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## **MODERN CHALLENGES OF AIR TRANSPORT: SAFETY, REGULATIONS, OPERATIONS AND INFRASTRUCTURE**

**Dmytro Bugayko, Yuliya Ierkovska, Fariz Aliyev, Danylo Bugayko.** «*Modern challenges of air transport*»: *safety, regulations, operations and infrastructure*». Openness to the negative consequences of global, regional and national financial crises, the tragic events associated with the activities of terrorist organizations and, first of all, the global COVID 19 pandemic lead to the fact that the issues of efficiency and economic feasibility are among the priorities in solving the challenge of maintaining an appropriate safety level. In fact, the philosophy of aviation safety is changing from an understanding of its purely technical and technological component and extends to determining the severity of risks to property, life and health of people, the environment, financial security, and legal liability of enterprises have shocked aviation transport. At the same time, harmonization, integrity and operational interchangeability of the industry's integrated security system are achieved; the worldwide exchange of safety-related information; global systemic hazards are identified and eliminated at an early stage. The effective management of aviation safety requires a systematic approach to the development of policies, procedures and recommended practices. Safety management

*integrates different types of aviation activities into a single whole. The main challenges of Ukrainian air transport in the context of the globalization of the air transportation market are the annexation of Crimea, the armed conflict in the east of Ukraine, the tragedy of the Boeing-777 of Malaysian Airlines, the closure of airspace over the vast territory of Ukraine, the refusal to fly over the Russian Federation, the tragedy of the Boeing-737 of International Airlines Ukraine" in Iran and, to a greater extent, the COVID-19 pandemic. These challenges are reflected in almost all macro, meso and microeconomic indicators of the activity and infrastructure of air transport. However, air transport is not only an open system, but also an adaptive system. Modern challenges of its activities indicate the need to develop strategic scenarios and develop a mechanism for institutional support for further sustainable development, taking into account the dynamic external environment, constant changes in the structure and intensity of threats and uncertainties.*

**Keywords:** air transport, safety, regulation, operation, infrastructure, hazards, risks.

**Дмитро Бугайко, Юлія Єрковська, Фаріз Алієв, Данило Бугайко. "Сучасні виклики авіаційного транспорту: безпека, регулювання, експлуатація, інфраструктура".** Відкритість до негативних наслідків загальносвітових, регіональних і національних фінансових криз, трагічні події, пов'язані з діяльністю терористичних організацій та, в першу чергу, всесвітня пандемія COVID 19 призводять до того, що саме питання ефективності та економічної доцільності є одними з пріоритетних при вирішенні завдання підтримки відповідного рівня безпеки. Фактично філософія безпеки авіації змінюється з розуміння її суто технічної та технологічної складової і поширюється на визначення ступеня тяжкості ризиків для майна, життя і здоров'я людей, довкілля, фінансової безпеки і юридичної відповідальності галузі авіаційного транспорту. При цьому досягаються гармонізація, цілісність і експлуатаційна взаємозамінність системи комплексної безпеки галузі; поширюється у всесвітньому масштабі обмін інформацією, пов'язаною з безпекою польотів; виявляються й усуваються глобальні системні джерела небезпеки на ранньому етапі. Для ефективного управління безпекою авіації необхідний системний підхід до розроблення політики, процедур і рекомендованої практики. Управління безпекою об'єднує різні види авіаційної діяльності в єдине ціле. Основними викликами авіаційного транспорту України в умовах глобалізації ринку авіаційних перевезень є анексія Криму, збройний конфлікт на сході України, трагедія Боїнгу-777 Малайзійських авіаліній, закриття повітряного простору над великою територією України, відмова від польотів над Російською Федерацією, трагедія Боїнгу-737 Міжнародних авіаліній України в Ірані та, в найбільшій мірі, пандемія COVID-19. Ці виклики знайшли відображення практично в усіх макро, мезо та мікроекономічних показниках діяльності та інфраструктури авіаційного транспорту. Однак авіаційний транспорт – не тільки система відкритого типу, але й адаптивна система. Сучасні виклики його діяльності вказують на необхідність розробки стратегічних сценаріїв та відпрацювання механізму інституційного супроводу його подальшого сталого розвитку з урахуванням динамічного зовнішнього середовища, постійної зміни структури та інтенсивності загроз та факторів невизначеності.

