MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY

Air Transportation Management Department

MASTER THESIS

(EXPLANATORY NOTES)

Theme: "Model of Ukrainian airports development as complex weighted system"

Done by: Daria Yu. Morhunova, FTML 202Ma

Supervisor: Yuliia V. Shevchenko, PhD in Economic, 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
Завідувач кафедри

_____ Шевчук Д. О.
"_____" _____2020

ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

**ВИПУСКНИКА ОСВІТНЬОГО РІВНЯ
"МАГІСТР"**

Тема: "Модель розвитку аеропортів України як складної зваженої системи"

Виконавець: Моргунова Дар'я Юріївна, ФТМЛ 202Ма

Керівник: к.е.н., доцент кафедри організації авіаційних перевезень НАУ Шевченко Юлія Вікторівна

Нормоконтролер: к.е.н., доцент Шевченко Юлія Вікторівна

Київ 2020

NATIONAL AVIATION UNIVERSITY

Faculty of Transport Management and Logistics

Air Transportation Management Department

Major: 6.070101 "Transport Technologies (by transport modes)"

APPROVED BY
Head of the Department
_____Shevchuk D.O.
"_____" _____2020

TASK

for completion the Master thesis

Morhunova Daria Yuriyivna

1. Theme of the Master thesis entitled "Model of Ukrainian airports development as complex weighted system" was approved by a decree of the Rector's order № 2026/art. of October 16, 2020.

2. Terms of thesis performance: from 05.10.2020 to 31.12.2020

3. Initial data required for writing the master thesis: production and financial results of Ukrainian airports, reports on air transportation and operational information of the State Aviation Administration of Ukraine.

4. Content of the explanatory notes: review of domestic and foreign literature sources, analysis of international experience in creating models of airport development, research of the Ukrainian air transportation market, review of existing civil airports of Ukraine, formation of a model of development of Ukrainian airports, identification of modern problems and outline prospects for their solution.

5. List of the mandatory graphic materials: List of regional transport systems of Ukraine, Map of zoning of regional air transport systems of Ukraine, Types of

airport hubs, The number of Ukrainian airlines that carried out commercial transportation of passengers, cargo and mail during 2015 – 9 months of 2020 years, Dynamics of passenger transportation by commercial flights by Ukrainian airlines during 2015-2019 years, Dynamics of the number of departing and arriving aircraft at the airports of Ukraine during 2015 – 2019 years, Dynamics of Ukrainian passenger air transportation during 9 months of 2015 – 9 months of 2020, Dynamics of freight and postal traffic by commercial flights of Ukrainian airlines during 2015-2019, Amount of departure and aircraft at Ukrainian airports during 2015 –2019 years, Dynamics of passenger turnover through the airports of Ukraine during 2015 – 2019 years, Freight and mail flows through the airports of Ukraine during 2015-2019 years, The share of leading airports in the total volume of passenger traffic through the airports of Ukraine for 2016 – 2019 years, Dynamics of passenger turnover through the airports of Ukraine during 9 months of 2015 – 9 months of 2020, The share of leading airports in the total volume of passenger traffic through the airports of Ukraine for 9 months of 2020, Coverage area of main Ukrainian airports, Extended coverage area of Boryspil International Airport, Dynamics of passenger turnover through Boryspil International Airport (KBP) and Kyiv International Airport (Zhuliany) (IEV) during 2015 - 2019 years, Dynamics of passenger turnover through Kyiv International Airport (Zhuliany) (IEV) by months from August 2019 to October 2020, Dynamics of passenger turnover through 5 leading regional airports of Ukraine during 2015 – 2019 years, Dynamics of passenger turnover through the regional airports of KHE, IFO and CWC during 2015 – 2019 years, Dynamics of passenger turnover through regional airports of Ukraine during 2015 - 2019 years, Model of development and activity of civil airports of Ukraine in the period 2016-2019, Ranking of global hub airports by the number of served passengers and the number of aircraft movements in 2019, List of the airports in Ukraine as of 2020.

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 master thesis: Yuliia V. Shevchenko
Task was accepted for completion: Daria Yu. Morhunova

REPORT

Explanatory note to the diploma project "Model of Ukrainian airports development as complex weighted system" consists of 123 pages, 38 figures, 4 tables, 63 sources used.

Key words: AIRPORT, AIRLINE, REGIONAL AIRPORT, HUB AIRPORT, HUB-AND-SPOKE, POINT-TO-POINT, AIRPORT DEVELOPMENT MODEL, REGIONAL AIR TRANSPORTATION SYSTEM.

Object of study: the system of airports of Ukraine.

Subject of study: the formation of a model for the development of airports in Ukraine as a complex weighted system.

Purpose of thesis developing a model of development of airports in Ukraine as a complex weighted system, by analyzing the theoretical foundations of models of development of airports in the world and analyzing the activities of civil airports in Ukraine, identifying their benefits and current problems.

Methods of analysis include analysis of literature sources, mathematical and statistical methods, analysis of financial parameters, comparative analysis and graphical research methods.

The master's thesis actuality: from a theoretical point of view - determined the place occupied by the airport in air transportation systems, from a analytical point of view - analyzed the operational activity of 20 airports of Ukraine during 2015-2019 years, from a design point of view - formed the model of development of airports of Ukraine as a complex weighted system.

The material base of this thesis is recommended to use the material base of this thesis for further research, educational process and professional practical implementation of the proposed improvements at the airports of Ukraine.

CONTENTS

LIST OF ABBREVIATION

ACI — Airports Council International

ASTC — Antonov - Aeronautical Scientific-Technical Complex named Antonov

EU – European Union

FAA – Federal Aviation Administration

IATA — International Aviation Transport Association

ICAO – International Civil Aviation Organization

ILS – Instrument Landing System

KLM — Royal Dutch Airlines, legally Koninklijke Luchtvaart Maatschappij

LLC – Limited Liability Company

NOTAM – Notice To Airmen

OECD – Organization for Economic Co-operation and Development

OJSC – Open Joint-Stock Company

RATS – Regional Air Transportation System

SAS — Scandinavian Airlines

UATA – Ukrainian Air Transport Association

UIA — Ukraine International Airlines

UN – United Nations

USA – United States of America

INTRODUCTION

9

The world is changing every day. The unpredictable and rapid spread of the COVID-19 pandemic has completely shattered all the plans and strategies that have been built up over the years. The tense pandemiological situations in the world, state restrictions and the closure of borders between countries to counter the spread of the virus have directly affected the global and domestic aviation industries. And the temporary suspension of airlines and air infrastructure, caused by a sharp drop in passenger traffic, has led not only to the bankruptcy of airlines and massive staff reductions, but also to global changes in the services of the aviation industry as a whole.

The International Airport Council also emphasizes the significant level of uncertainty about the prospects for the recovery of the industry. According to forecasts, the resumption of global passenger traffic at the level of 2019 will take place no earlier than 2023, and markets with significant international traffic will resume only by 2024.

The situation for the Ukrainian aviation industry has also become difficult. The closure of state borders in many countries to combat the spread of COVID-19 and, as a result of the suspension of scheduled air services in Ukraine from March 17, 2020, has provoked a significant reduction in aviation activities. Therefore, one of the first disappointing situations was experienced by the domestic airport industry. Although a year ago the industry demonstrated the success of rapid development and reaching the mark of passenger turnover through the airports of Ukraine at more than 24 million passengers a year.

The last crisis for domestic aviation was in 2015, caused by the difficult political and economic situation. The beginning of the war in Donbas, the annexation of Crimea, the loss of the country's leading revenue airports in those regions, and the closure of the skies over Russia caused the deepening of crises during 201-2015. The analysis conducted in these works covers the period from 2015 to 2019, because this period was marked by rapid growth of airport activities, defining the model of development of airports in Ukraine at the state level and

confirming the strength and steadfastness of the Ukrainian aviation industry development.

In order to understand the situation and develop a model of development of Ukrainian airports, each operating civil airport of the country will be studied. After all, it is air transport and related infrastructure that have a significant impact on the development of the national economy as a whole. The importance of the study lies in identifying problems and prospects for the development of domestic airports for the formation of a balanced airport system in Ukraine.

The purpose of this work is to develop a model of development of airports in Ukraine as a complex weighted system, by analyzing the theoretical foundations of models of development of airports in the world and analyzing the activities of civil airports in Ukraine, identifying their benefits and current problems.

Based on this goal, we can formulate the following objectives of this work:

1) review domestic and foreign literary sources on the formation of the concept of airport and classification of this concept;

2) consider the functioning of the airport as an element of the air transport system of the country;

3) consider approaches and models of airport development by analyzing domestic and foreign literature sources;

4) study and form the general characteristics of the air transport system of Ukraine in the period 2015-2019;

5) conduct a detailed analysis of each operating civil airport of the country, to determine its infrastructural characteristics, features of activity and to analyze statistical data of operational activity in the period of 2015-2019;

6) define and reproduce the model of development of airports of Ukraine as a system formed during the period 2015-2019;

7) characterize modern problems of the model of development of the airports of Ukraine, to find a way of overcoming of problems and prospects of existence of the Ukrainian model of development of airports.

1. **THEORETICAL PART**

Air Transportation Management Department				NAU.20.06.23 001 EN				
Done by:	Morhunova D. Yu					Letter	Sheet	Sheets
Supervisor	Shevchenko Yu.V.					D	12	23
Standards Inspector	Shevchenko Yu.V.			THEORETICAL PART				
Head of the Department	Shevchuk D.O.				FTML 275 ОП – 202Ma			

1.1. Definition of airport and its classification

Before considering the interpretation of the concept, it is necessary to determine the etymology of the word "airport", i.e. its origin. The word "airport" is formed of two parts: the first part of "ἀέριος" comes from the ancient Greek language and means "air", the second part of "portus" - from Latin means "harbor" or "pier" [1]. That is, it means "air harbor". The first known use of this term was recorded in 1902 to mean "a place from which aircraft operate that usually has paved runways and maintenance facilities and often serves as a terminal" [2].

From the legislative point of view, the Air Code of Ukraine gives the following definition of the term "airport". It is a complex of facilities designed for receiving, dispatching aircraft, servicing air transportation, maintenance work and has for such purposes an aerodrome, airport, other ground facilities and the necessary equipment [3].

The document on Concerning Approval of the Rules that Grant Permission to Operators for Departure and Arrival in Ukraine Airports provides the following definition [4]. Airport - an enterprise that provides services in the service of passengers, luggage, cargo and mail, provides flights and maintenance of the aircraft and includes and uses for these needs the aerodrome, airport, other ground facilities, appropriate equipment and trained personnel.

The Federal Aviation Administration (FAA) provides three interpretations of the term [5]. Airport means - 1) any area of land or water that is used, or intended for use, for the landing and takeoff of aircraft; 2) any appurtenant areas that are used, or intended for use, for airport buildings, other airport facilities, or rights-of-way; and 3) all airport buildings and facilities located on the areas specified in this definition.

Also, the International Civil Aviation Organization (ICAO) in the document "Review of the classification and definitions used for civil aviation activities" defines the concept of international airport as "any airport designated by the Contracting State in whose territory it is situated as an airport of entry and

departure for international air traffic, where the formalities incident to customs, immigration, public health, agricultural quarantine and similar procedures are carried out" [6].

Document 9626 ICAO gives the following definition of the term. An airport (or aerodrome, a term that is almost synonymous, though used more in a generic sense) is a defined area on land or water that is used for the arrival, departure and surface movement of aircraft [7].

In addition, another relevant interpretation of the concept can be defined as follows. The airport is a multifunctional air transport enterprise, which is a ground part of the air transport system, which provides takeoff and landing of aircraft and their ground service, reception and departure of passengers, luggage, mail and cargo, and creates the necessary conditions for airlines, government agencies, regulating aviation, customs and other activities [8].

At the regional and local levels, airports are considered as natural monopolies. After all, airports have a dual purpose, significantly affect the security of the country and are recognized as objects of strategic importance. In addition to servicing air transportation and connecting aviation with other modes of transport, airports perform a number of specific functions, namely:

- ensuring international political and business relations of Ukraine;
- maintaining international prestige and strengthening the state's position on the path to European integration;
- ensuring general security arising from the status of airports as dual-use facilities, as well as environmental security;
- generation of business activity and increase of jobs in the regions;
- providing operators with the necessary meteorological information provided by units of the State Hydro meteorological Service of the Ministry of Ecology and Natural Resources of Ukraine or other suppliers of meteorological information on a trusted basis, etc [9].

Nowadays, there are a huge number of different approaches to the classification of airports, but among them the basic definitions of international organizations do not lose relevance. FAA classifies airports by type of activity and divides them into the following categories [10].

1.*Commercial Service Airports* are publicly owned airports that have at least 2,500 passengers boarding's each calendar year and receive scheduled passenger service. In turn, commercial airports are divided into the following subclasses:

1.1. *Primary airports* are a commercial service airport with more than 10,000 annual enplanements. Within this class, the following types of hubs are distinguished:

1.1.1. *Large hub primary* – airports handling over 1% of the country's annual passenger boardings.

1.1.2. *Medium hub primary* – airports handling 0.25 to 1% of the country's annual passenger boardings.

1.1.3. *Small hub primary* – airports with 0.05 to 0.25% of the country's annual passenger boardings.

1.1.4. *Nonhub primary* – airports handling over 10,000 but less than 0.05% of the country's annual passenger boardings.

1.2. *Nonprimary Commercial Service* - also referred to as nonhub, these airports have scheduled passenger service and between 2,500 and 10,000 annual enplanements.

2. *Cargo Service Airports* are airports that, in addition to any other air transportation services that may be available, are served by aircraft providing air transportation of only cargo with a total annual landed weight of more than 100 million pounds. An airport may be both a commercial service and a cargo service airport.

3. *Reliever Airports* are airports designated by the FAA to relieve congestion at Commercial Service Airports and to provide improved general aviation access to the overall community. These may be publicly or privately-owned.

4. *General Aviation Airports* are public-use airports that do not have scheduled service or have less than 2,500 annual passenger boardings. This includes all aviation, except for military and commercial, operating on a regular basis, in turn, are divided into classes:

4.1. *National* - such airports support the national airport system by providing communities access to national and international markets. National airports have very high levels of aviation activity with many jets and multiengine propeller aircraft.

4.2. *Regional* - such airports support regional economies by connecting communities to regional and national markets. Generally regional airports located in metropolitan areas and serve relatively large populations. Regional airports have high levels of activity with some jets and multiengine propeller aircraft. The metropolitan areas in which regional airports are located can be Metropolitan Statistical Areas with an urban core population of at least 50,000 or Micropolitan Statistical Areas with a core urban population between 10,000 and 50,000.

4.3. *Local* - such airports supplement local communities by providing access to markets within a State or immediate region. Local airports are most often located near larger population centers, but not necessarily in metropolitan or micropolitan areas. Most of the flying at local airports is by piston aircraft in support of business and personal needs. These airports typically accommodate flight training, emergency services, and charter passenger service.

4.4. *Basic* - such airports link the community with the national airport system and supports general aviation activities, such as emergency response, air ambulance service, flight training, and personal flying. Most of the flying at basic airports is self-piloted for business and personal reasons using propeller-driven aircraft. They often fulfill their role with a single runway or helipad and minimal infrastructure.

The types of airports are also defined as domestic and international [4].

- **Domestic airport** - an airport designated by the state to service aircraft operating on the territory of this state only.

- **International airport** - an airport designated for the reception and departure of aircraft that perform international flights and in which customs, border, sanitary and quarantine control, aviation security control and other types of mandatory control.

ICAO in the Doc 9626 - Manual on the Regulation of International Air Transport (Second Edition) [7] classifies airports by types of aircraft serving:

- *a heliport* is an aerodrome or a defined area on a structure used for the landing, take-off or surface movement of helicopters;

- *a stolport* is an airport specifically designed for STOL aircraft separate from conventional airport facilities.

Airports can also be characterized by type of activity:

- *a commercial airport* is an airport used by the general public that includes facilities for processing passengers, handling cargo and servicing commercial aircraft;

- *a private airport* serves primarily small privately owned aircraft, flying clubs.

In addition, airports in this document are classified according to the degree of congestion. *A congested airport* is one whose capacity for handling traffic (air or ground) is inadequate to accommodate demand. To cope with congestion problems, one State has designated certain airports as *reliever airports*, i.e. airports that divert traffic from major commercial airports; and supplemental airports, i.e. airports that attract general aviation away from busy airports, thus relieving congestion in particular markets.

The Manual on the Regulation of International Air Transport (Second Edition) defines a separate classification of hub airports [7]. In the general context, *a hub airport* is any airport that has a large number of inbound and outbound flights and a high percentage of connecting flights. When viewed in the context of scheduling and marketing from the perspective of an air carrier operating a hub airport, the term refers to an airport where inbound and outbound schedules are coordinated to achieve the most convenient connections and / or transit for passengers, cargo and / or mail. The same airport can serve as a hub for several air

carriers, although this is an exception. A more detailed analysis of this species and its sub classification will be in the next sections.

1.2. Airport as an element of the country's air transport system

In general, the territorial transport system is one of the types of socio-geographical system, which is a natural relationship of different types and objects of human activity, which are functionally oriented in the whole area to meet the needs of a particular community of people. Territorial transport system consists of subsystems of different modes of transport, namely air, road, rail, sea and river.

An important position among such subsystems is played by the aviation transport system, which is a "combination in a single territory of routes (airlines) and technical means of transport for transport links to ensure the development of socio-geographical system" or "network of operators high-cost aircraft specializing in certain types of air transportation and service ground infrastructure" [11, 12].

The Order of the State Aviation Administration of Ukraine № 895 of 25.11.2005 gives the following definition of the term: air transport system - a set of elements (subjects) of the system, operating and interacting to meet the needs of society in aviation work and transportation.

The subjects of the air transport system are aircraft with their crews, airlines, airfields and airports, aircraft maintenance organizations, air traffic services, aviation administration and safety oversight institutions [13].

Characteristic of the air transport system are such traditional system-wide properties as integrity, complexity, hierarchy, dynamism, territoriality, stability.

The basis for the construction of the aviation transport system should consider the impact of systemic nature on the categorical apparatus of the concept. This presupposes the existence of a structure - a set of stable connections between the components of the system, which ensure its integrity and build the basis of the system and determine its functional direction. Therefore, the change of one

element causes certain changes in all other parts of the system, or the system as a whole.

The presence of such a close interaction, the organic relationship of the components is the reason that in various processes, in interaction with the environment, the system acts as a single, holistic entity. This is manifested in the fact that the internal connections between the components of the system are much closer and more stable than the connections of this system with other material objects of the external environment.

The structure of the aviation transport network is characterized by the field structure of the system, which forms its linear-nodal character [14]. The field structure of the system should be considered in the functional-managerial, functional-component and functional-territorial structures. The main body of the functional and administrative structure is the Ministry of Infrastructure of Ukraine and its organizational units. Also constituent elements of this structure are special governing bodies: state, such as the State Aviation Administration of Ukraine, and commercial, which manage civil and state aviation. The functional-component structure provides for the allocation of two elements: passenger and freight transport, where various airlines operate (airlines, aviation technical enterprises and air traffic management enterprises). In the functional-territorial structure of the air transport system there are point or discrete elements (infrastructure points, centers and nodes), linear elements (airways) and planar or areal elements (air transport areas – macro-regional, meso-regional and micro-regional). Due to the functioning of these elements of the structure, the linear-nodal character of the air transport system is built.

A characteristic feature of the air transport system is the hierarchy of structural levels. Considering comprehensively all levels, we can distinguish the following structure. The first is to determine the global or planetary level of the air transport structure, which describes the functioning of the aggregate activities of the elements of the global aviation transport system. The next subordinate level is the mainland air transport system, which covers the general existence of air

transport systems of parts of the world, a set of large regions and the unification of territories. The national air transport system provides coverage of the functioning of air transport systems of individual countries. This level is subordinated to the regional level or regional aviation transport system, which is formed by the interaction of systems of economic districts and administrative regions.

The air transport system of Ukraine belongs to the national level. That is, the national air transport system is an interconnected set of regional air transport systems within the state territory.

The national air transport system must meet the needs of the population and social production in passenger and cargo air transportation and in special aviation works and services. The spatial-territorial part of the national air transport system is a regional air transport system, which is defined as an interconnected and hierarchically ordered set of airports and airfields (together with related facilities) within a holistic in natural and economic sense of the territory (region, socio-geographical area). The hierarchical structure of regional air transport systems is formed by macro-regional, meso-regional and local systems [15].

The first level includes macro-regional air transport systems, which are formed on the basis of powerful multifunctional air transport hubs - cities. These cities are the centers (cores) of concentration of life of the respective regions. The core is the part of the region in which its typical features and functions are manifested to the greatest extent (with the highest density, intensity). The rest of the territory is the periphery that complements the core. This periphery is formed by the centers of the lower levels of the hierarchy. That is, the air transport hub operates on the basis of a large city - the center of the region (socio-geographical area), which is an international airport. They are usually monocentric, but can be two- and polycentric.

The second level corresponds to meso-regional air transport systems, which are formed on the basis of the respective air transport centers - cities, which play the functions of regional and inter-district settlement systems, which are subordinated to macro-regional centers. The air transport center is usually a

regional center with a civil aviation airport, which performs mainly the functions of passenger air transportation in domestic traffic.

The last third level is the local air transport systems, which are formed on the basis of air transport points, which have very limited and unsystematic (episodic) air transport functions. They are the centers of grassroots administrative districts or inter-district settlement systems. These are, in particular, civil aviation airfields, military and departmental airfields. On the basis of such points, local air transport systems are formed, which usually perform more production-transport and production-service functions than passenger transport systems.

Thus, the basis of the structure of regional air transport systems is formed by elements of different above levels. Such system-forming elements include airports, airfields, runways, temporary runways, and so on. In this case, the airport can be considered a central element of the regional air transport system, so it is worth considering in more detail the substantive essence of these elements.

Having considered the concept of airport in the previous section, we can make the following generalized definition of this concept. That is, the airport is a complex of facilities designed to receive and depart aircraft and service air transportation. To perform its functions, the airport uses the airfield, airport, station area, ground structures, equipment and involves staff.

To understand the essence of other system-forming elements, it is necessary to define their concepts. The Air Code of Ukraine provides the following definitions [3].

Aerodrome - a defined area of land, water surface, including any buildings, structures and equipment, intended in whole or in part for departure, arrival, parking and movement on such a surface of aircraft. The concept has several varieties. State aviation aerodrome is an aerodrome intended for use by state aircraft. Shared aerodrome - an aerodrome used for flights of civil and state aircraft. Civil aviation aerodrome is an aerodrome intended for use by civil aircraft.

Heliport - an aerodrome or landing area on land, water or on a structure, designed in whole or in part for the arrival, departure and movement of helicopters on its surface.

Runway - land (water, ice) area, specially prepared site or raised above the ground, water surface structures that are suitable and used for takeoff, landing, movement and parking of light aircraft with a maximum take-off weight of not more than 5700 kilograms. Runways are divided into permanent and temporary.

Based on the above, the primary system-forming element of the air transport system of any level is the airport, the role of which is determined based on its capacity, functionality, and scale of its activities and territorial area ofinfluence. In order to create and ensure the integrity of the aviation transport system, all airports must interact with each other in territorial and functional-industrial relations. Since between airports should be both direct and indirect relations, the closeness of which directly depends on the territorial proximity of airports. It is the presence of such relationships within the integral in the administrative and economic sense of the territory and determines the formation of territorial air transport systems [16].

According to the most common zoning schemes in Ukraine, there are nine regional air transport systems (Annex A): Carpathian, North-West, Podilska, Metropolitan, Central, North-East, Donetska, Prydniprovska, Black Sea [17].

Table 1.2.1

List of regional transport systems of Ukraine

№	Name of the RATS	Service area (regions of Ukraine)	Existing public airports of the RATS	Airport codes (IATA)
1	Carpathian	Lviv, Ivano-Frankivsk, Zakarpattia, Chernivtsi	Lviv Danylo Halytskyi International Airport, Ivano-Frankivsk International Airport, Uzhhorod International Airport, Chernivtsi International Airport	LWO, IFO, UDJ, CWC
2	North-West	Rivne, Volyn	Rivne International Airport	RWN

№	Name of the RATS	Service area (regions of Ukraine)	Existing public airports of the RATS	Airport codes (IATA)
3	Podilska	Vinnytsia, Ternopil, Khmelnytskyi	Vinnytsia Airport (Havryshivka), Ternopil International Airport	VIN, TNL
4	Metropolitan	Kyiv, Zhytomyr, Chernihiv	Boryspil International Airport, Kyiv (Zhuliany) International Airport, Zhytomyr Airport	KBP, IEV, ZTR
5	Central	Cherkasy, Kirovohrad	Cherkasy International Airport	CKC
6	North-East	Kharkiv, Sumy, Poltava	Kharkiv International Airport, Sumy Airport, Poltava Airport (Suprunivka)	HRK, UMY, PLV
7	Donetska	Donetsk, Luhansk	-	-
8	Prydniprovska	Dnipropetrovsk, Zaporizhzhia	Dnipropetrovsk International Airport, Zaporizhzhia International Airport, Kryvyi Rih International Airport	DNK, OZH, KWG
9	Black Sea	Odesa, Mykolaiv, Kherson, Crimea	Odesa International Airport, Mykolaiv International Airport, Kherson International Airport	ODS, NLV, KHE

Compiled by the author.

Each regional air transport system is formed around the largest cities in the region. Such centers in Ukraine are the cities of Kyiv (2,967 thousand people), Kharkiv (1,443 thousand people), Odesa (1,017 thousand people), Dnipro (990 thousand people), Zaporizhzhia (731 thousand people), Lviv (724 thousand people) [18]. Airports located near these cities form the territorial core of aviation services

of the regions and form the basis of the territorial structure of the national air transport system. In addition to airports, the system-forming elements include airfields, heliports and helipads, runways.

