle of flight and ground tests, modernization and certification of new and existing models of aircraft.

The aerodrome has a runway with an artificial surface with a length of 500 meters and associated facilities that provide takeoff and landing of aircraft in the 1st and 2nd categories according to the standards.

The runway provides reception for almost all types of aircraft. Kyiv (Antonov) Airport aerodrome corresponds to class "B".

Other aviation entities do not significantly affect passenger and cargo air transportation.

Uzyn Aerodrome has a 3,500-meter-long artificial runway and associated facilities that take off and land aircraft in simple weather conditions. The runway and facilities at the aerodrome are in need of major repairs. Uzyn aerodrome has been removed from the Register of Civil Aerodromes of Ukraine. There is currently no air traffic at the airport.

Aerodromes, located at a considerable distance from Kiev, significant investments are needed:

- Vasylykiv Airport is owned by the Ministry of Defense, has a 2,500 m long runway and is the base airfield of Spets-Avia. The characteristics of the aerodrome and its equipment, as well as the location do not allow to create a passenger or cargo airport on its basis;

- Kyiv (Sviatoshyn) aerodrome has a runway length - 1,800 m and is an airfield of the Aviant manufacture, used for production needs; there are no prospects for development due to its location;

- Borodyanka airfield has a long runway - 2,500 m and is the base airfield of JSC "AS". Used for small aircraft flights. Located 35 km away from Kiev. It has prospects for development in the existing and adjacent territories.

So, Kyiv aviation node needs much more investment, in order to increase profit indicators and quality services.

### **2.3. Forecasting methodology of the air transportation development**

Forecasting is the process of making predictions of the future based on past and present data and most commonly by analysis of trends. A commonplace example might be estimation of some variable of interest at some specified future date. Prediction is a similar, but more general term. Both might refer to formal statistical methods employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgmental methods. Usage can differ between areas of application: for example, in hydrology the terms "forecast" and "forecasting" are sometimes reserved for estimates of values at certain specific future times, while the term "prediction" is used for more general estimates, such as the number of times floods will occur over a long period.

According to the latest version of the IATA Airport Development Reference Manual, before planning and designing a new airport, it is necessary to predict the future level of development of the region that will serve this airport. The forecast needs to take into account many different factors, such as the number of flights expected and the corresponding passenger traffic, the volume of cargo to be transported, trends in economic development of the region, population growth and mobility, etc. The most important characteristic is the annual volume of passenger traffic. This value is determined when forecasting development prospects. The forecasting period to be considered during the construction of the new airport must be at least 30 years.

Due to the lack of empirical data to analyze the development of air traffic at Borodyanka Airport in the long run, an analysis of the general trend of air traffic in Ukraine and the world was used.

In other words, the operating conditions of the future airport are compared with similar conditions in other airports in the past, and their change is analyzed. After collecting and analyzing the required amount of data, an expert opinion is formed on the development of air transportation at the new airport in the next 30 years.

The described model of forecasting long-term demand for air transportation is presented at fig. 2.11. This model is based on the assumption that, if we study a sufficiently large database of airports, we can find at least one airport, which in the past had air traffic volumes similar to those currently observed at the airport under study.

According to the Strategic Development Concept, the following segments of air transportation will be developed at Borodyanka Airport:

- passenger transportation, including budget airlines;
- charter flights;
- air transportation of goods, including large industrial cargo;
- aircraft maintenance;
- general purpose aircraft not used for commercial air transportation or aviation operations.

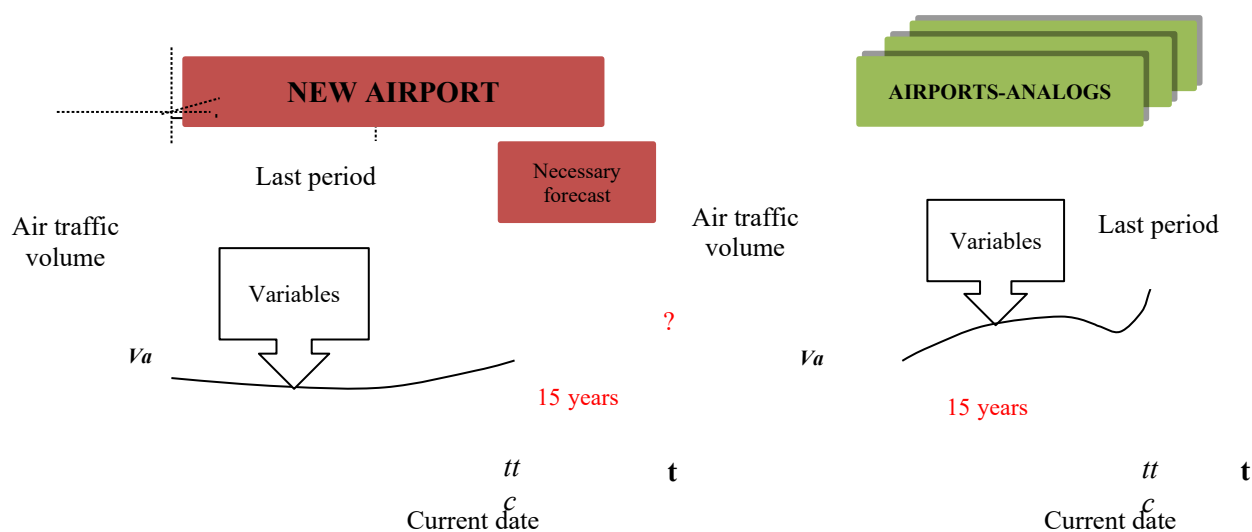


Fig. 2.11. Forecasting long-term demand model for air transportation

#### **2.4. Borodyanka airport establishment**

Borodyanka Airport will be designed to operate both domestically and on international airlines. The main emphasis is on the justification of transit flights, which will amount to approximately 75%.

Kyiv Borodyanka International Airport will perform the functions of the regional airport of Kyiv region, transport hub of the region, meeting the growing needs of passenger traffic, expanding the airport infrastructure of Kyiv, servicing the airline, charter flights, business aviation, transport aviation, providing transport logistics center [20].

A modern, efficient and expanded airport will unload the Kyiv aviation hub, and in the future, will become the basis for economic growth of our country and will serve as an invisible bridge between Ukraine and the world.

The creation of Borodyanka Airport should provide:

- increase in the volume of air transportation, both special and general;
- creation of additional jobs, growth of employment;
- increase in budget allocations;
- change of infrastructure of the region (transport, medical care, education, etc.);
- attracting foreign investment in the national economy of Ukraine;
- increase in the production of consumer goods, including increased complexity - light aircraft and small helicopters;
- increasing the quantity and quality of aviation and non-aviation services to the population of Kyiv, adjacent regions and Ukraine;
- the possibility of creating aviation salons-exhibitions for showing, advertising and concluding business contracts for aircraft of domestic and foreign production;
- creation of a reserve airfield in the Kyiv region

The creation of Borodyanka Airport will allow Kyiv, the capital of the country, to have two powerful international airports.

#### **2.4.1. Practicability of Borodyanka airport creation**

The implementation of this project will cause further development of the existing infrastructure of the region, the network of roads and railways, the creation of about 12,500 additional jobs.

Execution of air transportation services will ensure a stable income of Borodyanka Airport, will lead to more intensive use of Ukrainian airspace by airlines. All the above will ensure the growth and stability of the state budget.

In addition to the direct output of the civil aviation sector and the employment it provides, air transport has a wider impact on the economy as a whole. Civil aviation acts as a catalyst for the activities of passenger markets, as well as for trade in goods, indirectly complementing the overall growth of the developing economy at the expense of the public who uses its services. These indirect types of economic activity also create employment. Finally, profits from employment and commercial activities provide another stage of spending on personal consumption goods directly in civil aviation and indirectly in other areas of the economy and help to invest in all sectors of the economy. Direct, indirect and artificially induced economic factors have a total impact on the economy of the region as a whole. Research in this area shows that the overall contribution of civil aviation to the global economy increases the direct economic contribution by 3 times in value and 6 times in terms of job creation. The estimated cost of the project, according to analogues, is about 1.5 billion US dollars.

The main purpose of the Concept is to create a solid foundation for the renewal and modernization of the airport's infrastructure and its further development, as an International Airport, which will be focused on transportation both within the country and on international airlines. The shortest route from Europe to the Far East and Central Asia is through Russia and Ukraine, which is about 20% shorter than the southern option through Turkey and Iran. Given these trends, as well as the strategic position of Ukraine, it is advisable to create an international complex on its

territory to provide air transportation. This is confirmed by numerous statements and proposals of foreign brokerage and freight forwarding companies.

#### **2.4.2. Strategic vision of the aerodrome development**

In accordance with the information above, the main emphasis is on servicing transit flights, which will amount to approximately 75%. To achieve this, it is planned to develop a wide network of air services from regional airports in Europe, regional airports in Ukraine and Middle Eastern airports to become the best choice for people traveling between Europe, Ukraine and Asia, based on quality of service, speed of service, optimality and infrastructure.

The main strategic task of Borodyanka International Airport is to create a transnational center of air transportation, a transnational air corridor "north-south", "east-west".

The creation of a transnational air transportation center will be another confirmation of Ukraine's positive image as a democratic, open country with a market economy. Based on this, the following strategic objectives for the construction of Borodyanka International Airport are determined:

- meeting the needs of the market in the growing volume of passenger air traffic;
- meeting the needs of the market in heavy freight transportation with the use of large wide-body aircraft with a capacity of 130-150 tons and more (such as An-124, AN-70, B-747F, MD-11);
- bringing, using the geographical position of Borodyanka Airport, the volume of cargo flow services to 100 thousand tons of cargo per year, which will also lead to more intensive use of Ukrainian airspace by airlines;
- conducting flight tests of new models of aircraft, sale through the trade network of Ukraine, CIS countries and abroad of aircraft and helicopters of Ukrainian production;
- maintenance, repair of aircraft of any airlines;

- provision of aviation services to individuals - storage, maintenance, repair of aircraft;

- provision of non-aviation services - vocational education, hotels, hairdressers, cafes, bars, offices, bank branches, parking lots and service stations, shops, etc.;

In perspective:

- holding air shows with full service of organizations demonstrating their products and visitors to exhibitions;

- in the absence of an air show, the provision of pavilions (hangars) for the demonstration of any kind of goods (exhibitions).

Based on an estimate of the heavy and bulky cargo market (estimated by OBN Aviation Inc, Washington), one tenth of this volume can be performed by air, which is equivalent to two million tons. In 2016, 716 billion ton-kilometers of freight traffic is expected to be performed by air. The share of cargo aircraft will be 44%.

At present, the region has the necessary infrastructure to start work, namely - a network of roads and railways, a certified airport "Borodyanka" and a large area of over 1000 hectares for its expansion.

In case of further need to expand the Kyiv aviation hub, the site allows (see the scheme of the master plan) to expand the airport "Borodyanka" with the construction of the second SZPS.

The technological process of air transportation services takes into account measures that eliminate or reduce the negative impact on the environment - air and water basins, the impact of aviation noise on people and fauna, removal and disposal of waste, exposure to electromagnetic radiation.

Due to the nature of technological processes of air passenger service, cargo handling, operation of technological equipment, no emergency and volley emissions of harmful substances into the environment are envisaged.

The facility is environmentally friendly and does not contain any "degree of environmental risk". The project provides for objective means of control over aircraft noise and emission of aircraft engines on the basis of a comprehensive

monitoring system, which consists of stationary and mobile points of observation and display of information.

### **2.4.3. Analysis of factors influencing the airport construction and development**

The study found that there are a number of factors that have the greatest impact on the probability of projected air traffic. These include:

- growth of the national economy and purchasing power of the population living in the airport service area;
- entry of budget airlines into the air transportation market;
- increase in demand for air transportation as a result of future development of Kyiv International Airports. Igor Sikorsky and Boryspil;
- requirement for airport certification and obtaining international status for the start of international passenger and cargo flights;
- free access and free competition of prices and services in the air transport markets of the European Union and Ukraine;

Based on the analysis of the factors of greatest influence on the development of the air transportation market, three scenarios for the development of air transportation at Borodyanka Airport in the period from 1 to 30 years of its operation are proposed: optimistic, realistic and pessimistic. A summary matrix of factors with the greatest impact on the forecast of air traffic development at Borodyanka Airport for each scenario is given in table 2.5.

The complex forecast of air transportation development through the new Borodyanka Airport in the next 30 years, made in this section, includes: forecast of passenger air transportation; cargo air traffic forecast; forecast of take-off and landing operations (intensity of aircraft movement); forecast of the number of passengers at peak hours.

The forecast made some assumptions, including the following: the macroeconomic situation in Ukraine remains stable; the share of transfer passengers will increase significantly; Borodyanka has the potential as a transfer point and regional center of the Eastern European region; passenger flows from / to the EU



will represent the strongest market segment; long-distance connections will be developed (especially to North America and Southeast Asia); technical constraints will not affect the growth rate of traffic.

Table 2.5

**Analysis of the most probable factors influencing the projected volumes of air traffic at Borodyanka Airport**

| Influencing factors  | Scenarios of events   |   |  |
|--|---|---|--|
|  | Optimistic  | Realistic   | Pessimistic  |
| 1  | 2   | 3   | 4  |
| <b>GDP of Ukraine</b>  | The expected growth of the Ukrainian economy is about 15% annually for 10 years.  | The expected growth of the Ukrainian economy is about 10% annually for 10 years.  | Slower growth of the Ukrainian economy at 4% or less per year.   |
| <b>Coexistence of airports</b>                                   | Competition between the three main airports at the Kyiv Air Transport Hub can be assessed by comparing the characteristics of airport capacity, land use and air fares, the population living in the airport area.                | Competition between the three main airports at the Kyiv Air Transport Hub takes place in conditions of free competition without regulation by the authorities.  | The development of Kyiv and Boryspil airports allows meeting the demand for air transportation in the region.  |
| <b>Legislative regulation in the field of air transportation</b> | In the case of Common Aviation Area Agreement signing with the EU countries, provided that the budget companies of the EU member states are allowed to operate domestic flights, the volume of domestic air traffic may increase. | An Agreement on Common Aviation Area with EU countries will be adopted, and airlines from EU member states will be able to operate domestic flights in Ukraine. | If Directive 2009/12 / EU on airport charges is not implemented in the short term, Borodyanka Airport will not be able to discuss the rates of charges. Borodyanka Airport must obtain the status of an international airport in order to obtain a permit for international flights. |
| <b>Lowcost airlines</b>  | Ryanair and other low-cost carriers will be able to increase their stake in air travel at Borodyanka Airport, where they will be able to operate without any restrictions and at  | Borodyanka Airport will be able to attract leading budget airlines by reducing airport fares or by introducing various financial incentives.                    | Ryanair is expected to start operations with Boryspil Airport, continue to develop the domestic air transport market in accordance with the Common Aviation Area Agreement and won't be  |

|  |             |  |                    |
|--|-------------|--|--------------------|
|  | lower cost. |  | able to relocate.. |
|--|-------------|--|--------------------|

*Table 2.5 (completion)*

| 1                         | 2   | 3   | 4   |
|---------------------------|---|---|---|
| <b>Airport management</b> | Optimizing the management of the program of development of both passenger and cargo air transportation to attract airlines. | Borodyanka will be able to develop an optimal program for the development of both passenger and cargo air transportation to attract airlines. | Air travel development programs cannot be implemented on a permanent basis and are expensive. |

#### 2.4.4. SWOT analysis of Borodyanka airport

Since the 1960s and to this day, SWOT analysis has been widely used in the process of strategic planning. SWOT analysis (or SWOT matrix) is a strategic planning technique used to help a person or organization identify strengths, weaknesses, opportunities, and threats related to business competition or project planning.