**Ключові слова:** авіаційний транспорт, безпека, регулювання, експлуатація, інфраструктура, загрози, ризики.

**Дмитрий Бугайко, Юлия Ерковская, Фариз Алиев, Даниил Бугайко. "Современные вызовы авиационного транспорта: безопасность, регулирование, эксплуатация, инфраструктура".** Открытость негативным последствиям общемировых, региональных и национальных финансовых кризисов, трагические события, связанные с деятельностью террористических организаций и, в первую очередь, всемирная пандемия COVID 19 приводят к тому, что именно вопросы эффективности и экономической целесообразности являются одними из приоритетных при решении задачи поддержания соответствующего уровня безопасности. Фактически философия

безопасности авиации изменяется с понимания ее чисто технической и технологической составляющей и распространяется на определение степени тяжести рисков для имущества, жизни и здоровья людей, окружающей среды, финансовой безопасности, юридической ответственности предприятий отрасли авиационного транспорта. При этом достигаются гармонизация, целостность и эксплуатационная взаимозаменяемость системы комплексной безопасности отрасли; распространяется во всемирном масштабе обмен информацией, связанной с безопасностью полетов; выявляются и устраняются глобальные системные источники опасности на раннем этапе. Для эффективного управления безопасностью авиации необходим системный подход к разработке политики, процедур и рекомендуемой практики. Управление безопасностью объединяет разные виды авиационной деятельности в единое целое. Основными вызовами авиационного транспорта Украины в условиях глобализации рынка авиационных перевозок являются аннексия Крыма, вооруженный конфликт на востоке Украины, трагедия Боинга-777 Малайзийских авиалиний, закрытие воздушного пространства над обширной территорией Украины, отказ от полетов над Российской Федерацией, трагедия Боинга-737 «Международных авиалиний Украины» в Иране и, в большей степени, пандемия COVID-19. Эти вызовы нашли отражение практически во всех макро, мезо и микроэкономических показателях деятельности и инфраструктуры авиационного транспорта. Однако авиационный транспорт – не только система открытого типа, но и адаптивная система. Современные вызовы его деятельности указывают на необходимость разработки стратегических сценариев и отработки механизма институционального сопровождения дальнейшего устойчивого развития с учетом динамической внешней среды, постоянного изменения структуры и интенсивности угроз и факторов неопределенности.

**Ключевые слова:** авиационный транспорт, безопасность, регулирование, эксплуатация, инфраструктура, угрозы, риски.

**Introduction.** The development of world civil aviation is accompanied by continuous technological progress and requires constant improvement in the field of control and reduction of the impact of hazardous factors in its activities. However, despite all efforts to prevent failures and errors, they will still take place, and one hundred percent safety cannot be achieved. No human activity and no artificial system can be guaranteed to be completely safe, ie free from risks. Global cooperation in international civil aviation is an effective tool for reducing risks.

The article is a logical continuation of a number of publications devoted to the development of air transport safety, regulations, operations and infrastructure aspects of Ukrainian scientists G. Suslova [1], D. Bugayko [1 – 7], Y. Kharazishvili [2, 3 – 5], M. Hryhorak [3 – 4], Y. Ierkovska [6 – 7], O. Ovdiienko [4], V. Marchuk [4], V Lyashenko[5], V Sokolovskiy [5], V Baranov[5], Mariia Bahrii [7], Polish scientists (Z. Zamiar [3]), Azerbaijan

Scientists F. Aliev [7], and scientists of other countries. Statistical data for aviation transport risk assessment are taken from the following statistical sources of the State Statistics Service [8], Ministry of Infrastructure [9], the Civil Aviation Authorities [10] and National Bureau for the Investigation of Aviation Accidents and Incidents with Civil Aircraft of Ukraine [11].

**The purpose of the article** is to provide structural analysis of modern challenges of air transport by the aspects of safety, regulations, operations and infrastructure.

**Presentation of the main results.** *Problems of aviation safety regulation in the conditions of globalization.*

One of the main goals of the world's leading and regional civil aviation organizations is to create a single global aviation safety system in deep cooperation of ICAO member states on global support for International Civil Aviation Organization (ICAO) Standards and Recommended

Practices (ICAO SARPS), which are constantly updated within 19 Annexes to the Chicago Convention 1944. ICAO's strategic objectives are to ensure flight safety, aviation and environmental safety.

An important step in the development of global civil aviation safety was the decision to enter into force in November 2013 19 of the Annex to the Chicago Convention on Safety Management. The new Annex contains the concept of the State Aviation Safety Program and 8 critical elements of the safety oversight system. The application covers activities in the field of general and commercial aviation, strengthens the role of the state in maintaining safety at the state level, emphasizing the concept of joint work on safety in all areas, coordination with air navigation service providers.