Ukraine has an extensive network of airports located throughout the country. However, due to geopolitical and territorial problems in the east and south of the country, several of the country's leading airports have been lost and annexed. According to the State Aviation Service of Ukraine, as of the end of September 2020, aviation activities were carried out by 19 airports. Also, as of September 30, 2020, 27 aerodromes entered in the State Register of Civil Aerodromes of Ukraine, 1 helipad entered in the State Register of Civil Aerodromes of Ukraine, and 48 runways of Ukraine entered in the Journal of Registration and Admission to operation of permanent runways [19]. There is also an alternative network of airports, consisting of military airfields and airfields of some departments.

In Ukraine, as of September 2020, there are 6 leading international airports, which are the core of the region, and provide almost 98% of all passenger and mail flows through their activities. They are located near such city centers as Kyiv, Lviv, Odesa, Kharkiv and Zaporizhzhia. That is, the macro-regional air transport systems of Ukraine include the Capital, Lviv, Odesa, Kharkiv and Zaporizhzhia.

The second level or meso-regional air transport systems are formed on the basis of air transport centers - cities that function as regional and inter-district settlement systems, and belong to the subordination of macro-regional centers. Meso-regional air transport system-forming centers in Ukraine include Uzhhorod, Ivano-Frankivsk, Chernivtsi, Rivne, Vinnytsia, Poltava, Mykolaiv, Kherson, Dnipro and Kryvyi Rih. In total, the systems form 13 operating airports, as of September 2020. However, these airports account for only 2% of total passenger traffic in 2020, due to the partial cessation of their activities with the onset of the pandemic. Most of the airports of meso-regional air transport systems have stopped regular traffic and are in a difficult financial situation.

Local air transport systems are formed at the expense of air transport points, which perform mainly service air transport functions. These are airfields of civil

aviation - for example: Kyiv / Antonov-1 (Sviatoshyn), Kyiv / Antonov - 2, Ozerne, Kirovohrad; military and departmental airfields. Most of these airfields do not have a permit for passenger traffic and provide maintenance only on a daily basis.

1.3. Features of the hub model of airport development

Ukrainian aviation companies (airports and airlines) are increasingly identifying the need to introduce new business models that can ensure effective operation both in periods of rapid growth in air traffic and in times of crisis. One such model is the "hub and spoke", which is often practiced by foreign airlines. The main essence of this model is the joint activities of the airline and the airport to carry out transportation in accordance with the system.

Historically, efforts to organize a system of transportation through the base airport have been made by foreign airlines since the mid-50 of last century. In 1955, Delta Airlines (USA) formed a system of transfer of passengers through Atlanta airport. This case was unique at the time, because such attempts to create transfer systems were isolated and did not develop. Over time, the reason for the mass transition of leading foreign airlines to the use of the "hub-and-spoke" scheme was the application of the policy of deregulation of the air transport industry.

It is believed that one of the first to develop this scheme, successfully implemented and continues to develop the corporation FedEx (USA), specializing in the urgent delivery of goods and mail. Since the 1970s, FedEx has used its base airport in Memphis as a cargo hub to transport daily express mail within the United States.

The documentation of ICAO - Manual on the Regulation of International Air Transport (Second Edition) states that "hub-and-spoke system", or "hubbing" is "an operational system in which flights from numerous points (the spokes) arrive at and then depart from a common point (the hub) within a short time frame so that

traffic arriving from any given point can connect to flights departing to numerous other points" [7].

That is, the "hub" in the "hub-and-spoke" system is the hub airport, and the "spokes" are airlines that connect the hub with peripheral airports, also called auxiliary or secondary. The basis of the system of operation of the "hub-and-spoke" system is the so-called nodal schedule, which provides for the organization of mass connections of a large number of flights for a limited period of time to ensure that passengers can immediately change to other directions. A flight included in a wave schedule system is called a connecting flight.

Foreign journalistic sources call the airports of their base "hubs" of one or another airline, without taking into account their scale, peculiarities of correspondence flows and schedules [20].

The hub airport is usually a large airport with a high percentage of connecting flights. At the same time, airlines operating the hub airport coordinate the flight schedule in order to achieve the most convenient connections for the transfer of passengers, cargo and mail. Transfer means the transfer of passengers, transshipment of luggage or cargo on a connecting flight of the same or another airline, provided that the duration of the passenger or cargo at the airport of transfer or in the locality where the airport is located does not exceed the prescribed period (for a passenger, usually , not more than 24 hours) [21].

In addition, the term "hub" is used in the original sense, denoting an airport with a large share of transfer correspondence, which has a coordinated schedule. Also, the "hub" is used to denote a transfer aviation hub - a city or urban agglomeration with several nearby airports and a developed transport structure, working to provide transfer air transportation as a single system. An example of a "hub" in this sense is London, which has five international airports that seek to function as a holistic system.

For the development and efficient functioning of the hub airport it is necessary to base in it a large air carrier or an alliance of air carriers, which creates its own route network at the airport type "hub-and-spoke". An alternative is a

network of the type "Point-to-point", which involves the performance of traffic from one point to another, without stopping at the hub airport.

The desire of airlines to increase the attractiveness of transfer transportation for passengers, reducing the waiting time at the airport transfer, forces them to plan flights from peripheral airports to the hub at almost the same time. The hub airport must provide the possibility of almost simultaneous reception of all arriving aircraft, rapid service, transfer of passengers and transshipment, and then the same almost simultaneous departure of all serviced aircraft.

There may be several such cycles or "waves" of arrivals and departures at the hub airport during the day. Such a "wave" structure, which is a feature of the hub schedule, leads to a pronounced uneven flow of flights, passengers, luggage, and cargo at the hub airport. All this requires the introduction of the most advanced organizational schemes and technologies of transportation services, the use of high-performance aerodrome and terminal equipment, equipment and facilities, extensive use of information systems.

As mentioned above, the most important feature of the hub-and-spoke transportation system is the presence of a large share of transfer correspondence at the hub airport. Transfer correspondence here means passengers who change from one flight to another; their luggage is reloaded, as well as cargo and mail, the transportation of which involves transshipment from one aircraft to another at the airport of transfer.

Effective use of hub airports requires that aircraft from peripheral airports connected by airlines to the hub airport arrive at it almost simultaneously. In this case, peripheral are not only airports of regional and local importance, but also large airports, including hub, from which passengers change at the hub. Aircraft arriving at the hub airport simultaneously undergo ground service there, which facilitates the transfer of passengers and their luggage between these aircraft, or, as in the case of FedEx, the transfer of cargo and express mail. After that, the planes also depart almost simultaneously to the peripheral airports of destination.

An airline that serves the airline's hub networks operates flights between its one or more hub airports and a set of peripheral airports. The airline is forced to coordinate the arrival and departure of flights at its hub airport to minimize delays for transfer passengers passing through it. This strategy of the airline is aimed primarily at passengers traveling to such points of departure and destination, for which the volume of traffic is insufficient to organize high-frequency direct flights.

The transfer system through the hub airport is usually formed by the airline for which the airport is the base. Therefore, often the airlines that form the hub system are dominant in the hub airport. Their share in the level of traffic served by the airport prevails over other airlines. There are examples when the created hub airport is not one, but several, usually two airlines that use one airport as their hub.

Airlines – members of one global alliance seek to use for connecting flights not only the same hub airport, but also to provide transfer passengers in one terminal. Large airlines and alliances have a system of hubs on their routes. In this regard, there are two main types of networks of hub airlines – single- and multi-node networks [22]. Networks of the first type are based on a single hub airport, networks of the second type - on several.

Most often, the term "hub" includes any significant airport, which is not necessarily within the United States. In this sense, all major airports are hubs. Annex B reproduces the ranking of the 20 busiest airports in 2019, based on data from the Airport Council International (ACI) World [23].

The ranking table of airports is reproduced on the basis of the analysis of indicators on the served passengers and the general movement of planes in 2019. Passenger figures are calculated by summing the total number of departing and arriving passengers, as well as transfer and transit passengers at each airport during the year. Data on total aircraft traffic are calculated by summing all landings and take-offs at each airport during the year.

Among the leaders are undoubtedly the American airports, which are a model for the implementation of the "hub-and-spoke" model. Analyzing the rating, we can also note the rapid development of Asian airports, which are increasingly

occupying a leading position in the world list. However, it is too early to call them fully hubs, due to the small share of transfer correspondence compared to American and Western European hubs.

Interestingly, the list of airports with the most intensive traffic flows is significantly different from that given in Annex B. According to the results of 2019, the first five seats in it were distributed among the airports as follows:

1. Hong Kong International Airport (HKG, China) – 4 809 485 tons of cargo.

2. Memphis International Airport (MEM, USA) – 4 322 740 tons of cargo.

3. Shanghai Pudong International Airport (PVG, China) – 3 634 230 tons of cargo.

4. Louisville Muhammad Ali International Airport (SDF, USA) – 2 790 109 tons of cargo.

5. Incheon International Airport (ICN, South Korea) – 2 764 369 tons of cargo.

This list is based on figures from (ACI) and displays the airports in order of tons of cargo handled in 2019 [23]. Figures are calculated by totaling all loaded and unloaded freight and mail at each airport throughout the course of the year. So the top five includes hub airports in America and Asia, confirms their leadership in the world.

Comparing the "hub-and-spoke" and "point-to-point" systems, we can distinguish both advantages and disadvantages. The advantage of the hub-and-spoke system is the creation of opportunities for the airline to provide communication between a much larger numbers of points compared to the system "point-to-point". At the same time, the airline concentrates traffic flows in a single center, without expanding the size of the existing fleet. As a result, the airline redistributes aircraft more efficiently on routes, using more economical small-class aircraft on regional routes, and has the ability to increase the frequency and commercial congestion of flights.

Another advantage for the hub airport is to increase the level of aircraft flows, as well as passenger and cargo flows. All this is a source of growth in commercial performance of both the airline and the airport. Passengers become available not only airports, surrounding hubs, but also much more separate points,

with which the hub is connected by long-distance routes. But thanks to the global system of hub airports, passengers have the opportunity to travel without having to wait long between any two medium or even small airports in the world.

The main disadvantages of the "hub-and-spoke" system for the airline are the need to develop and carefully adhere to the nodal schedule, which provides for the organization of connections. For passengers traveling from one peripheral airport to another, the disadvantage is the inevitability of more or less tedious waiting for a transfer at the hub airport. And for the airport, the disadvantage is the increased capacity requirements of airport complexes in order to service traffic during short peak intervals of mass transfers of passengers, baggage and cargo transshipment. As a rule, during the rest of the operation of the hub airport, its capacity is excessive.

The literature describes several classification systems of hub airports. ICAO documents define the types of hub airports that can be grouped by the following characteristics [7]:

Classification of hubs by *type of correspondence* served:

- *Passenger hub airports* include most of the world's hubs. Many hub airports (mostly passenger airports) have significant capacity to service other types of correspondence.

- *Cargo hub airports* – airports where funds are provided for unimpeded and rapid docking and transshipment of air cargo.

- *Postal hub airports* (mail hub) – airports used as a transit center for postal items.

- **Inter-modal hub airports** (multimodal hub) – hub airports that allow convenient docking or reloading of correspondence from one mode of transport to another.

Classification by *coverage of served regions*:

- ➢ **Major hub airports** – the largest airports that serve several airlines with a large number of long-haul connecting flights. They are usually located in the

center of densely populated areas, generating heavy traffic. Several of the world's largest hub airports are called mega hub or super-hub airports.

Within the category of large hub airports, in turn, can be divided into two categories. The first of them is based on airlines that provide a global network with a wide choice of destinations and high frequency of flights. A number of such airports belong to the category of mega hubs. In Western Europe, these include transfer airports in London and Paris, hub airports in Frankfurt am Main, Schiphol (Amsterdam), Barajas (Madrid). In the United States, these are the hub airports of Atlanta, O'Hara (Chicago), International (Los Angeles) and the New York transfer hub (J. Kennedy and Newark airports). In the Persian Gulf and Asia-Pacific countries, these are the airports of Dubai, Doha, Bangkok, Hong Kong, Seoul and Singapore, where with a very high overall performance; the share of transfers is still lower than in Western European or North American hubs.

Hub airports of the second lower category create a global network of smaller coverage or specialize in servicing a certain segment of the air transport market. These include airports such as San Francisco, Toronto, Washington in North America; Copenhagen, Munich, Vienna, Zurich in Western Europe; Kuala Lumpur, Osaka, Shanghai, Sydney in the Asia-Pacific region.

Bright examples of specialized hubs are the airports of Schwechat (Vienna) and Kastrup (Copenhagen). The first of these is the hub airport of Austrian, Austria's national carrier. This airline is effectively developing a niche air market related to transportation between Eastern and Western Europe.

The second is the hub airport of SAS, a joint airline of three Scandinavian countries: Sweden, Norway and Denmark, which is part of the global Star Alliance. SAS and other members of the alliance use Copenhagen Airport as a transfer point for passengers in the Scandinavian region and the Baltic Sea.

➢ *Regional hub airports* – hub airports that serve a region of a state or a region that includes several states. Relatively small airports that offer regional connections within specialized markets have proved particularly popular in Western Europe. These include, for example, the airports of the cities of Lyon,

Prague, Stockholm, and others, which have a significant share of passengers transferring between local flights and medium-haul flights.

Classification of hub airports in relation to *the hub-and-spoke airline system of airlines using* these airports:

- *An interline hub* is a hub at which connections or transferring of traffic are chiefly made between flights of different carriers.

- *An online hub* is a hub at which connections or transferring of traffic is mostly made between different flights of the same airline.

Airline hub airports by *functions performed within multi-node networks* can be classified as follows [7]:

❖ *Primary hubs* – hub airports that serve as the center of the airline's network. Most of them belong to the category of large hub airports.

❖ *Secondary hubs* – auxiliary hub airports created by carriers. Many regional airports serve as secondary hubs for airlines. They act as a hub for the flow of air correspondence from small serviced airports, which are sent to the primary hub and back.

❖ *Mini-hubs* – small regional hubs that serve a small number of destinations, sometimes called "focus-city". It should be noted here that the use of the term "focus-city" to denote a small hub is not entirely correct. The fact is that the latter name, borrowed from the American aviation business, originally means a secondary airport for the airline's aircraft. Unlike the main airport – the hub of the airline, where it organizes a system of connecting flights and from which flights are performed with high frequency in many directions, in the "focus-city" schedule is usually uncoordinated, flight frequencies are much lower, and themselves flights are served by smaller regional aircraft. For these reasons, the share of transfers in "focus-city" is insignificant, which does not allow including airports of this category in the hubs.

❖ *Second country hub* - hub airports created by an air carrier in a foreign country and usually allow it to communicate between different points in their country or different points of third countries.

Most of the carriers that build multi-node networks are US airlines. For example, the hubs of US Airways are McCarran (Las Vegas), Douglas (Charlotte), Philadelphia, Sky Harbor (Phoenix). "Focus-city" are Logan (Boston), Pittsburgh, them. Reagan (Washington), Fort Lauderdale. Most European airlines have a single hub, and if they create a multi-node network, then through the use of alliance or other forms of partnership. Thus, the primary hubs of Lufthansa are Frankfurt am Main and, since 2002, Munich. Lufthansa's secondary hub, Zurich, is the hub airport of Swiss airline, Lufthansa's Star Alliance partner. In this case, Zurich acts for Lufthansa as the hub airport of another country.

Another feature used in foreign works for the classification of hub airports is the presence (or absence) of a pronounced spatial orientation of the air traffic network, which is formed on the basis of the airport. On this basis, hub airports are divided into two types, for which the proposed names, for the first type – *directional hubs* (or "sand clock") and for the second – *omnidirectional hubs* (or "inland areas") [24].

A hub located between two groups of peripheral airports, from which passengers make a change in it, is considered to be directional. This type includes a number of the largest hub airports in the United States, which make transfers of passengers transported between airports in densely populated areas of the east and west coasts.

These are such airports as Dallas - Fort Worth (hub-forming company American Airlines), O'Hara, (United Airlines and American Airlines), Houston (Continental Airlines), Minneapolis St. Paul (NorthWest), Denver (United Airlines) , Salt Lake City (Delta Airlines) and others [25]. Along with hubs that specialize in the West-East direction, a number of leading American airports provide North-South transportation, which is especially in demand in the eastern states of the United States. In addition, it is transportation between the United States and Mexico, as well as the Caribbean. Airports in this direction include Miami (American Airlines), Charlotte Douglas (US Airways), partly Atlanta (Delta) and others.

Airlines using directional hubs build their route network in such a way that flights begin at the peripheral airport "on one side" of the hub and end "on the other side" of it. This scheme increases the transfer potential of the hub, but leads to increased costs for the base of the fleet at peripheral airports. It is noted that to maintain a network of directional hub requires a fleet consisting of aircraft of one or more similar types.
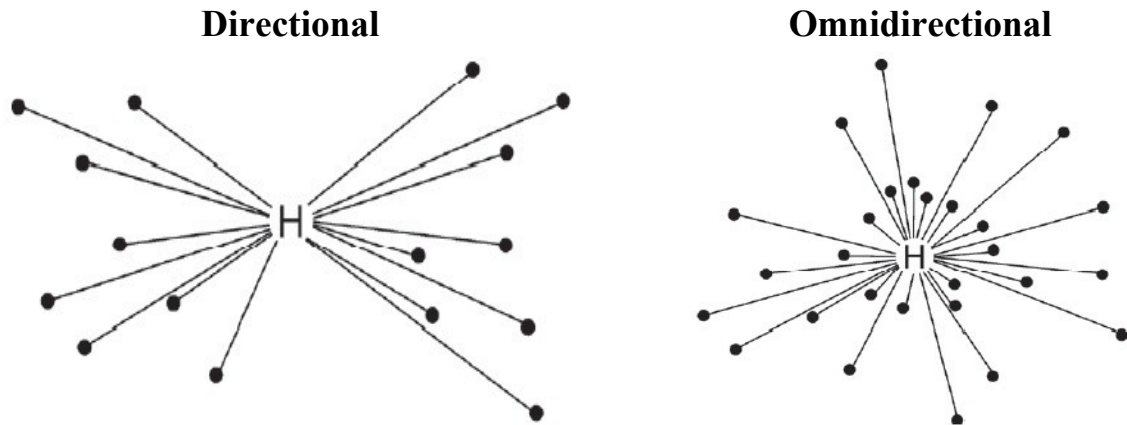
Directional   **Omnidirectional**

Figure 1.3.1. Types of airport hubs

The hub, which connects long-distance, including international and regional flights from the surrounding airport hubs, is omnidirectional. The airline network does not have any preferred direction, so the hub is called "omnidirectional". This type includes many European airports, such as Heathrow (London), them. S. de Gaulle (Paris), Schiphol (Amsterdam). An omnidirectional hub requires a much more diverse fleet.

I. *ANALYTICAL PART*

Air Transportation Management Department				NAU.20.06.23 001 EN				
Done by:	Morhunova D. Yu					Letter	Sheet	Sheets
Supervisor	Shevchenko Yu.V.					D	35	60
Standards Inspector	Shevchenko Yu.V.			*ANALYTICAL PART*				
Head of the Department	Shevchuk D.O.					FTML 275 ОП – 202Ma		

2.1. General characteristics of the air transportation market of Ukraine

The development of the air transportation market, as well as civil aviation in general, is one of the key and strategic directions for Ukraine. First of all, this is due to the fact that Ukraine is the second largest country in Europe with a favorable geographical location, which can claim the status of an international transit hub. Especially the western part of the country is a connecting link on the Eurasian roads, which favorably connects Eastern and Western Europe, the Baltic and Caspian regions. So, let's analyze the air transportation market of Ukraine during the last five years and examine the changes that have taken place in the market.
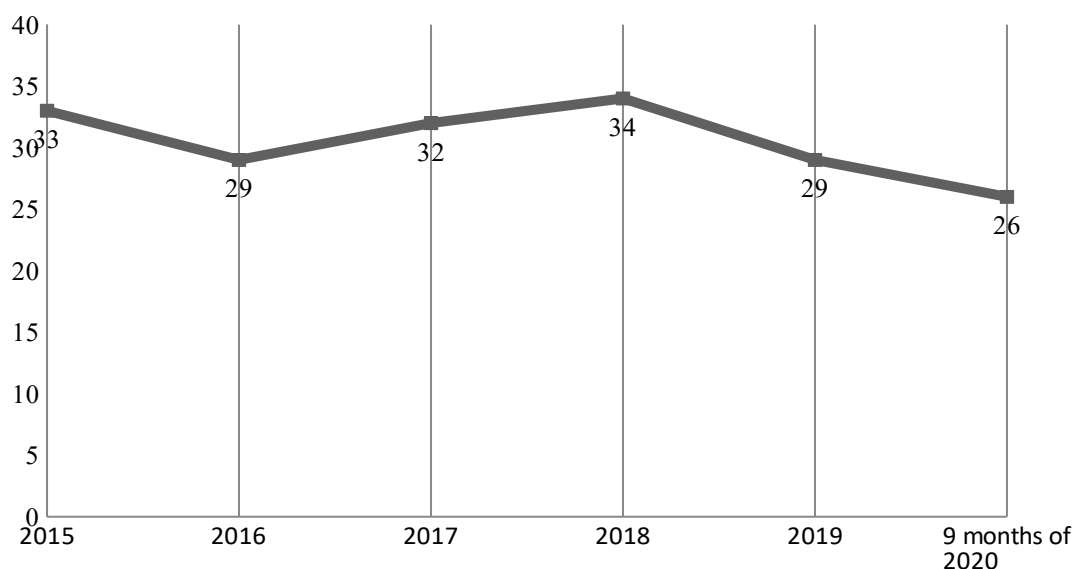

Figure 2.1.1. The number of Ukrainian airlines that carried out commercial transportation of passengers, cargo and mail during 2015 – 9 months of 2020 years. Built by the author based on [26]

Since 2015, 33 commercial air carriers have been operating in the air transportation market. During the analyzed period from 2015 to 2020, the maximum number of carriers in the market operated in 2018, with the beginning of entry into the market of low-cost companies. During January – September of the current year, 26 domestic airlines flew on the market of passenger and freight transportation, which reaches the lowest mark for the analyzed period.

Passenger transportation

In 2014 – 2015, the air transportation market suffered a significant blow from the political situation in the country. Therefore, 2015 became the point of the crisis bottom, from which rapid growth began. Figure 2.1.2 shows the dynamics of passenger traffic by domestic commercial airlines during 2015 – 2019. To better understand the emergence of growth dynamics, we analyze the situation in the passenger market for each year separately.
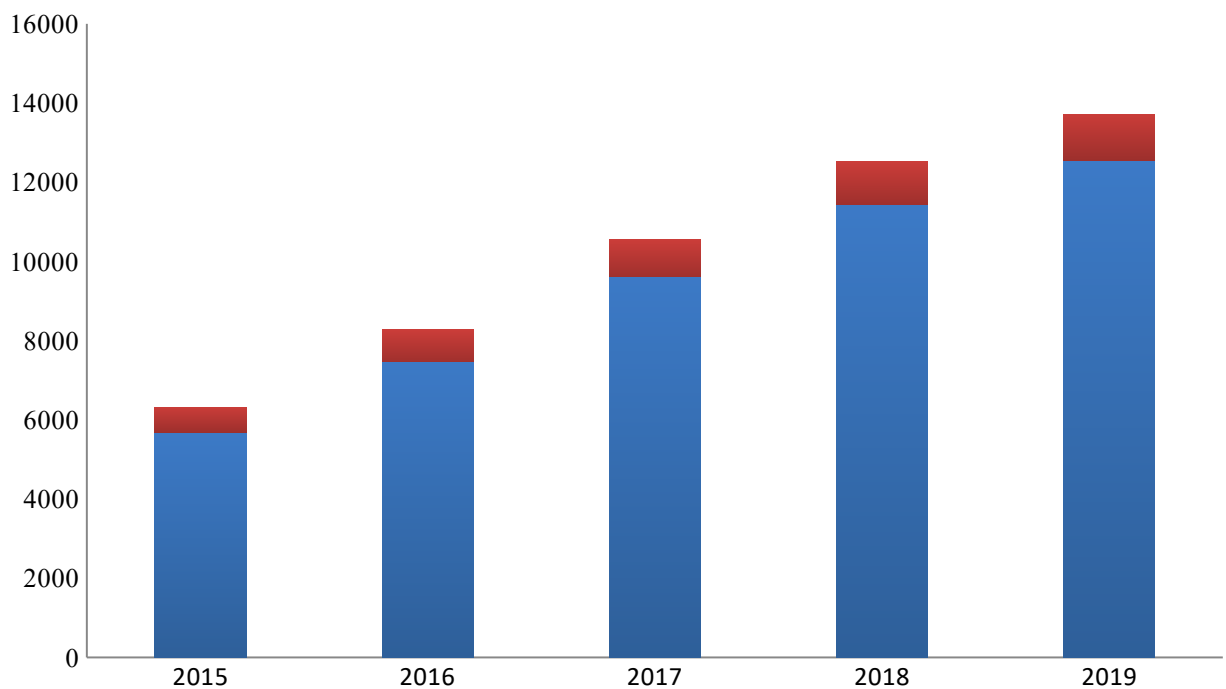

Figure 2.1.2. Dynamics of passenger transportation by commercial flights by Ukrainian airlines during 2015-2019 years. Built by the author based on [26]

As noted earlier, 2015 was the starting point for the growth of passenger traffic in the domestic market. In 2015 domestic airlines carried 6304,3 thousand passengers. However, the following year was marked by the excess of the number of transported passengers by 2,1% of the peak of 2013, which indicates the recovery of the Ukrainian passenger air transportation market after the recession of 2014 – 2015.

During 2016 passenger transport activities were carried out by 19 domestic airlines. During this year, 95% of the total passenger traffic was performed by 6

leading airlines: UIA, Azur Air Ukraine, Windrose Airlines, YanAir Airlines, Bravo Airways and Atlasjet Ukraine. UIA has increased passenger traffic by 24,9% compared to the previous year 2015, Azur Air Ukraine – by 17%, Windrose Airlines – by 75,8%, YanAir Airlines – by 6,8 times and Atlasjet Ukraine – 10,5 times (provides transportation since September 2015). It should also be noted that the fifth position in terms of volume was taken by Bravo Airways, which began performing passenger traffic in April 2016.