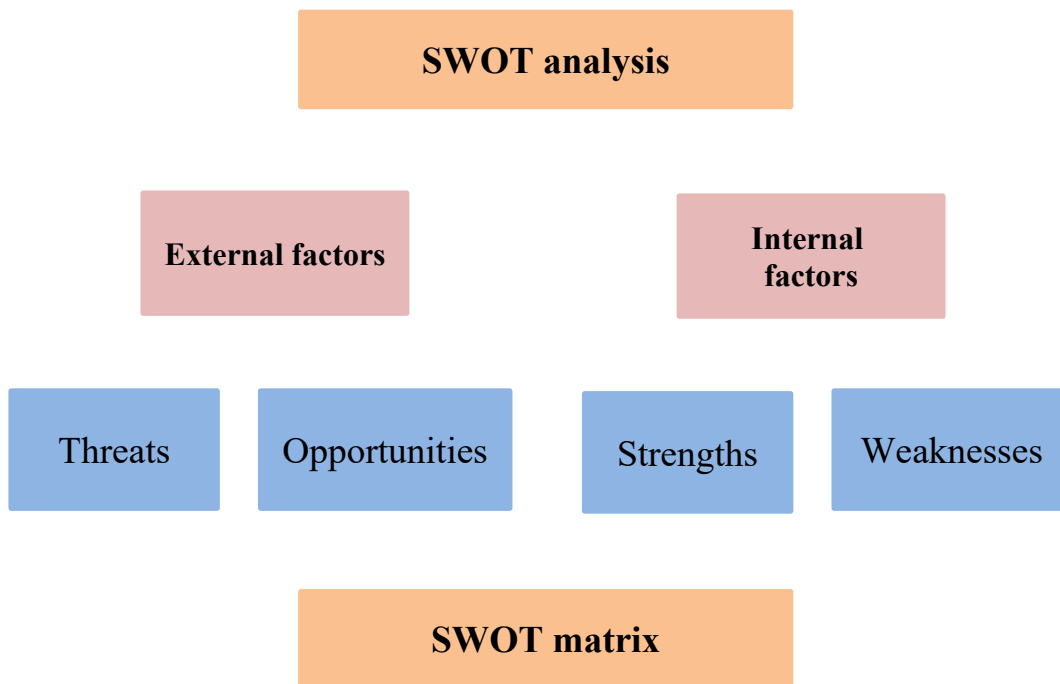


Fig. 2.12. The structure of SWOT analysis

This technique, which operates by 'peeling back layers of the company is designed for use in the preliminary stages of decision-making processes and can be

used as a tool for evaluation of the strategic position of organizations of many kinds (for-profit enterprises, local and national governments, NGOs, etc.). It is intended to specify the objectives of the business venture or project and identify the internal and external factors that are favorable and unfavorable to achieving those objectives.

It consists in dividing the factors and phenomena of the internal and external environment of the project into four categories: strengths of the project; weaknesses of the project; opportunities that open up during its implementation; threats associated with its implementation.

To substantiate the feasibility of creating an aviation complex - Borodyanka International Airport, a SWOT-analysis of the creation of such an airline was conducted [21].

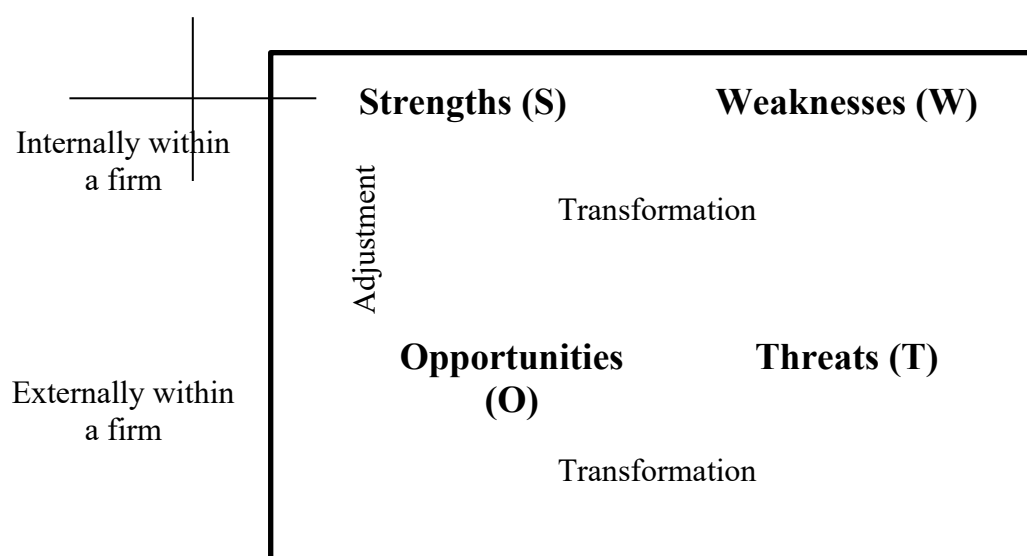


Fig. 2.13. SWOT analysis application diagram

At the first stage of the SWOT analysis, the forces - competitive advantages of the airport in the following areas are deeply studied:

- price of services;
- progressiveness of technology;
- qualification of personnel;
- the geographical location of the firm;

- infrastructure;
- the strength of competition at the "input" and "output" of the company's management system, etc.

The second stage of the SWOT analysis examines the weaknesses of the airport. It starts with an analysis of competitiveness across all markets. A tree of competitiveness indicators is built: at the 0th level - a complex indicator of the competitiveness of a particular service; at the 1st level - the beneficial effect (integral quality indicator), total costs, conditions for the use of services; at the 2nd level - specific indicators, etc. Indicators are calculated in accordance with the constructed tree. Similar figures are collected or projected for competing airports. Weaknesses on the competitive advantages of the airport studied at the first stage are determined.

At the third stage of the SWOT analysis, the factors of the macro environment (political, economic, technological, market, etc.) are studied in order to predict strategic and tactical threats to the airport and timely prevent losses from them.

The fourth stage examines the strategic and tactical capabilities of the airport (capital, assets, etc.) necessary to prevent threats, reduce weaknesses and increase strength.

At the last, fifth stage of the SWOT analysis is matched with the possibilities for the formation of the draft of individual sections of the airport development strategy.

A SWOT analysis helps evaluate where a company stands in a competitive market and what steps need to be taken for further strategic planning, helping decision makers draw a future roadmap for the company. A SWOT analysis helps organizations get visibility on their current status, letting them understand and measure overall business performance.

In conclusion, SWOT is an important tool to understand the health of an organization. It allows decision makers to identify not only where an organization stands, but also where they need to improve. This gives them the ability to be a proactive player in the market while helping them remain competitive.

SWOT-analysis of Borodyanka Airport, developed on the basis of market analysis and opportunities for airport development, is given in table 2.6.

Table 2.6

### SWOT-analysis of Borodyanka International Airport

| <b>Strengths</b>  | <b>Weaknesses</b>   |
|---|---|
| <ol style="list-style-type: none"> <li>1. The territory is free from construction, which gives the opportunity to build a new SZPS up to 4000 meters long for the operation of aircraft of all types without restrictions.</li> <li>2. Free lanes of air approaches.</li> <li>3. Favorable conditions in terms of environmental impact;</li> <li>4. Rapid population growth of cities and towns adjacent to the aerodrome.</li> <li>5. Proximity to the existing railway.</li> <li>6. Proximity to the new ring road of Kyiv, which is being designed, as well as to the international highway M07 Kyiv-Kovel-Yagodyn.</li> <li>7. Creation of about 12,500 new jobs, employment growth.</li> <li>8. Abolition of the visa regime with EU countries.</li> <li>9. Meeting the needs of the market in the growing volume of air traffic.</li> </ol>   | <ol style="list-style-type: none"> <li>1. High level of formalities when crossing the state border, which prevents an increase in transfer passenger traffic.</li> <li>2. Insufficiently developed transfer infrastructure.</li> <li>3. Basement of most national carriers, which provide a significant amount of air traffic, at Boryspil Airport.</li> <li>4. Low level of aviation security, which is a national problem.</li> <li>5. Low development of air cargo in Ukraine.</li> </ol>  |
| <b>Opportunities</b>  | <b>Threats</b>  |
| <ol style="list-style-type: none"> <li>1. Geographical position, which contributes to the development of the network of transit routes and increase the status of Ukraine as an aviation state with the full realization of its transit potential.</li> <li>2. Base airport for leading Ukrainian airlines.</li> <li>3. There are opportunities to expand the infrastructure without significant additional costs.</li> <li>4. The possibility of creating aviation showrooms.</li> <li>5. The possibility of developing business aviation.</li> <li>6. Increase in budget allocations</li> <li>7. Attracting foreign investment in the national economy of Ukraine.</li> <li>8. Development of international tourism in Ukraine</li> <li>9. Signing of the Common Aviation Area (CAP) Agreement with Ukraine.</li> <li>10. Deferred demand for air transportation, which should be met after the stabilization of the epidemiological and socio-political situation in the country.</li> </ol> | <ol style="list-style-type: none"> <li>1. Falling attractiveness of Ukraine for potential passengers as a result of hostilities, the difficult socio-political situation in the country.</li> <li>2. High degree of monopolization of the air transportation market.</li> <li>3. Economic crisis, falling purchasing power of the population.</li> <li>4. Rising prices for aviation fuel.</li> <li>5. More successful and dynamic development of competitors' airports.</li> <li>6. Rising foreign exchange rate.</li> <li>7. Complicating the epidemic situation on the territory of Ukraine and in the world, in connection with the pandemic of acute respiratory disease COVID-19, which led to a sharp decline in demand for air transportation.</li> <li>8. Reduction of investments in infrastructure and reduction of budget financing.</li> </ol> |

#### **2.4.5. Positive impact of Borodyanka airport creation on aviation overall in Ukraine**

The major pro argument for growing airports is the positive contribution to the economic welfare of the region. This becomes apparent through increases in created value, income and employment. While the internationalization and globalization cause more demand for air traffic, it is of utmost importance for developed nations to offer effective air services as a pre-condition of participating and competing in this opening world.

Airports trigger investments (e.g. runways, buildings, train lines) at the airport which automatically leads to direct employment in the region (people hired for e.g. constructions and their salary), indirect effects (other companies that benefit from employment of the people, e.g. bakery), induced (secondary) effects by higher spending power of all directly or indirectly affected people and attractiveness of the whole region. Same applies for all people employed by companies operating at the airfield.

Regional airports have many economic benefits:

- Regional airports provide jobs. Thousands of people are employed at regional airports, with an average regional airport providing up to 200 jobs for airline employees, security personnel, and passenger services employees.
- Regional airports provide freight transportation to markets throughout the country and around the world for locally produced goods.
- Regional airports provide access to the local market for goods imported from around the country and around the world.
- Regional airports enable local small business owners, contractors, and consultants to travel into and out of the local community for work, and saving valuable time that in turn can be used to conduct business.

- Regional airports can attract large business and major corporations to build local offices, factories, and distribution centers because of the readily accessible to air transportation.

Tourists, by and large, have a limited time to spend on vacation. The time spent traveling to and from a destination is often a factor in deciding where to vacation [22].

Regional airports facilitate the daily operations of general aviation. General aviation includes all aviation other than commercial and military flights. For example, training flights, law enforcement flights, medical flights, private business flights, and recreational flights all fall under the category of general aviation.

A regional airport can provide a base of operations for law enforcement search and rescue operations, just as the Illinois State Police calls Springfield's Abraham Lincoln Capital Airport home.

One of the greatest benefits to regional airports is the convenience to local travelers. Moreover, flying from a regional airport saves fuel since a round trip drive to a larger airport. In this respect, regional airports can be viewed as environmentally friendly since they eliminate many travelers' drives to a major airport.

Crowds at regional airports are generally much less than those at major airports. Jets that service regional airports usually carry between 50 and 90 passengers. Even on a day with a full flight schedule and sold out airplanes, it would be unusual to encounter more than a few hundred passengers moving through a regional airport. This reduced level of crowding and congestion in the airport translates in many ways to an improved passenger experience:

- Lines to check baggage are shorter.
- Security lines move faster. While TSA has uniform security standards, wait times are always shorter at the less crowded regional airports.
- Shorter waits for passenger services.

Less crowded parking.

According to the above mentioned information, we have the need to create another International Airport on the territory of the Kiev aviation hub, it will give the significancy for the country, economic feasibility for the region and the state as a whole (budget allocations, growth of industrial and economic potential, additional jobs, transport infrastructure development etc.). For my opinion, it is appropriate to create an aviation complex - Borodyanka International Airport.

The location of the new airport has a favorable geographical location and the possibility, if necessary, the construction of several runways, taking into account the minimum acoustic impact on the surrounding settlements.

Ukraine's economy will benefit significantly from revenues of Borodyanka International Airport usage by multinational companies involved in the implementation of powerful international projects. The construction and operation of the airfield will create more than 12,500 new jobs, as well as involve a large number of multidisciplinary enterprises in the Kyiv region, which will ensure the operation of the airport.

The development of a new airport in the Kyiv region will create conditions for aviation fairs, salons, and this is very important for Ukraine as an aviation state. It is especially important to take into account that Borodyanka airfield has great territorial opportunities for this, which are absent in the countries of Eastern Europe.

The creation of Borodyanka International Airport will allow Kyiv, the capital of the country, to have two powerful international airports. It will raise the status of Ukraine as an aviation state and full realization of its transit potential;

Given the growing volumes of passenger and cargo air traffic in Ukraine and the world, which are confirmed by the forecasts of leading aviation organizations ICAO, IATA, Boeing, Airbus and others, Boryspil Airport and Borodyanka Airport cannot be competitors by their purpose and should be considered, as two separate transport enterprises to solve state economic problems [23].



3. ***DESIGN PART***

Air Transportation Management  
Department

NAU.20.03.86 004EN

|            |                   |  |  |
|------------|-------------------|--|--|
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DESIGN PART

| Letter | Sheet | Sheets |
|--------|-------|--------|
|        | D     | 71     |
|        |       | 32     |

|                        |                 |  |  |
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| Head of the Department | Shevchuk D.O.   |  |  |

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### 3.1. Forecast of Kyiv air traffic node development

A transport hub is a place where three or more lines and flows of one or more modes of transport intersect.

*Table 3.1*

#### Passenger and cargo traffic statistics in Kyiv Airport, 2010-2019

| Year | Passenger Traffic, pass. | Cargo Traffic, tons |
|------|--------------------------|---------------------|
| 2010 | 590770                   | 1350                |
| 2011 | 640160                   | 1425                |
| 2012 | 961900                   | 2590                |
| 2013 | 1250266                  | 1680                |
| 2014 | 1090120                  | 1210                |
| 2015 | 944305                   | 1100                |
| 2016 | 1127500                  | 1420                |
| 2017 | 1851600                  | 1530                |
| 2018 | 2812300                  | 1610                |
| 2019 | 2617900                  | 1566                |

According to the table 3.1 it is possible to see development trend of passenger and cargo traffic statistic in Kyiv Airport. But, the location of this airport doesn't allow expanding its territory, so, for my opinion, in Kyiv there should be more than one airport.