The new application is being developed in two stages. The first step is to summarize the existing safety management provisions contained in the 6 Annexes in one new Annex 19. However, the main safety management provisions have been moved from the following annexes:

- Annex 1 - Issuance of certificates to aviation personnel;
- Annex 6 - Aircraft Operations,
  - Part I - International Commercial Air Transport - Aircraft,
  - Part II - International General Aviation - Aircraft and
  - Part III - International Flight - Helicopters;
- Annex 8 - Airworthiness of aircraft;
- Annex 11 - Air Traffic Services;
- Annex 13 - Investigation of aviation incidents and incidents;
- Annex 14 - Aerodromes, Volume I - Design and operation of aerodromes.

Adoption of Program 6, Part II, Annex 5 and Part III, Annex 1 - Control over flight safety by operators, as well as repetition of Annex 13, Appendix E - Legal framework for protection of information on systems for collecting and processing safety data. The main difference between the provisions of Annex 19 was the extension of the conceptual

framework of the safety management system to the level of organizations responsible for the design or manufacture of aircraft, raising safety standards, expanding the powers of the state safety oversight system to the level of all service providers. Particular attention is paid to the collection, analysis of safety data, their exchange and legal principles of information protection in systems for the collection and processing of safety data. In 2013, the third edition was published, and in 2019 - the fourth edition of Document 9859 "Aviation Safety Management Guide", which is based on the conceptual provisions of the State Aviation Safety Program and Flight Safety Management System [12].

The second stage of the development of Annex 19 is devoted to the definition of extended standards and recommended practices in the field of a single aviation safety management system. Also international cooperation in the field of aviation safety at the following levels:

- cooperation within the framework of corporate associations (for example, the International Air Transport Association (IATA), the American Air Transport Association (ATA) and the Civil Aviation Navigation Services Organization (CANSO);
- cooperation within national and international aviation associations (for example, the National Business Aviation Association (NBAA), the European Business Aviation Association (EBAA), etc.);
- cooperation within the framework of international federations of national associations (for example, the International Federation of Airline Pilots Associations (IFALPA) and the International Federation of Air Traffic Controllers Associations (IFATCA);
- activities of international aviation security bodies (for example, the World Aviation Safety Fund (FSF) and the International Society for Aviation Safety Researchers (ISASI));
- cooperation within industry / government groups (eg the Commercial Aviation Safety Group (CAST) and the Pan



American Commercial Aviation Safety Group (PAST));

– holding large aviation safety forums with the participation of aircraft and equipment manufacturers.

A positive aspect of such cooperation is the development of a comprehensive approach to solving the problem of aviation safety, taking into account not only purely technical and technological issues, but also identifying commercial and economic risks for various actors in the air transport market. This is extremely important, because in the context of globalization there is a steady trend of weakening state support for aviation enterprises. In such conditions, the world's civil aviation focuses on achieving three main goals - safety, efficiency and economic feasibility. Problems in achieving any of them threaten the effective functioning of the industry. At the same time openness to the negative consequences of global, regional and national financial crises, tragic events related to the activities of terrorist organizations (such as September 11, 2001 in the US), natural disasters, volcanic eruptions, tsunamis, earthquakes, etc., and, first of all, the global pandemic COVID 19 lead to the fact that the issue of efficiency and economic feasibility is one of the priorities in solving the problem of maintaining an appropriate level of safety. In fact, the philosophy of aviation safety changes from understanding its purely technical and technological component and extends to determining the severity of risks to property, human life and health, environment, financial security and legal responsibility of the airline, its image and public confidence in it. At the same time harmonization, integrity and operational interchangeability of the system of complex safety of the branch are achieved; the exchange of safety-related information is spreading worldwide; global systemic sources of danger are identified and eliminated at an early stage. Effective aviation safety management requires a systematic approach to the development of policies, procedures and recommended practices. Safety

management combines different types of aviation activities into a single whole [1].

The conceptual step in the development of the national aviation safety system of Ukraine was the signing by the Cabinet of Ministers of Ukraine of the Order of June 16, 2021 № 656-r "On approval of the State Safety Program." The State Safety Program includes the following national approaches to ensuring the following aspects of air transport safety development:

- State policy and objectives in the field of aviation safety,
- Management of risk factors for aviation safety at the state level
- Commitments to the safety management system
- Investigation of aviation incidents and incidents
- Safety management & risk management
- Ensuring aviation safety at the state level
- Obligations to supervise
- Effectiveness of flight safety at the state level
- Promotion of flight safety issues at the state level [13].