The growth of passenger air transportation during 2015 – 2016 by 31,3% indicates a positive dynamics in the market, which is associated with the development of the international air transportation sector. Regular flights between Ukraine and the world during 2016 were operated by 10 domestic airlines to 42 countries and 28 foreign airlines to 27 countries, including 2 new ones (SprintAir (Poland) and Air Serbia (Serbia)). UIA carried 4944,4 thousand passengers, foreign – 3847,5 thousand passengers (an increase of 23% and 2,1% respectively). During 2016 in accordance with the approved schedule, domestic international airlines started operating on a regular basis 27 international airlines, foreign airlines – 13 airlines.

There was an increase of 52,5% in the number of passengers carried by domestic airlines on international flights on an irregular basis, for the reporting year UIA carried 2531 thousand passengers. The largest volumes of such traffic (91%) fall on 5 airlines: UIA, Azur Air Ukraine, Windrose Airlines, YanAir Airlines and Bravo Airways. Regular domestic passenger traffic between 9 cities of Ukraine was performed by 5 domestic airlines, 791,9 thousand passengers were transported (an increase compared to 2015 – by 29,5%).

The next 2017 was marked by the growth of the main economic indicators of the industry due to domestic aviation companies. For the second year in a row, the Ukrainian passenger air transportation market showed high growth rates. At the same time, in the previous 2016 the market recovered after the recession that took place in 2014 – 2015. If in 2016 the volume of passenger traffic of domestic airlines exceeded the "pre-crisis" 2013 by 2,1%, in 2017 – by 30,1%.
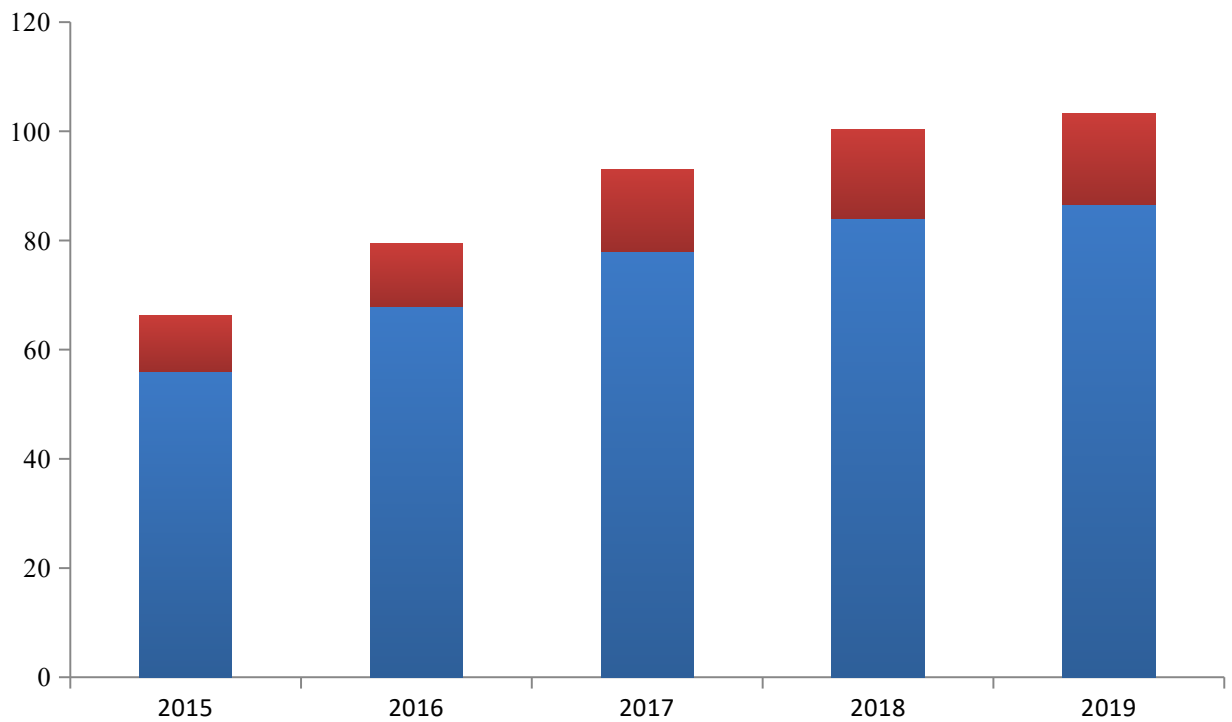
Figure 2.1.3. Dynamics of the number of departing and arriving aircraft at the airports of Ukraine during 2015 – 2019 years. Built by the author based on [26]

Figure 2.1.3 shows that during the reporting year in the market of passenger and cargo air transportation flights were operated by 32 domestic airlines, which performed 93,0 thousand commercial flights, which provided an increase compared to 2016 by 17%. At the same time, according to statistics, the number of transported passengers increased compared to the previous year by 27,5% and amounted to 10555,6 thousand people.

During the year, passenger traffic was provided by 18 domestic airlines. According to statistics [26] in 2017, 93% of total passenger traffic was carried out by five leading air carriers. In addition to UIA, the leadership is maintained by such companies as Windrose Airlines, Azur Air Ukraine, Atlasjet Ukraine and Bravo Airways.

Windrose Airlines achieved a 2,5-fold increase in passenger traffic compared to the previous 2016, Atlasjet Ukraine – by 73,8%, Bravo Airways – by 49,9%, Azur Air Ukraine – by 17,2% and UIA – by 16,5%.

Regular flights between Ukraine and the world in 2017 were operated by 10 domestic airlines to 43 countries and 29 foreign airlines to 27 countries. Among the new foreign airlines entering the Ukrainian market are Qatar Airways from Qatar, Ernest Airlines from Italy and Kish Air from Iran.

Along with this, the geography of international scheduled flights of both domestic and foreign airlines expanded. In January – December 2017, in accordance with the approved schedule, 20 international airlines were put into operation on a regular basis, including 10 international airlines – domestic airlines. UIA carried 5837,5 thousand passengers on international scheduled flights, foreign – 4975,8 thousand passengers (an increase of 18,1% and 29,3%, respectively).

The highest growth rate of the number of transported passengers by domestic airlines was observed in such a segment of the air transportation market as international flights on an irregular basis (49,2 %): for the reporting year 15 Ukrainian airlines carried 3777,0 thousand passengers. At the same time, 85% of such traffic was carried out by four airlines, including Windrose Airlines, UIA, Azur Air Ukraine and Bravo Airways.

During the year, the intensification of regular transportation within Ukraine continued. Regular domestic passenger traffic between 9 cities of Ukraine was performed by five domestic airlines: 930,9 thousand passengers were transported, which is 17,6% more than in 2016.

Gradually, in three years, the volume of passenger traffic has almost doubled compared to 2015 and at the same time more than one and a half times the level of "pre-crisis" 2013. And 2018 has become an example of stable development, which is confirmed by statistics.

According to Figure 2.1.3, during 2018, transportation of passengers, cargo and mail was carried out by 34 domestic airlines, which performed 100,3 thousand commercial flights. At the same time, the number of transported passengers increased compared to 2017 by 18,7% and amounted to 12529,0 thousand people (Figure 2.1.2).

In 2018, passenger traffic was carried out by 21 domestic airlines, among which the top five were UIA, Windrose Airlines, Azur Air Ukraine, YanAir Airlines and Bravo Airways. By the end of the year, the five largest passenger airlines transported 1162,6 thousand people, which is 20,2% more than in 2017, and is almost 93% of the total passenger traffic of Ukrainian airlines.

More than half – 54,2 % of all passenger traffic of domestic airlines are international scheduled traffic. In 2018, according to the approved schedule, regular international flights were operated by 10 domestic airlines to 46 countries, the number of passengers who used the services of Ukrainian air carriers increased by 16,4% and amounted to 6796,2 thousand people.

Simultaneously with the increase in the intensity of flights in many mastered areas, the network of routes of domestic airlines developed. Thus, during the year, Ukrainian airlines opened 17 new scheduled routes.

At the same time, there was an expansion of activities in the Ukrainian market of foreign airlines, 5 new foreign airlines started regular flights to Ukraine. 2018 was also marked by the development of the route network of foreign airlines, which started operating 27 international airlines. In total, in 2018, 38 foreign airlines from 37 countries flew to our country. Their services were used by 6857,3 thousand passengers, which is 37,8% more than in 2017 and accounts for 50,2% of the total volume of regular passenger traffic between Ukraine and the world.

An increase of 23,1% was observed in such a sector of the passenger air transportation market as international flights on a non-scheduled basis, during the reporting period 16 Ukrainian airlines carried 4649,9 thousand passengers. At the same time, almost 84% of such flights were carried out by the five above-mentioned leading airlines.

During the year, the intensification of regular transportation within Ukraine continued. Domestic passenger traffic was performed on a regular basis by four domestic airlines, which provided air services to ten cities of Ukraine. During the reporting year, 1071,4 thousand air passengers were transported, which is 15,1% more than in the previous 2017.

The positive dynamics of market growth in previous years gave impetus to continue to demonstrate the positive dynamics of passenger air traffic in 2019. Figure 2.1.2 shows that the number of passengers who used the services of Ukrainian airlines in 2019 increased by 9,4% and amounted to 13705,8 thousand people.

Passenger traffic during the year was carried out by 18 domestic airlines, among which the largest volumes were performed by UIA, Azur Air Ukraine, SkyUp Airlines, Windrose Airlines and Bukovyna Airlines. During the reporting year, the five leading airlines transported a total of 13306,7 thousand, which is 22,4% more than in 2018 and is 97% of the total passenger traffic of Ukrainian airlines.

More than half – 51,9% of all passenger traffic of domestic airlines are international scheduled services. In 2019, according to the approved timetable, 10 domestic airlines to 46 countries of the world carried out regular international passenger traffic. The number of passengers who used the services of Ukrainian companies increased by 4,6% and amounted to 7107,2 thousand people, while the average percentage of passenger traffic on international scheduled flights increased by 2,1% points and amounted to 80,9%. The network of routes of domestic air carriers, which started operating on a regular basis of 17 international airlines, continued to develop. At the same time, there was an expansion of activities in the Ukrainian market of foreign airlines, which used 9422,5 thousand passengers, which is 37,4% higher than in 2018 and is 57% of the total volume of regular passenger traffic between Ukraine and the world.

In total, 40 foreign airlines from 37 countries performed regular passenger flights to Ukraine, including four new ones - Austrian Laudamotion, French Aigle Azur (operated until September 2019), Israeli Israir Airlines and Norwegian Scandinavian Airlines System. During the year, 29 new routes were opened by foreign airlines, including 21 new routes by Ryanair and Wizz Air Hungary.

According to the results of 2019, the largest growth rate, namely 16,9%, the number of passengers carried by domestic airlines was observed in such a market

segment as international flights on a non-scheduled basis. During the year UIA transported 5440 thousand passengers. At the same time, almost 97% of such flights are operated by the five above-mentioned leading airlines.

Regular domestic passenger traffic between 11 cities of Ukraine was performed by four domestic airlines: UIA, Motor Sich Airline, Windrose Airlines and SkyUp Airlines. During 2019, 1145,2 thousand passengers were transported by regular flights within Ukraine, which is 6,9% more than in the previous year.

2020 was a very difficult year for the aviation industry. The complication of the epidemic situation in Ukraine and in the world, associated with the spread of COVID-19, led to a decline in demand for air transportation and reduced commercial traffic at the end of the first quarter of this year, in connection with which airlines were forced to reduce frequency or cancel performing the vast majority of flights.

Due to the introduction by the Government of Ukraine of restrictive measures in the framework of combating the spread of COVID-19, from March 17, 2020 to June 15, 2020, international passenger flights were almost temporarily suspended. Domestic passenger flights were temporarily suspended for the period from March 24, 2020 to June 5, 2020. In addition, from August 28, 2020 to September 28, 2020, temporary restrictions on crossing the Ukrainian border for foreign citizens were reintroduced, which together with the extension of restrictions on entry of Ukrainian citizens to a number of countries significantly curbed demand in the air transportation market.

As a result, the volume of passenger traffic of Ukrainian airlines in the first quarter of 2020 decreased compared to the same period last year by 17,7%, for the second quarter, which was the peak of restrictive measures - by 98,3%. However, after the resumption of passenger flights in June, the rate of decline in traffic slowed significantly and in the third quarter amounted to 61,4%.
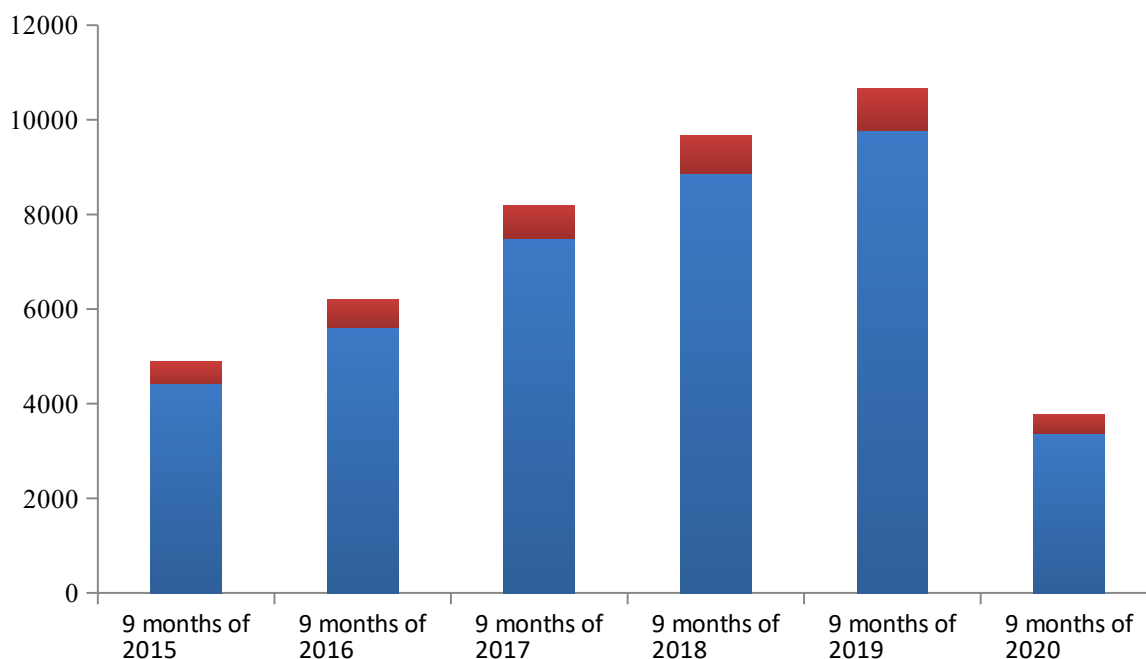
Figure 2.1.4. Dynamics of Ukrainian passenger air transportation during 9 months of 2015 – 9 months of 2020. Built by the author based on [26]

To analyze the consequences of the pandemic impact, Figure 2.1.4 was created, which shows the dynamics of passenger traffic through the airports of Ukraine, as of 9 months of each year from 2015 to 2020. During January-September of the current year, 26 domestic airlines operated flights on the air transportation market, according to statistics, 34,2 thousand commercial flights were performed (for the same period in 2019 – 79,7 thousand). A total of 3770,8 thousand passengers were transported by 14 domestic airlines in the first 9 months of 2020, which is 64,6% less than in the same period last year. At the same time, the share of the four largest passenger airlines, which today are UIA, SkyUp Airlines, Azur Air Ukraine and Windrose Airlines, was 98%.

During January-September 2020, regular flights between Ukraine and the world were operated by 8 domestic airlines (7 in the third quarter) to 43 countries (19 in the third quarter). According to statistics for 9 months of 2020, 1124,4 thousand people were transported (reduction – by 80%), while the percentage of passenger traffic on international scheduled flights of Ukrainian airlines decreased by 10,1% points and amounted to 71,1%.

44

At the same time, 31 foreign airlines (19 – in the third quarter) from 34 countries (26 – in the third quarter) performed regular passenger flights to Ukraine, the services of which were used by 2659,1 thousand passengers, which is 61,7% less, than the figure for 9 months of 2019. Along with the forced reduction of the route network and the closure of a number of routes by many airlines, during the reporting period, regular flights were launched on 27 new routes, including four new routes – by Ukrainian airlines.

During the reporting period, 11 Ukrainian airlines carried 2256,2 thousand passengers on international flights on a non-scheduled basis (a reduction of 45,6%), of which almost 98% are accounted for by Azur Air Ukraine, SkyUp Airlines, UIA and Windrose Airlines. During January-September this year, passenger traffic on a regular basis between the ten cities of Ukraine was carried out by four domestic airlines; the volume of traffic decreased by 56% and amounted to 384,9 thousand people.

Cargo and mail transportation

Freight and mail transportation by air also began to grow during 2015 – 2019. Freight transportation was a significant advantage over postal transportation.

According to the statistics of Figure 2.1.5, in the period from 2015 to 2016, there was an increase of 4,8% in freight traffic and an increase of 16,2% in mail traffic. Since in 2016 cargo and mail were transported by 18 domestic airlines, most of the transportation is charter flights in other countries under UN humanitarian and peace programs, as well as under contracts and agreements with other customers. Almost 83% of the total volumes in the reporting period were performed by Antonov Airlines, UIA, ZetAvia Airlines, Maximus Airlines, Air Urga and Europe Air.

In 2017, cargo was carried out by 23 domestic airlines. Antonov Airlines, UIA, ZetAvia Airlines, Maximus Airlines, Ukrainian Helicopters, Ukraine Air Alliance and Alfa Air became the leaders of transportation. In 2017, these airlines performed almost 85% of the total cargo and mail traffic.
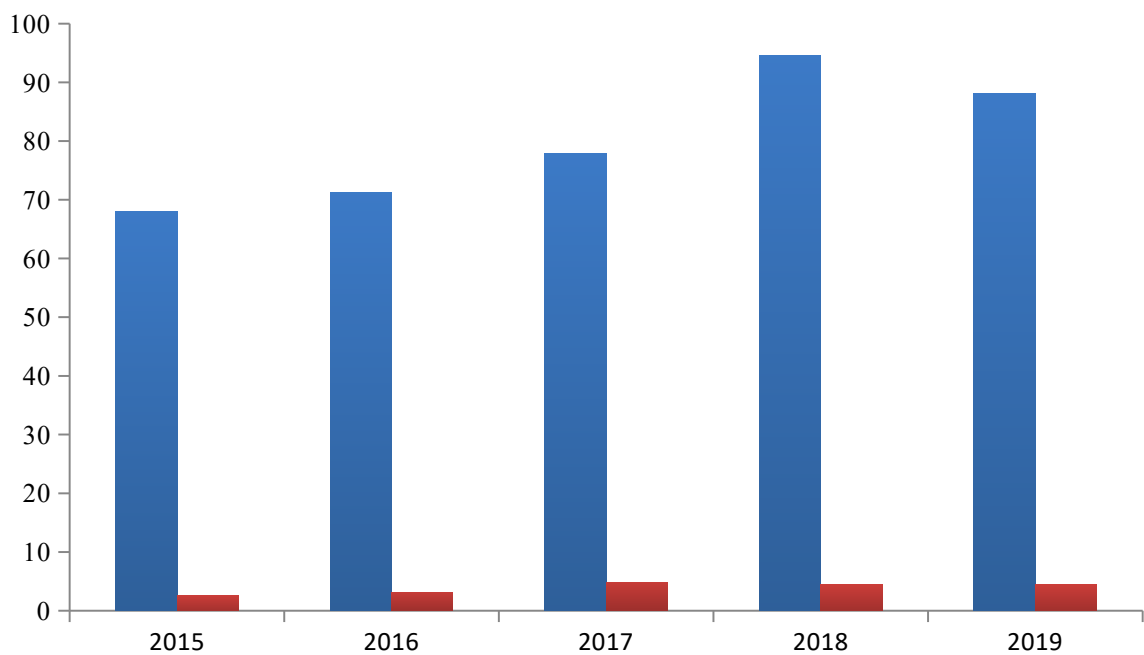
Figure 2.1.5. Dynamics of freight and postal traffic by commercial flights of Ukrainian airlines during 2015-2019. Built by the author on the basis of [26]

In 2018, 22 domestic airlines performed cargo and mail transportation. The period of 2017 – 2018 had the highest growth rate of freight traffic, namely 21%. However, during the same period, the rate of postal traffic began to decline by 7,4%. In 2018, the leaders of transportation were Antonov Airlines (growth compared to 2017 by 15,3%), UIA (growth – by 10,2%), ZetAvia Airlines (growth – by 36,8%) and Maximus Airlines (growth – 2,2 times). These airlines performed 78% of the total cargo and mail traffic in the reporting period.

Volumes of cargo and mail transportation by air transport of Ukraine in 2019 decreased by 6,6% and amounted to 92,6 thousand tons. Transportation was performed by 20 domestic airlines. But among the leaders of freight transport remained - Antonov Airlines, UIA, ZetAvia Airlines, Maximus Airlines and Yuzhmashavia. These airlines performed almost 85% of the total cargo and mail traffic in the reporting year. It should be noted that most cargo has traditionally been charter flights to other countries under UN humanitarian and peace programs, as well as under contracts and agreements with other customers.

However, the volume of cargo and mail by air transport in Ukraine amounted to 62 thousand tons (for 9 months of 2019 – 68,4 thousand tons). Cargo

and mail were transported by 19 domestic airlines. The leaders in transportation are ZetAvia Airlines, Antonov Airlines, UIA, Maximus Airlines, Constanta Airline and SkyUp. These airlines performed almost 92% of the total cargo and mail traffic in the reporting period. It should be noted that most freight has traditionally been charter flights in other countries.

Airport activities

Airport activities during 2015 – 2019 also showed positive growth dynamics. The increase in passenger traffic through airports, through a proportional increase in the number of passenger traffic, led to the establishment of the maximum record of passenger traffic in 2019.
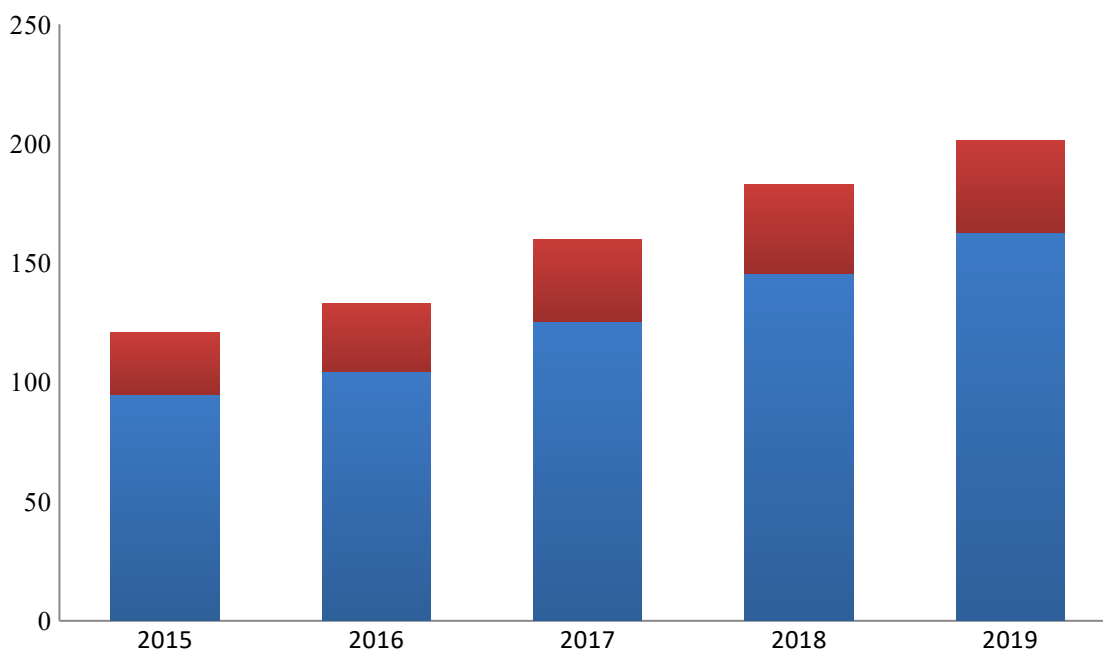

Figure 2.1.6. Amount of departure and aircraft at Ukrainian airports during 2015 – 2019 years. Built by the author arrival on the basis of [26]

As noted earlier, 2015 was the beginning of a rapid growth in air traffic in Ukraine. This year, the number of departing and arriving aircraft was 120,7 thousand aircraft. Passenger traffic then amounted to 10695,1 thousand passengers. The flow of mail through domestic airports amounted to 16498,9 thousand passengers.