*Table 3.2*

| Year | Passenger Traffic, pass. | Cargo Traffic, tons |
|------|--------------------------|---------------------|
| 2010 | 6691800                  | 61530               |
| 2011 | 8029400                  | 62628               |
| 2012 | 8478000                  | 85820               |
| 2013 | 7930000                  | 69440               |
| 2014 | 6890400                  | 58950               |
| 2015 | 7277100                  | 51825               |
| 2016 | 8650000                  | 52010               |
| 2017 | 10554800                 | 62100               |
| 2018 | 12603300                 | 70361               |

|      |          |       |
|------|----------|-------|
| 2019 | 15260300 | 69450 |
|------|----------|-------|

**Passenger and cargo traffic statistics in Boryspil Airport, 2010-2019**

According to the table 3.2 it is possible to see development trend of passenger and cargo traffic statistic in Boryspil Airport. But, the location of this airport doesn't allow expanding its territory, so, for my opinion, in Kyiv there should be more than one airport

There are specialized and integrated transport hubs. Specialized are the centers of one mode of transport. Integral combines 2-4 modes of transport. Kyiv is the only integrated automobile-aviation-railway-river transport hub.

*Table 3.3*

| Year | Passenger Traffic, pass. | Cargo Traffic, tons |
|------|--------------------------|---------------------|
| 2010 | 7282570                  | 62880               |
| 2011 | 8669560                  | 64053               |
| 2012 | 9439900                  | 88410               |
| 2013 | 9180266                  | 71120               |
| 2014 | 7980520                  | 60160               |
| 2015 | 8221405                  | 52925               |
| 2016 | 9777500                  | 53430               |
| 2017 | 12406400                 | 63630               |
| 2018 | 15415600                 | 71971               |
| 2019 | 17878200                 | 71016               |

**Passenger and cargo traffic statistics in Kyiv Aviation Node, 2010-2019**

According to the plates described above, passenger traffic is developing faster. Therefore, it is urgent to transfer their future share to Borodyanka Airport to improve the environment of Kyiv and to expand the transport aviation network of Kyiv.

In general, air mode of transport in our country develops the quantity of its transportations each year. So, for my opinion it is rational to create new modern airport in the future on the territory of Borodyanka aerodrome, because it has a big space for expansion, it is located not far from Kiev. Borodyanka Airport is going to be designed approximately to serve middle and long-haul air transport. In addition

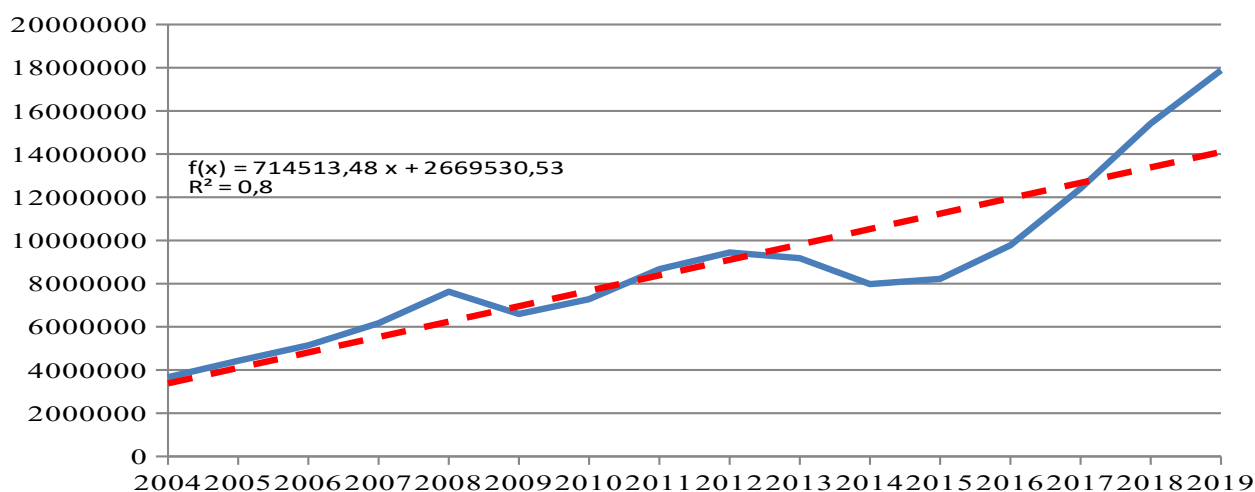
to Ukraine's needs, it will be able to provide West-East and South-North transport links, which, in turn, will form a kind of Air Bridge of world importance.

In order to predict approximate passenger and cargo traffic of Borodyanka airport we need to use above said data (tables 3.1 – 3.3) and make a forecast of the whole passenger and cargo traffic in Kyiv region.

Trend is a general direction in which something is developing or changing. It is possible to make forecast using the following types of trend lines at MC Exel:

- Linear;
- Polynomial;
- Exponential;
- Logarithmic;
- Power.

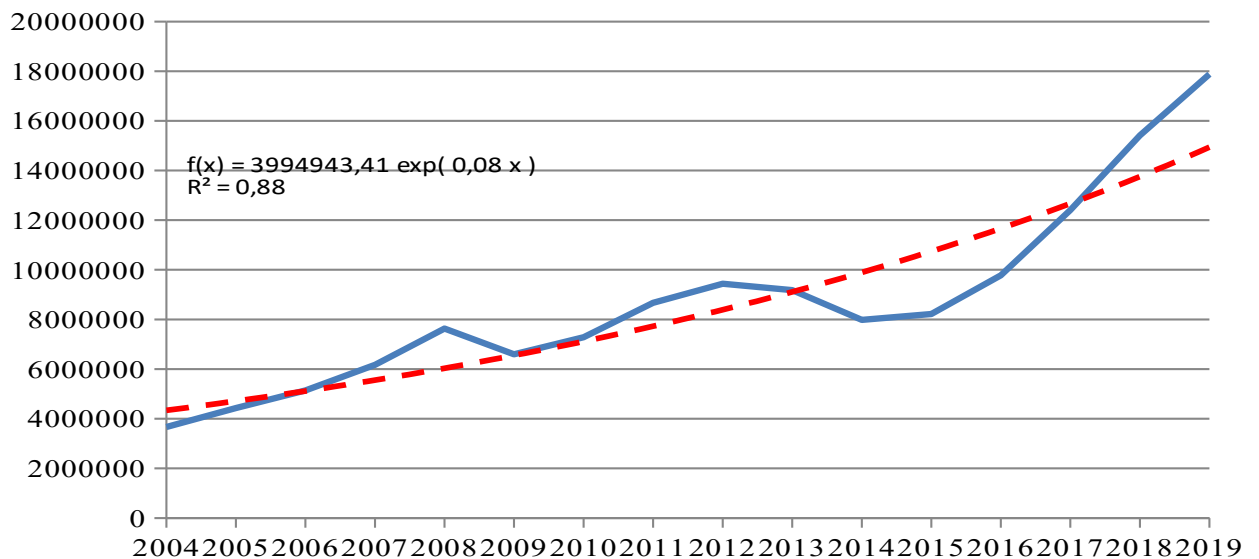
Most line equations are in the form  $Y = MX + C$  with Y as variable on the y-axis, M as the slope or coefficient of the X variable, which is the values on your y-axis, C is the constant or value when no X value is present. The linear graph can sometimes be unrealistic, for example, the y-intercept is negative. In this case when there are no sales profit is negative, in this context it may make sense, but it always something to look out for, especially if the y-axis shouldn't take negative numbers.



In our case the linear trend will have the following result:

Fig. 3.1. Passenger traffic statistics (linear trend line)

According to the fig. 3.1 we can see that R-squared is only 0,8039, means that it is better to search other type of trend, which can be more accurate ( $R^2$  should be more than 0,95).



An Exponential equation is of the form  $Y = M_1 e^{(m \cdot X)}$ , where  $e$  - represents the 2.71828, or  $(1 + 1/n)^n$ .  $e$  is a very important in mathematics and economics, for example in determining the value of a return of investment with compounding interest like an account that starts at \$1 and offers an annual interest rate of  $R$  will, after  $t$  years, will yield  $e^{Rt}$ . The name derives from its shape, an exponential or rapid increase.

Fig. 3.2. Passenger traffic statistics (an exponential trend line)

According to the fig. 3.2 we can see that R-squared is only 0,8782, means that it is better to search other type of trend, which can be more accurate ( $R^2$  should be more than 0,95).

A logarithmic equation is always of the form  $Y = m_1 \cdot \ln(X) + C$ . A logarithmic equation is similar to the inverse of the exponential function. Here Ln represents the natural logarithm or log base e. As a result  $\ln(e) = 1$ . To use other numbers so that it does not look so complex,  $\ln(10) = 2.302$ , so  $e^{2.302} = 10$ , you take e as the base (what to the power of e gives the value derived by the natural logarithm). The graph tends to rise very quickly and then trails off slowly rising as the x value increases.

According to the fig. 3.3 we can see that R-squared is only 0,642, means that it is better to search other type of trend, which can be more accurate ( $R^2$  should be more than 0,95).

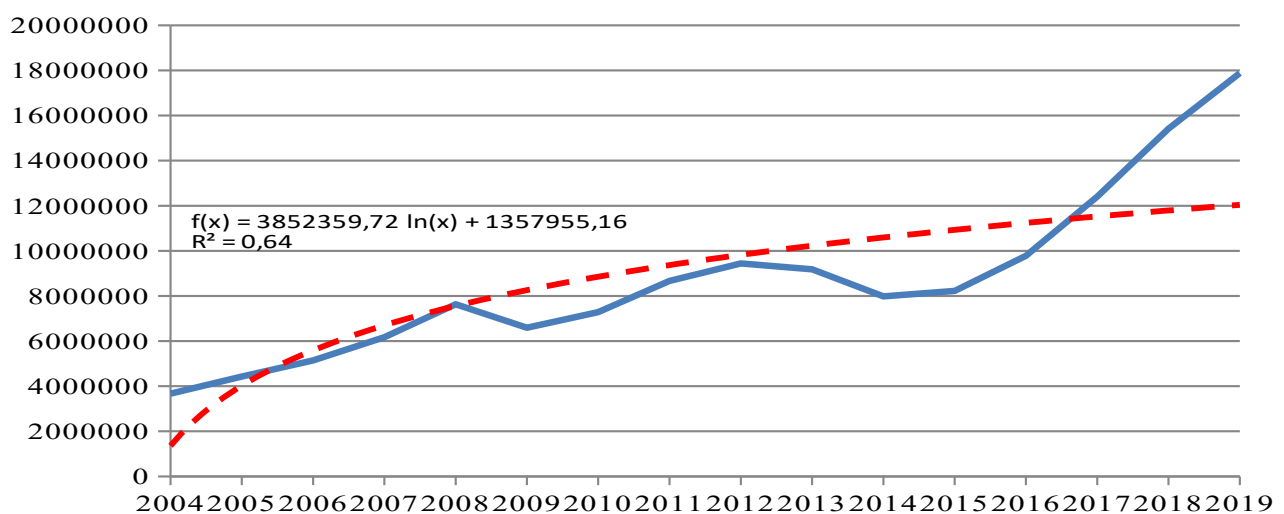
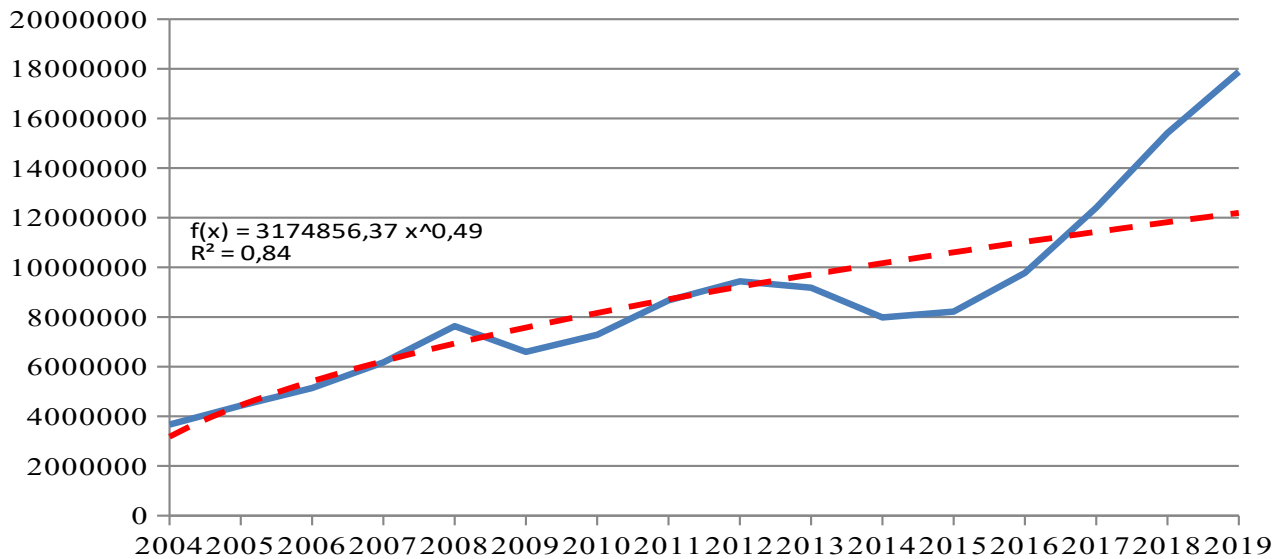


Fig. 3.3. Passenger traffic statistics (logarithmic trend line)



A power curve is of the form  $Y = m_1 * X^{(m_2)}$ . The power trend line does not have a constant and is dependent on the x-axis value and a constant determined by tableau. It may look similar to the linear function in the graph, but it is created from a completely different function. R-squared is only 0,8365.

Fig. 3.4. Passenger traffic statistics (power trend line)

Polynomial Regression is a form of regression analysis in which the relationship between the independent variables and dependent variables are modeled in the nth degree polynomial. Polynomial Regression models are usually fit with the method of least squares. The least square method minimizes the variance of the

coefficients, under the Gauss Markov Theorem. A Polynomial equation is always in the form  $Y = M_1X_1 + M_2X_2^2 + M_3X_3^4 + M_4X_4^5 + M_5X_5^6 + M_6X_6^7 + M_7X_7^8 + C$ .