Aviation safety is an important component of the concept of general national security, personal security, public safety and transport safety from external and internal hazards. With advanced risk management, hazards monitoring and precautionary measures are carried out in a complex in the areas of aviation economic development planning, aviation infrastructure, economic security, aviation security and their quintessential aviation safety.

*Global trends in aviation infrastructure development.*

Civil aviation statistics show that the growth of the main indicators of air traffic doubles every fifteen years. This is much more dynamic than the growth of most other industries. Since 1960, the demand for passenger, luggage, freight and postal

services has been steadily increasing. The development of technological progress and related investments are combined and make it possible to multiply the output of the aviation industry by a factor of more than 30. Such expansion of air transport is extremely beneficial for global economic growth, especially for world production (global GDP). In real terms, it multiplied more than five times over the same period [14].

However, a structural analysis of air traffic volumes suggests that the dynamic growth of air traffic is consistently opposed by recessionary cycles. The aviation industry is an open system that is affected by a wide range of technical, natural, human and economic threats. For its part, it itself is a generator of significant threats to the environment. Among the most significant threats to civil aviation in the history of development are the following:

- fuel crisis (1973),
- the war between Iran and Iraq (1981),
- the Gulf War (1991),
- The Asian crisis (1997-1998),
- the terrorist attack in the United States on September 11 (2001),
- SARS (2003),
- global recession (2008) [15].

However, one of the most threatening challenges in the history of air transport is the spread of a new deadly infection, COVID-19, which effectively leads to a quarantine blockade of entire regions and a sharp reduction in or ban on air traffic. The COVID-19 pandemic in 2020 significantly affected the volume of air passenger traffic. In the industry as a whole, the volume of passenger-kilometers decreased by 65.9% compared to the same period last year. In total, about 1.5 billion passenger trips have been made during this time. The decline in air passenger traffic in 2020 has been the largest since global passenger-kilometers began to be tracked since 1950. As noted above, since 1990, long-term average industrial growth has been around 5% per year. The pandemic also had a significant impact on economic activity, with deteriorating business

conditions, declining consumer confidence, a sharp decline in corporate incomes and employment, which ultimately directly affected the individual living standards of the majority of the world's population. In fact, world GDP has fallen by 3.6% and this is the biggest drop in recent history. But the decline in passenger-kilometers was much greater than GDP due to tight controls on air travel, particularly internationally. The COVID-19 crisis has made domestic aviation markets more resilient than international ones. This is because internal controls are generally less stringent than external ones. Thus, in 2020, the volume of global domestic passenger-kilometers decreased by 48.7% year on year, while for international passenger-kilometers it was a decline of 75.6%. The market share of the world's domestic passenger-kilometers also increased from 36% of industry passenger-kilometers in 2019 to 54% in 2020 [16].

#### *Planning of economic development of air transport of Ukraine.*

Ukraine is an aviation state that has a full cycle of development and serial production of aircraft, commercial operation of civil aviation, training and retraining of professionals for the industry. Statistical data on the activities of air transport in Ukraine should be studied in two phased periods from 2010 to 2019 and separately for 2020. The first stage allows to make analytical conclusions on the main trends in the development of air transport of the state, which indicate its stable development during this period. 2020 is the year of force majeure of the global pandemic COVID-19, which poses a critical threat to its further development and has a negative impact on almost all indicators of the industry. During the period from 2010 to 2019, the share of air transport in the country's export-import operations is gradually increasing: in 2019, exports amounted to USD 1,419.7 million. USA (15.5% of total exports of transport services). However, the COVID-19 pandemic in 2020 reduced air transport exports by 43.5% to \$ 802.2 million. USA. A

similar trend is observed with regard to imports of air transport - 757.8 million dollars. USA (48.6% of total imports of transport services). The impact of the COVID-19 pandemic in 2020 reduced air transport exports by 58% to \$ 319.9 million. USA [8]. Statistical data on exports and imports of transport services and air transport services in the period from 2010 to 2020 are given in Table 2.1. .3. Planning of economic development of air transport of Ukraine. Ukraine is an aviation state that has a full cycle of development and serial production of aircraft, commercial operation of civil aviation, training and retraining of professionals for the industry. Statistical data on the activities of air transport in Ukraine should be studied in two phased periods from 2010 to 2019 and separately for 2020. The first stage allows to make analytical conclusions on the main trends in the development of air transport of the state, which indicate its stable development during this period. 2020 is the