The following year, commercial flights of domestic and foreign airlines served 19 Ukrainian airports and airfields. However, in 2016, the number of departing and arriving aircraft increased to 133,2 thousand aircraft, i.e. an increase of 10,4% (Figure 2.1.6). Passenger traffic amounted to 12929,9 thousand passengers, which is 20,9% more than the previous year. Also, freight traffic in 2016 also increased by 24,7% and amounted to 42,9 thousand tons.
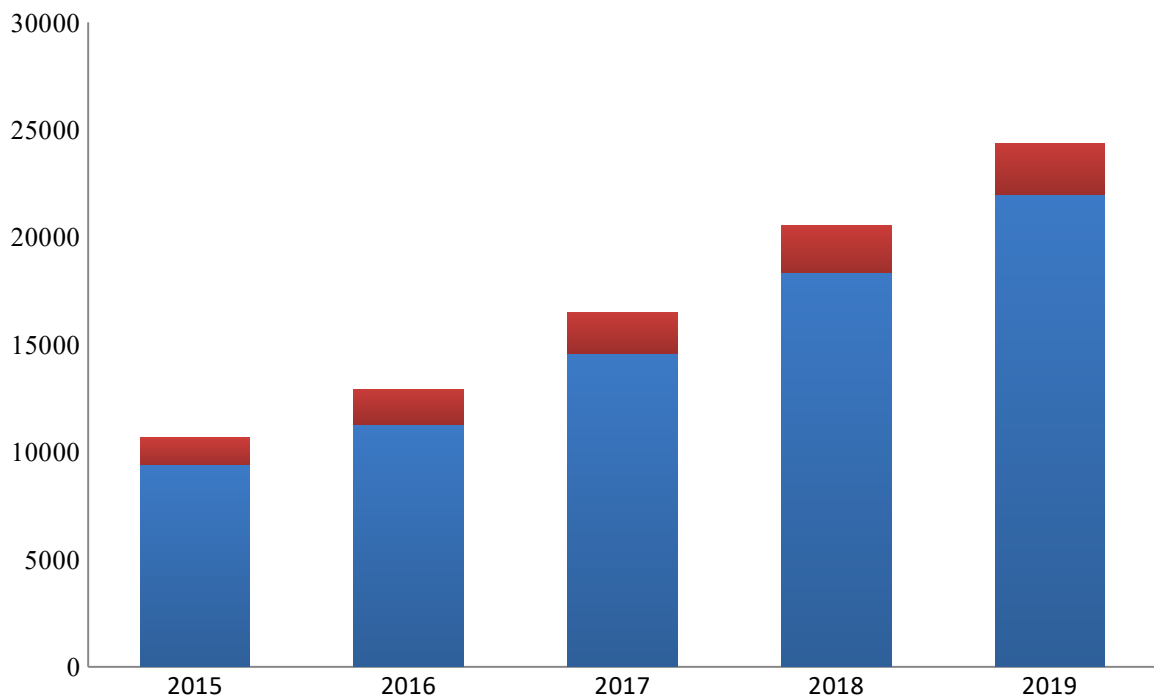

Figure 2.1.7. Dynamics of passenger turnover through the airports of Ukraine during 2015 – 2019 years. Built by the author based on [26]

According to the State Aviation Service, commercial flights of domestic and foreign airlines in 2017 served 20 Ukrainian airports and airfields. Figure 2.1.6 shows a positive increase in the number of departing and arriving aircraft, which in 2017 amounted to 159,9 thousand aircraft. This is 20% higher than in the previous 2016. In Figure 2.1.7 reflected the flow of passengers through domestic airports, which amounted to 16498,9 thousand passengers. This figure is 27,6% more than in 2016. Postal traffic also increased by 21,9% and amounted to 52,3 thousand tons.

Commercial flights of domestic and foreign airlines in 2018 served 20 Ukrainian airports and airfields, during the reporting period the total number of

departing and arriving aircraft amounted to 182,8 thousand units, which is 14,4% more than in 2017 (Figure 2.1.6) . At the same time, passenger traffic through the airports of Ukraine (Figure 2.1.7) reached 20545,4 thousand people, which increased by 24,5%. Freight traffic increased by 7,8% and amounted to 56,4 thousand tons.
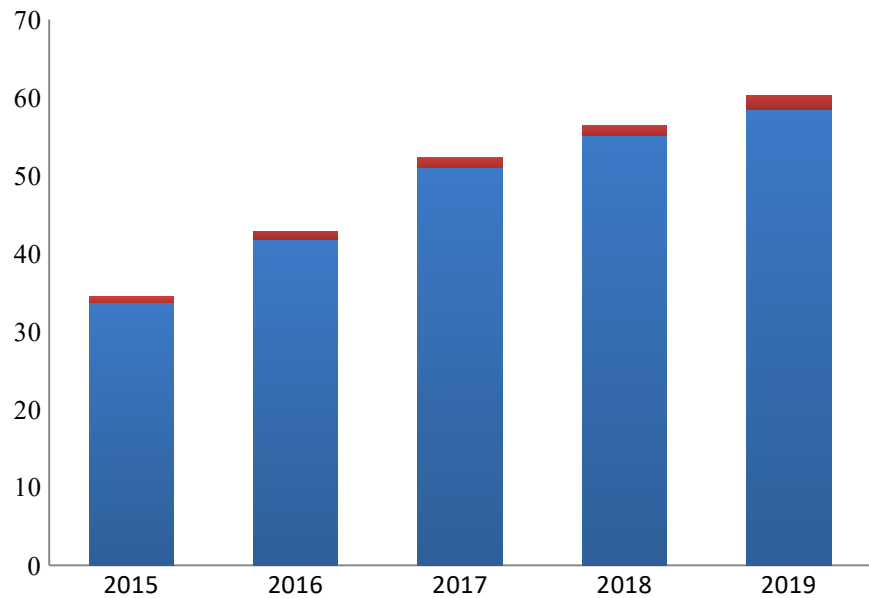

Figure 2.1.8. Freight and mail flows through the airports of Ukraine during 2015-2019 years. Built by the author on the basis of [26]

In total, commercial flights of domestic and foreign airlines in 2019 served 19 Ukrainian airports and airfields. The number of aircraft sent and arrived during the year was 201,2 thousand, compared to 182,8 thousand in the previous year (Figure 2.1.6). Passenger traffic through the airports of Ukraine reached 24334,5 thousand people and increased by 18,4%. Mail and cargo flows increased by 6,7% and amounted to 60,2 thousand tons.

In total commercial flights of domestic and foreign airlines served 19 Ukrainian airports and airfields during the 9 months of 2020. From January 2020 to September 2020, 70,9 thousand aircraft were serviced by Ukrainian airports. Compared to the corresponding period of 2019, when the number of serviced aircraft was 153,9 thousand, the volume has more than halved. At the same time,

passenger traffic through the airports of Ukraine decreased by 63%, mail and cargo traffic – by 12,5% and amounted to 6856,8 thousand people and 37 thousand tons, respectively.

Due to the rapid growth of the capacity of domestic airports during 2016 – 2019, it is necessary to consider in more detail the distribution of the leading airports market share of air transportation services. Table 2.1.1 shows the dynamics of changes in the distribution between airports of the share in total passenger turnover.

Table 2.1.1

The share of leading airports in the total volume of passenger traffic through the airports of Ukraine for 2016 – 2019 years

№	Airport	Years			
		2016	2017	2018	2019
1	Boryspil International Airport	67%	64%	61%	63%
2	Kyiv International Airport (Zhuliany)	9%	11%	14%	11%
3	Odesa International Airport	8%	7%	7%	7%
4	Lviv International Airport	6%	7%	8%	9%
5	Kharkiv International Airport	4%	5%	5%	5%
6	Zaporizhzhia International Airport	2%	2%	2%	2%
7	Dnipropetrovsk International Airport	2%	2%	1%	1%
8	Others	2%	2%	2%	2%
	Total	100%	100%	100%	100%

Compiled by the author according to [26]

During the analyzed period – from 2016 to 2019, about 98% of total passenger and mail flows were concentrated in 7 leading airports in the country – Boryspil International Airport, Kyiv (Zhuliany) International Airport, Odesa International Airport, Lviv Danylo Halytskyi International Airport, Kharkiv International Airport, Zaporizhzhia International Airport and Dnipropetrovsk International Airport. During these years, for some airports, the percentage changed by only a few points.

Boryspil International Airport remains the country's largest hub. During the analyzed period, the airport began to implement a hub development model, which provides for the mandatory development of the transit potential of the airport. The share of the airport over these four years was the largest and ranged from 67% in 2015 to 63% in 2019.

At a time when Boryspil International Airport had the lowest share of 61%, Kyiv (Zhuliany) International Airport had the highest share of 14%. After all, the previous share of Kyiv (Zhuliany) International Airport varied at the level of 9 – 11%.

Odesa International Airport and Lviv Danylo Halytskyi International Airport share third and fourth place in terms of share in total passenger and mail traffic. In 2016, the share of Odesa International Airport was 8%, but for the last three years the share has been fixed at the level of interest. In contrast, Lviv Danylo Halytskyi International Airport demonstrates stable market conquest and an annual increase in airport share of 1%. Thus, in 2019, the share of Lviv Danylo Halytskyi International Airport reached 9%, which automatically moves the airport to the third step in terms of market share.

Kharkiv International Airport in 2016 had 4% of the market, and from 2017 to 2019 consistently demonstrates ownership of 5% of the market. Zaporizhzhia International Airport, for the analyzed four years, demonstrates constant ownership of 2% of the market. At a time when Dnipropetrovsk International Airport in 2016 was 2% of the market, and in 2019 – 1%. All other operating airports in the country together account for 2% of the market in total passenger and mail traffic.

In the analytical report published by the State Aviation Service of Ukraine, following the results of 9 months of 2020, there is a significant reduction in the production performance of aviation enterprises compared to the same period last year. It should be noted that almost 98% of all passenger and mail flows are provided by the 6 leading airports in the country.
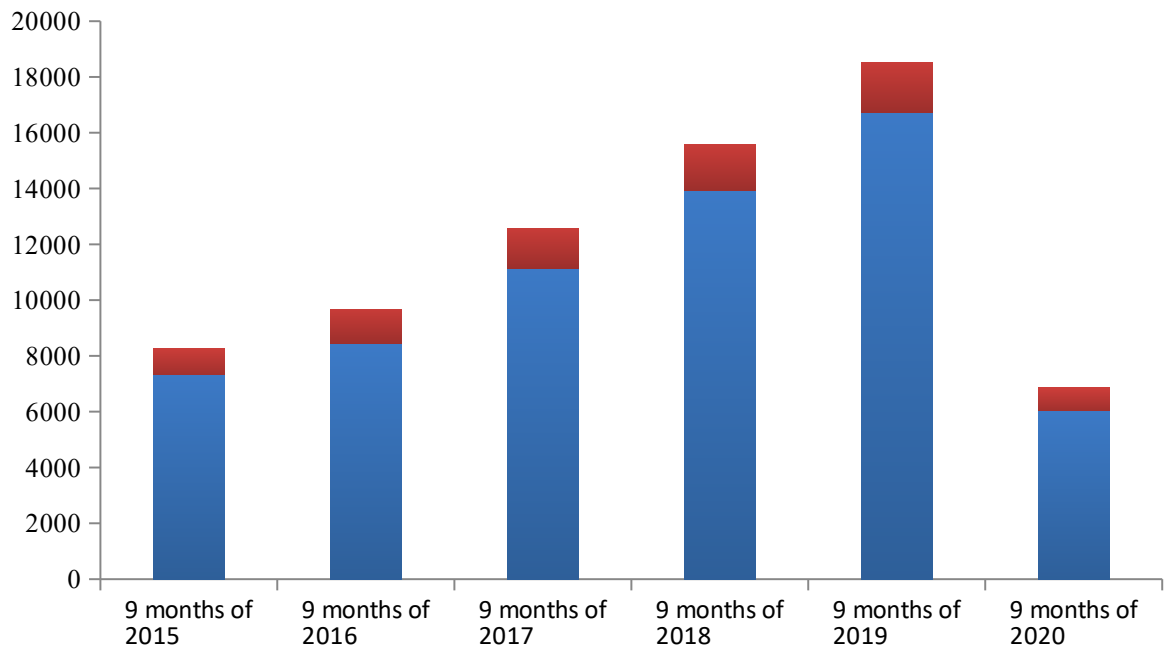
Figure 2.1.9. Dynamics of passenger turnover through the airports of Ukraine during 9 months of 2015 – 9 months of 2020. Built by the author based on [26]

Thus, the share of the leading airports in the total volume of passenger traffic through the airports of Ukraine was distributed as follows. The share of Boryspil International Airport (KBP) was 59%, Lviv International Airport Danylo Halytskyi (LWO) – 10%, Kyiv International Airport (Zhulyany) (IEV) – 9%, shares of Odesa International Airport (ODS) and Kharkiv International Airport (HRK) were 8 % each, Zaporizhzhia International Airport (OZH) - 4%.
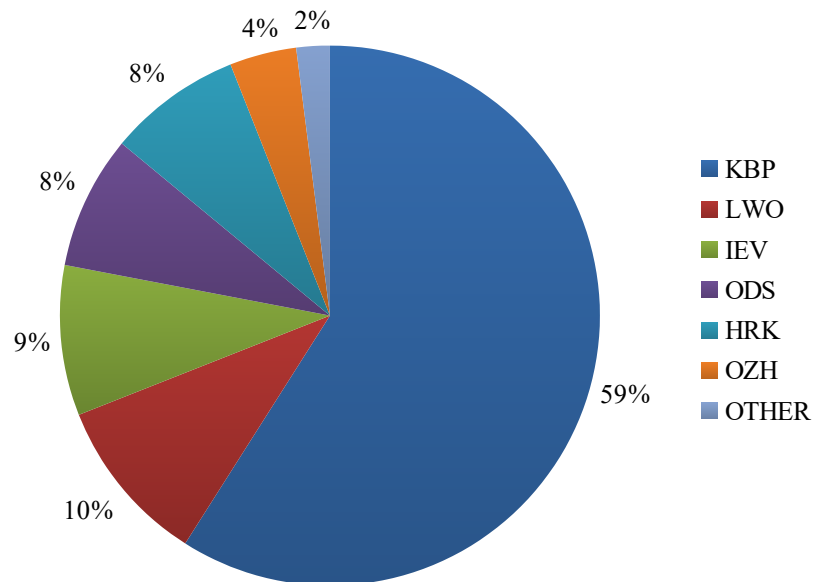
Figure 2.1.10. The share of leading airports in the total volume of passenger traffic through the airports of Ukraine for 9 months of 2020.

Built by the author based on [26]

Having got acquainted in general with the situation which has developed in the market of air transportations of Ukraine during 2015 – 9 months of 2020, it is possible to define the following. After the crisis in 2014 – 2015, the rapid development of the domestic air transport sector began. Statistics and their analysis confirm the dynamic growth, but the global pandemic has made its adjustments to the rapid development, stopping it. To understand the state of domestic airports, we will conduct a detailed analysis of each of them in the next section.

2.2. Analysis of the activities of 7 leading Ukrainian airports

As of 2020, there are 20 airports in Ukraine, of which 2/3 need reconstruction and significant re-equipment. In total, commercial flights of domestic and foreign airlines in 2019 served 19 Ukrainian airports and airfields. According to the State Aviation Services of Ukraine, a list of airports of Ukraine was created, which is formed in Annex C [27].

Most of the above airports provide both scheduled and non-scheduled air services, i.e. operate on a permanent basis. The rest of the regional airports operate

only to service non-scheduled traffic. The state of airports in 2020 has changed almost radically due to the spread of the pandemic.

In this section we will consider and analyze the operational activities of 7 leading airports in Ukraine, which form 98% of the total passenger traffic. We will be the first to consider the airports of Kyiv and analyze the statistics of passenger traffic Boryspil International Airport and Kyiv International Airport (Zhuliany).

Figure 2.2.1. Boryspil International Airport logo [28]

Boryspil International Airport (IATA: KBP, ICAO: UKBB) is the main and largest passenger international airport in Ukraine and its capital. The airport serves Kyiv, Kyiv agglomeration and other regions of Ukraine, providing almost two thirds of air passenger traffic in the country. It serves more than 15 million national and foreign passengers every year.

Boryspil International Airport State Enterprise is a state-owned commercial civil aviation enterprise that is managed by the Ministry of Infrastructure of Ukraine (Authorized Management Authority). 100% of the authorized capital of the Boryspil International Airport belongs to the State represented by the Ministry of Infrastructure of Ukraine.

According to the Resolution of the Cabinet of Ministers of Ukraine dated 23.12.2004 №1734 "On approval of the list of enterprises of strategic importance for the economy and security of the state" Boryspil International Airport is included in the list of enterprises of strategic importance for the economy and security of the state. Boryspil International Airport is included in the list of state-owned objects that are not subject to privatization, but may be corporatized, in accordance with the Law of Ukraine "On the List of State Property Objects Not Subject to Privatization".

According to the Procedure for compiling and maintaining a consolidated list of natural monopolies, approved by the order of the Antimonopoly Committee of Ukraine dated 28.11.2012 № 874-r, Boryspil International Airport is classified as a natural monopoly by the following product groups: ensuring the landing and take-off of the aircraft; ensuring aviation security; ensuring excessive parking of the aircraft; providing passenger service at the airport.

The airport is a full member of relevant international and national associations: the International Council of Airports of the European Region "(Airports Council International; ACI Europe), Ukrainian Air Transport Association (UATA), Chamber of Commerce and Industry of Ukraine, Ukrainian Quality Association, Employers' Organization of Transport Services taxes of Ukraine, etc., and is guided in its activities by the standards and practices of the International Air Transport Association (IATA), the International Civil Aviation Organization (ICAO).

Boryspil International Airport has two runways with a length of 4,000 m and 3,500 m and four passenger terminals (among which only two newer ones, "D" and "F", are in operation). The main runway 18L / 36R with a length of 4000 meters and a width of 60 meters can accommodate aircraft of all types around the clock, including in conditions of limited inspection during bad weather and ice. The second runway 18R / 36L is currently used in a limited mode by the sides of Terminal F and according to the development strategy will be reconstructed by 2020.

Due to its convenient geographical location, the airport has all the prerequisites to fight for the position of a leading international hub airport, which provides transfer services to passengers in the region. After all, the airport is located at the intersection of many air routes from Asia to Europe, America and back. This is the only airport in Ukraine that has transcontinental status. Ukraine's economic and geographical position contributes to the development of its aviation potential and integration into European and world transport systems.
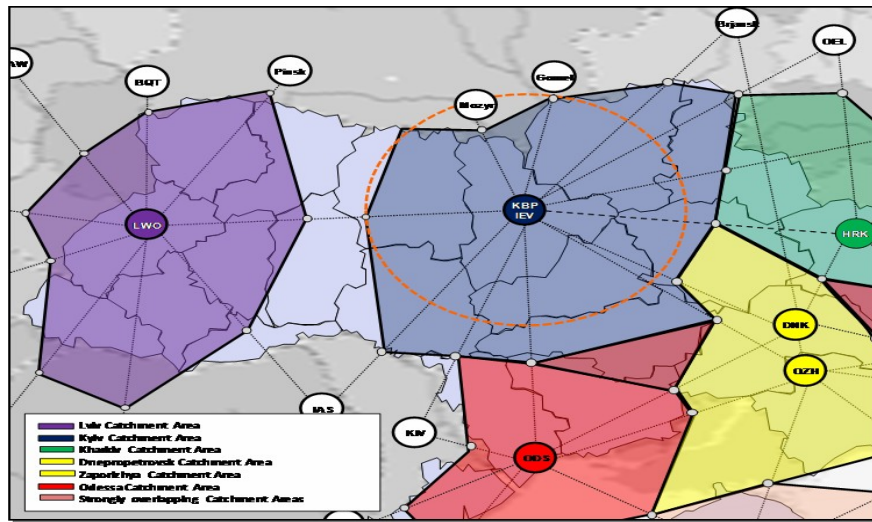
Figure 2.2.2. Coverage area of main Ukrainian airports [29]

The blue sector illustrates the immediate coverage area of the airport, which shows an accurate geographical picture of the coverage of the territory and the people living there. The distance from Boryspil Airport to competing domestic airports, as well as nearby foreign cities and airports is taken into account. The airport's coverage area includes a population of about 12 million people, which is thus the basic market potential.

Figure 2.2.3. Extended coverage area of Boryspil International Airport [29]

The development of the airport due to the direct coverage area is quite promising, as the city of Kyiv remains the main business and tourist center of the country. But it should be noted that the development due to the direct coverage

area is a limited population, so the main promising potential of the airport is to develop and attract transfer passenger flows from the expanded coverage area.

The airport is the only international hub airport in Ukraine and the hub airport for domestic airlines Ukraine International Airlines and SkyUp. The airport is also a focus city for Windrose Airlines (Ukraine), which connects regional airports with a center at Boryspil International Airport.

In 2019, Boryspil International Airport will provide services to more than 50 airlines due to an active policy of attracting air carriers. Among them are Air Arabia, Air Astana, Air Baltic, Air France, Air Malta, Air Moldova, Adria Airways, Atlasjet Ukraine, Azerbaijan Hava Yollary, Azur Air, Austrian Airlines, Belavia, British Airways, Bravo Airways, Brussels Airlines, Bukovyna, Czech Airlines, El Al, Ellinair, Flydubai, Georgian Airways, Iraqi Airways, KLM, LOT, Lufthansa, Myway Airlines, Pegasus Airlines, Qatar Airways, Ryanair, SkyUp, SWISS, Turkish Airlines, Ukraine International Airlines, Wind Rose, YanAir, etc.

Boryspil International Airport is the only airport in Ukraine that successfully competes with major European airports - hubs. According to the results of 2018, Boryspil International Airport increased passenger traffic by 19,4% and took first place in the ranking of the Airport Council International (ACI Europe).
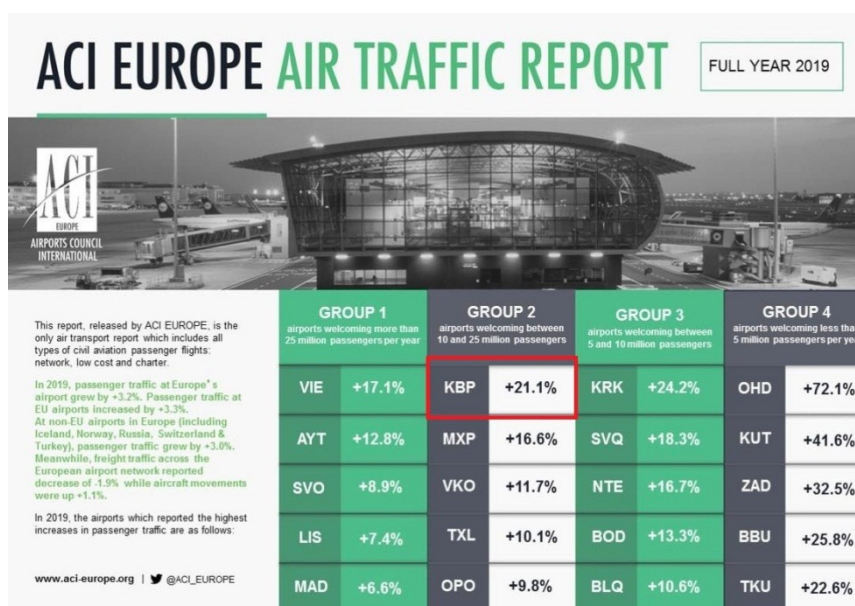

Figure 2.2.4. Image of the ACI Europe 2019 ranking [30]

Also in 2019, the company topped the ACI Europe ranking of growth among major airports in Europe. Namely, the airport took first place in the group of European airports, which serve from 10 to 25 million passengers.
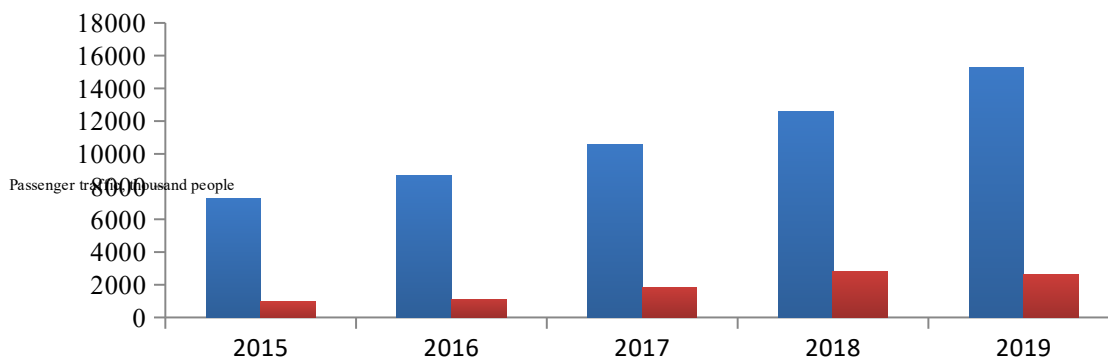

Figure 2.2.5. Dynamics of passenger turnover through Boryspil International Airport (KBP) and Kyiv International Airport (Zhuliany) (IEV) during 2015 - 2019 years. Built by the author based on [31]

Analyzing the dynamics of passenger traffic growth through Boryspil International Airport (Figure 2.2.1), the following conclusions can be drawn. After the crisis period for the aviation of Ukraine in 2014 – 2015, the airport in 2015 shows an increase in passenger traffic exceeding the limit of 7 million passengers. And in 2016, thanks to the successful implementation of the chosen hub strategy for the development of the airport, the number of serviced passengers increased compared to 2015 by 18,9%.

In 2017, Boryspil International Airport continued to lose its leading position in the number of passengers served. The share of the airport in the total volume of passenger traffic through the airports of Ukraine decreased to 64%, compared to 2016, when the share was 6%. However, this year there was an increase in passenger traffic through the airport by 22% compared to 2016 and reached 10,5 million passengers.

As a result of airport activities in 2018, there was a significant increase in the number of passengers served at all major airports in the country, so the share of the airport in total passenger traffic has decreased to 61% compared to 2017. However, passenger traffic again showed positive growth dynamics and increased by 19,4% compared to last year, as the figure reached 12,6 million passengers per year.

The peak in terms of growth in passenger traffic at Boryspil International Airport was 2019. The airport has historically reached the maximum mark of passenger traffic, namely more than 15 million passengers, which amounted to 63% of the share of passenger traffic of Ukrainian airports. The airport then showed an increase of 21,1%, which once again confirmed the status of the leading strategic airport in Ukraine.

The spread of the global pandemic in 2020, the mass closure of borders and the cessation of passenger traffic have dramatically changed the vector of airport development to the vector of use. Following the results of 9 months of 2020, there was a reduction in passenger traffic at all airports without exception, in particular, the number of passengers served by Boryspil International Airport decreased compared to January-September of the previous 2019 by 65,1%.

The difficult situation completely affected the operational activities of the country's main airport, but Boryspil International Airport was almost the only airport in the country that provided charter evacuation flights during the difficult period of aviation lockdown.