**Passenger traffic forecast, which excludes data of 2020:**

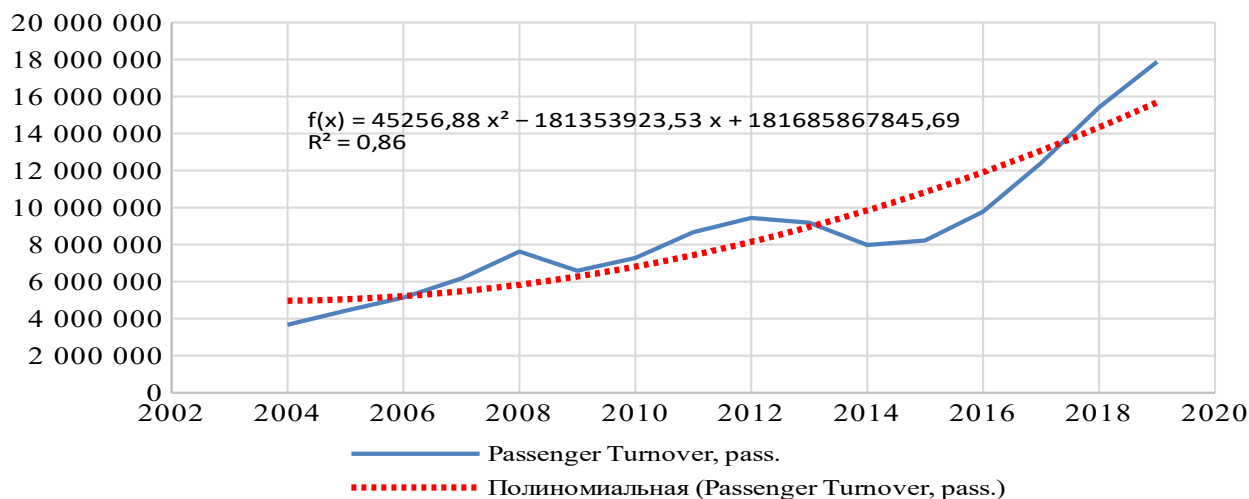


Fig. 3.5 Passenger traffic statistics of Kyiv air node, passengers

According to the fig. 3.5 we can see that R-squared is more than 0,95 - 0,968, means that it is the best type of trend, which can be used in our forecast of passenger and cargo traffic in Borodyanka airport.

A polynomial trend line is a curved line that is used when data fluctuates. It is useful, for example, for analyzing gains and losses over a large data set. The order of the polynomial can be determined by the number of fluctuations in the data or by how many bends (hills and valleys) appear in the curve. An Order 2 polynomial trend line generally has only one hill or valley. Order 3 generally has one or two hills or valleys. Order 4 generally has up to three. More accurate data appears when we are using order 2 in predictions.

For forecast calculation of passenger traffic in Kyiv air node the following formula should be used:

$$y = 45257x^2 - 2E+08x + 2E+11, \tag{3.1}$$



where  $x$  is a certain period of time, which should be predicted.

Table 3.4

**Polynomial coefficients for passenger traffic forecast**

| 1        | 2       | 3      |
|----------|---------|--------|
| $x^2$    | $x$     | $b$    |
| 45256,88 | -2,E+08 | 2,E+11 |

Using formula 3.1. we can predict approximate passenger traffic in Kyiv node from 2021 to 2030.

Table 3.5

**Passenger traffic forecast in Kyiv avian node**

| Year | Passenger traffic, passengers |
|------|-------------------------------|
| 2021 | 18 653 498                    |
| 2022 | 20 273 149                    |
| 2023 | 21 983 314                    |
| 2024 | 23 783 993                    |
| 2025 | 25 675 185                    |
| 2026 | 27 656 891                    |
| 2027 | 29 729 111                    |
| 2028 | 31 891 845                    |
| 2029 | 34 145 092                    |
| 2030 | 36 488 854                    |

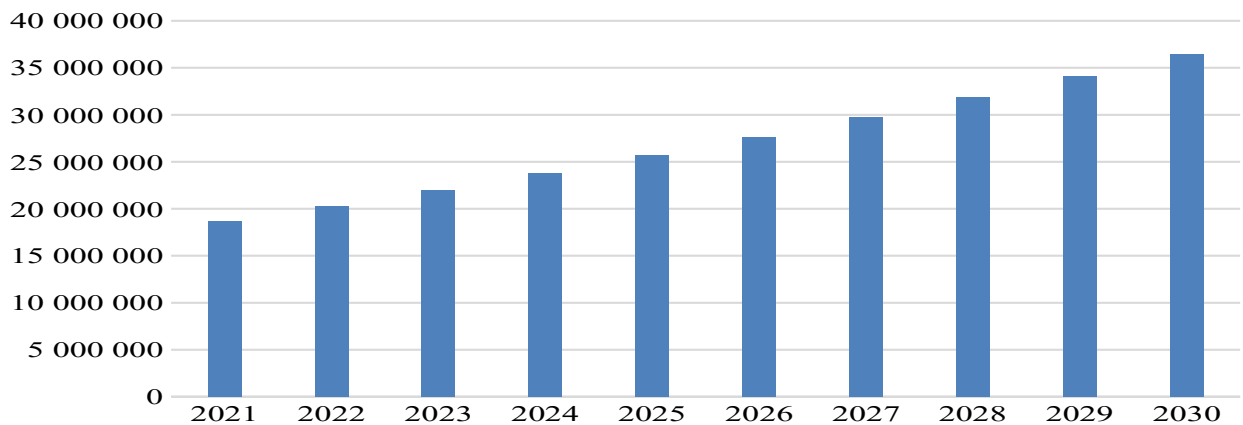


Fig. 3.6. Diagram of passenger traffic forecast in Kyiv avian node, passengers

So, according to the obtained above information, the passenger traffic in Kyiv node in 2030 will be increased in several times.

The issue of increasing air traffic is becoming attractive. This will give a certain financial effect for our country. However, already in 2025-2027, passenger traffic will force the airport administration to limit the growing demand of citizens for air transportation. In order to increase passenger traffic and economy situation of Ukraine we need to create new airport, which can help to handle above said (fig.3.6) advanced quantity of passengers.

**Cargo traffic forecast, which excludes data of 2020:**

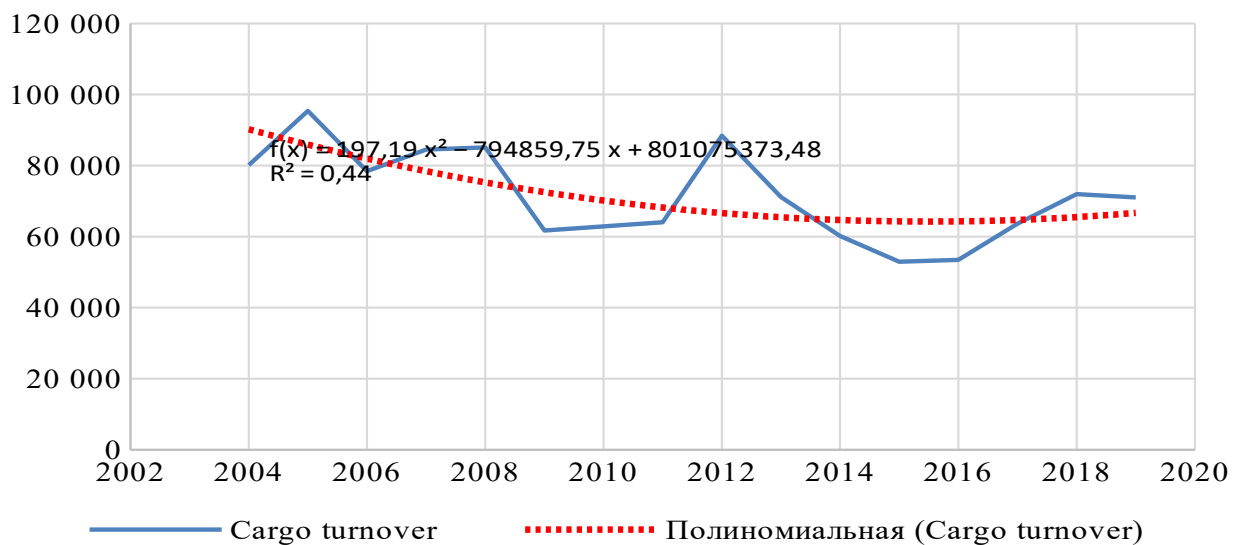


Fig. 3.7 Cargo traffic statistics of Kyiv air node, tons

R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the

coefficient of multiple determinations for multiple regressions. The definition of R-squared is fairly straight-forward; it is the percentage of the response variable variation that is explained by a linear model. R-squared is always between 0 and 100%. In our case, it is 93%, that is relatively high, that means our forecast is correct.

For forecast calculation of freight traffic in Kyiv air node the following formula should be used:

$$y = 197,19x^2 - 794860x + 8E+08, \quad (3.2)$$

where x is a certain period of time, which should be predicted.

*Table 3.6*

**Polynomial coefficients for cargo traffic forecast**

| 1                    | 2        | 3        |
|----------------------|----------|----------|
| <b>x<sup>2</sup></b> | <b>x</b> | <b>b</b> |
| 197,19               | -794 860 | 8,E+08   |

Using formula 3.2 we can predict approximate cargo traffic in Kyiv node from 2021 to 2030.

*Table 3.7*

**Freight traffic forecast in Kyiv avian node**

| Year | Cargo traffic, tons |
|------|---------------------|
| 2021 | 70 252              |
| 2022 | 72 627              |
| 2023 | 75 396              |
| 2024 | 78 560              |
| 2025 | 82 118              |
| 2026 | 86 071              |
| 2027 | 90 418              |
| 2028 | 95 159              |
| 2029 | 100 294             |
| 2030 | 105 824             |

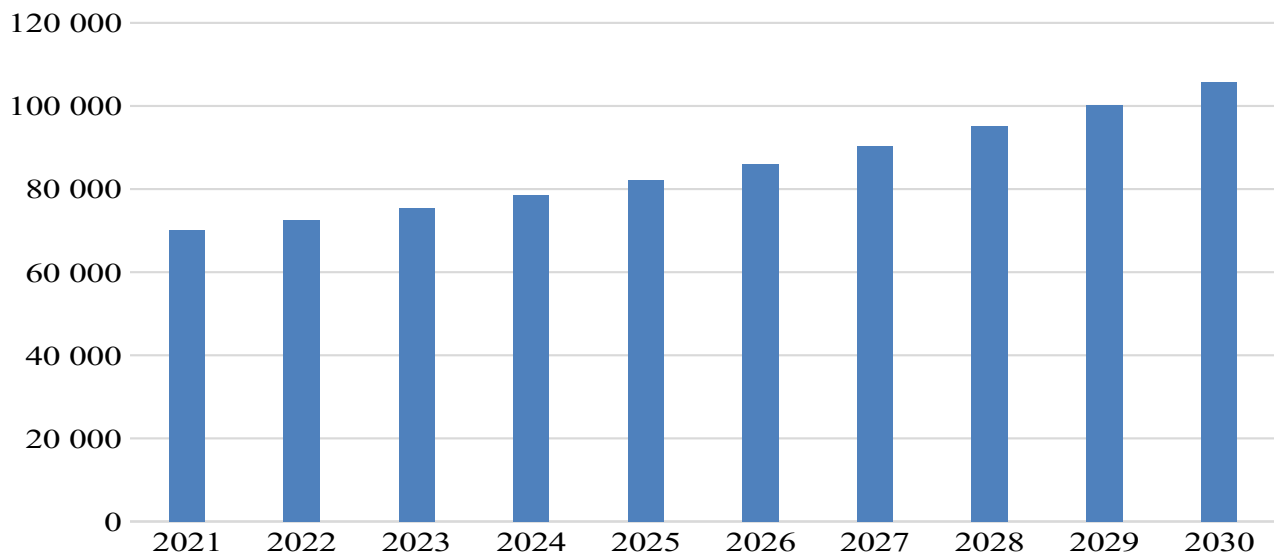
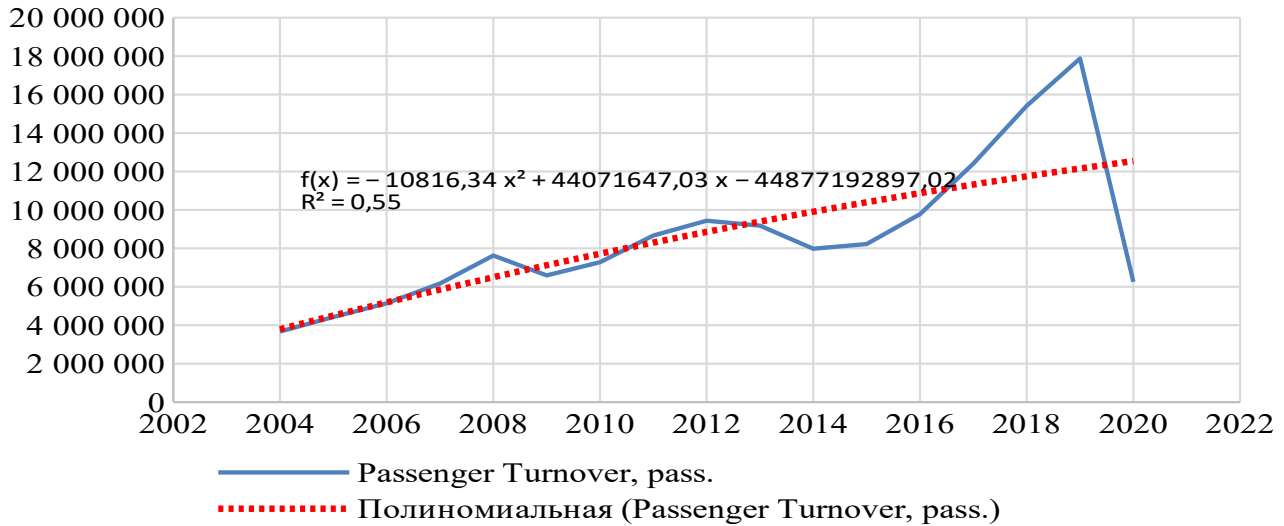


Fig. 3.8 Diagram of cargo traffic forecast in Kyiv avian node, tons

So, according to the obtained above information, the cargo traffic in Kyiv node in 2030 won't be increased in several times like passenger traffic. For my opinion, new airport should be constructed from the perspective of passenger traffic.

For sure, freight transportation is very important nowadays and it is possible to build one small warehouse, but, for my opinion, we should begin our construction based on passenger traffic in Kyiv avian node.



**Passenger traffic forecast, which includes data of 2020:**

Polynomial trendline

Fig. 3.9 Passenger traffic statistics of Kyiv air node, passengers

The COVID-19 pandemic has had a significant impact on the air transportation system worldwide. In order to prevent the spread of the COVID-19 pandemic, countries around the world have taken a variety of restrictive measures. The travel restrictions, and the other measures taken by a majority of countries worldwide, are having an unprecedented impact on the air transportation system. According to the same IATA, the total revenue of passenger carriers in 2020 will decrease by more than half from last year - by 314 billion dollars. UIA suffers from the coronavirus no less and therefore have to take painful steps. Thus, the largest domestic airline - UIA currently estimates its losses at \$ 60 million.

For forecast calculation of passenger traffic in Kyiv air node considering data of 2020, the following formula should be used:

$$y = -10816x^2 + 4E+07x - 4E+10, \quad (3.3)$$

where, x is a certain period of time, which should be predicted.

Table 3.8

**Polynomial coefficients for passenger traffic forecast**

| 1         | 2      | 3       |
|-----------|--------|---------|
| $x^2$     | $x$    | $b$     |
| -10816,34 | 4,E+07 | -4,E+10 |

Using formula 3.3 we can predict approximate passenger traffic in Kyiv node from 2021 to 2030, considering data of 2020.