year of force majeure of the global pandemic COVID-19, which poses a critical threat to its further development and has a negative impact on almost all indicators of the industry. During the period from 2010 to 2019, the share of air transport in the country's export-import operations is gradually increasing: in 2019, exports amounted to USD 1,419.7 million. USA (15.5% of total exports of transport services). However, the COVID-19 pandemic in 2020 reduced air transport exports by 43.5% to \$ 802.2 million. USA. A similar trend is observed with regard to imports of air transport - 757.8 million dollars. USA (48.6% of total imports of transport services). The impact of the COVID-19 pandemic in 2020 reduced air transport exports by 58% to \$ 319.9 million. USA [8]. Statistical data on exports and imports of transport services and air transport services in the period from 2010 to 2020 are given in Table 1.

Table 1 - Export-import of transport services and air transport services

Years	2010	2014	2015	2016	2017	2018	2019	2020
Exports (million USD)								
Transport services	7835,2	6102,0	5263,2	5300,5	5861,4	5851,4	9109,9	4988,4
Aviation services	1181,9	1071,2	8536,1	8828,4	1091,7	1221,6	1419,7	802,2
Imports (million USD)								
Transport services	1178,9	1376,5	1153,3	9892,7	1213,1	1464,8	1559,1	1061,0
Aviation services	447,6	431,0	466,9	357,5	452,4	695,7	757,8	319,9

Source: State Statistics Service of Ukraine [8].

Air transport is an effective catalyst for investment. Thus, in just 8 years (2014-2020), even in conditions of political instability, armed conflict in eastern Ukraine and the global pandemic COVID-19, the industry was attracted 7.14 billion UAH. capital investment [8]. Statistical data on capital investments of enterprises of economic activities and air transport in the period from 2010 to 2020 are given in table 2.

These results are particularly relevant given the tendency that the total number of people involved in air transport is not very large (16 thousand people, or 2.5% of the total population involved in transport) [8]. At the same time, it is conceptual that air transport accumulates highly educated people with a professional level of competence with one of the highest levels of the average monthly salary, which is almost twice the average monthly salary in transport.

Table 2 - Capital investments of enterprises of economic activities and air transport

Years	2010	2014	2015	2016	2017	2018	2019	2020
In actual prices, UAH billion								
Transport services	19,59	15,50	18,70	25,11	37,94	50,08	43,79	34,88
Aviation services	0,62	0,41	0,65	0,62	1,30	1,53	1,77	0,86

Source: State Statistics Service of Ukraine [8].

However, as mentioned above, air transport has not only direct but also indirect and inductive effects. That is, it creates jobs in various sectors of the economy and contributes to achieving synergistic social effects of sustainable development of the national

economy. Statistical data on the average number and average monthly salary of full-time employees of enterprises of economic activities and air transport in the period from 2010 to 2020 are given in table 3.

Table 3 - The average number and average monthly wages of full-time employees of enterprises of economic activities and air transport.

Years	2010	2014	2015	2016	2017	2018	2019	2020
Average number of full-time employees, thousand								
Transport services	824,3	731,0	661,4	659,9	655,2	648,4	635,1	625,8
Aviation services	11,1	7,3	6,9	7,1	8,2	8,1	16,2	16,0
Average monthly salary of full-time employees, UAH								
Transport services	2658	3768	4653	5810	7688	9860	11704	11951
Aviation services	6774	11967	18470	24688	31088	35651	27300	21685

Source: State Statistics Service of Ukraine [8].

The dynamics of changes in the number of aircraft fleets reflects not so much quantitative as qualitative change. The dynamic decrease in the number of aircraft in the period from 2010 to 2015 is mainly due to the gradual decommissioning of economically unprofitable and obsolete aircraft manufactured during the Soviet era. In fact, in the period from 2016 to 2019, the

airlines optimized the total fleet of about 200 aircraft. Unfortunately, the impact of the COVID-19 pandemic in 2020 optimized the fleet of Ukrainian airlines by 25% to 155 [8]. Statistical data on the fleet of aircraft of Ukrainian airlines in the period from 2010 to 2020 are given in table 4.