However, Boryspil International Airport is constantly striving for improvement and development, even in the current difficult period for the entire airport sector. In the pre-crisis period - until 2019, the main strategic objectives of the airport were infrastructure development, attracting new airlines and improving the quality of service. In 2019, the Cabinet of Ministers of Ukraine approved the Concept for the Development of Boryspil International Airport for the period up to 2045, the main priorities of which are the development of infrastructure and the introduction of modern services.

Figure 2.2.6. Kyiv International Airport logo [32]

Igor Sikorsky Kyiv International Airport (Zhuliany) (IATA: IEV, ICAO: UKKK) is one of the two passenger airports of the Ukrainian capital Kyiv, the other being Boryspil International Airport. It is owned by the municipality of Kyiv and located in the Zhuliany neighborhoods, about 7 kilometers southwest of the city center. Aside from facilitating regular passenger flights, Kyiv International Airport is also the main business aviation airport in Ukraine, and one of the busiest business aviation hubs in Europe [32].

Legally, the airport is in the communal ownership of the capital of Ukraine, Kyiv, but in 2005 there were attempts to subordinate the facility to the Ministry of Transport and Communications to create an International Airport for Small and Commercial Aviation.

Kyiv International Airport covers an area of 265 hectares and has one runway with a length of 2310 m and three passenger terminals ("A", "B" and "D"). In the first half of 2009, the reconstruction of the runway was completed. Thanks to the extension of the runway by 510 m, it became possible to receive heavier aircraft, including the Boeing 737 and Airbus A320. On May 11, 2009, the airport began operating around the clock. There is a Category I ILS for two runway runways, which restricts the landing of aircraft in poor visibility. The runways of the airport are actively used by Plant 410 of civil aviation, which borders the territory of the aerodrome.

Kyiv International Airport has undergone significant development in preparation for the Euro-2012 championship. On May 17, 2012, a new international terminal "A" was opened for international flights, which became the largest terminal of the airport - at the time of opening; its capacity was 320

passengers per hour. In 2013, the domestic flight terminal "D" and the business terminal "B" were put into operation. All terminals are privately operated.

Kyiv International Airport is a hub for Wizz Air. On March 27, 2011, Wizz Air Ukraine changed its hub from Boryspil Airport to Zhulyany Airport, which ceased operations in 2015 due to unprofitability. However, its air fleet was taken over by the parent airline Wizz Air Hungary, which continued to operate at Kyiv Airport.

Kyiv International Airport also received and serviced flights of such airlines as Wizz Air, Motor Sich Airlines, Belavia, LOT Polish Airlines, EllinAir, Alitalia, Pegasus Airlines, Jonika Airlines and Vueling. The airport cooperates with various carriers that perform both scheduled and charter flights, as well as business flights on private planes. Each of the passengers, regardless of the type of flight, can get a decent level of service.

The coverage area of the airport (Figure 2.2.2) correlates with the coverage area of Boryspil International Airport. However, the geographical location of the airport, namely within the city of Kyiv, creates both positive and negative effects on the airport's operational activities. The airport can serve as a profitable hub for business aviation and low-cost carriers, as well as to develop domestic transportation across the country. However, the infrastructural capabilities of the airport are very limited by geographical location. Thus, the airport plans to extend the runway by 500 meters to make it possible to receive aircraft of various types. But another problem for the airport is the surrounding area of the airport with urban housing, which requires the airport to control the level of noise emissions in certain periods of time.

However, Kyiv International Airport ranks second in terms of the share of the airport in the total volume of passenger traffic (Table 2.1.1) and in terms of passenger traffic after Boryspil International Airport (excluding temporarily occupied territories).

Figure 2.2.5 shows the passenger traffic at the airport in the period from 2015 to 2019. Thus, in 2015, passenger traffic through Kyiv International Airport

amounted to 944 thousand passengers. The following year, 2016, the airport showed an increase in passenger traffic by 19,4% and crossed the limit of 1 million passengers served. At the same time, the airport provided 9% of the passenger turnover market in Ukraine.

High growth rates of passenger traffic were recorded in 2017, as there was an increase of 64,2%. That is, the passenger flow of 1,8 million passengers provided the airport with an 11% share in passenger traffic in the aviation market of Ukraine. Stable growth of airport passenger traffic was in 2018. It was then that the airport reached its maximum market share – 14%, as it showed growth of 51,9% per year.

However, after that, in 2019, Kyiv International Airport began to lose passenger traffic, when it decreased by 6,9% over the year. The airport lost 200 thousand passengers a year, thus losing a percentage of its share of the Ukrainian market. However, this decline cannot even be compared with what happened in 2020, when the airport's passenger traffic for 9 months of 2020 decreased by 70,1% compared to the same period in 2019.
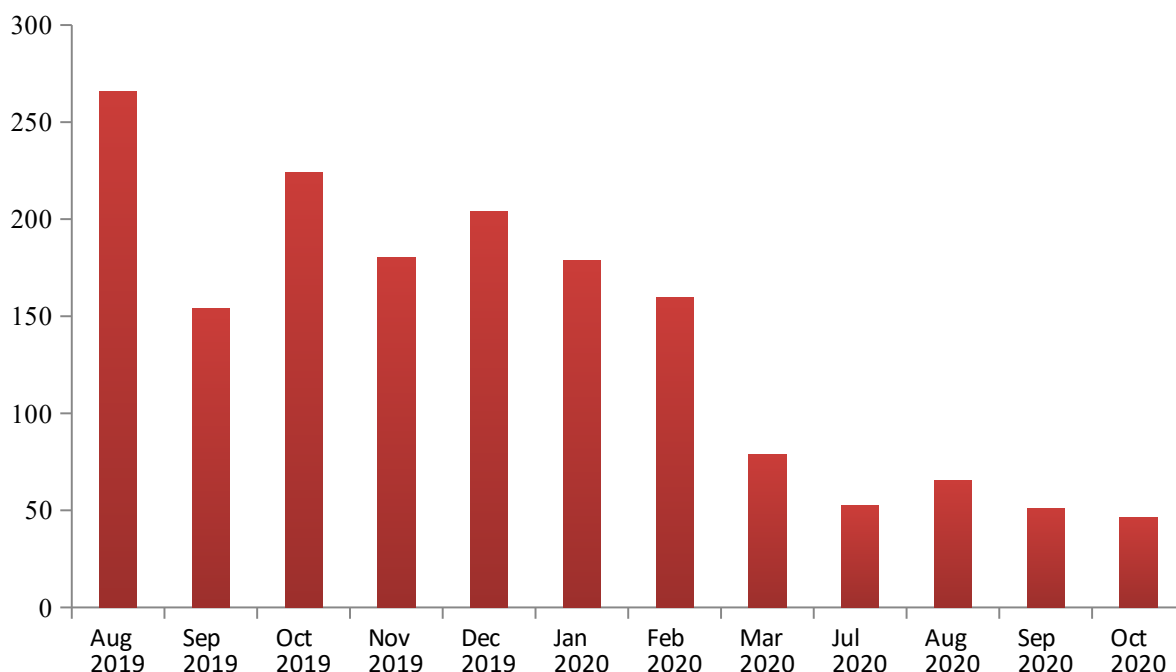

Figure 2.2.7. Dynamics of passenger turnover through Kyiv International Airport (Zhuliany) (IEV) by months from August 2019 to October 2020. Built by the author based on [33]

Figure 2.2.7 shows the negative dynamics of the reduction in passenger traffic at Kyiv International Airport caused by the spread of the corona virus pandemic. In the period from February to March 2020, there was a sharp decline in passenger traffic by 50,6%. And from March 17, 2020, Ukraine closed the passenger air service, so the figure from April to June is missing. At present, there is still a negative dynamics of falling passenger traffic through Kyiv International Airport, which is caused by the operation of several flights a day. All this has caused huge losses to the aviation company, making it impossible for it to develop further and possibly go bankrupt.
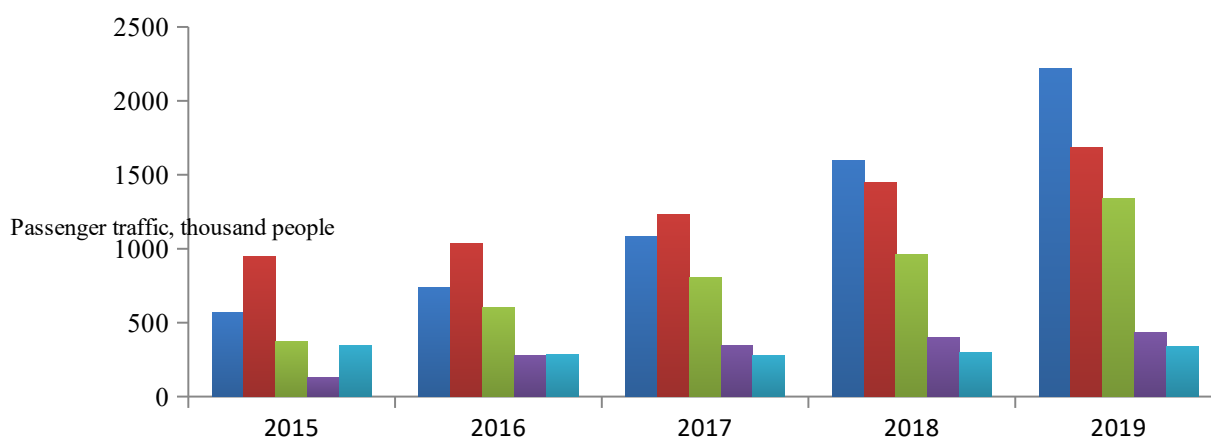

Figure 2.2.8. Dynamics of passenger turnover through 5 leading regional airports of Ukraine during 2015 – 2019 years. Built by the author based on [31]

Next, we will consider the five regional airports that make up the main passenger traffic in the country, and analyze the dynamics of passenger traffic at these airports (Figure 2.2.8).

Figure 2.2.9. Lviv Danylo Halytskyi International Airport logo [34]

Lviv Danylo Halytskyi International Airport (IATA: LWO, ICAO: UKLL) is an international airport in Lviv, Ukraine. The airport is located 6 km from central Lviv. The airport is named after King Daniel of Galicia, the historical founder of the city in 1256 AD. Lviv International Airport is the largest airport in western Ukraine in terms of passenger traffic and route network.

State Enterprise Lviv Danylo Halytskyi International Airport was established in accordance with the order of the Ministry of Transport of Ukraine dated 19.12.2003 №988 "On the establishment of the State Holding Company Lviv Airlines" by separating ground services from the State Aviation Enterprise Lviv Airlines. Now the airport belongs to the Ministry of Infrastructure of Ukraine.

According to the Resolution of the Cabinet of Ministers of Ukraine dated 04.03.2015 №83 "On approval of the list of state-owned objects of strategic importance for the economy and security of the state", Lviv Danylo Halytskyi International Airport is not included in the List of enterprises of strategic importance for the economy and security of the state. Lviv Danylo Halytskyi International Airport is not included in the list of state-owned objects that are not subject to privatization, but can be corporatized in accordance with the Law of Ukraine "On the list of state-owned objects that are not subject to privatization".

The main activities of Lviv Danylo Halytskyi International Airport are servicing of aircraft, passengers, luggage, cargo and mail. These include take-off and landing, passenger and baggage handling at the airport, aviation security, aircraft ground handling services, aircraft parking and refueling, and other specialized aircraft and passenger services.

In addition, Lviv Danylo Halytskyi International Airport provides on-board catering, provides commercial space rental services, communications, parking and

parking of vehicles, heat generation, services for organizing and conducting events (conferences, forums, etc.), infrastructure use, commercial services warehouse, luggage packaging, business halls, others.

The airport has a new terminal "A" with an area of 39,000 m2, with a capacity of 2,000 passengers per hour. The old terminal is capable of carrying 300 passengers per hour on arrival and 220 on departure. It has a VIP lounge. The 3305-meter-long runway is capable of accommodating Type D aircraft. It is possible to carry out 20 flights per hour of Type D aircraft. In preparation for Euro 2012, light signaling equipment and a Category II instrument landing system were installed. This system facilitates approach and landing in conditions of poor horizontal visibility up to 350 meters and vertical - up to 30 meters.

According to the indicative action plan for investment in the trans-European transport network (TEN-T), which was presented in January 2019 by the European Commission and the World Bank, it is planned to complete the reconstruction of Terminal "1" - by 2020, reconstruction of the airport complex and hotel "Tustan", Construction of a cargo terminal, as well as hangars for aircraft maintenance - until 2030.

Lviv Danylo Halytskyi International Airport operates regular and irregular air services in international and domestic traffic. Airport is a focus city for UIA, Wizz Air and SkyUp. The main air carriers from the airport are International Airlines of Ukraine, WizzAir, Ryanair, LOT, Turkish Airlines, Ernest SPA, Belavia, Lufthansa, Austrian Airlines, Pegasus Airlines, Windrose Airlines, SkyUp, Bukovyna and others.

Due to its geographical location, the coverage area of Lviv Danylo Halytskyi International Airport concentrates the territory of the western part of Ukraine and is illustrated by the purple sector in Figure 2.2.2. The city of Lviv is an aviation hub in Western Ukraine, covering more than 9 million passengers, only one million of them from the Lviv region. This creates the conditions for the development and leadership of the airport in the region. After all, the coverage area reaches the territory of 6 oblasts, while the Ukrainian regional airports located

nearby don't create significant competition for Lviv airport. However, the airport's competition is made up of Polish airports, which become partners in the context of international cooperation.

During the analyzed period from 2015 to 2019, Lviv Danylo Halytskyi International Airport showed annual growth, as evidenced by the annual increase of 1% in the share of the airport in total passenger traffic (Table 2.1.1).

In 2015, which was preceded by the domestic aviation crisis and a drop in passenger traffic by 3 years, the airport reported a passenger flow of 570,6 thousand people and ownership of 6% of total passenger traffic. The following year, 2016, passenger traffic statistics increased by 29,3% and amounted to 738 thousand passengers per year.

In 2017, Lviv Danylo Halytskyi International Airport recorded an increase in passenger traffic by 46,3% and exceeded the limit of 1 million passengers served per year. In 2018, the airport reported even greater positive dynamics of operating activities of 1,598 million passengers and achieved an increase in passenger traffic by 48% compared to last year. This fast-growing dynamics was reflected in the conquest of 8% of the air transportation market in the country.

Lviv International Airport in 2019, like most airports in the country, increased passenger traffic by 38,7%, which in quantitative equivalent amounted to 2.217 million passengers. This figure became the largest among the country's regional airports, providing the airport with 9% of Ukraine's air transportation market.

Unfortunately, the crisis year 2020 damaged the airport and created a negative dynamics of falling passenger traffic by 58% in the period from January to September 2020. As of September 2020, the airport's passenger traffic amounted to 702,6 thousand passengers. Already in August 2020, with the aggravated crisis, the management of Lviv airport optimized all costs and was able to reach a break-even point. At the same time, when the passenger service was stopped, the airport management focused on the development of freight traffic, which created opportunities for additional income.

Figure 2.2.10. Odesa International Airport logo [35]

Odesa International Airport (IATA: ODS, ICAO: UKOO) is an international airport in Odesa, located 7 kilometers southwest of the city center. It is one of the largest airports in Ukraine and is connected by air with many cities in Ukraine, Eastern Europe, as well as Western Europe, Asia and Africa.

The Odesa International Airport utility company was established by the Order of the Odesa Mayor dated August 25, 1999. № 943-01p and is the property of the territorial community of Odesa in the person of the Odesa City Council. However, on December 1, the State Aviation Service of Ukraine issued a certificate of operation to Odesa International Airport LLC, and not to a utility company. The land on which the airport is located still remains in communal ownership and is used by the municipal enterprise and the state enterprise "Directorate for Construction of Odesa International Airport", which is reconstructing the airfield complex [36].

The airport is located in the southwestern part of Odesa. The distance from the city center to the airport – 7,5 km. The airport covers an area of 570,3 hectares. Passenger terminal designed to serve international and domestic flights, total capacity 400 passes / year. The production area of the airport complex is 5905 m2.

The airport has a runway with a length of 2800 m, a width of 56 m, a width of the main stern track of 17.6 m, connecting taxiways of 16 m, which allows it to accept medium-haul aircraft. Odesa International Airport is capable of accepting aircraft of code 4D and below, including: A320, A319, Boeing 737 (-300 / -400 / -500 / -600 / -700 / -800), Boeing 757 (-200 / -300)), E135, E145, E175, E190, An-124, An-70, An-148, An-140, IL-76, IL-62, TU-154, Tu-204, helicopters of all

types and lighter aircraft. The airport corresponds to the category I meteominimum according to the ICAO classification [37].

The airfield, built 50 years ago, has hardly been reconstructed in the following years. The main inconsistencies are in the condition of the aerodrome surfaces (unsatisfactory equality and insufficient bearing capacity), in their insufficient geometric dimensions, as well as in the complex longitudinal and transverse profiles of the runway and taxiways.

In 2018, a new terminal was built and work began on the construction of a new runway, the characteristics of which will accommodate heavier aircraft - for this, in addition to the construction of the runway itself, will be upgraded lighting and radio navigation equipment.

Odesa International Airport operates regular and non-scheduled international and domestic flights. Airport is a focus city for Ukraine International Airlines. The main air transport operators from the airport are Ukraine International Airlines, WizzAir, Ryanair, Azur Air Ukraine, Bulgaria Air, Buta Airways, Czech Airlines, flydubai, SkyUp, Turkish Airlines, Belavia, etc.

The red sector in Figure 2.2.2 illustrates the immediate coverage area of Odesa International Airport, which shows an accurate geographical picture of the coverage of the area and the people living there. The distance from the airport to the Black Sea, on the territory of which the largest seaports of Ukraine – Odesa, Chernomorsk, Mykolaiv and Kherson are located is taken into account. The coverage area of the airport includes the population of the two regions, which thus confirms the function of air services in the south of Ukraine.

Analyzing the dynamics of passenger traffic Odesa International Airport in Figure 2.2.8, we can draw the following conclusions. In 2015, the airport's passenger traffic amounted to 949,1 thousand people and accounted for 8% of the total air transportation market. In 2016, passenger traffic increased by 8,9%, which is equivalent to the achieved mark of 1,034 million passengers.

The following 2017, the airport increased passenger traffic to 1,228 million people and an increase of 18,8% compared to 2016. In 2018, the number of

passengers served reached 1,466 million passengers, which in percentage terms corresponds to an increase of 17,8%. The positive dynamics was maintained in 2019, when the airport's passenger traffic reached 1,866 million passengers, i.e. increased by 16,6%. During 2017 – 2019, the airport consistently held a percentage of the aviation services market.

In January – September 2020, Odesa International Airport reduced passenger traffic to 555,8 thousand passengers, which is 55% less than in the same period of 2019. The number of flights performed in the first nine months of 2020 amounted to 7048, which is 46% less than in the same period of 2019.

In September 2020, the airport's passenger traffic amounted to 71.9 thousand people, which is 60% less than in September 2019. Because, in September of this year, 1,035 were performed, this is 38% less than in September 2019 [38].

Figure 2.2.11. Kharkiv International Airport logo [39]

Kharkiv International Airport (IATA: HRK, ICAO: UKHH) is an airport located in Kharkiv, Ukraine. It is the main airfield serving the city of Kharkiv, Ukraine's second largest city. It is located to the south-east of the city center, in the city's Slobidskyi district.

Kharkiv International Airport is one of the most important facilities in the city of Kharkiv, which was reconstructed in preparation for the 2012 European Football Championship. The large-scale project was launched on April 1, 2008, when New Systems AM won a tender to lease the entire property complex of Kharkiv Airport.

The project was financed by a private investor - New Systems AM (DCH Group) and the state budget of Ukraine. DCH share - UAH 508,8 million. At the expense of these funds a new passenger terminal with an area of 20 m2 with a capacity of 650 passengers per hour was built, the existing terminal - the current VIP-terminal - was restored, the station area was reconstructed and parking spaces were completed, construction of a temporary reverse terminal, complete modernization of the airport infrastructure, purchase of special vehicles.

State share - UAH 727 million. At the expense of these funds, a new 2,500-meter-long runway was built, which can accommodate without restrictions all types of medium-haul aircraft and some types of long-haul aircraft, platforms and aircraft parking areas, a new rescue station and air traffic control tower, light signal replacement. systems and systems of aircraft landing facilities (ICAO II category). Upon completion of the reconstruction, the airport was able to accept unrestricted aircraft of class A, B and C; Class D aircraft by agreement.

On October 18, 2018, it became known that the US Federal Aviation Administration had allowed flights to Kharkiv Airport because the city was "located at a safe distance from the war zone" after a 2014 ban on proximity to hostilities due to the war in the east of Ukraine. The lifting of restrictions was facilitated by the safe flights of non-US airlines on Black Sea routes.

Figure 2.2.2 defines the green sector as the coverage area of Kharkiv International Airport, which concentrates only a small part of the two regions and covers a small part of the neighboring country - Russia. However, for the Northeast Regional Transport System, Kharkiv International Airport is the only airport that currently operates scheduled flights.

Kharkiv International Airport is a focus city for SkyUp, Ukraine International Airlines, Wizz Air. Windrose Airlines, Azur Air Ukraine, Turkish Airlines, Pegasus Airlines, Ryanair, LOT Polish Airlines, Belavia, Buta Airways, etc. also provide air transportation from the airport.

Analyzing the dynamics of passenger traffic Kharkiv International Airport, shown in Figure 2.2.8, we can conclude about the stable positive development of

the airport's operations. Due to the political crisis in eastern Ukraine, Kharkiv Airport was suspended during 2013-2014. In 2015, the airport's passenger traffic was 373.6 thousand people.

Already in 2016, Kharkiv International Airport increased passenger traffic by 60,5% and reached 599,7 thousand passengers. The following year, passenger traffic also had a positive growth rate of 34,4%, which is equivalent to 806,2 thousand people. Since 2017, the airport has secured ownership of 5% of the total air traffic in Ukraine. Therefore, in 2018 the airport served 961,5 thousand passengers and showed an increase of 19,3%.

In early March 2019, the Ukrainian airline SkyUp announced the opening of a base at Kharkiv airport with one aircraft [40]. As a result of the airport's activity in 2019, the passenger traffic mark was 1,34 million passengers and the indicator grew by 39,4%.

For 10 months of 2020, passenger traffic amounted to 53% of the same period last year, ie the airport served only 588,5 thousand people. A new wave of COVID-19 morbidity and the end of the summer holiday season have reduced passenger activity. A total of 2992 departures from the airport were made during this period. Almost two thirds of them are international. In October 2020, passenger traffic at Kharkiv International Airport reached 53% of October's volume last year. A total of 74,3 thousand people used the flights [41].
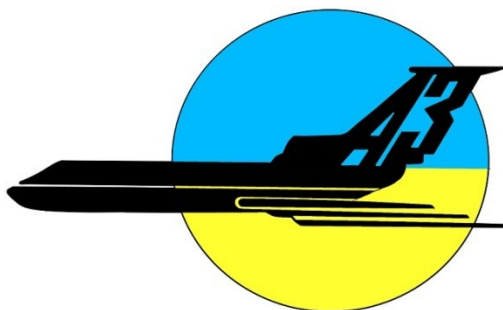

Figure 2.2.12. Zaporizhzhia International Airport logo [42]

Zaporizhzhia International Airport (IATA: OZH, ICAO: UKDE) is the international airport that serves Zaporizhzhia, Ukraine - one of three airfields

around the city. The international airport is located 15 km northeast of the center of Zaporizhzhia.

In 2013 Zaporizhzhia International Airport changed its ownership and was transferred to the local community. At the session of the City Council, the city target program "Ensuring proper and uninterrupted operation of the Municipal Enterprise Zaporizhzhia International Airport". It was this year that the airport began to grow significantly.

In 2016 the Zaporizhzhia City Council and the airport management developed and began to implement measures to develop the airport and ensure its operation. UAH 12,5 million from the city budget and UAH 19,6 million of the airport's own funds were allocated for these purposes. The terminal for domestic airlines was overhauled, the terminal for international airlines was repaired, projects for the reconstruction of the runway lighting equipment and radio equipment were completed, and several units of necessary equipment were purchased. In February, the airport was included in the State Target Program for Airport Development for the period up to 2023. It is planned to allocate over UAH 611 million to support the airport.

In 2018 the first overhaul of the runway in 36 years was carried out, about UAH 20 million was spent on repair work. The airport aerodrome is able to take off and land all types of ships, including such as Airbus A320, Boeing 737, Boeing 757, Airbus A321, as well as Boeing 767, Airbus A330, An-124. In addition, the airfield allows the takeoff and landing of helicopters of all types.

The construction of a new terminal was completed in May 2020, which will be able to serve 400 passengers per hour with a potential increase to 500. Its area is 12 thousand km2. The cost of construction exceeded UAH 1 billion; the city took a loan of UAH 400 million [43].

Figure 2.2.2 defines the yellow sector as the coverage area of Zaporizhzhia International Airport, which forms the sector through cooperation with Dnipropetrovsk International Airport. Considering the influence of Zaporizhzhia

International Airport, it is safe to say that the airport is one of the main air transport companies serving the eastern and south-eastern regions of Ukraine.

The airport's coverage area covers areas with a population of more than 4 million people, which is the basic market potential that will develop in the future. The city of Zaporizhzhia and the surrounding areas remain an attractive destination for business, which demonstrates the growing demand for air transportation in the airport coverage area.

Now Zaporizhzhia International Airport is increasing the number of partner airlines, and also intends to cooperate with low-cost airlines, which is extremely important for the development of regional Ukrainian airports. Currently, the airport actively cooperates with Ukrainian and foreign airlines, such as: Ukraine International Airlines, Motor Sich, Turkish Airlines, Pegasus Airlines, Atlasglobal, Azur Air, Bravo Airways, Anda Air, WINDROSE, YanAir, SkyUp and LOT Polish Airlines. These airlines operate regular and charter flights to domestic and international destinations, such as: Istanbul, Antalya, Kiev, Minsk, Tel Aviv, Batumi, Sharm El Sheikh, Tivat, Monastir, Bourgas and Warsaw.