Table 3.9

**Passenger traffic forecast considering data of 2020 in Kyiv avian node**

| Year | Passenger traffic, passengers |
|------|-------------------------------|
| 2021 | 12 900 385                    |
| 2022 | 13 241 567                    |
| 2023 | 13 561 116                    |
| 2024 | 13 859 032                    |
| 2025 | 14 135 316                    |
| 2026 | 14 389 967                    |
| 2027 | 14 622 985                    |
| 2028 | 14 834 370                    |
| 2029 | 15 024 123                    |
| 2030 | 15 192 243                    |

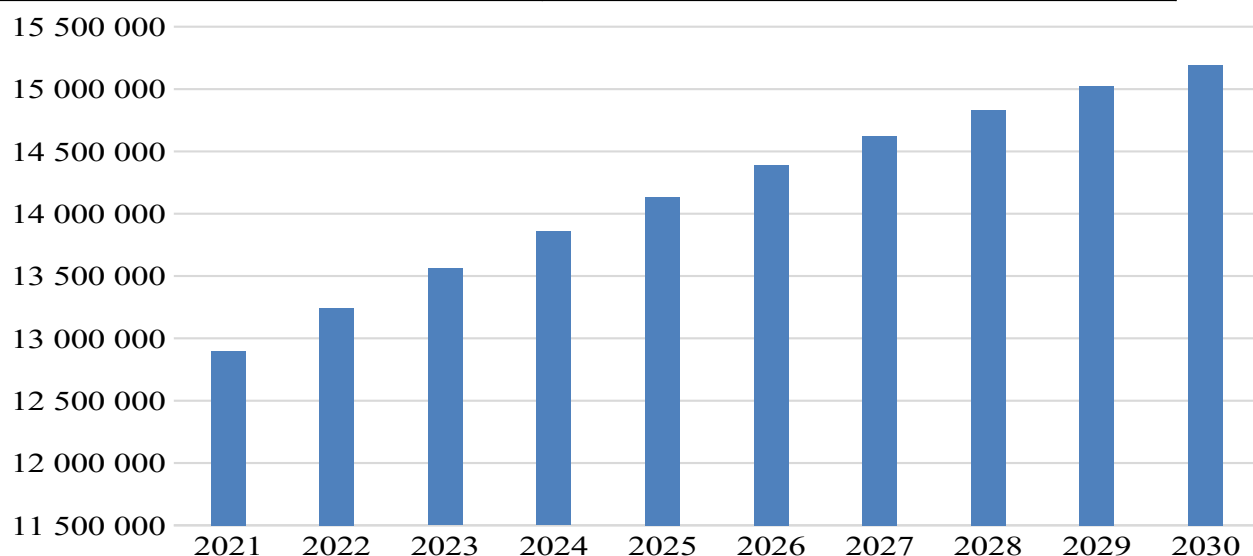
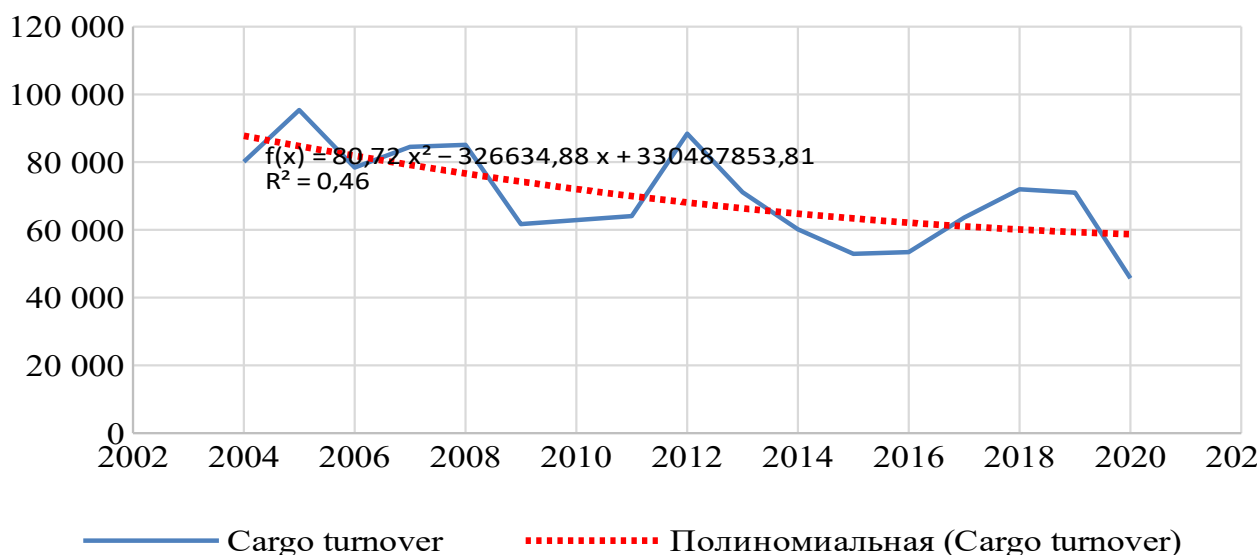


Fig. 3.10 Diagram of passenger traffic forecast considering data of 2020 in Kyiv avian node, passengers

In general, without loans or state aid, it will be difficult for airlines and aircraft companies to overcome the crisis caused by the pandemic. Small carriers that have not yet established themselves in the market or serve only seasonal summer flights may be in danger of extinction. Much less the crisis will affect government-backed companies or large airlines that have the potential to raise significant additional funds.

**Cargo traffic forecast, which includes data of 2020:**



Polynomial trendline

Polynomial trendline

Fig. 3.11 Cargo traffic statistics of Kyiv air node, tons

Given the measures to prevent the spread of COVID-19, both worldwide and in Ukraine, the global market for logistics services is experiencing a significant crisis.

Freight traffic did not suffer as much as passenger traffic. For example, in March, global demand for freight decreased by 15.8%, while demand for passenger transport fell by 52.9%. Based on WTO forecasts, IATA experts predict that the volume of cargo traffic in 2020 will fall by a maximum of 14-31%. Quarantine restrictions have led to the closure of a large number of businesses in Europe, including Ukraine.

For forecast calculation of freight traffic considering data of 2020 in Kyiv air node the following formula should be used:

$$y = 80,721x^2 - 326635x + 3E+08, \tag{3.4}$$

where x is a certain period of time, which should be predicted.

Table 3.10

**Polynomial coefficients for cargo traffic forecast**

| 1     | 2        | 3      |
|-------|----------|--------|
| $x^2$ | $x$      | $b$    |
| 80,72 | -326 635 | 3,E+08 |

Using formula 3.4 we can predict approximate cargo traffic in Kyiv node from 2021 to 2030, considering data of 2020.

Table 3.11

**Freight traffic forecast in Kyiv avian node**

| Year | Cargo traffic, tons |
|------|---------------------|
| 2021 | 70 252              |
| 2022 | 72 627              |
| 2023 | 75 396              |
| 2024 | 78 560              |
| 2025 | 82 118              |



|      |         |
|------|---------|
| 2026 | 86 071  |
| 2027 | 90 418  |
| 2028 | 95 159  |
| 2029 | 100 294 |
| 2030 | 105 824 |

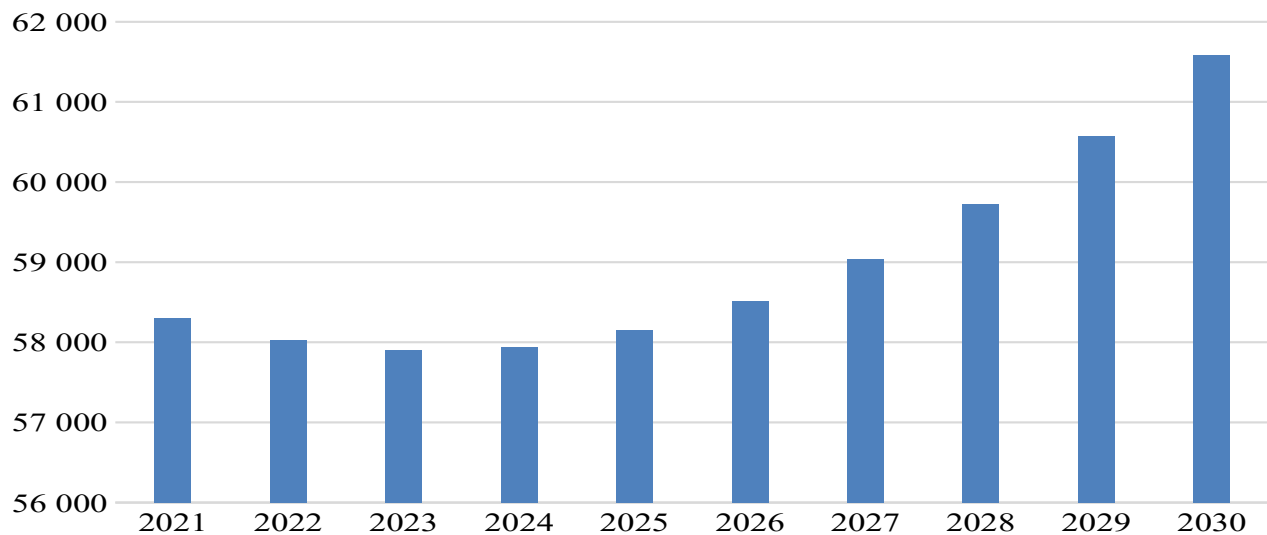


Fig. 3.12. Diagram of cargo traffic forecast in Kyiv avian node considering data of 2020, tons

In the field of air freight worldwide, there is a decrease in demand by 15%. Thus, the cancellation of passenger flights also affected the cost of cargo delivery services, as most of them were previously delivered by passenger aircraft. There are no cargo planes in almost any airline in the world due to the very high cost. Thus, tariffs have more than doubled: previously - \$ 4 / kg, now start at \$ 11 / kg.

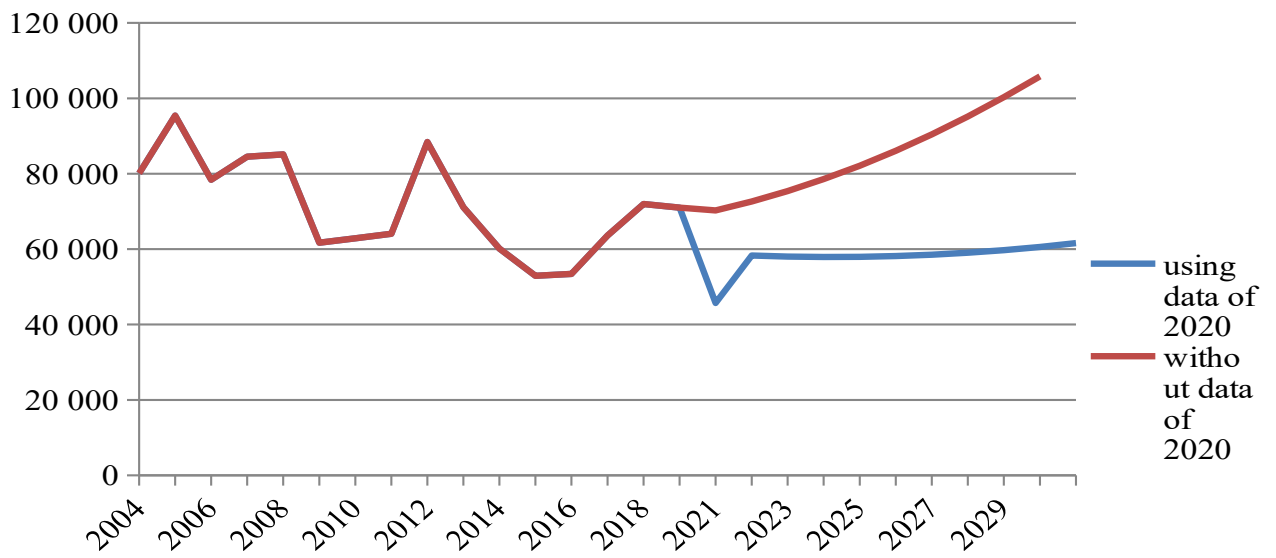
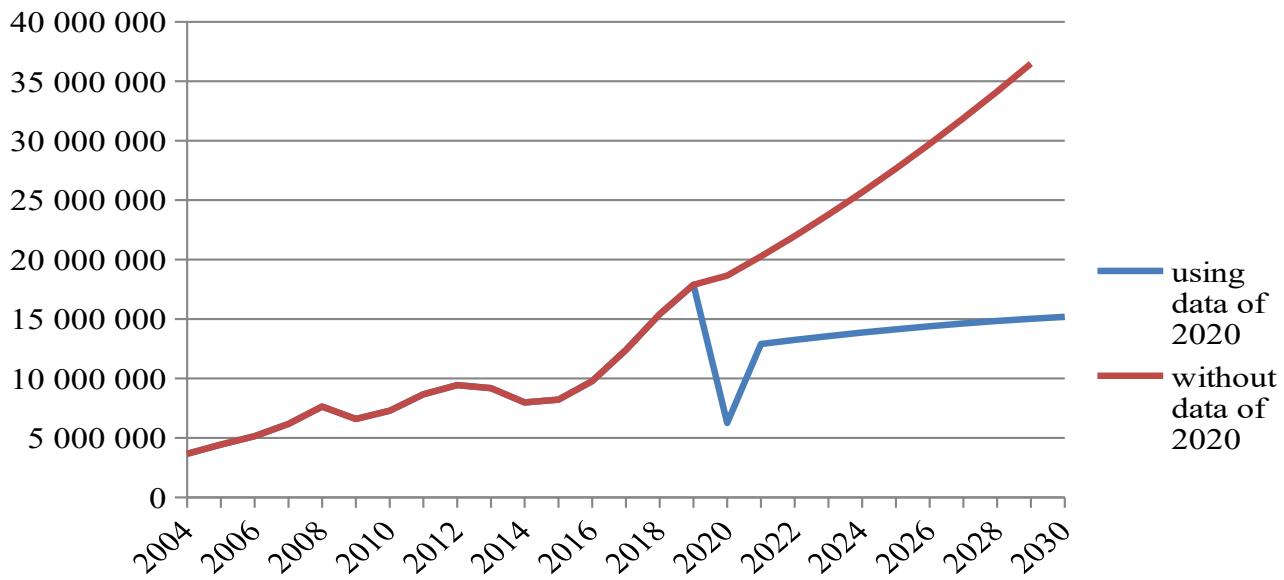


Fig. 3.13. Comparative analysis of passenger traffic forecast in Kyiv avian node, passengers

Fig. 3.14. Comparative analysis of freight traffic forecast in Kyiv avian node, tons

Regarding fig. 3.13 and fig. 3.14 we can see comparative analysis of passengers and cargo traffic forecasts in Kyiv aviation node. It's possible to see the major impact of COVID-19 on the aviation industry. Strict quarantine in Ukraine has mainly affected passenger traffic. In the field of air freight worldwide, there is a decrease in demand by 15%.

Coronavirus COVID-19 has already caused a lot of suffering to the world, and its economic effect will be a heavy burden for a long time to come, both in countries and on individual companies, large and small. For many projects and businesses, unprecedented responses to threats around the world can be catastrophic.