Table 4 - Fleet of Ukrainian airlines

Years	2010	2014	2015	2016	2017	2018	2019	2020
Aircraft, helicopters								
Aircraft, helicopters	395	222	196	208	200	205	205	155

Source: State Statistics Service of Ukraine [8].

This trend was offset by the renewal of the park with the latest economic and environmental modifications of Western-made aircraft (Boeing, Airbus, Embraer, etc.). At the same time, the airlines did not aim to

maximize the fleet of aircraft, but to implement the policy of optimizing the fleet of aircraft and mass departure from direct purchases of their own aircraft to the development of leasing agreements. This is

one of the protective mechanisms to respond to sudden changes in demand for transportation.

*Trends in the development of aviation infrastructure in Ukraine.*

Similarly to the statistics on the activities of air transport, the trends in the development of aviation infrastructure in Ukraine should be studied in two stages in the period from 2010 to 2019 and separately for 2020. The first stage allows to make analytical conclusions about the main trends in the development of aviation infrastructure in Ukraine. 2020 is a year of force majeure - the global pandemic COVID-19, which poses a critical threat to the development of global, regional, international and national aviation infrastructure.

*Passenger air transportation of Ukraine.*

As well as at the global level, there is a direct dependence of production indicators on the negative impact of external factors that caused a significant decline in passenger traffic, namely: annexation of Crimea, armed

conflict in eastern Ukraine, downing of Boeing 777 Malaysia Airlines, airspace closure over a large territory of Ukraine, refusal to fly over the Russian Federation, etc. However, civil aviation is not only an open system, but also an adaptive system. And these significant recessionary trends have been overcome through the development of infrastructure, taking into account the newly created constraints. During the period from 2010 to 2019, there was a 2.3-fold increase in passenger traffic from 6 to 14 million passengers per year. The corresponding trend is inherent in the volume of passenger turnover, which has increased almost threefold during this period from 11 to 30.3 billion passenger-km.

During 2020, domestic airlines (29 - in 2019) performed 56% of commercial flights less than in 2019 - 45.3 thousand against 103.3 thousand flights in 2019 (Civil Aviation Service, 2020) [10].

Statistical data on the volume of passenger traffic and passenger turnover in transport and air transport of Ukraine in the period from 2010 to 2020 are given in table 5.

Table 5 - Transportation of passengers and passenger turnover in transport and air transport of Ukraine

Years	2010	2014	2015	2016	2017	2018	2019	2020
Passenger traffic (million passengers)								
Transport services	6845	5902	5167	4854	4648	4487	4262	2570
Aviation services	6	6	6	8	10	12	14	14
Passenger turnover (billion passenger km)								
Transport services	130,0	106,3	97,0	102,2	99,4	104,4	107,2	49,0
Aviation services	11,0	11,6	11,4	15,5	20,4	25,9	30,3	10,1

Source: State Statistics Service of Ukraine [8]

One of the most serious crises in the world aviation, related to the COVID-19 pandemic, is currently underway. The air transport economy is extremely vulnerable to external factors, as it has a number of fixed cost items that must be paid regardless of standard or force majeure conditions. First of all, it is the payment of lease payments for the fleet of aircraft, which now consists mainly of leased aircraft. Airlines pay an average of 10

thousand dollars. US per day for leasing one Boeing 737-800 or Airbus 320. Thus, the daily leasing budget of UIA may be about 300 thousand dollars. USA, SkyUp and Wind Roses - up to 100 thousand dollars. USA. To these costs are added other fixed items: salaries of employees, insurance, maintenance of airworthiness of aircraft, etc. Under such conditions, it is advanced risk management and consolidation measures by the state,

aircraft or helicopter operators, approved maintenance organizations, organizations responsible for the design or manufacture of aircraft and leasing organizations, air traffic service providers, certified aerodrome operators, approved training organizations can hinder the overall destruction of the industry. Thus, the specificity of open systems

is the phenomenon of the "domino effect". If organizations of one segment disappear from the market, it systematically affects the performance of others, as well as the overall synergy of the industry. The dynamics of the volume of passenger traffic by air transport of Ukraine in the period up to 2020 is shown in Fig. 1.