The dynamics of Zaporizhzhia International Airport passenger traffic, shown in Figure 2.2.8, reflects the beginning of the development of air traffic for the airport. Since 2015, Zaporizhzhia International Airport has been actively cooperating with major global and Ukrainian carriers. In particular, such as Turkish Airlines, Pegasus Airlines and Atlasglobal. The passenger traffic rate that year was 128,1 thousand passengers.

In 2016, the airport signed a cooperation agreement with Ukraine International Airlines, and Zaporizhzhia Airport was recognized as the best airport in Ukraine. The growth rate of passenger traffic increased by 115% and amounted to 275,4 thousand passengers.

In 2017, the airport signed contracts with Anda Air and Bravo Airlines. Passenger traffic increased to 348,4 thousand passengers per year, i.e. there was an increase of 26,5% compared to last year.

In 2018 the management of the aviation company joined the cooperation of one of the largest European carriers Polish Airlines LOT. Due to this, for the first time in the history of Zaporizhzhia, regular flights to Western Europe began to be operated from the local airport. The first of them was the flight Zaporizhzhia - Warsaw. Another new carrier, which began to cooperate with the Zaporizhzhia airport, was the domestic airline SkyUp. As a result, in 2018 passenger traffic amounted to a record 400,3 thousand passengers, which indicated an increase of 14,9%.

Next 2019, the airport was able to reach the mark of 434 thousand passengers and note an increase of 8,4%. During the analyzed period from 2015 to 2019, the share of Zaporizhzhia International Airport in the total passenger traffic of the country was stable at 2%, which is a very good indicator of the regional airport in such a short period of time since the start of modernization.

For 9 months of operation in 2020, the airport experienced a drop in passenger traffic by 26,9% compared to the same period last year. With the decline in passenger traffic and the number of flights served, the airport decided to switch to a reduced schedule. Due to the COVID-19 pandemic, Zaporizhzhia International Airport from November 9, 2020 operates flights only during the day (from 5.00 to 23.00) [44].

Figure 2.2.13. Dnipropetrovsk International Airport logo [45]

Dnipropetrovsk International Airport (IATA: DNK, ICAO: UKDD) is an airport serving Dnipro, a city in Dnipropetrovsk Oblast, Ukraine. It is located 15 kilometers southeast from the city center.

Currently, the airport belongs to the partner airline "Dniproavia". This led to a number of management problems and slowed down the development of the airfield, as Dniproavia repeatedly refused to provide the necessary funds for a

comprehensive modernization program. In addition, it was difficult for foreign airlines to gain access to Dnipropetrovsk as a result of Dniproavia's protectionist policy along routes to and from the airport.

In 2020 a large-scale reconstruction began, which includes the construction of a new terminal, runway and modernization of airfield infrastructure. Production processes are improved, constant training and advanced training of personnel is carried out. There is an ongoing process of improving and ensuring a comfortable stay of customers at the airport by upgrading facilities and equipment to the level of modern European practice, as well as staff training.

The airport's infrastructure is outdated, and the renovation is expected to begin in 2020. The airport is located at an altitude of 147 m above average sea level. It has one runway, marked 08/26, with a concrete surface measuring 2841 by 44 meters. A new terminal complex in Dnipro is being built by a private investor and this airport is an example of a productive and profitable public-private partnership. The investor has started work in parallel with the construction of the runway, and preparatory work is underway for the construction of terminals with a peak capacity of up to 1 000 passengers per hour. As of September 2020, the completion of a new runway is foreseen for late 2022 or early 2023 [46].

Dnipropetrovsk International Airport is a significant regional airport in Ukraine and an important part of the air transport system that connects the Dnieper with other cities and countries. Figure 2.2.2 defines the yellow sector as the coverage area of Dnipropetrovsk International Airport, which forms the sector through cooperation with Zaporizhzhia International Airport. Considering the impact of Dnipropetrovsk International Airport, it is safe to say that the airport is one of the main air transport companies serving the eastern and southeastern regions of Ukraine.

Currently, the airport cooperates with Ukrainian and foreign airlines, such as: Ukraine International Airlines, Windrose Airlines and Austrian Airlines.

The dynamics of passenger traffic in Dnipropetrovsk International Airport, shown in Figure 2.2.8, is reflected in the suspension of the development of air

transportation at the airport. Along with the modernized airport in Zaporizhzhia, Dnipropetrovsk International Airport loses the opportunity to compete for modern facilities. The airport has lost the opportunity to be among the leading airports in the country, as it forms about 1% of the total passenger traffic of the country.

In 2015, the airport had a passenger flow of 346 thousand passengers, which exceeded the passenger flow of Zaporizhzhia International Airport more than twice. However, next year the airport will lose 17,7% of passenger traffic and the figure drops to 284,9 thousand passengers. In 2017, passenger traffic still continues the dynamics of reduction by 2,8% and amounts to 277 thousand passengers.

In 2018, the situation at the airport will improve by 8,1%, as the passenger traffic rate increases to 299,3 thousand people. At the same time Zaporizhzhia International Airport attracts new airlines and increases passenger traffic to 400 thousand passengers per year. In 2019, the figure grows by 13,2% and passenger traffic becomes 338,9 thousand passengers.

2.3. Analysis of the activities of other regional Ukrainian airports

Next, consider the regional airports that carry out airport activities, however, in total, form only 2% of the total passenger traffic in Ukraine.
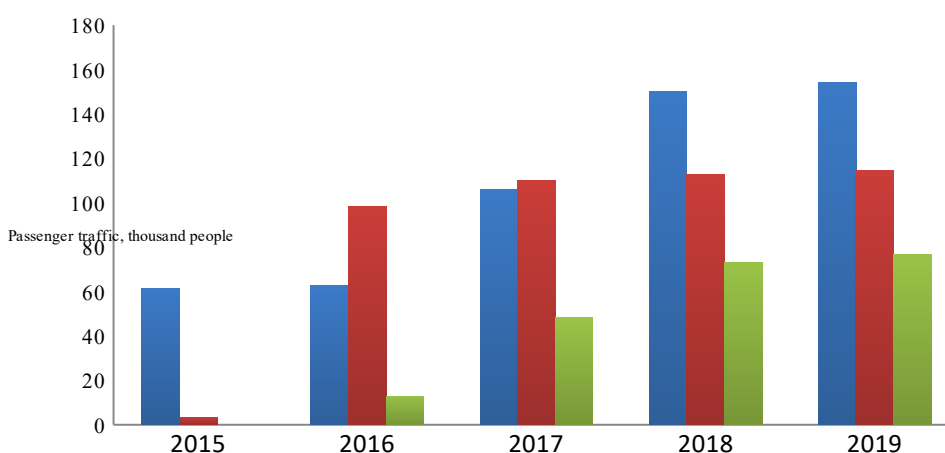

Figure 2.3.1. Dynamics of passenger turnover through the regional airports of KHE, IFO and CWC during 2015 – 2019 years. Built by the author based on [31]

Figure 2.3.2. Kherson International Airport logo [47]

Kherson International Airport (IATA: KHE, ICAO: UKOH) is an airport serving Kherson in Kherson Oblast, Ukraine.

By government order of March 5, 2008, the Cabinet of Ministers announced its intention to return Kherson Airport to state ownership. Until 2006, the airport did not accept flights. In 2006, it received the status of an international, becoming the thirtieth international checkpoint across the state border for air communication.

The runway of the airport is capable of accepting aircraft of various types – from An-2 to Boeing-737. The solemn ceremony of resumption of activity of the Kherson International Airport took place on April 10, 2013.

On July 27, 2013, Motor-Sich Airlines performed the first regular flight on the Kherson-Moscow-Kherson route. In July 2013, Kherson Airport was included in the intergovernmental agreement on air services between Ukraine and Turkey. From that moment, preparations began for the launch of the Turkish Airlines flight on the Kherson-Istanbul-Kherson route. On October 15, 2014, Turkish Airlines will start operating flights to Istanbul.

In 2015, the airport's passenger traffic amounted to 61,2 thousand passengers. Next year, passenger traffic will increase to 62,6 thousand passengers, i.e. by 2,2%. On April 14, 2017, UIA started daily flights to Boryspil International Airport, and on October 29 – twice a day. Usually flights were performed by Embraer ERJ-145 aircraft. Therefore, the total passenger traffic in 2017 increased by 69,3% and amounted to 105,9 thousand passengers per year.

In 2018, flights to Istanbul were performed twice a day. UIA flights to Kyiv-Boryspil from June 15, 2020 – three times a day. In the same year, the airport management initiated negotiations with low-cost airline WizzAir on the start of flights. As a result, Kherson Airport in 2018 was visited by a record more than

150,1 thousand passengers, which is 41,7% higher than in 2017. From December 2019, Ryanair arrives at the airport with a flight to Krakow. Therefore, the airport's passenger traffic increased by 2,6% and amounted to 154 thousand passengers.

Figure 2.3.3. Ivano-Frankivsk International Airport logo [48]

Ivano-Frankivsk International Airport (IATA: IFO, ICAO: UKLI) is an airport in Ivano-Frankivsk, Ukraine, some 4,4 km by road from the town center.

In 2002, the airport was transferred to communal ownership, and it was first leased by PE "Yavson", and since 2005 – OJSC "Petrochemical of Prykarpattia", the contract with which expired in 2013. In March 2010, Scorzonera LLC won the right to a 30-year airport concession from OJSC Naftohimik Prykarpattia.

The airport consists of one passenger terminal (airport), airfield, more than three dozen hangars for MiG-29 fighters, control tower, fuel base and other structures. The airfield has two runways with a length of 2507 × 44 m and 1928 m, the second lane is now used as a parking lot for the 114th Tactical Aviation Brigade of the Air Force of Ukraine.

Ivano-Frankivsk International Airport belongs to the class "B" airports, index 6 (code 4C) with restrictions. Performs the functions of a spare airfield for the cities of Lviv, Chernivtsi. The airport is equipped to receive and service ICAO first category aircraft. The airport is capable of accepting medium-haul aircraft A320 and Boeing-737, as well as DC-9, MD 82, Tu-154, IL-76, Yak-40, Yak-42, Tu-134, An-24, An-12, as well as helicopters and helicopters of all types. At present, due to the condition of the runway, the airport is able to service aircraft with a maximum lifting weight of less than 50 tons.

On July 16, 2020, the airport resumed its operations. Regular flights are operated by Ukraine International Airlines and Windrose Airlines.

Analyzing the dynamics of passenger traffic at the airport, according to Figure 2.2.13, we can draw the following conclusions. In 2015, the airport had a passenger flow of 3,3 thousand passengers. In 2016, Turkish Airlines opened a direct flight to Turkey and provided a rapid increase in airport passenger traffic by 2908,3%, as passenger traffic then amounted to 98,1 thousand people.

In 2017, passenger traffic amounted to 110 thousand people, an increase of 12,1% compared to the previous year. In 2018, there was a dynamics of growth of the indicator to 112,6 thousand passengers, by 2,4%. And in 2019, the airport's passenger traffic amounted to 114,7 thousand passengers, i.e. there was an increase of 1,9% compared to last year.

Figure 2.3.4. Chernivtsi Leonid Kadeniuk International Airport logo [49]

Chernivtsi Leonid Kadeniuk International Airport (IATA: CWC, ICAO: UKLN) is an airport in the south-western part of Ukraine, 30 kilometers from the border with Romania, within the city of Chernivtsi. In September 2018, Chernivtsi International Airport was named after the first Ukrainian cosmonaut, prominent Bukovinian and Hero of Ukraine Leonid Kadeniuk.

In 1994, Chernivtsi Airport became an independent legal entity, and in 1999 by order of the Cabinet of Ministers of Ukraine № 695-r received international status. Since 2002, the airport has been transferred from state ownership (Ministry of Transport of Ukraine) to the ownership of territorial communities of the city of

Chernivtsi region (by the Order of the Cabinet of Ministers of Ukraine dated 08.01.2002 № 3-r). In 2006, the Chernivtsi Regional Council decided to transfer the real estate of the Chernivtsi International Airport utility company to the balance of the city council (№ 110-7 / 6 of October 16, 2006).

The airport has two runways. The main one has 2216 m in length and 42 m in width, the bearing capacity belongs to class 2 (PCN 21 / F / D / Y / T) and allows to accept aircraft type: Embraer-90, Embraer 145, Boeing 737-500, etc. by weight up to 75 tons. Used in the daily work of receiving and sending aircraft.

Additional ground, located parallel to the main, is not used in the work of the airport. The aerodrome is suitable for aircraft operation all year round without restrictions, in light and dark times of the day. Bandwidth of 12 takeoffs and landings per hour. The airport is equipped with rescue and fire-fighting vehicles in accordance with the 6th category. Light-signaling equipment, drive radios and course-gliding systems allow safe landing in poor visibility (ICAO Category I minimum).

Analyzing the dynamics of passenger traffic at the airport, according to Figure 2.2.13, we can draw the following conclusions. In 2015, the airport did not operate due to repair of the runway. In 2016, the airport's passenger traffic amounted to 12,7 thousand passengers. With the full resumption of the airport in 2017 and the introduction of regular connections with the capital, the airport's passenger traffic increased by 208,4% and amounted to 48,2 thousand people.

In 2018, the positive dynamics was maintained and the airport had an increase in passenger traffic by 51,6%, which amounted to 73,1 thousand passengers. After all, on September 9, 2018, the light signaling equipment of high-intensity SSO VVI-1 lights was put into operation. Thus, the exact landing approach for the first ICAO landing category with both courses is provided at Chernivtsi Airport. The airport became the eighth airport in Ukraine to provide an ICAO landing event. In 2019, passenger traffic increased to 76,8 thousand passengers, which was an increase of 5,1% compared to last year.

The spread of the global corona virus pandemic has led to the suspension of scheduled passenger flights, which have not yet been resumed. From April 2020, the airport is in a state of forced downtime [50]. Occasional flights of a certain category are serviced according to the relevant NOTAM.
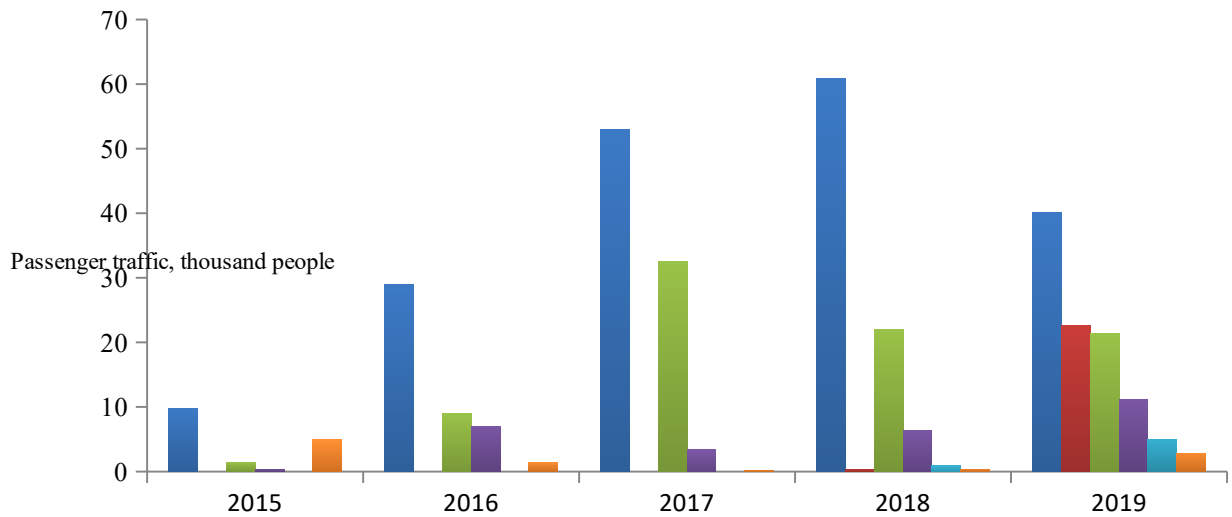

Figure 2.3.5. Dynamics of passenger turnover through regional airports of Ukraine during 2015 - 2019 years. Built by the author based on [31]

Figure 2.3.6. Vinnytsia International Airport logo [51]

Vinnytsia International Airport (IATA: VIN, ICAO: UKWW) is an airport located near the village of Havryshivka, serving the city of Vinnytsia in the Vinnytsia region of Ukraine.

The length of the concrete runway is 2,5 km. Take-off and landing for aircraft of index 6 (six), category 4D and below (Boeing-737, Airbus A320, Tu-154, IL-76, An-74, An-12) are allowed around the clock.

On October 15, 2010, Vinnytsia Airport received the first flight of the Vinnytsia-Lodz-Vinnytsia flight. The airport is equipped with a light signal system that allows aircraft to take off and land in low visibility.

In 2015, the airport's passenger traffic was 9,8 thousand people. As of 2016, the airport complex building has been renovated at the airport, and currently has a capacity of 400 people per hour. A new luggage compartment equipped with a conveyor was built.

In 2016, the airport's passenger traffic increased to 29 thousand passengers, i.e. by 195,9%. The following 2017, passenger traffic showed a positive dynamics of increase by 82,5% and reached 52,9 thousand passengers.

On March 25, 2018, UIA began operating regular flights between Boryspil Airport and Vinnytsia. The route is the shortest in the history of the airline – its length in a straight line is about 200 km. Flights were operated daily on Embraer 145 regional jets. From April 2018, flights from Vinnytsia via Kyiv to all cities of the UIA route network were available. As a result, the airport's passenger traffic amounted to 60.9 thousand passengers, an increase of 15% compared to last year.

However, according to statistics in 2019, the airport's passenger traffic decreased by 34,1% and reached 40,1 thousand passengers. In February 2019, the government presented a plan for the reconstruction of Vinnytsia airport, according to which repair and construction work is going to be divided into two stages. The total amount of the project will be UAH 2,2 billion. And they want to launch the first flight in 2019. As part of the first phase, the reconstruction of the runway, partial reconstruction of the platform, renovation of light signaling equipment, engineering networks, etc. are planned.

In 2020 the airport does not perform regular passenger traffic and needs reconstruction of infrastructure facilities.

Figure 2.3.7. Mykolaiv International Airport logo [52]

Mykolaiv International Airport (IATA: NLV, ICAO: UKON) is an airport in Mykolaiv in the Mykolaiv Oblast of Ukraine. It is one of the largest and most technically equipped airports in the South of Ukraine.

Class B airport has a modern runway ready to receive aircraft with landing weight up to 220 tons and to hold eight "IL-76" aircraft equipped with lighting, radio and navigation equipment. The airport is also increased to receive the Airbus 310.

On September 15, 2015 in Mykolaiv the city council Mykolaiv International Airport was created. During the session of the city council, 53 deputies voted for this decision (a potential investor - the RDS Group). From 2015 to 2017, the airport did not carry out aviation activities.

As of the middle of 2017 the initiative group, with participation of People's Deputies of Ukraine from Mykolaiv, in April made the decision on revival of the airport. Restoration has begun at the airport, in particular, the renovation of the asphalt-polymer-concrete pavement of the runway and the repair of the airport, and the repair of the light signal system (replacement of airfield lights).

On November 19, 2018, from the Mykolaiv airport for the first time after a long break the flight was executed. On December 26, 2018, the first international flight operated by SkyUp Airlines to Sharm-el-Sheikh (Egypt) was performed. At the end of the year, the airport's passenger traffic amounted to 300 passengers.

In January 2019, the tour operator Join UP announced the start of ticket sales to Antalya (Turkey), a flight operated by SkyUp Airlines since May 2019. According to the results of 2019, the passenger traffic at the airport amounted to 22,7 thousand passengers.

From May 18, 2020, the first regular flight of Windrose Airlines to Boryspil was to take place. Due to the situation with the coronavirus, the launch of the flight was postponed indefinitely. It is currently known that this flight is operated weekly.

Figure 2.3.8. Kryvyi Rih International Airport logo [53]

Kryvyi Rih International Airport (IATA: KWG, ICAO: UKDR) is an airport near Kryvyi Rih, Ukraine. It is located 4,2 km west of the town Lozuvatka, and 17,5 km northwest of the city of Kryvyi Rih.

From 2001, Kryvyi Rih International Airport is in the communal property of the city for the purpose of financial support. On 24 December 2003, the City Council decided to approve a program of financial support and development for KP Kryvyi Rih International Airport. The airport municipal company remained unprofitable as of January 2012. In 2004 aircraft carried out internal flights to Lviv, Kyiv, and Donetsk and international flights to Istanbul, Zagreb, Moscow, Thessaloniki, and other cities.

The total land area of the airport is 166,2 hectares. Kryvyi Rih Airport belongs to the B class (code) of the aerodrome. The dimensions of the runway are 2500 x 42 m, and the total area of the platform is 61475 m2, which can accommodate up to 12 aircraft. The aerodrome is equipped with the necessary means of radio-technical flight control and meteorological support. The aerodrome is equipped with a light signal system of high-intensity lane lights, thanks to which aircraft can land at night.

In the round-the-clock mode the airport of Kryvyi Rih accepts aircraft of type: IL-76, Boeing 737-800, Airbus A319, Airbus A320, McDonnell Douglas MD-80, McDonnell Douglas MD-83, Boeing 737-500, Boeing 737-300, AN- 26, AN-24b, Saab340 and lower class, as well as helicopters of all types.

Figure 2.2.17 shows that in 2015 the passenger traffic at the airport was 1,3 thousand passengers. In 2016, this figure was 9 thousand passengers, i.e. there was an increase in passenger traffic by 568%. In 2017, passenger traffic was at the level of 32,5 thousand passengers, i.e. there was an increase of 262,8%.

Starting from 2018, passenger traffic decreased by 32,4%, i.e. reached the level of 22 thousand passengers. In 2019, this figure decreased to 21 thousand passengers, i.e. a decrease of 2,9% compared to the previous year.

As of July 2020, there are no regular scheduled flights at the airport.

Figure 2.3.9. Rivne International Airport logo [54]

Rivne International Airport (IATA: RWN, ICAO: UKLR) is an airport in Rivne, Ukraine. It is located at a distance of 8 km from the center of Rivne, almost within the city. Motorways (in particular, E-40) pass near the airport, which allows you to get to the train station, bus station and city center in a matter of minutes.

The airport covers an area of 170 hectares. It has two runways: one 2626 m long and 42 m wide, the other 655 m. As of 2016, only the first of the runways is in working order. At the airport there are: ticket offices, airline offices, customs control point, border post, transportation service, hall of official delegations, air ticket. On the station square there are: round-the-clock paid guarded parking, cafe. Near the airport is the hotel "Sofia". The airport is open from 8:00 to 17:00 (at the request of airlines - around the clock).

In 2015, the airport did not provide regular passenger traffic, but only operated on the basis of charter non-scheduled flights of private aircraft. Therefore, the passenger traffic at the airport for the year amounted to 394 people.

As of 2016, the airport combines the work of 16 services and departments that serve passengers, freight transport, charter flights, cafes, road freight transport and fuel wholesale. The company has more than 100 employees. And on July 10, 2016, for the first time in the last 10 years, a charter regular passenger flight on the route Rivne - Antalya was performed. From now on, Bravo Airways operates weekly Sunday flights on the specified route in both directions. The customer of charter flights is the tour operator TPG.

In July 2016, Bravo Airways began flights on the route Rivne-Antalya. In October, the carrier launched charter flights to Hurghada and Sharm el-Sheikh. In 2016, the airport received 6 997 passengers, which indicates an increase in passenger traffic by 165,9%. That is, the growth of passenger traffic at Rivne airport became possible due to the launch of charter programs.

In 2017, the airport's passenger traffic decreased by 50,4% and amounted to 3,5 thousand people, which occurred due to the suspension of regular charter flights. On December 28, 2018, an agreement was signed on the basis of 3 An-26s owned by Eleron for the purpose of freight transportation in Ukraine and abroad. The airport and the carrier shall take steps to obtain appropriate licenses.

In 2018, passenger traffic amounted to 6,4 thousand passengers, which indicates an increase of 84,4% in irregular charter flights of passengers and cargo. And in 2019, the passenger traffic at the airport remained positive and amounted to 11,2 thousand passengers, an increase of 74,4% per year.

The airport is planned to be transferred to concession. According to the draft decision of the deputies of the regional council, a tender commission will be set up to hold a tender for the transfer to the concession, which will include 12 people. By prior arrangement, investors are ready to invest 60 million USD in the development of the airport and repay all its debts.

It has been open at the airport since June 15, 2020, but there are no regular scheduled flights.

Figure 2.3.10. Poltava International Airport logo [55]

Poltava International Airport (IATA: PLV, ICAO: UKHP) is a public airport located approximately 7 kilometers west of Poltava, Ukraine. It is one of two airfields near Poltava, the other being Poltava Airbase. The airport is located near the villages Ivashky and Suprunivka.

In 2002, there was a clear threat of closure of the airport by the Ministry of Transport of Ukraine, as it was unprofitable and had no sources of funding, and therefore could not ensure an adequate level of flight safety and aviation security. As a way out of the difficult situation, the Order of the Cabinet of Ministers of Ukraine of July 11, 2002 № 380-R "On the transfer of the entire property complex of Poltava civil aviation airport from state to joint ownership of territorial communities of Poltava region" was issued.

Today, the airport is a complex property complex located on a land plot of 214 hectares. The total length of the perimeter is 10 200 meters. Concrete runway with a length of 2 550 m and a width of 42 m provides reception - release of aircraft code 4C and lighter aircraft, equipped with a light - signal system for landing aircraft M2 / 2. The property complex includes an airport complex with a total area of 682 m2, a station area of 10 000 m2, production facilities with an area of 13 300 m2, two-storey and three-storey family dormitories for 45 families, a fuel and lubricants warehouse with a capacity of 2 400 cubic meters, gas pipeline with gas distribution point, pressure sewer collector with pumping station, cold

water supply system, double connection to the power supply network with the central distribution point.