Airlines have a safety margin of no more than three months. Further downtime could lead to the bankruptcy of small and medium-sized airlines. There is a high risk of mass layoffs of workers working in this field. One aircraft under downtime is 4-5 crews, or 36-50 people. Most domestic companies will send staff on unpaid leave. Aviators should expect a way out of the crisis no earlier than 2021-2022.

In accordance with above said information (tables 3.5 and 3.7) we can make a conclusion, that passenger and cargo traffic are developing in our country and in 10 years we will have substantial increase of transported cargo and passengers quantity (excluding data obtained in 2020). That's why it is necessary to open the new airport in Kyiv region. During my analysis, I made a conclusion the best place is Borodyanka aerodrome. Advantages are listed at the Part 2 of Master Thesis. In general, without loans or state aid, it will be difficult for airlines and aircraft companies to overcome the crisis caused by the pandemic. Small carriers that have not yet established themselves in the market or serve only seasonal summer flights may be in danger of extinction. Much less the crisis will affect companies that have government support, or large airlines that have the ability to raise significant additional funds.

For further calculations I am going to use data obtained above, that exclude numbers of 2020, because coronavirus is, from a formal point of view, force majeure, that means an extraordinary and unavoidable circumstances that objectively make it impossible to fulfill contractual and other obligations. We can't make a long-term forecast using data in 2020 because that traffic doesn't show real numbers. After Covid-19 termination, for my opinion, the quantity of passengers is going to rise in several times because of lockdowns and strict rules that government set. So it is more realistic to suppose that forecast should be based on data obtained at period before COVID-19 appearance (before 2020).

The following calculations are going to be based using data of passenger traffic, because it is developing a lot more than cargo traffic.

### **3.2. Application of the game theory models for analysis of market interactions of the airports**

Boryspil Airport and Borodyanka Airport cannot be competitors in their purpose and should be considered as two separate transport enterprises to solve state economic problems. Also, we have another reason for creation of the new airport – the Zhulyany International Airport is located in the Kyiv. It has not much space for expansion of its territory, so it won't be able to handle needed amount of passengers in 10 years. Also, because of Zhulyany airport the capital of Ukraine receives a huge damage of the city's ecology. So we must relocate the airport outside the capital. The second, very important reason is the level of Kyiv citizen safety.

The problems of market interaction are close to the problems of game theory and can be effectively described and studied in its terms. Game theory is a mathematical method for studying optimal strategies in games. A game is understood as a process in which two or more parties participate, fighting for the realization of their interests. Each of the parties has its own goal and uses some strategy, which can lead to a win or loss, depending on the behavior of other players. Game theory helps to choose the best strategies, taking into account the ideas of other participants, their resources and their possible actions. Game theory is a branch of applied mathematics, more precisely, operations research. Most often,

the methods of game theory are used in international relations, economics, a little less often in other social sciences - sociology, political science, psychology, ethics, jurisprudence and others. Since the 1970s, it has been adopted by biologists to study animal behavior and the theory of evolution. It is very important for artificial intelligence and cybernetics, especially with the manifestation of interest in intelligent agents.

Suppose that the airport "Zhulyany" receives 360 million UAH annually. Borodyanka Airport decides whether to expand its airport and carry out air transportation or refuse to enter the air transportation market. However, it knows that the airport Zhulyany can react on incursion and may take some kind of actions in response. On the one hand, the airport Zhulyany can reduce the volume of traffic (the number of flights) giving up some of its flights to the future airport Borodyanka and share the profit (for example, each airport will receive 180 million UAH profit). On the other hand, Zhulyany can keep the volume of its traffic. In this case, the growth of the total supply of transportation volumes of Borodyanka and Zhulyany will reduce transportation tariffs, and as a consequence, the profit of Zhulyany will fall to 280 million UAH. Simultaneous reduction of tariffs will lead to the fact that Borodyanka, having made preliminary costs for entering a new market for it, will suffer net losses: it will lose UAH 120 million [24].

If the airport Borodyanka refrains from entering the transportation market, it will not gain or lose anything (its profit is 0 million UAH) and Zhulyany will continue to make a profit of 360 million UAH. If the airport Zhulyany suddenly decides in this situation to reduce the number of flights (traffic), its profit will fall to 360 million UAH.

This situation can be described by the gains matrix of non-antagonistic game (table 3.12) of two persons where the winnings of the airport Zhulyany (in million UAH) are the first specified.

*Table 3.12*

**Strategies of the Zhulyany and Borodyanka airports**

|                                    |                                 | Strategy of the airport Zhylyany      |   |
|------------------------------------|---------------------------------|---------------------------------------|---|
|                                    |                                 | To save the volumes of transportation | To decrease the volumes of transportation |
| Strategy of the airport Borodyanka | To enter the market             | (280; -120)                           | (180; 180)                                |
|                                    | Refrain from joining the market | (360; 0)                              | (300; 0)                                  |

In this game, the airport Zhulyany makes a decision (already knowing about the decision of the Borodyanka administration) in response to the actions of the airport Borodyanka.

This game is positional, which can be clearly represented as a decision tree (fig.3.15) below:

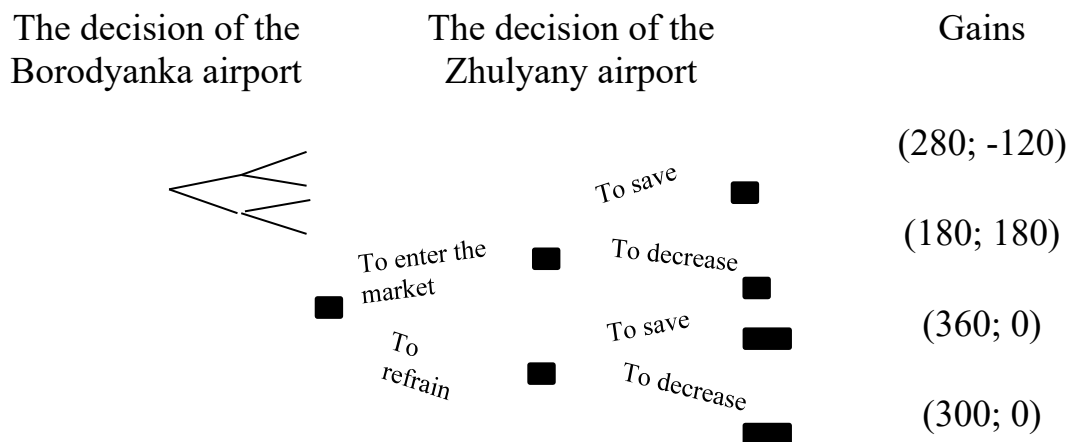


Fig. 3.15 The decision tree of the gains theory

The data analysis of the described game above shows the threat of the airport Zhulyany to keep the traffic volume is quite plausible: the profit of the airport Zhulyany in this case is 280 million UAH, not less than if the airport Zhulyany will reduce the volumes of traffic and remise the part of the market to the airport Borodyanka (180 mill. UAH).

A strategy of the airport Zhulyany – to maintain the volume of traffic is dominant, i.e. following this strategy, the airport gets more profit than in the case of

implementing its other strategy: to reduce the volume of traffic – regardless of the decisions of the airport Borodyanka. Considering this fact, the airport Borodyanka, in order to avoid unnecessary losses, must choose the strategy to "Refrain from entering the air transportation market" As a result, in this case, the most probable is the realization of an equilibrium batch, when the Borodyanka branch refrains from entering the air transportation market, and the Zhulyany branch maintains the volume of its air transportation. This example describes the case of the so-called stable monopoly, when a monopoly firm is able to effectively implement the threat of suppressing its potential partners. In case of opening a new airport, the airport Borodyanka needs the help of state bodies to control, and, if possible, limit the activities of the firm of stable monopolists.

Borodyanka International Airport will perform the functions of the regional airport of Kyiv region, transport hub of the region, meeting the growing needs of passenger traffic, expanding the airport infrastructure of Kyiv.

### **3.3. Determination of passenger traffic of Borodyanka airport**

According to the above said trends, as well as the strategic position of Ukraine, it is advisable to create an international complex on its territory to provide air transportation. This is confirmed by numerous statements and proposals of foreign brokerage and forwarding companies engaged in the transportation of goods and passengers, expressed in business negotiations with the Ministry of Transport of Ukraine and airports. In order to calculate passenger and cargo traffic in Borodyanka airport we should use data from the tables 3.5 and 3.7 excluding numbers of 2020. It is necessary to build one more airport in Kyiv region.

Boryspil Airport, Kyiv Airport and Borodyanka Airport cannot be competitors by their purpose, and should be considered as three transport enterprises for solving state economic tasks, which is confirmed by forecasts of passenger and freight traffic. So, we have to distribute amount of passenger traffic between 3 airports to the same extend as it was in order to save existed traffic of Boryspil and Kyiv airports.

*Table 3.13*

### Predicted passenger traffic of the main airports in Kyiv region

|      | <b>Boryspil Airport,<br/>passengers</b> | <b>Borodyanka Airport,<br/>passengers</b> | <b>Kyiv Airport,<br/>passengers</b> |
|------|---|---|-------------------------------------|
| 2021 | 14922798                                | Construction process                      | 3730699                             |
| 2022 | 16218519                                | Construction process                      | 4054629                             |
| 2023 | 17586651                                | Construction process                      | 4396662                             |
| 2024 | 19027194                                | Construction process                      | 4756798                             |
| 2025 | 20540148                                | Construction process                      | 5135037                             |
| 2026 | 18120979                                | 5531378                                   | 4148533                             |
| 2027 | 19323922                                | 5945822                                   | 4459366                             |
| 2028 | 20729699                                | 6378369                                   | 4783776                             |
| 2029 | 22194309                                | 6829018                                   | 5241763                             |
| 2030 | 23717755                                | 7297770                                   | 5473328                             |

In order to correctly distribute the amount of passenger traffic we have to analyze how is it distributed nowadays. For example, 15260300 passengers were serviced at airport Boryspil in 2019 (60% of general passenger traffic of Kyiv region), 2617900 passengers were handled at airport Kyiv in 2019 (40% of general passenger traffic). After construction of the 3<sup>rd</sup> airport in Kyiv node it is correct, for my opinion, to distribute intensity of passengers as following: Boryspil – 65%, Kyiv – 15%, Borodyanka airport – 20%. Boryspil airport has a needed area for expansion, a lot of closed terminals which can provide handling of passengers and cargo (if needed), so it is correct to give a lot more intensity to Boryspil airport. Kyiv airport is also important one, but it is located in the capital of Ukraine and it doesn't have enough area for expansion and couldn't handle the increased passenger traffic, that's why it is correct to give 15% of general passenger traffic of Kyiv region. The rest of passengers should be handled at the new constructed airport – Borodyanka airport. It has a lot of advantages: a huge area for extension, developed infrastructure, is located not far from Kyiv.

According to the data at the table 3.13, after Borodyanka airport construction completion the passenger traffic at Boryspil and Kyiv airports is going to decrease slightly, but it will rise in recent years (at Boryspil in 2028, at Kyiv – 2029). Also,



each year the traffic of Borodyanka airport is going to raise, average number of handled passengers would be 6,4 mil passengers each year.

So, in accordance with above said data and table 3.13 we can make a conclusion, Ukraine needs one more airport in the capital of country. It will allow handling a lot more passengers that result positively in economy situation. Also, after a long period of positive functioning of Borodyanka airport we should create a strong hub that can handle all transit flights (both passengers and cargo). Either on the new airport territory it is necessarily to develop business aviation (for example to open hangars, where owners of small aircrafts can store them. In the following calculations I am going to calculate the general

### **3.4. Calculation of Borodyanka passenger terminal area**

The required capacity of terminals and their associated facilities will, to major degree, is determined by the projected traffic growth. In order to arrive at a single figure to describe terminal capacity an analysis of the various processes which take place within the terminal and around it must be completed. These processes will vary with the nature of the operation/process (international or domestic; arrival or departure; transfer or transit etc.).

A typical departure flow could include any or all of the following activities:

- landside access to terminal (related to car space and curbside space);
- baggage check-in;
- passenger check-in;
- immigration check;
- security check;
- boarding check.

In order to understand an approximate value of Borodyanka passenger terminal we need to calculate an average terminal area which should be constructed.

**Area of an External Departure is calculated by means of the next formula:**

$$L = \frac{a \times p \times l \times t}{60 \times n} = 0.095 \times a \times pm (+10\%), \text{ where} \quad (3.5.)$$

a - peak hour number of originating passengers;

p - proportion of passengers using car/taxi;

n – average number of passengers per car/taxi;

l - average curb length required per car/taxi (m);

t – average curb occupancy time per car/taxi (minutes)

Calculation:

$$L = 3000 \times 0,7 \times 6,5 \times 1,5 / 60 \times 1,5 = 227,5 \text{ m} + 10\%$$

**Area of the departing passengers Holding Room is calculated by means of the next formula:**

$$A = s \times \frac{y}{60} \times \frac{3(a(1+o)+b)}{2} = 0.75(a(1+o)+b) \text{ m}^2, \text{ where} \quad (3.6.)$$

a - peak hour number of originating passengers;

b - the number of transfer passengers not processes airside;

y – average occupancy time per passenger/visitor (minutes);

s – space required per person (m<sup>2</sup>);

o – number of visitors per passenger.

Calculation:

$$A = 0,75 * (5000(1+1,5) + 500) = 9750 \text{ m}^2 (+10\%)$$

**Queuing Area during Check-in is calculated by means of the next formula:**

$$A = s \times \frac{20}{60} \times \left( \frac{3(a+b)}{2} - (a+b) \right) \approx 0.25(a+b) \text{ m}^2 (+10\%), \text{ where} \quad (3.7.)$$

a - peak hour number of originating passengers;

b - number of transfer passengers not processes airside;

s – space required per person (m<sup>2</sup>);

Calculation:

$$A = 0,25 (5000+500) = 1375 \text{ m}^2 (+ 10\%)$$

**Area of the Holding Room (excluding all concessions except bars and eateries) is calculated by means of the next formula:**

$$A = s \times \left( \frac{c \times u \times i}{60} + \frac{c \times v \times k}{60} \right) = c \times \left( \frac{u \times i + v \times k}{30} \right) \text{ m}^2 (+10\%), \text{ where} \quad (3.8.)$$

c- Peak hour number of departing passengers; s – Space required per passenger, m<sup>2</sup>;

u – Average occupancy time per long-haul passenger (minutes);

v – Average occupancy time per short-haul passenger (minutes);

i – Proportion of long-haul passengers; k – Proportion of short-haul passengers.

Calculation:

$$A = 3000 \cdot (50 \cdot 0,4 + 30 \cdot 0,6) / 30 = 3000 \cdot 1,26 = 3800 \text{ m}^2 + 10\% = 4180 \text{ m}^2$$

**Area of the Holding Room (near Departure Gate) is calculated by means of the next formula:**

$$A = m \times s m^2, \text{ where} \quad (3.9.)$$

m – Maximum number of seats on largest aircraft handled at the gate;

s – Space required per passenger ( $\text{m}^2$ );

Calculation:

$$A = 200 * 1 = 200 \text{ m}^2$$

**Queuing Area – Passport Control – Arrival is calculated by means of the next formula:**

$$A = s \times \frac{15}{60} \times \left( \frac{4 \times (d+b)}{2} - (d+b) \right) = 0,25 \times (d+b) m^2, \text{ where} \quad (3.10.)$$

d – Peak hour number of terminating passengers;

b - Number of transfer passengers not processed airside;

s – Space required per passenger ( $\text{m}^2$ ).