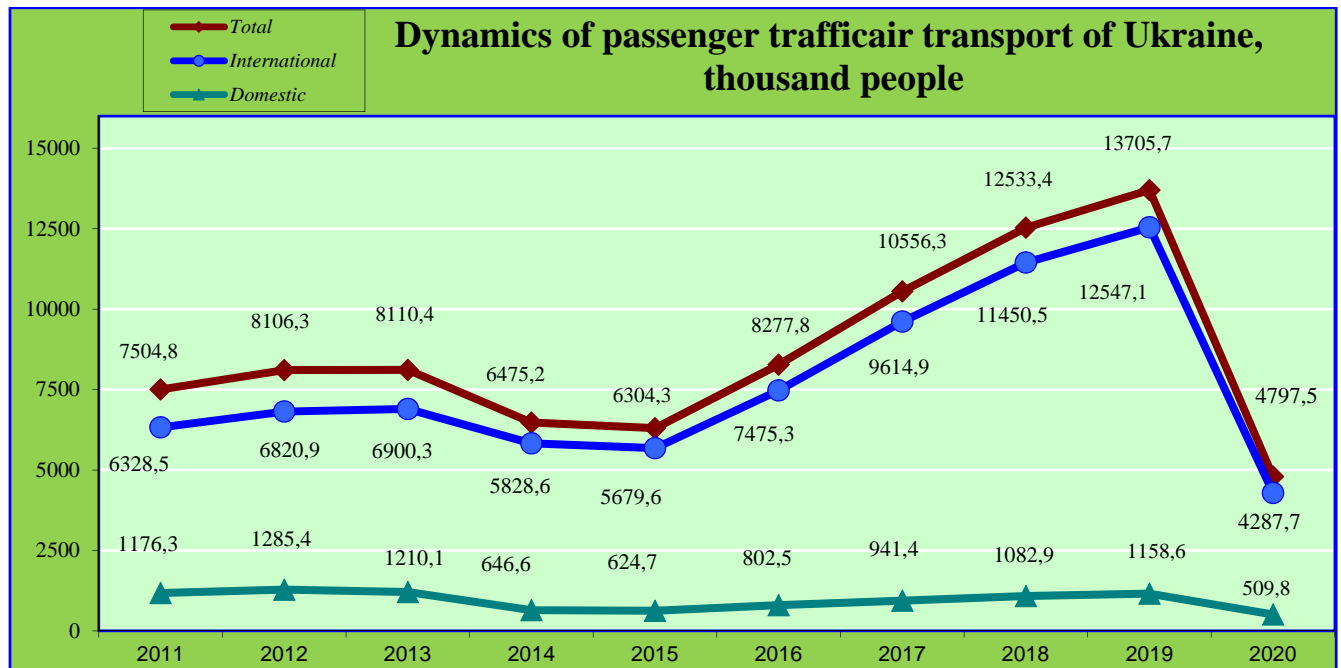


Figure 1 - Dynamics of passenger air transport in Ukraine in the period up to 2020  
 Source: State Aviation Service, 2020 [10]

At the same time, the volume of passenger traffic by air transport of Ukraine returned to approximately the level of 2006 - 2007, when the mentioned figure was 4208.3 thousand and 4928.6 thousand people. in accordance. Passenger traffic was provided by 14 domestic airlines during the year. The largest volumes were performed by Ukraine International Airlines, Skype, Azur Air Ukraine and Wind Rose, which accounted for almost 98 percent of the total passenger traffic of Ukrainian airlines.

*Freight air transportation of Ukraine.*

In contrast to passenger traffic, the volume of cargo and mail by air of Ukraine during the COVID-19 pandemic did not decrease critically. According to the results of 2020, the volumes of cargo and mail transportation by air transport of Ukraine

amounted to 88.3 thousand tons (for 2019 - 92.6 thousand tons). In total, 20 domestic airlines performed cargo and mail transportation in the reporting year. Leaders of cargo transportation are ZetAvia Airlines, Antonov ATP, Maximus Airlines, Ukraine International Airlines, Constanta and Skype. In the reporting year, these airlines performed almost 90 percent of the total cargo and mail traffic. It should be noted that the majority of freight traffic has traditionally been charter flights to other countries under UN humanitarian and peacekeeping programs, as well as under contracts and agreements with other customers [10]. Statistical data on the volume of cargo transportation and cargo turnover on transport and air transport of Ukraine in the period from 2010 to 2020 are given in table 6.