Meridian Airlines, the Poltava Air Traffic Management Service of UkSATSE, and the Poltava Regional Hydrometeorological Center meteorological station operate at the airport. Free premises are leased to other organizations with a total area of 2494,3 m2 and hard surfaces with a total area of 7453,0 m2. For the last 8 years, the Condor Flight School has been operating at the airport to train pilots on AT-3, BE-76, and Cessna-172 aircraft.

From 2015 to 2017, the airport did not carry out airport activities. In December 2017, the airport received international status, so from 2018, international charter flights are operated from / to the airport. The passenger traffic at the airport then amounted to 1 thousand passengers.

In 2019, tourist flights to Egypt and Turkey were opened. Passenger traffic amounted to 5 thousand passengers, i.e. there was an increase of 5 times, but these statistics are only evidence of irregular passenger traffic.

Now the airport is only used for charter flights. The availability of appropriate infrastructure for rail and road transport, sufficient capacity for expansion, the great industrial potential of the region, the involvement of new airlines and the provision of an open skies policy may ensure the successful operation of the airport in the future.
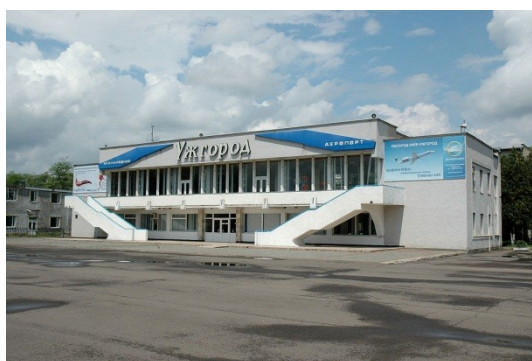

Figure 2.3.11. Uzhhorod International Airport [56]

Uzhhorod International Airport (IATA: UDJ, ICAO: UKLU) is an international airport located in the city of Uzhhorod, in the western Ukrainian province of Zakarpattia.

Uzhhorod Airport has one terminal and an asphalt runway 2038 m long and 40 m wide. On March 28, 2019, the DME-435 long-range beacon was launched. The unique airport is that the planes take off and land through the airspace of Slovakia, as the border is located 100 m from the beginning of the runway.

During 2010, flights to the airport were operated only by Motor Sich, which served the Kyiv-Uzhhorod route. In 2016, the carrier twice suspended flights to the airport – in February and June. In February 2016, the State Aviation Service suspended the airport's aviation security certificate, then the airport administration managed to resolve the issue, and flights were briefly resumed. Since June 2016, the airport does not accept regular flights.

In September 2016, the leadership of the Zakarpattia region held talks with UIA on the resumption of flights. However, this required repairing the runway and navigation equipment, equipping the airport with the necessary computer and maintenance equipment.

During the analyzed period, the passenger flow of the airport changed. Thus, in 2015, passenger traffic amounted to only 5 thousand people, and in 2016, passenger traffic decreased by 72,1%, which amounted to 1,4 thousand passengers. In 2017, the situation became even worse, as the reduction in passenger traffic by 87 percent provoked a total passenger flow of 200 passengers per year.

At the end of 2018, the airport passed EASA certification and from March 15, 2019, regular flights were resumed. The first was the flight Kyiv – Uzhhorod with a stop in Lviv. The flight was operated by Motor Sich on an Antonov AN-24 aircraft. However, as of May 11, 2019, Motor Sich has no flights to Uzhhorod due to unprofitability of flights to Zakarpattia. Passenger traffic in 2019 amounted to 2.8 thousand people. As of the end of 2019, the airport was operating in VFR mode. According to NOTAM, the aerodrome light signal system in the part of the

west and the runway did not function until 20.03.2020. Ukraine planned to sign an agreement with Slovakia on the use of the latter's airspace.

On September 24, 2020, Ukraine and Slovakia signed an agreement on the joint use of airspace, thus allowing the full resumption of the airport. As of September 2020, there are no regular flights from Uzhhorod International Airport.

Ternopil International Airport, Zhytomyr International Airport, Cherkasy International Airport and Sumy Airport are among the four operating but not operating regular passenger air transportation. Consider the activities of each of them.

Ternopil International Airport (also known as Ternopol Airport) (IATA: TNL, ICAO: UKLT) is an airport in Ukraine located 8 km southeast of Ternopil.

The airport is a communal property of the Ternopil Regional Council and covers an area of 164.29 hectares. There are two runways: the main - 10/28, 2000 * 42 m, pavement - concrete, and the old asphalt-concrete 12/30, which now serves as part of the taxiway. Two platforms can accommodate 6 Yak-42 aircraft.

The aerodrome is certified on 11.02.2013 for a period of 3 years and is ready to accept aircraft with a maximum take-off weight of up to 64.9 tons type L-410, An-28, An-24, An-2, An-26, An-30, An- 72, An-32, Yak-40, Yak-42, An-12, An-140, An-148, An-158, Tu-134, IL-18, Airbus A320, Boeing B737 with a frequency of not more than five daily flights and helicopters of all types.

Refers to class 2B aerodromes. After the restoration of the light and signal equipment of Ternopil airfield, the work schedule will be round the clock (currently the restoration work is completed by 60%). The airport has two passenger terminals (one for departure with an area of 1070 m2, the other - for arrival with an area of 384 m2) with a capacity of 100 passengers per hour, a checkpoint across the state border, autonomous supply of heat, water and electricity. The construction volume of the airport is 12775 m3 [57].

The airport has all the necessary services to ensure the maintenance of aircraft and passengers, maintenance in good condition of the airfield, refueling air conditioning aircraft and cars.

The location of the airport complex and facilities allows the modernization of the airport, in particular the extension of the runway to 2300 m on the existing land allotment, construction of a new airport, additional platforms and creation of modern cargo handling terminals.

Ternopil airport is not in a state of disrepair, only charter flights are performed here, there are no regular flights. The last scheduled flights at the airport took place from May 31 to July 2, 2010. The An-24RV aircraft operated flights on the route Ternopil - Kyiv "Zhulyany" and in the opposite direction. The carrier was Zaporizhzhia Motor Sich OJSC. After July 2, 2010 the flight Ternopil - Kyiv - Ternopil is closed. Negotiations are underway to introduce international flights from Ternopil.

From 2014 to 2016, the music festival "Fine City" took place at the airport. In 2016, the State Aviation Service granted the airport a license to operate. In 2018, there are plans to build a cargo terminal. By 2023, within the framework of the State Target Program for Airport Development, UAH 170 million should be allocated for the reconstruction of the airport complex, and UAH 25 million for the construction of the terminal complex [58].

Zhytomyr International Airport (ICAO: UKKV) is an airport in Zhytomyr, Ukraine. The airport is owned by Zhytomyr City Council [59].

In November 2011, his Civil Airport Certificate was revoked due to the lack of flights since 1990. On December 30, 2015, the airport again received the relevant Certificate, and on January 29, 2016 accepted the first technical flight of Saab 340. Yanair Airlines repairs and maintains the airport. From the end of July 2018, Janeir JSC planned to launch flights to Batumi, but later the possibility of booking flights on the company's website was removed, and regular flights were canceled.

In November 2011, his Civil Airport Certificate was revoked due to the lack of flights since 1990. On December 30, 2015, the airport again received the relevant Certificate, and on January 29, 2016 accepted the first technical flight of Saab 340. Yanair Airlines repairs and maintains the airport. . From the end of July 2018, Janeir JSC planned to launch flights to Batumi, but later the possibility of booking flights on the company's website was removed, and regular flights were canceled.

According to the State Aviation Services of Ukraine, the airport was not allowed to serve passenger traffic (only during the day) [19], but on October 7, 2020 received the appropriate permits, including the opening of an international checkpoint. The results of the inspection by a special commission of this airport showed that there are appropriate conditions for carrying out the types of control provided by law.

Cherkasy International Airport (IATA: CKC, ICAO: UKKE) is located 5,5 km from the city center. The airport is owned by Cherkasy City Council [60].

Cherkasy International Airport has an airport complex, which includes: an airport with a capacity of 400 passengers per hour, providing customs clearance, a cargo terminal for storing 1,000 tons of cargo, an administrative building with a dining area, fuel storage, technical equipment and an air base building. The airport belongs to class "B" with an artificial runway with a maximum takeoff weight of up to 185,5 tons.

Currently, Cherkasy International Airport serves only charter flights in Ukraine, due to its relative proximity to Boryspil International Airport (Kyiv), which serves most international flights in Ukraine. In addition, Cherkasy International Airport is considered as an alternative airport in Borispol in case of unforeseen situations and adverse weather conditions.

As of 2011, the airport did not work as intended. The reason for this was the proximity of Boryspil Airport (200 km). In addition, Cherkasy International

Airport was considered a backup in case of unforeseen situations and bad weather conditions in Boryspil.

In 2016, a government program was developed to rehabilitate local airports, according to which Cherkasy International Airport will be transferred to the Ministry of Infrastructure and will belong to the Cherkasy Regional Council. UAH 90 million will be allocated from the state budget, UAH 10 million from the Ministry of Infrastructure and UAH 500 thousand from the regional budget.

In 2018, it was planned to repair the runway, for which more than UAH 100 million was allocated. In mid-July 2019, it was planned to conduct certification and test flight of aircraft such as Airbus and Boeing, but the pandemic changed plans.

Sumy Airport (IATA: UMY, ICAO: UKHS) is a state international airport located in Sumy, Ukraine. Sumy Airport is a state-owned airport located in Sumy, 6 km southwest of the city center. It has been able to operate international flights since December 8, 2006 [61].

In 2000, a decision was made to reorganize Sumy Airlines by separating Sumy Airport from its composition and to organize Sumy Airport State Enterprise. In February 2002, it was transferred from state ownership (Ministry of Transport of Ukraine) to the territorial communities of Sumy region (Order of the Cabinet of Ministers of Ukraine of January 8, 2002 № 3-r) and the Regional Utility Company Sumy Airport was established.

Since 2006, Sumy Airport has resumed operations and accepts Tu-134 (with restrictions), An-24, Yak-42 and lower class aircraft. The terminal has a capacity of 100 people per hour. In December 2006, by the Order of the Cabinet of Ministers of Ukraine № 598-r of December 8, 2006, an international checkpoint was opened at the airport, which made it possible to expand the geography of flights.

In 2010, the Sumy administration planned to restore the airport, which required repairing the runway and repairing the terminal building to meet European

standards. In 2011, it was planned to give the airport to investors from the UK, who were willing to invest in the company from 500 – 700 million UAH for the repair of the terminal, the reconstruction of the runway and the construction of catering and hotel. In 2015, there was an agreement with the Polish airport of Katowice for cargo flights, which brought to the company's budget UAH 400 thousand annually, thus covering part of the 2,2 million UAH required annually for the airport. In addition, work is underway to find investors for the reconstruction of the airport.

In December 2016, the Cabinet of Ministers changed the classification of the international border crossing point in Ukraine at Sumy Airport from passenger to cargo-passenger. This will allow servicing air freight, which will lead to the development of the industry in the region. In January 2017, the complex of airport buildings was visited by the heads of the Sumy regional council. According to them, the airport is now "in a state of disrepair, but with the hope of development".

The main difficulty is still the lack of money for the repair of the runway, which slows down the development of the whole complex. In 2017, the regional budget set aside UAH 4,25 million to finance the airport, but since the airport received additional international cargo status in December 2016, its management plans to request another UAH 5 – 7 million to equip the jobs of customs and border guards, certification, purchase of equipment.

1. DESIGN PART

3.1. Consideration of the model of development of airports of Ukraine as a complex weighted system

Air transport and related infrastructure have a significant impact on the development of the national economy as a whole. Therefore, the development of airports is one of the priorities of the state transport strategy, because for the first time in the history of our country in 2021, UAH 4,5 billion of state money is provided for the construction and reconstruction of airports.

The network of airports in Ukraine is quite extensive, due to their location throughout the country. As noted in previous sections in Ukraine as of the end of September 2020, aviation activities were carried out by 19 airports, 27 airfields, 1 heliport and 48 runways. With each passing year, unfortunately, the number of aviation infrastructure facilities is declining, primarily due to untimely repairs and modernization of facilities, and, like most problems in the country, lack of investment.

There is also an alternative network of airports, consisting of military airfields and airfields of some departments. However, these facilities are subordinated to the military, and have classified development data. Therefore, we will focus on existing civilian airports specializing in passenger, cargo and mail transportation.

In Ukraine, as of September 2020, there are 6 leading international airports that provide almost 98 percent of all passenger and mail flows through their activities. They are located near such city centers as Kyiv, Lviv, Odessa, Kharkiv and Zaporizhzhia. The airports of these cities are the market leaders, as they have the most appropriate state of infrastructure and developed airport activities. 13 other regional airports in our time cannot demonstrate growth and development, because they balance between the desire to work and survive in a growing market.
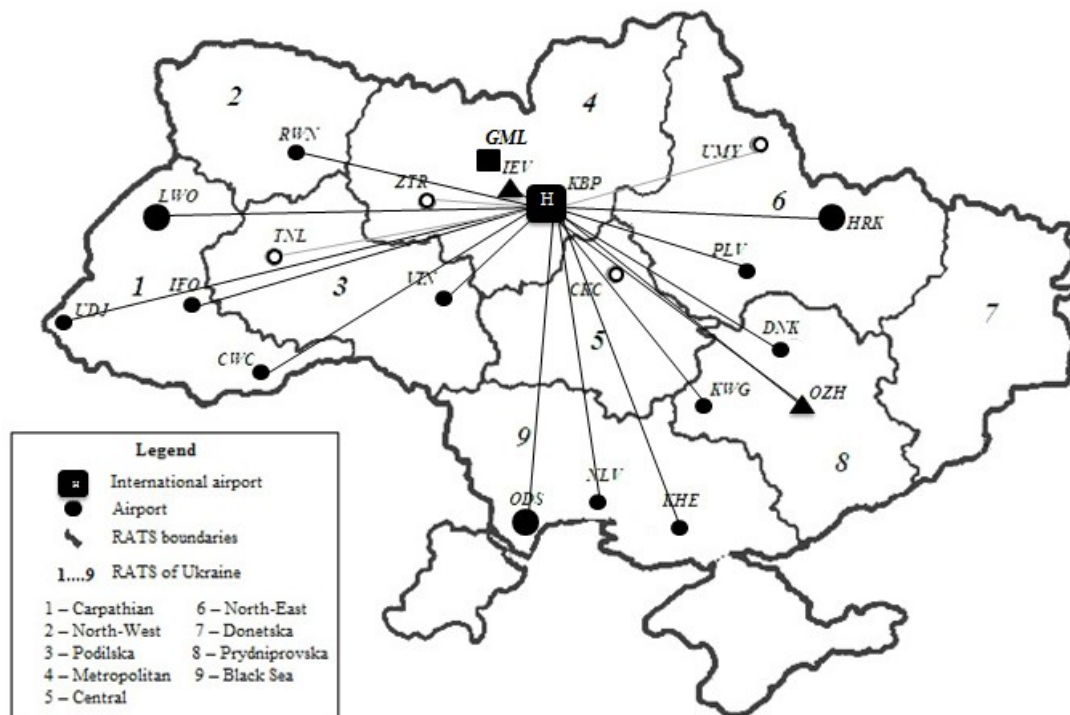
Figure 3.1.1. Model of development and activity of civil airports of Ukraine in the period 2016-2019. Built by the author based on [17]

In the period 2016 - 2019, the aviation market in Ukraine is growing rapidly. After all, the previous few years have been a crisis. With the start of hostilities in the Donbas and the annexation of Crimea, Ukraine has lost some of its leading airports. The airport in Donetsk was one of the most promising air hubs in the east of the country. Its upgrade to Euro 2012 has created opportunities to attract airlines and embed a regional hub development model. However, the war destroyed not only the plan but also its existence.

In 2015, the strategy for the development of the country's largest airport was determined at the state level, as well as Boryspil International Airport. The strategic development plan of Boryspil International Airport State Enterprise was developed on the basis of the order of the Ministry of Infrastructure of Ukraine dated 20.01.2014 №29 "On conducting a coordinated investment policy in institutions, organizations and enterprises belonging to the Ministry of Infrastructure of Ukraine" in accordance with the Guidelines methodological support for the preparation of medium - and long-term strategic plans for the

development of state enterprises, state joint stock companies and economic structures, approved by the order of the Ministry of Economic Development and Trade of Ukraine dated 14.08.2013 №971.

The main objectives of the airport's strategy until 2019 were:

1) The emergence of a strong base airline that follows the strategy of the hub.

2) Ensuring operational efficiency primarily in the service of transfer passengers, ensuring a minimum docking time.

3) Development of the non-aviation activity of the airport.

4) Introduction of a flexible system of motivation of air carriers, aimed at the development of new directions, long-distance program, transfer passenger flows.

A significant contribution of this airport strategy was the recognition at the state level of the choice of the airport development model - the hub model. Boryspil International Airport has become a hub-and-spoke hub.

The transfer system through the hub airport is usually formed by the airline for which the airport is the base. At Boryspil International Airport, Ukraine International Airlines became such an airline. By choosing a hub-and-spoke model for air travel, the UIA has launched the airport's strategy. After all, the share of this airline in the level of traffic served by the airport prevails over other airlines. The UIA has coordinated the flight schedule in order to achieve the most convenient connections for the transfer of passengers, cargo and mail.

Thus, in the activities of the airport formed several cycles or "waves" of arrivals and departures at the hub airport during the day. Such a "wave" structure, which is a feature of the nodal schedule, has led to a pronounced uneven flow of flights, passengers, luggage and cargo at Boryspil International Airport. All this requires the introduction at the airport of the most advanced organizational schemes and technologies of transportation services, the use of high-performance aerodrome and terminal equipment, equipment and facilities, extensive use of information systems.

Thus Boryspil International Airport became the basis of the domestic hub development model. On the territory of Ukraine, the airport has no analogues and direct competitors, but competition abroad is intensifying.

Boryspil International Airport, as an airport that provides a full range of services and provides one of the highest levels of service quality in Eastern Europe (in 2015 the airport entered the top three airports in Eastern Europe), has a fairly high cost and cost of services. A significant part of airport fees is regulated by government agencies, which reduces the flexibility of pricing policy and reduces the competitiveness of the airport.

Among the nearest airports - competitors in terms of competition between hubs for long-haul and medium-haul routes and transfer flows, as well as in the field of attracting new flights, are:

⤷ Airports of Eastern Europe: Warsaw Chopin Airport (WAW), Vaclav Havel International Airport Prague (PRG), Budapest Ferenc Liszt International Airport (BUD).

⤷ Moscow Airport System: Domodedovo Moscow Airport (DME), Sheremetyevo International Airport (SVO), Vnukovo International Airport (VKO).

Figure 3.1.2. Main competitors for Boryspil International Airport [29]

All of the above airports have higher traffic volumes and stronger base network airlines (except Budapest Airport) compared to Boryspil International Airport. For example, the airports of the Moscow airport system, although they

have higher performance in the field of passenger traffic and a wider route network, but the function of passenger transfer "international - domestic" works only partially.

Moderate competition is identified by European airports in Germany (FRA, MUC), Turkey (IST) and Austria (VIE). These European airports are the base for the Star Alliance, led by Lufthansa. Most of these hubs were developed due to transfer flows generated by basic airlines, such as Frankfurt and Munich by Lufthansa, Istanbul by Turkish Airlines, Warsaw by LOT, Sheremetyevo by Aeroflot Russian Airlines, and so on.

Approaches to transfer passenger charges vary from airport to airport. In any case, the goal is to stimulate and support this segment of transportation, which generates additional income from non-aviation activities, in the practical absence of additional costs.

Thus, in order to compete successfully with hub airports, Boryspil International Airport must provide the necessary transfer infrastructure and deepen cooperation with basic carriers on the development of routes and transfer flows.

From Figure 3.1.2 it can be concluded that Boryspil International Airport is the primary directed hub airport in Ukraine. Domestic airlines connect Boryspil International Airport with regional airports. All regional airports include Odesa International Airport, Lviv Danylo Halytskyi International Airport and Kharkiv International Airport. These three airports can be classified as secondary regional airports.

The issue of naming these airports hubs is controversial, as the interpretation of this concept is ambiguous. These airports each provide 5-8% of the total passenger traffic in the country. In addition, they have regular and charter services, and form the basis of passenger traffic for the Black Sea, Carpathian and North-East regional air transport systems.

Odesa International Airport, Lviv Danylo Halytskyi International Airport and Kharkiv International Airport provide not only the accumulation of passenger traffic for the hub in Boryspil, but also independently operate profitable airport

activities. Such activities are provided through a point-to-point development model. Unlike the main airport of the country, these airports serve as the starting and ending points of large regions. The airport coverage area ensured stable development during 2016-2019.

Lviv Danylo Halytskyi International Airport is a leading airport in Western Ukraine. Favorable territorial location, updated airport infrastructure and qualified top management of the airport, in synergy, give an annual increase in passenger traffic and stable growth of the airport.

Odesa International Airport is the leading airport in the south of Ukraine. Renovation of the terminal and rebranding of the airport contribute to the promotion of use, and the territorial location - near the Black Sea, provides a flow of both domestic and foreign tourists. And the next three construction of the airport complex, with a total cost of over UAH 932 million, will increase the volume of passenger and freight traffic at the airport.

Kharkiv International Airport is the leading airport in the East. The airport topped the priority of the east, after the loss of Donetsk and Luhansk airports. Because the airport coverage area extends not only to the east, but also the central and northeastern part of the country. The management of the company, which is currently in concession by the DCH group of companies, has developed new directions and connected more and more airlines, offering good terms of cooperation and a flexible service tariff grid. This led to the airport showing an annual increase of 20%.

It is worth noting that these airports, together with Boryspil International Airport, actively cooperate with low-cost airlines, which provide relatively cheap international flights. This, in turn, increases the demand for air travel. This point-to-point development of these airports provides an opportunity for passengers to travel and ensures the existence of end points for the spokes of the main hub of the country.

In the Metropolitan regional air transport system, in addition to the hub airport, there are 2 more powerful airports that complement the system of the

region. Kyiv International Airport (Zhuliany) is located in the capital of Ukraine and creates competition for Boryspil International Airport, as they cover coverage areas. This is manifested in the struggle of airports for charter flights and flights of low-cost airlines (low-cost carriers). This type of competition is relevant for short-haul flights. Therefore, Zhulyany competes with Boryspil in terms of point-to-point transportation, aviation business and low-budget transportation.

Kyiv International Airport (Zhuliany) provides an average of 11% of the total passenger traffic in the country, and therefore ranks first among regional airports in terms of passenger traffic. The advantages of the airport are a new terminal infrastructure and a flexible system of fees and tariffs, which, combined with a convenient location in the center of the capital, make the airport attractive for low-cost carriers. However, for this airport, the locational advantage is the disadvantages of infrastructure constraints: existing requirements for compliance with noise and environmental constraints, aircraft category restrictions and capacity constraints. These restrictions do not allow for the reorientation of large network carriers.

The third promising in terms of freight is Hostomel Antonov Airport. The airport is used by Antonov Airlines and as a flight test base of ASTC Antonov. The location of the cargo airport 25 km from Kyiv and its infrastructure facilities create undeniable advantages for it as a promising object for the domestic air freight sector.

The end points of the hub model of Ukrainian airports development are small regional airports. The leader in growth and development among which is Zaporizhzhia International Airport. In 2020, the airport opened a new terminal complex and upgraded its infrastructure. Due to the active involvement of airlines, the airport generates 2% of total passenger traffic in the country.

Competing airports in Prydniprovska RATS are Dnipropetrovsk International Airport and Kryvyi Rih International Airport. The first airport was of strategic importance and generated passenger traffic in the region. The second one recently opened and provided 1-2 flights a day. These airports urgently need to

upgrade the airport infrastructure in order to be able to stay on the map of airports in Ukraine.

Now the stage of preparatory works worth UAH 12 million is being completed in Dnipro. A new terminal complex in the Dnieper is being built by a private investor and this airport is an example of a productive and profitable public-private partnership. The investor started work in parallel with the construction of the runway; now preparatory work is underway to build terminals with a capacity of up to 1,000 people per hour.

Point-to-point competition is also taking place in western and southern Ukraine. Carpathian RATS has Ivano-Frankivsk International Airport, Chernivtsi Leonid Kadeniuk International Airport and Uzhhorod International Airport. These airports exist independently, providing, albeit low, but still passenger traffic. These airports, like other regional airports in Ukraine, need reconstruction. That is why, ignoring the logic, the state offered private partners to build another airport in Transcarpathia - having previously recognized the location on the basis of the airport in Mukachevo.

In the south, Mykolaiv International Airport and Kherson International Airport compete. Their neighboring location leads to direct competition in the Black Sea RATS. With the opening of Mykolaiv International Airport, Kherson Airport lost some potential passengers, and therefore the opportunity to accumulate revenue. These airports are no exception and also need updating. In Ukraine, there are airports in Zhytomyr, Sumy, Poltava and Ternopil and Vinnytsia. Some of these airports do not even have the ability to create model endpoints due to the state of their airport infrastructure and location. Nowadays, to create a competitive advantage requires a strong infrastructure and skilled management, at least, but this is not enough for these airports.

Thus, the model of development of Ukrainian airports can be characterized as combined. Because the leading airport focuses on implementing a hub development model, medium-sized regional airports implement a combination of the two models to support operations and small regional airports are examples of a

point-to-point model that saves them from closure. The combination of these models in the system creates a Ukrainian model of airport development.

3.2. Modern problems and prospects of the Ukrainian model of airport development

The modern development of Ukraine's airports is accompanied by both problems and prospects. Having conducted a thorough analysis of the air transportation market and the activities of domestic airports in the previous sections, we can identify the following problems that exist in the airport activities of Ukraine.

The incompleteness of the process of signing the Agreement on the Common Aviation Area of Ukraine with the EU remains a difficult issue. Every year the question arises that every time the country is in a waiting period due to the unsystematic incorporation of EU acts into the legislative system of Ukraine.