Calculation:

$$A = 0,25 * (2000 + 500) = 625 \text{ m}^2$$

**Baggage Claim Area (excluding claim devices) is calculated by means of the next formula:**

$$A = \frac{e \times w \times s}{60} = \frac{e \times 30 \times 1,8}{60} = 0,9 \times e \text{ m}^2 (+10\%), \text{ where} \quad (3.11.)$$

e – Peak hour number of terminating passengers, including international/domestic passengers, where applicable;

w – Average occupancy time per passenger (minutes);

s – Space requires per passenger ( $\text{m}^2$ ).

Calculation:

$$A = 0,9 * 6500 = 5850 \text{ m}^2 + 10\% = 6435 \text{ m}^2$$

Calculation of the total area of the passenger terminal:  $6435 + 625 + 200 + 1375 + 4180 + 9750 = 22565 \text{ m}^2$

According to the above said calculations the main parts of passenger terminal area is  $22565 \text{ m}^2$ . It's only 60% of needed general area of the airport terminal (there should be a place for registration, dressing room, shops, eateries, restaurants, duty-free, chop houses, office space, rooms for security and safety of the airport. So, the total area of the first passenger terminal of Borodyanka airport should be not less than 35 thousand  $\text{m}^2$  for the average traffic above 6 million passengers. For the first years the dimensions of terminal expected to be enough. The airport has sufficient area for expansion which investors can use in the near future.

### **3.5. Investment calculation of the Borodyanka airport development**

The best choice for Ukraine, for my opinion, is finding investors in the United Arab Emirates. This country is interested in our agro-enterprises and cereal crop. In accordance with calculations above and additional information about cost of terminals that were built previously in Ukraine we can calculate an approximate cost of passenger terminal of Borodyanka.

For regional airports, the cost of reconstruction or construction of a new facility can vary in a wide range - from several tens to half a billion dollars. The cost of the project will be significantly affected by the need to build a runway. The cost of the runway for the A-320 airliners can range from \$40 million and the whole range of work, equipment, certification, and trainings costs the same amount. The airport terminal is being built and equipped separately. Technical requirements differ depending on the landscape, weather conditions, distance to infrastructure and residential buildings.

The budget for the construction of terminal D with an area of 110 thousand  $\text{m}^2$  in Boryspil (2011) is 1661 million UAH, packing - 395 million UAH. In 2011 rate of exchange was  $1\text{USD} = 8\text{UAH}$ . So, we can calculate approximate cost of passenger terminal of Borodyanka (using rate of exchange as in 2011) as follows:

$$C_{t(2011)} = (C_{t_2} * S_{b_1}) / S_{b_2}, \text{ where} \quad (3.12.)$$

$C_{t_2}$  – cost of terminal D construction in 2011, UAH;

$S_{b_1}$  – total area of passenger terminal of Borodyanka airport, m<sup>2</sup>;

$S_{b_1}$  – total area of passenger terminal of Boryspil airport, m<sup>2</sup>;

Calculation:

$C_{t_1(2011)} = (1661000000 * 22565) / 110000 = 340\text{mil.UAH} = 42,5\text{mill.USD}$  – approximate cost of Borodyanka terminal if it had been constructed in 2011.

In 2020 we have another rate of exchange – 1USD = 28UAH, so the cost of Borodyanka passenger terminal will be approximately:

$$C_{t_1} = 42591437,5 * 28 = 2192\text{mil.UAH} (114\text{mill.USD})$$

An approximate price ( $C_{\text{total}}$ ) of Borodyanka airport construction should be calculated as:

$$C_{\text{total}} = C_{t_1} + C_r + C_c + C_p + C_a + C_f, \text{ where} \quad (3.13.)$$

Approximate cost of the new runway construction according to data from other airports construction in Ukraine is up to 2000 mil.UAH ( $C_r$ ), and the whole range of works, equipment, vehicles, certification, trainings costs the same ( $C_c$ ), parking – up to 800 mil. UAH ( $C_p$ ); Also, additional amendments should be included: the taxiway and the platform of the apron complex is estimated at 400 million UAH ( $C_a$ ); the cost of airport fencing approximately is 140 mil.UAH ( $C_f$ ).

Calculation:

$$C_{\text{total}} = 2192\text{mil.UAH} + 1000\text{mil.UAH} + 1000\text{mil.UAH} + 800\text{mil.UAH} + 400\text{mil.UAH} + 140\text{mil.UAH} = 5532\text{mil.UAH} (305\text{mil.USD})$$

Experts say that considering the payback of an infrastructure facility, it is worth looking not only at direct financial receipts, but also at the overall economic effect for the region. Every \$ 1 invested in aviation infrastructure brings the country \$ 2.5.

The total cost, that investor should pay ( $C_i$ ) is:

$$C_i = C_{t_1} + 0,7C_c + C_p + C_a + C_f \quad (3.14.)$$

An airport is a runway and a terminal with associated infrastructure. According to the above said formula, we can make a conclusion, that investor can't provide

financing for the runway, because it belongs to the state as a strategically important facility. And private investments cannot be attracted for its construction. In theory, of course, they can, but it will not be an investment. Also there are some changes in formula with Cc (means the whole range of works, equipment, vehicles, certification, trainings), investor shouldn't pay for certification, trainings etc. all value, it should be divided between him/her and government (because government should provide certification and training, but equipment and vehicles should be financed by investor).

Calculation of the total cost, that investor should pay:

$$C_i = 2192\text{mil.UAH} + 700\text{mil.UAH} + 800\text{mil.UAH} + 400\text{mil.UAH} + 140\text{mil.UAH} = 4232\text{mil.UAH} = 151,1\text{mil.USD}$$

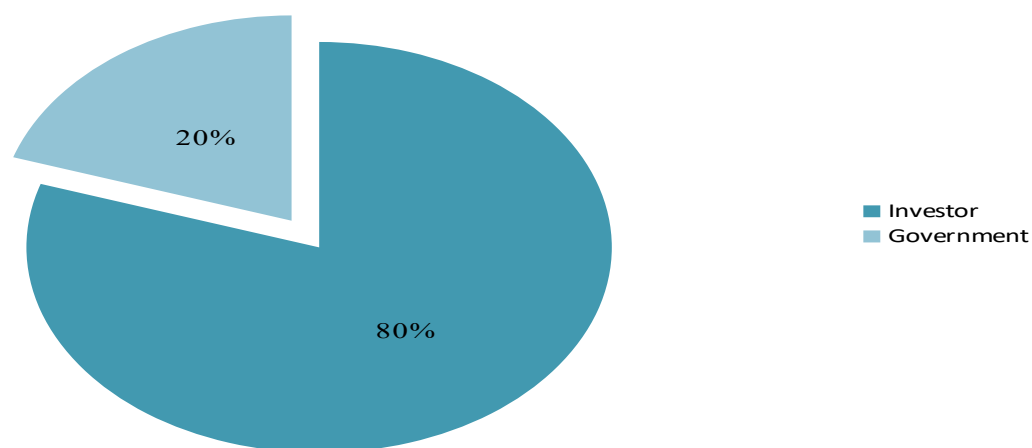


Fig. 3.16. The share of funds reception between government and investor

The construction of the runway and the terminal should be launched in parallel. No investor will start construction of the terminal and infrastructure until there is a clear guarantee that the state will provide money for the construction of the runway and work will begin.

After having analyzed all potential investors, **the Middle Eastern branch of Angel Investment Network** is an excellent online resource for investors and entrepreneurs in the United Arab Emirates (UAE) who are seeking business partners, seed capital to start a business, and private funding to expand their business. Connections within the city, country or region of your choice can be made through a simple registration process on our network. The Middle East investment network helps connect entrepreneurs with potential investors from all over the world.

The business model is calculated using the “income per passenger” formula. The volume of passenger traffic per year is the main figure that an investor is guided by when deciding whether to invest. So, the terminal and infrastructure is a regular income for it. Of course, no one can guarantee a stable passenger flow. A project such as the construction of a terminal and airport infrastructure will pay off within 4-5 years, provided there is a stable passenger flow. This assessment was voiced by the investor himself, based on his previous experience at the Kharkov airport. But, in our case it is planned to recover the costs in 3-4 years.

There are no regulatory difficulties at the legislative level for an investor. Since the region provides empty land for a long-term lease and provides all the necessary communications, and not a ready-made business object for operation.

The land can be delivered to usage for investor by 2 different ways:

1. The investor pays land tax and also creates jobs. This is the foundation of public-private partnership in our case. And these relations are regulated by the law "On land lease". The terms of lease can be from 30 to 50 years.

2. At the same time, an agreement in the format of a concession within the framework of the law "On public-private partnership" is always more complicated. It's obligatory to understand the cost of the object that the investor takes. In our

case, there is one concession object – aerodrome, not just a land. And the investor is able to build a terminal and infrastructure on it.

Our country has economically advantageous location and has transit potential. Also nowadays Ukraine is a good country for investment – the President of Ukraine proposed an "investment nanny", which means that the investor is assigned a personal Minister from Cabinet of Ministers (in our case it should be the Minister of Transport sphere), who leads investor's project to the latter, thereby speeding up the process of signing all the documentation.

State and local authorities should provide the most favorable conditions for a potential investor for investment generation, such as:

1. Mention the clear specific conditions and rules for the future airport creation;

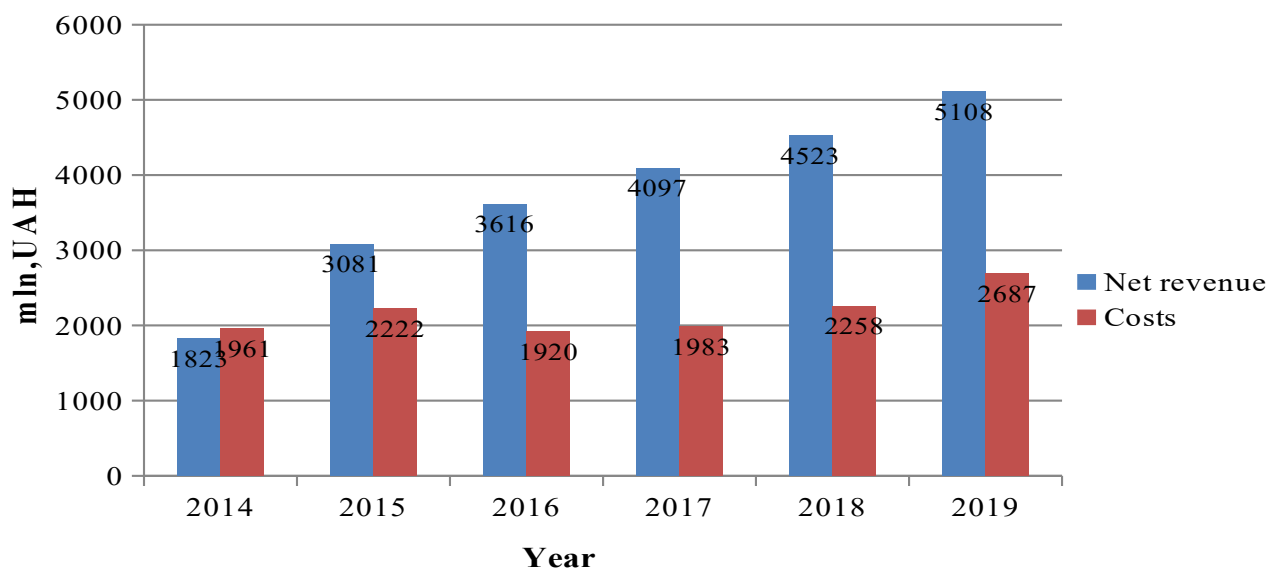
2. To ensure the fastest possible passage and consideration of documents through state institutions and local authorities (for example it is possible to use an "investment nanny");

3. If it is necessary to initiate proposed amendment before the Verkhovna Rada of Ukraine;

4. To ensure the attraction of state funds for the runway construction for its further transfer to the Ministry of Infrastructure.

### **3.6. Estimation of economic efficiency of investments**





In order to calculate the economic efficiency of investments we need to analyze the net revenue per one passenger. As an example we can review airport Boryspil. According to the data of the financial plan we can see dynamics of the revenues and costs of the airport Boryspil (fig. 3.17).

Fig. 3.17. Dynamics of the revenues and costs of airport Boryspil

So, in accordance with above said information the net revenues of the airport Boryspil are presented below (table 3.14).

Table 3.14

**The net revenues of the airport Boryspil, 2014-2019**

| Year | The net revenue, mill.UAH |
|------|---------------------------|
| 2014 | -138                      |
| 2015 | 859                       |
| 2016 | 1696                      |

|      |      |
|------|------|
| 2017 | 2114 |
| 2018 | 2265 |
| 2019 | 2421 |

The net revenue per one passenger in certain year should be calculated by means of the following formula:

$$Rop = \frac{Rnet}{Npas}, \text{ where} \quad (3.15.)$$

$Rnet$  – the net revenue of the airport per year, UAH;

$Npas$  – the quantity of passenger traffic at the airport per year, passenger.

Calculation:

$$Rop_{(2015)} = 118 \text{ UAH}$$

$$Rop_{(2016)} = 196 \text{ UAH}$$

$$Rop_{(2017)} = 200 \text{ UAH}$$

$$Rop_{(2018)} = 180 \text{ UAH}$$

$$Rop_{(2019)} = 159 \text{ UAH}$$

For understanding an average value of net revenue per passenger we have to use the following formula:

$$R_{av} = \frac{Rop_{2015} + Rop_{2016} + Rop_{2017} + Rop_{2018} + Rop_{2019}}{n} \quad (3.16.)$$

Calculation:

$$R_{av} = (118 + 196 + 200 + 180 + 159) / 5 = 170,6 \text{ UAH per passenger}$$

Using above said information (formula 3.16) and data from table 3.13 we can predict approximate net revenue of Borodyanka airport per year (table 3.15) with the help of the next formula:

$$R_{ern} = R_{av} * N_{pas} \quad (3.17.)$$

Table 3.15

### Approximate net earnings of Borodyanka airport

| Year | Net earnings per year, mill.UAH |
|------|---------------------------------|
| 2026 | 985                             |
| 2027 | 1120                            |
| 2028 | 1290                            |
| 2029 | 1370                            |
| 2030 | 1450                            |

According to the above said data and numbers from formula 3.7 we can make a conclusion, that airport will pay off the investments in 2029, because the sum of net revenues from the beginning of the airport functioning till 2029 will be approximately 4765mill.UAH, so we will receive 533mill.UAH.

Investing is a great way to generate passive additional income. At the same time, there are many investment opportunities - every project you invest in has its own strengths and weaknesses, pros and cons. The following method can evaluate the effectiveness of our investment.

Return on invested capital (ROIC) is an indicator that characterizes the return on capital invested in a company's activities. The return on invested capital shows how much of the net profit falls on each ruble of invested capital. The return on invested capital is calculated as the ratio of the amount of net profit for the analyzed period (usually for a year) to the average annual amount of equity and long-term liabilities. Only the capital invested in the core activities of the company should be considered as invested capital, just as the considered profit is the profit from core activities.