The regulation of attracting investment in the transport sector and the limited level of private investment in the transport sector, which limits the tools for private investment in infrastructure, remain ineffective. At the same time, the lack of mechanisms to compensate for investments in strategic transport facilities and the lack of an effective mechanism to control the provision and use of allocated funds for the repair, reconstruction and construction of air transport infrastructure of airports have a negative impact.

There are imperfections in the regulation of airports and the aviation industry in general, unsystematic incorporation of EU acts into the legislative system of Ukraine and the lack of a comprehensive legislative package, as in the EU, which takes into account the technological features of airports, strict international infrastructure requirements and modern approaches to economic regulation and prudent tax policy for airport activities, etc.

The country lacks tax incentives and the practice of using alternative energy sources at Ukrainian airports, despite the high share of energy and heat costs of regional airports during the autumn-winter navigation.

Ukraine's low sovereign rating according to OECD criteria and legal barriers to attracting competitive funding for the renewal of the fleet of domestic airlines, as well as for the modernization of airport infrastructure and air navigation systems create delays in the development and implementation of models.

A huge problem for the development of regional airports is the significant deterioration of all infrastructure elements of most airports in Ukraine and their non-compliance with the requirements of modern airlines of various business models and EU legislation, including regulations of the European Aviation Safety Agency. After all, the lack of airports with modern navigation and light signaling equipment, ground equipment and equipment for ground handling and ensuring the level of aviation safety in accordance with ICAO requirements leads to a halt in the development of airports and cessation of cooperation with air carriers.

Infrastructural problems of regional airports create a problem of small volumes of air traffic through regional airports of Ukraine (63% or 12 airports serve less than 100 thousand passengers per year), which significantly limits their investment attractiveness, makes international commercial lending impossible. Most of these airports are in the communal ownership of the regions and there is a problem of lack of financial resources from municipal owners for quality modernization or construction of terminals and airfields, purchase of modern light signal systems, landing instrument systems, ground machinery and equipment, etc.

Regional airports in Ukraine are unprofitable enterprises that do not generate revenue and create a field for subsidized activities of the state and carriers, which in turn report the problem of unprofitable domestic traffic. However, it is the domestic air service that provides the development of the hub model of the country's main airport. What to say about the lack of funds of regional airports to improve staff skills and attract young promising aviation professionals with knowledge of foreign languages.

The problem of unprofitable domestic transportation arises not only due to financial and infrastructural problems, but also due to the inability to compete with domestic rail and road transport. Now the potential passenger mainly prefers these types of transport, as the ticket price is much lower than for a similar faster flight route. The model of subsidizing airlines by the state could stimulate the flow between cities. But there is no such model. Therefore, today the cost of travel by train and plane differ many times, not by interest.

Weakness and unresolved issues have provoked exacerbated crises at regional airports with the onset of a pandemic that halted aviation and related areas. Everyone has suffered losses, so the problem of the airport's exit from the crisis is currently the most pressing.

From these above problems there are ways out and prospects for the development of airports in Ukraine.

First of all, aviation issues must begin to be addressed at the state level. The government's action plan should include short-term and long-term goals. In the short term, the government should prevent the closure of major airports such as Boryspil, Zhulyany, Lviv, Kharkiv and Odessa. After all, together these airports provide 98% of total air traffic and the bankruptcy of any of them will lead to serious economic losses.

The closure of major airports will not only cause irreparable damage to the aviation industry, but can also potentially lead to an increase in unemployment of almost 12%. This, in turn, can lead to problems such as declining tax revenues and, as a result, increased government borrowing, social problems and political instability. In the long run, the government should be more active in supporting existing airports and trying to increase their traffic. And the decision to open new airports should be made only after a careful analysis of the fact that this airport will indeed cover an area where it can actually generate significant volumes of passenger traffic and be profitable in its activities.

One of the desirable ways to develop small regional airports is to give them the freedom to attract investment in airport infrastructure development. With

modern infrastructure, small regional airports will be able to generate more traffic through an aggressive policy of attracting new airlines. Freedom for airports is also demanded in terms of the establishment of airport charges, which, in turn, requires the government to gradually loosen the regulation of air navigation charges and their gradual liberalization. This is a very important issue, especially against the background of the expected signing of an open skies agreement with the EU.

At the state level, it is necessary to develop and adopt as a matter of priority a package of laws on airports similar to the one adopted in the EU, which should regulate the critical aspects that hinder the development of airports in Ukraine and the entire aviation market. Issues that need to be considered are the protection of airports as integral property complexes, including through their corporatization without the right to privatize, effective control over compliance with restrictions on high-rise buildings within a radius of 50 km around airports, reservation and protection against land use or illegal development of airports needed to build airport infrastructure for a period of 20-30 years and simplify the procedures for obtaining international status by regional airports as strategic tools in ensuring decentralization and attracting investment to the regions.

To save regional airports, it is necessary to develop and adopt a Program for the Development of Regional Airports of Ukraine (in particular, due to part of the existing EU grant for strategic projects in Ukraine's transport sector) depending on their role, purpose and market positioning, including setting priorities in the national average. and long-term planning (basic, auxiliary, remote/socially important, joint base with the Air Force of the Armed Forces of Ukraine, for general aviation, etc).

In addition, it is necessary to conduct a study of regional airports with valid certificates for compliance with the state of their infrastructure and an estimate of the estimated budget for bringing such infrastructure in line with the conditions of unrestricted use. After the analysis, the state should ensure measures at the state level with international financial institutions and national funds of partner

countries, in order to obtain preferential and/or grant funding for aviation infrastructure modernization projects for regional airports of Ukraine.

According to the state programs of development of airports of Ukraine, reconstruction of aerodromes (as a result of which they must have I or II category of instrument landing system (ILS), 7th category of fire protection) is provided, providing them with appropriate equipment and ground equipment, taking into account the requirements of European aerodromes regulations for unrestricted acceptance of aircraft by airports. As well as the implementation at the stage of airport infrastructure design of the requirements of Regulation (EU) №1107 / 2006 of the European Parliament and of the Council on the rights of persons with disabilities and persons with reduced mobility traveling by air.

The need to complete the reconstruction projects of the international airports in Lviv and Kharkiv envisaged by the Euro-2012 program and to put all relevant infrastructure facilities into operation as soon as possible is still relevant. The policy of building Kyiv International Airport (Zhulyany) as a point-to-point airport, or through the design and construction of a new modern international airport in Kyiv region, will ensure the growth of tourist and business potential of the capital of Ukraine. The development of access roads and high-quality land connections with domestic airports by various types of public transport should be a priority for the infrastructural development of the state's transport systems.

In the future, the further formation of the hub development strategy at Boryspil International and the creation of its status as the leading international hub airport (hub) of Eastern Europe should be preserved. This will require strengthening the air transportation market, including domestic airlines, expanding the network of air services, building a modern transit infrastructure, applying a flexible approach to attracting air carriers of various business models and increasing the share, size and types of revenues from non-aviation activities.

But we should not forget about the development of modern terminal passenger and cargo complexes at airports. This can be done through the cooperation of their owners and / or public-private partnership mechanisms with

the provision of ICAO international standards and IATA recommendations on the levels of quality of service for passengers, cargo and mail. Therefore, in the perspective of successful construction of the domestic development model, it is possible to use the airfields of Hostomel, Bila Tserkva, and Zhytomyr for "low-cost" transportation of passengers to Kyiv and surrounding settlements.

CONCLUSIONS

The airport is a multifunctional air transport enterprise, which is a ground part of the aviation transport system, which provides takeoff and landing of aircraft and their ground service, reception and departure of passengers, luggage, mail and cargo, as well as creates the necessary conditions for airlines, government regulators. aviation, customs and other activities. In addition to comparing and defining this concept, the paper compared several classifications of this concept by type of activity, by area of transportation, by types of aircraft served at the airport.

The basis of the structure of regional air transport systems is formed by elements of different levels, which include airports, airfields, runways, temporary runways and more. The airport can be considered a central element of the regional air transport system.

In Ukraine, as of September 2020, there are 6 leading international airports, which are the core of the region, and provide almost 98 percent of all passenger and mail flows through their activities. They are located near such city centers as Kyiv, Lviv, Odessa, Kharkiv and Zaporizhzhia.

Ukrainian aviation companies (airports and airlines) are increasingly identifying the need to introduce new business models that can ensure effective operation both during periods of rapid growth in air traffic and in times of crisis. One such model is the "hub and spoke". The "hub" in the "hub-and-spoke" system is the hub airport, and the "spokes" are airlines that connect the hub with peripheral airports, also called auxiliary or secondary. The basis of the system of operation of the "hub-and-spoke" system is the so-called nodal schedule, which provides for the organization of mass connections of a large number of flights for

a limited period of time in order to provide passengers with immediate transfer to other destinations.

The development of the air transportation market, as well as civil aviation in general, is one of the key and strategic directions for Ukraine. First of all, this is due to the fact that Ukraine is the largest country in Europe with a favorable geographical location, which can claim the status of an international transit hub. Especially the western part of the country is a link on the Eurasian roads, which favorably connects Eastern and Western Europe, the Baltic and Caspian regions.

Having analyzed the air transportation market of Ukraine during 2015-2016 and 9 months of 2020, the following conclusions can be drawn. The market crisis marked by statistics took place in 2015 and 2020. During these years, the Ukrainian air transportation market has shown dynamic growth. Airport activities in 2019 reached a record high in passenger traffic - a record 24 million passengers per year. The statistical results of the years ahead are planned for many points, which prompted optimistic plans for the development of the industry. But 2020 has once again become a year of halt not only for the Ukrainian aviation sector, but also for the world.

Boryspil International Airport remains the country's largest hub. During the analyzed period, the airport began to implement a hub development model, which provides for the mandatory development of the transit potential of the airport. The list of system-forming airports includes Lviv International Airport, Kyiv International Airport (Zhulyany), Odessa International Airport, Kharkiv International Airport and Zaporizhzhia International Airport. Small regional airports in

Ukraine are unprofitable for enterprises, as they carry out activities mainly aimed at irregular traffic related to seasonality. Also, they do not have the resources to modernize the airport infrastructure and attract new carriers.

The model of development of airports of Ukraine can be characterized as combined. Because the leading airport focuses on implementing a hub development model, medium-sized regional airports implement a combination of the two models to support operations, and small regional airports are examples of a point-to-point model that saves them from closure. The combination of these models in the system creates a Ukrainian model of airport development.

Today, the aviation industry as a whole meets only the basic needs of the population and the economy in transportation by volume, but not by quality. The current state of the airport industry does not fully meet the requirements of effective implementation of Ukraine's European integration course and integration of the national transport network into the Trans-European Transport Network.

It is necessary to increase the efficiency and competitiveness of the airport sector, improve the legal mechanism of public-private partnership, and strengthen cooperation between the public and private sectors, public and local governments, carry out necessary reforms, including decentralization, especially through coordinated public policy initiatives. The ways of solving some urgent problems presented in the work will provide a solid basis for sustainable development of the airport industry and the creation of a free and competitive market of air transportation.

REFERENCCES

1. Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3lfHmBI

2. Definition of the word Airport [Electronic resource] // Merriam-Webster. – Access mode: https://bit.ly/33jgACs

3. Air code of Ukraine [Electronic resource] // The Verkhovna Rada of Ukraine. – Access mode: https://bit.ly/3gfnqOt

4. Concerning Approval of the Rules that Grant Permission to Operators for Departure and Arrival in Ukraine Airports [Electronic resource] // The Verkhovna Rada of Ukraine. – Access mode: https://bit.ly/33H9gAT

5. 14 CFR § 152.3 – Definitions [Electronic resource] // Legal Information Insitute. – Access mode: https://bit.ly/2VHs9PK

6. Review of the classification and definitions used for civil aviation activities [Electronic resource] // International Civil Aviation Organization. – 2009. – Access mode: https://bit.ly/3mOCRzG

7. Manual on the Regulation of International Air Transport [Electronic resource] // International Civil Aviation Organization. – 2004. – Access mode: https://bit.ly/3geH6lV

8. Yudin O.K., Ivannikova V. Yu., Gyrych S. Yu. State information resources in the field of the aviation transport system of Ukraine: terms and definitions // Science-intensive Technologies, № 1 (29), 2016.– p.87-90.

9. Trotsenko A.M. Airports of Ukraine // Chronicle, 2012, p.415.

10. Airport Categories [Electronic resource] // Federal Aviation Administration. – Access mode: https://bit.ly/36HBWM0

11. Bordun O.Yu. Transport infrastructure of the Western Ukrainian border: economic and geographical research, 2002. - 172 p.

12. Baran R.T. Legal and economic aspects of air transport logistics terminology in the conditions of air transport restructuring of Ukraine // Visnyk of Kharkiv

National University named after V.M. Karazina. Economic Series X, № 522, 2001. – p. 103.

13.   On approval of the Regulations on the flight safety management system on air transport [Electronic resource] // The Verkhovna Rada of Ukraine. – Access mode: https://bit.ly/2IhpZTV

14. Borisyuk O. Theoretical aspects of the air transport system of Ukraine in crisis // Visnyk of Kyiv Taras Shevchenko National University, № 1 (63), 2015. – p. 44-46.

15. Dudnyk I.M, Borisyuk O.A Regional air transport system as a form of territorial organization of aviation transport // Economic and social geography, № 64, 2012. – p. 146-154.

16. Dudnyk I.M. Geographical aspects of research of air transport systems // Scholarly notes, №24 (63), 2011.

17. Zastavny F.D. Geography of Ukraine: textbook manual: in 2 volumes. - Lviv, 1993.

18.   Number of existing population of Ukraine as of January 1, 2020 [Electronic resource] // State Statistics Service of Ukraine, 2020. – Access mode: https://bit.ly/3ggU7v9

19.   Certification [Electronic resource] // State Aviation Administration of Ukraine, 2020. – Access mode: https://bit.ly/3gdnm1X

20. Danesi A. Spatial concentration, temporal coordination and profitability of airline hub-and-spoke networks – Bologna, 2006. – 143 p.

21. Romanenko V.A. Mathematical models of the functioning of airports in the conditions of the modern air transport market: monograph// Samara: As Gard Publishing House, 2010. - 244 p.

22. Holloway, S. Straight and Level / S. Holloway // Practical Airline Economics, Ashgate. – 2003.

23.   ACI reveals top 20 airports for passenger traffic, cargo, and aircraft movements [Electronic resource] // Airports Council International, 2020. – Access mode: https://bit.ly/3liCaNH

24. Bootsma P. D. Airline Flight Schedule Development - Analysis and design tools for European hinterland hubs // University of Twente. – 1997.

25. De Neufville R. Effects of deregulation on airports // Massachusetts institute of technology. – 2002.

26. Periodic statistical information [Electronic resource] // State Aviation Administration of Ukraine. – Access mode: https://bit.ly/3ge4zDu

27. Airports of Ukraine [Electronic resource] // State Aviation Administration of Ukraine. – Access mode: https://bit.ly/3lOAU58

28. Boryspil International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3qvOVIH

29. Strategic development plan of Boryspil International Airport [Electronic resource] // Minister of Infrastructure of Ukraine, 2015. – Access mode: https://bit.ly/33Ceo9a

30. Boryspil International Airport leads the ACI Europe rating [Electronic resource] // Boryspil International Airport. – Access mode: https://bit.ly/39xHfPY

31. List of the busiest airports in Ukraine [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3fWE3yv

32. Kyiv International Airport (Zhuliany) [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3lAqmGJ

33. IEV passenger traffic statistics [Electronic resource] // Kyiv International Airport. – Access mode: https://bit.ly/3mDTmPd

34. Lviv Danylo Halytskyi International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3qqkwLG

35. Odesa International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/2I9aj53

36. Odesa Airport was put into operation by a private company [Electronic resource] // Nova Vlada News Agency, 2020. – Access mode: https://bit.ly/33ERNsA

37. About the airport [Electronic resource] // Odesa International Airport. – Access mode: https://bit.ly/2KX73KW

38. Odesa Airport significantly reduced passenger traffic [Electronic resource] // Infographic, 2020. – Access mode: https://bit.ly/37xbpQF

39. Kharkiv International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/39HvzKu

40. SkyUp opened a base at Kharkiv airport [Electronic resource] // Avianews. – Access mode: https://bit.ly/2VzF9a1

41. The results of the Kharkiv airport in October [Electronic resource] // Kharkiv International Airport. – Access mode: https://bit.ly/37A2XAg

42. Zaporizhzhia International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/37xuGS1

43. About the airport [Electronic resource] // Zaporizhzhia International Airport. – Access mode: https://bit.ly/37wx37z

44. Windrose resumes flights to Zaporizhzhia airport, which switches to a shorter opening hours [Electronic resource] // New Time Business. – Access mode: https://bit.ly/3omzv7E

45. Dnipropetrovsk International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3orq1bf

46. The new runway at Dnipro Airport in 2021 will require 1.6 billion [Electronic resource] // Economichna Pravda. – Access mode: https://bit.ly/2Vz93LJ

47. Kherson International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/36Bi9Of

48. Ivano-Frankivsk International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3oqCEDt

49. Chernivtsi International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3g9b5eN

50. Airport news [Electronic resource] // Chernivtsi International Airport. – Access mode: https://bit.ly/3oq7tYC

51. Havryshivka Vinnytsia International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/39F98FR

52. Mykolaiv International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3ozK33t

53. Kryvyi Rih International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3mJ9RcA

54. Rivne International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/36EZGAv

55. Poltava International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/33HfTmC

56. Uzhhorod International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/2L9x21Z

57. Ternopil International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3qsS9wq

58. About the statement of the State target program of development of airports for the period till 2023 [Electronic resource] // The Verkhovna Rada of Ukraine. – Access mode: https://bit.ly/3opm7ja

59. Zhytomyr International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/3lGGIxq

60. Cherkasy International Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/33HzdQG

61. Sumy Airport [Electronic resource] // Wikipedia. – Access mode: https://bit.ly/2KZCOTE

62. Morhunova D. Implementation of innovative technologies at the airports of Ukraine in the conditions of the world pandemic // XVII scientific and technical conference INNOVATIVE TECHNOLOGIES, 2020. – p. 356-360.

63. Morhunova D. Challenges and threats for Ukraine airports caused u the global pandemic [Electronic resource] // International scientific-practical conference. – Access mode: https://bit.ly/33WrGh1

APPENDICES

Air Transportation Management Department			*NAU.20.06.23 001 EN*	

				Letter	Sheet	Sheets
Done by:	*Morhunova D. Yu*					
Supervisor	*Shevchenko Yu.V.*			*D*	*119*	*4*
Normative Supervisor	*Shevchenko Yu.V.*		*SUMMARY*			
Head of the Department	*Shevchuk D.O.*			*FTML 275 ОП – 202Ma*		

Map of zoning of regional air transport systems of Ukraine
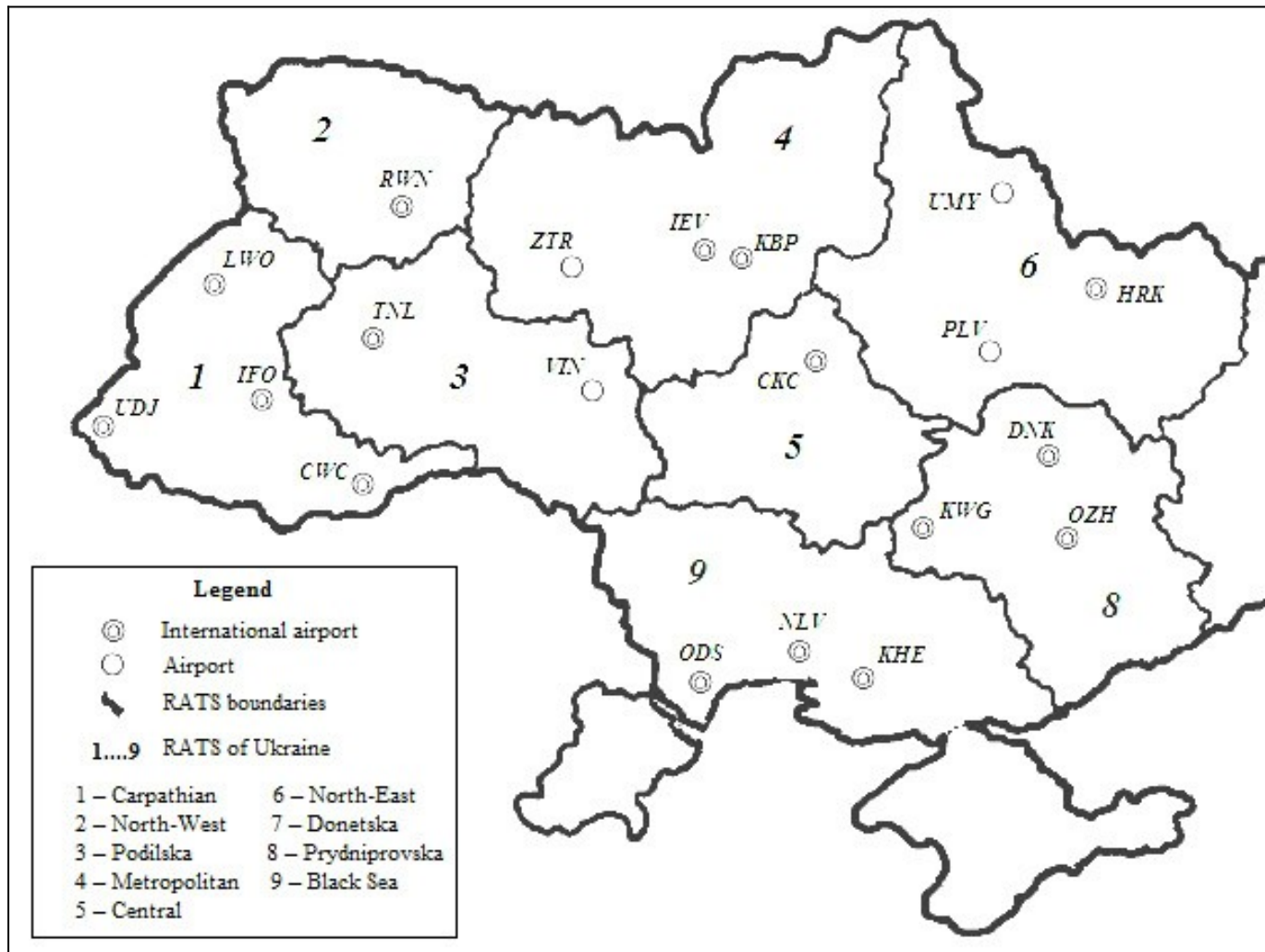
Ranking of global hub airports by the number of served passengers and the

number of aircraft movements in 2019

Airport (country)	IATA code	Rating by passenger number		Rating by aircraft movements	
		Rank	Total passengers, thousand people	Rank	Total aircraft movements, movements
Hartsfield-Jackson Atlanta International Airport (USA)	ATL	1	110 531,3	2	904 301
Beijing Capital International Airport (China)	PEK	2	100 011,4	6	594 329
Los Angeles International Airport (USA)	LAX	3	88 068,0	4	691 257
Dubai International Airport (UAE)	DXB	4	86 396,7	-	-
Tokyo Haneda Airport (Japan)	HND	5	85 505,0	19	458 368
Chicago O'Hare International Airport (USA)	ORD	6	84 649,1	1	919 704
London Heathrow Airport (UK)	LHR	7	80 888,3	15	478 002
Shanghai Pudong International Airport (China)	PVG	8	76 153,4	11	511 846
Paris Charles de Gaulle Airport (France)	CDG	9	76 150,0	13	482 676
Dallas/Fort Worth International Airport (USA)	DFW	10	75 066,9	3	720 007

Continuation of APPENDIX B

Airport (country)	IATA code	Rating by passenger number		Rating by aircraft movements	
		Rank	Total	Rank	Total

			passengers, thousand people		aircraft movements, movements
Guangzhou Baiyun International Airport (China)	CAN	11	73 386,1	12	491 249
Amsterdam Airport Schiphol (The Netherlands)	AMS	12	71 706,9	9	515 811
Hong Kong International Airport (China)	HKG	13	71 415,2	-	-
Seoul Incheon International Airport (South Korea)	ICN	14	71 204,1	-	-
Frankfurt Airport (Germany)	FRA	15	70 556,0	10	513 912
Denver International Airport (USA)	DEN	16	69 015,7	5	631 955
Indira Gandhi International Airport (India)	DEL	17	68 490,7	16	466 452
Singapore Changi Airport (Singapore)	SIN	18	68 283,0	-	-
Suvarnabhumi Airport (Bangkok, Thailand)	BKK	19	65 421,8	-	-
John F. Kennedy International Airport (USA)	JFK	20	62 551,0	-	-

List of the airports in Ukraine as of 2020

№	Airport	City	IATA code
1	Boryspil International Airport	Kyiv	KBP
2	Kyiv International Airport (Zhuliany)	Kyiv	IEV
3	Lviv International Airport	Lviv	LWO
4	Odesa International Airport	Odesa	ODS
5	Kharkiv International Airport	Kharkiv	HRK
6	Zaporizhzhia International Airport	Zaporizhzhia	OZH
7	Dnipropetrovsk International Airport	Dnipro	DNK
8	Kherson International Airport	Kherson	KHE
9	Ivano-Frankivsk International Airport	Ivano-Frankivsk	IFO
10	Chernivtsi International Airport	Chernivtsi	CWC
11	Vinnytsia International Airport	Vinnytsia (Havryshivka)	VIN
12	Mykolaiv International Airport	Mykolaiv	NLV
13	Kryvyi Rih International Airport	Kryvyi Rih	KWG
14	Rivne International Airport	Rivne	RWN
15	Poltava Airport	Poltava (Suprunivka)	PLV
16	Uzhhorod International Airport	Uzhhorod	UDJ
17	Ternopil International Airport	Ternopil	TNL
18	Zhytomyr Airport	Zhytomyr	ZTR
19	Cherkasy International Airport	Cherkasy	CKC
20	Sumy Airport	Sumy	UMY