In order to understand the economic efficiency of our project we need to calculate ROIC – Return on Investment Capital by the means of the following formula:

$$ROIC = \frac{R_{net}}{C_{iy}} * 100\%, \text{ where} \quad (3.18)$$

$R_{net}$  – the net revenue of the airport per 5 years, UAH;

$C_{iy}$  – the cost, that investor paid for airport construction during 5 years.

Calculation:

$$ROIC = 6215\text{mill.UAH}/4232\text{mill.UAH} * 100\% = 146\%$$

According to the above said calculations we can make a conclusion, that our project will return money for investor as follows: **each 1 UAH of investment will earn 2,46 UAH in the future.**

So, with confidence we can make a conclusion that our proposal (creation of Borodyanka airport) will earn profit for Ukraine and investor.

### **3.7. Locating of the new low-cost airline on the territory of Borodyanka airport**

Throughout its history, Ukraine has been at the crossroads of world trade routes and has been a kind of center and an important fulcrum on the way from Europe to Asia. The main idea of this diploma project is fully realize this potential and turn Ukraine into the main transit country of the Eurasian continent with the most comfortable conditions for transportation in the Europe-Asia connection and a reliable international partner-provider of the best logistics services on the continent.

For my opinion, it is a correct choice to open new LC airline “Flynas“ administration office on the territory of Borodyanka airport, because it has a sufficient quantity of the new fleet, flights to European countries, cheap prices. Also, it is of fundamental importance that airline Flynas is on 69% governmental, so all agreements and communications are going to be on governmental level between two Presidents.

Flynas Airlines is a Saudi Arabia low-cost carrier specializing in domestic and international flights. The main headquarters of the company is located in Riyadh. The main base of the carrier is the King Khalid Airport. In addition, there is an additional air hub - the airport named after King Abdulaziz in the city of Jeddah. The airline was named Nas Air until November 2013. The year of foundation of the Arabian low-cost carrier is 2007, in the same year the company began operating flights. In 2014, the airline introduced its Global Flight program, which aims to provide low-cost fares for flights between Jeddah and cities in Europe, Africa, Asia and the transportation of religious tourists to Saudi Arabia. The airline's ground handling services at all airports in Saudi Arabia are provided by Saudi Ground Services.

In 2017, the airline entered into a major agreement with Airbus for the supply of 120 Airbus A320neo aircraft. In the summer of 2019, the airline leased 13 wide-body aircraft such as Airbus A380, Airbus A330neo, Boeing 747, Boeing 767 to serve pilgrims. In November 2019, the airline ordered 10 Airbus A321XLRs at the Dubai Airshow in Dubai. In 2019, the airline carried 7.6 million people.

### The fleet of Flynas

| Aircraft title | Quantity (operating aircrafts) | Quantity (ordered aircrafts) | Seats num. | Length, m    | Wingspan, m  | Height (ZA), m | Payload, t   |
|----------------|--------------------------------|------------------------------|------------|--------------|--------------|----------------|--------------|
| Airbus A319    | 20                             | —                            | 156        | 33,8         | 35,8         | 11,8           | 14           |
| Airbus A320    | 24                             | —                            | 180        | 37,6         | 35,8         | 11,8           | 16,6         |
| Airbus A320neo | 6 + 1                          | 113                          | 180        | 37,6         | 35,8         | 11,8           | 16,6         |
| Airbus A321XLR | —                              | 10                           | —          | Missing data | Missing data | Missing data   | Missing data |

To date, the fleet of the low-cost airline from Saudi Arabia includes 31 aircraft exclusively from the French manufacturer Airbus A320-200. Liners with passenger capacity up to 180 people fully cover the demand for the company's tickets. Flynas Airlines passengers can fly in economy or business class. Together with Airbus' A330neo, the A321XLR perfectly addresses the “middle of the market” (the gap between single-aisle aircraft and the smallest widebodies), and also enables Airbus to enhance the product coverage between its A220 and A320 single-aisle families and the widebody A330neo and A350 XWB. The A321XLR is due to enter service in 2023.

Flynas Airlines aircrafts fly on routes in 23 directions. These are mainly flights between cities within the country and cities of neighboring countries (UAE, Pakistan, Iraq, Bahrain, Kuwait, Lebanon). In addition, the Arab low-cost airline operates international flights to countries in Africa (Nigeria, Algeria, Egypt, Sudan, Morocco) and Europe (Great Britain, Austria, Greece, Turkey, Georgia, Azerbaijan). With regard to destinations, international flights will remain the most promising for regional airports so far, since it is still difficult to compete with the railway on the domestic aviation market.

Also, on the territory of Borodyanka airport we can locate other Ukrainian airlines in order to receive more profit, to handle passenger and cargo traffic.

# ***CONCLUSIONS***

|  |                   |  |  |                    |                     |       |        |   |
|--|-------------------|--|--|--------------------|---------------------|-------|--------|---|
| Air Transportation Management Department |                   |  |  | NAU.20.03.86 004EN |                     |       |        |   |
| Done by:                                 | Korynevskaya T.B. |  |  | CONCLUSIONS        | Letter              | Sheet | Sheets |   |
| Supervisor                               | Ivannikova V.Yu.  |  |  |                    |                     | D     | 104    | 3 |
| Normative Supervisor                     | Shevchenko Yu.V   |  |  |                    | FTML 275 OII- 202Ma |       |        |   |
| Head of the Department                   | Shevchuk D.O.     |  |  |                    |                     |       |        |   |

In the diploma work the research, the analysis of strategy of development of the new airport on a place of the Borodyanka aerodrome is carried out and the calculation of future efficiency of creation of the new airport in the Kiev region is carried out. The practical implementation of this project will help solve the problem of transit potential of our country, and thus increase the number of transported passengers, resulting in an increase in the economic situation and living standards of our country.

At this Master's Degree Diploma we considered the situation on the need to create another International Airport at the territory of the Kiev aviation hub, given the policy significance for the country, economic feasibility for the region and the state as a whole (budget allocations, growth of industrial and economic potential, additional jobs, transport infrastructure development, etc.), we consider it expedient to create an aviation complex - Borodyanka International Airport.

The following steps of Borodyanka International Airport establishment should be provided:

- construction of SHZPS (length of SHZPS - 4000 m, width - 60 m) with a hard concrete covering, a network of taxiways, places of parking of aircraft, cargo platforms;
- the bearing capacity of the airport cover should be designed to receive heavy transport aircrafts;
- construction of buildings and structures of landing facilities, air traffic services (ATS) and radio navigation facilities in accordance with ICAO international standards;

- creation of buildings and structures for maintenance of aircraft (hangar, pre-hangar site, industrial and domestic premises with the placement of crews performing aircraft maintenance);
- construction of fuel supply facilities (centralized aircraft refueling system, rail fuel drain, fuel and lubricant consumption, pipeline blocking fuel);
- construction of buildings and structures of the engineering support of the aviation complex (special transport services and airfield base);
- engineering support of the complex:
  - heat supply - from own boiler house on natural gas;
  - power supply networks of the complex (central distribution point with diesel power plant);
  - water supply and sewerage facilities and networks of the complex;
  - network of rain sewerage and rainwater treatment plants from the flight zone of the complex;

The location of the new airport has a favorable geographical location and the possibility, if necessary, the construction of several runways, taking into account the minimum acoustic impact on the surrounding settlements.

Ukraine's economy will benefit significantly from revenues from the use of Borodyanka International Airport by multinational companies involved in the implementation of powerful international projects. The construction and operation of the airfield will create about 12,500 new jobs, as well as involve a large number of multidisciplinary enterprises in the Kiev region, which will ensure the operation of the airport. In our work we have discovered the growing volumes of passenger and cargo air traffic (table 3.1.3) in Ukraine and the world, which are confirmed by the forecasts of leading aviation organizations ICAO, IATA, Boeing, Airbus and others. According to our calculations (formula 3.6.4 and table 3.6.2) we can consider, that our project is cost effective and an investor will be interested in capital investments.



The development of a new airport in the Kyiv region will create conditions for aviation fairs, salons, and this is very important for Ukraine as an aviation state. It is especially important to take into account that Borodyanka airfield has great territorial opportunities for this, which are absent in the countries of Eastern Europe.

The creation of Borodyanka International Airport will allow Kyiv, the capital of the country, to have two powerful international airports. Boryspil Airport and Borodyanka Airport cannot be competitors by their purpose and should be considered, as two separate transport enterprises to solve state economic problems.

The construction of a modern runway at Borodyanka Airport and its geographical location will ensure the Kyiv aviation hub with a high level of aviation security, which today is given an extremely important role in the world practice of airport construction.

The main advantages of Borodyanka International airport creation:

- increase in air traffic for both special and general purposes;
- creation of additional jobs, growth of employment;
- increase in budget allocations;
- change of infrastructure of the region (transport, medical care, education, etc.);
- attracting foreign investment in the national economy of Ukraine;
- increase in the production of consumer goods, including increased complexity - light aircraft and small helicopters;
- increasing the quantity and quality of aviation and non-aviation services to the population of Kyiv, adjacent regions and Ukraine;
- the possibility of creating aviation salons-exhibitions for showing, advertising and concluding business contracts for aircraft of domestic and foreign production;
- creation of a reserve airfield in the Kyiv region.

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# *APPENDICES*

|  |                   |  |  |                    |                     |       |        |   |
|--|-------------------|--|--|--------------------|---------------------|-------|--------|---|
| Air Transportation Management Department |                   |  |  | NAU.20.03.86 005EN |                     |       |        |   |
| Done by:                                 | Korynevskaya T.B. |  |  | SUMMARY            | Letter              | Sheet | Sheets |   |
| Supervisor                               | Ivannikova V.Yu.  |  |  |                    |                     | D     | 110    | 2 |
| Normative Supervisor                     | Shevchenko Yu.V   |  |  |                    | FTML 275 OII- 202Ma |       |        |   |
| Head of the Department                   | Shevchuk D.O.     |  |  |                    |                     |       |        |   |

УКРАЇНА  
ДЕРЖАВНА АвіАЦІЙНА  
СЛУЖБА УКРАЇНИ

UKRAINE  
STATE AVIATION  
ADMINISTRATION OF UKRAINE

СЕРТИФІКАТ АЕРОДРОМУ  
AERODROME CERTIFICATE

№ АП 09-03

Цим засвідчується, що  
*This certifies that*

Аеродром **Бородянка**  
*Name of Aerodrome*

Місцезнаходження аеродрому **46 км на північний захід від м. Київ,  
північна околиця смт. Бородянка**  
*Location of Aerodrome*

відповідає вимогам законодавства України про цивільну авіацію і  
придатний до експлуатації повітряних суден, що є в додатку до цього  
сертифіката. Сертифікат не підлягає передаванню і дійсний протягом  
зазначеного терміну, якщо від нього не відмовляться, не буде тимчасово  
зупинена його дія або він не буде анульований.

*meets the requirements of Ukraine Aviation Laws and available for operation of  
flights that are contained in the attached Appendix. This Certificate is not  
transferable and, unless sooner suspended or revoked, will continue in effect until  
otherwise terminated.*

Дата введення в дію: **21 березня 2019 року**  
*Effective date*

Сертифікат діє до **21 березня 2022 року**  
*The certificate is valid till*

В.о. Голови **С. КОРШУК**  
*Acting Chairman*

АА №019620

Fig. A-1 Certificate of the Borodyanka airfield

Appendix B

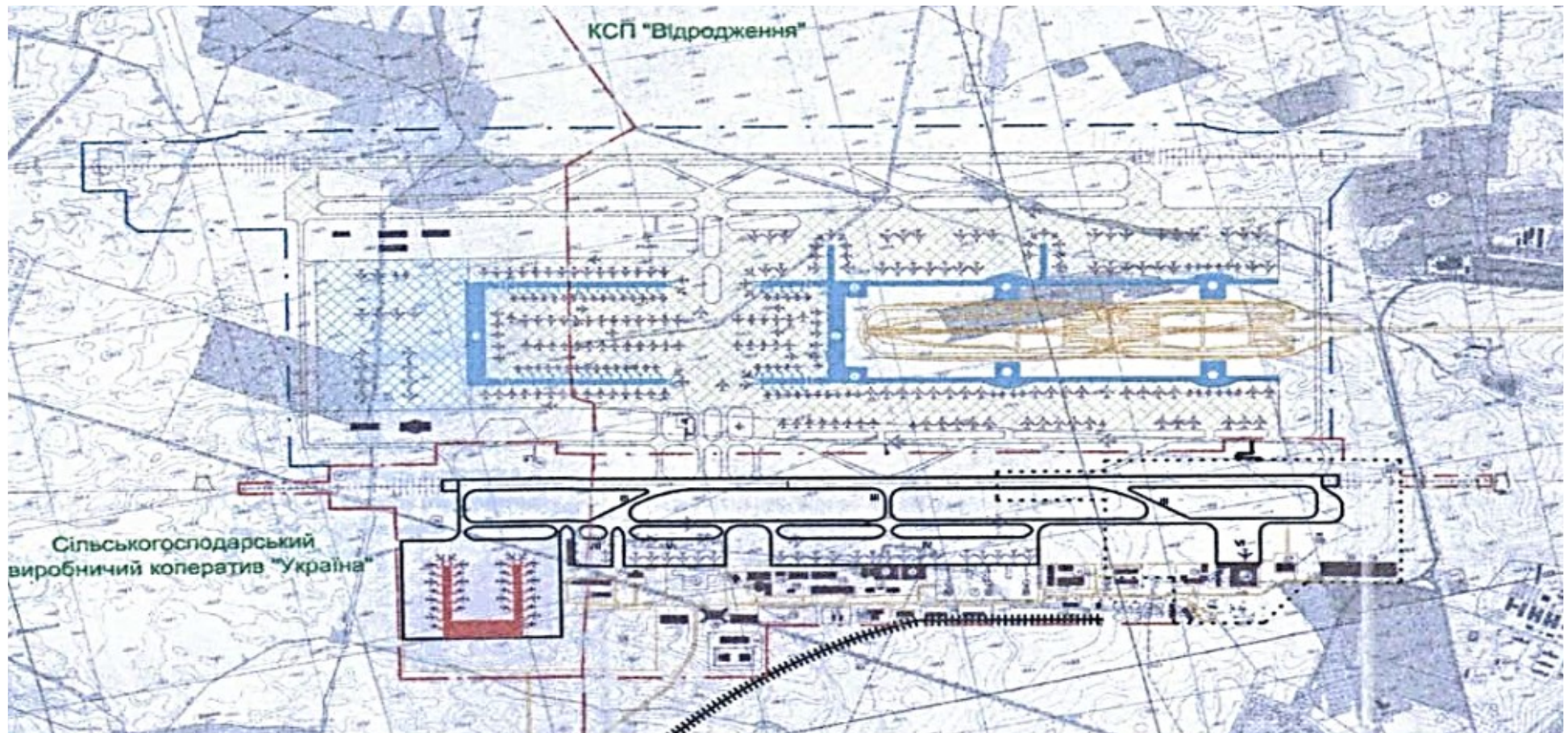


Fig. B-1 The master plan scheme of the Borodyanka Airport on a scale 1:20000