Table 6 - Cargo transportation and cargo turnover on transport and air transport of Ukraine

Years	2010	2014	2015	2016	2017	2018	2019	2020
Cargo transportation (million tons)								
Transport services	1765	1623	1474	1543	1582	1643	1579	1641
Aviation services	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Cargo turnover (billion tkm)								
Transport services	418,7	353,6	334,7	344,2	364,2	361,3	355,0	313,2
Aviation services	0,4	0,2	0,2	0,2	0,3	0,3	0,3	0,3

Source: State Statistics Service of Ukraine [8]

#### Airport operations.

One of the most vulnerable adverse effects of the COVID-19 pandemic. elements of the aviation infrastructure system of Ukraine were airports. Unlike airlines, which are able to drastically reduce their fleet of aircraft during critical periods by quickly abandoning leasing operations, airports do not have the ability to quickly reduce their own operating costs. The number of aircraft sent and arrived in 2020 amounted to 94 thousand (against 201.2 thousand in the

previous year). At the same time, passenger traffic through the airports of Ukraine decreased by 64.4 percent, freight traffic - by 13.3 percent and amounted to 8664.5 thousand people and 52.2 thousand tons, respectively. During the year, commercial flights of domestic and foreign airlines served 19 Ukrainian airports and airfields [10]. In fig. 2 shows the volume of passenger traffic through the airports of Ukraine in the period from 2011 to 2020.

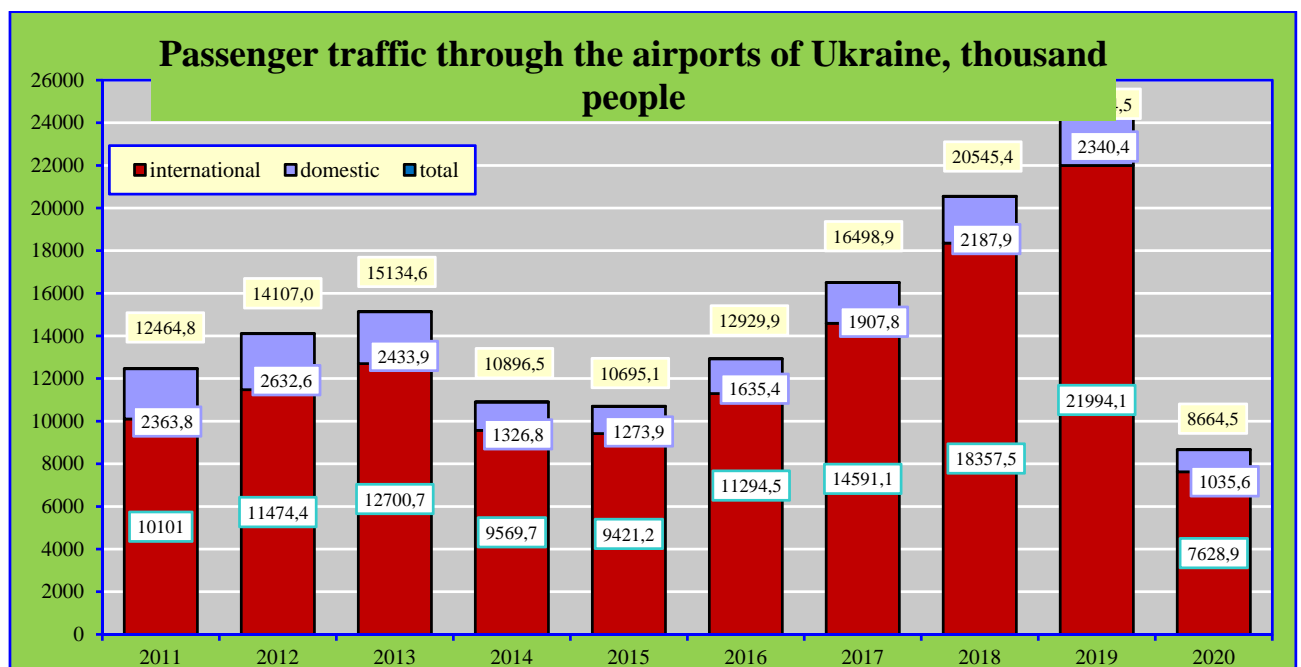


Figure 2 - The volume of passenger traffic through the airports of Ukraine in the period from 2011 to 2020

Source: State Aviation Service, 2020 [10]

Today, 97 percent of all passenger traffic and almost 99 percent of mail and cargo traffic are concentrated in 6 major airports

(Kyiv (Boryspil), Lviv, Kyiv (Zhulyany), Odessa, Kharkiv and Zaporizhia) [10]. In fig. 3 shows the share of leading airports in the total

volume of passenger traffic through the airports of Ukraine.

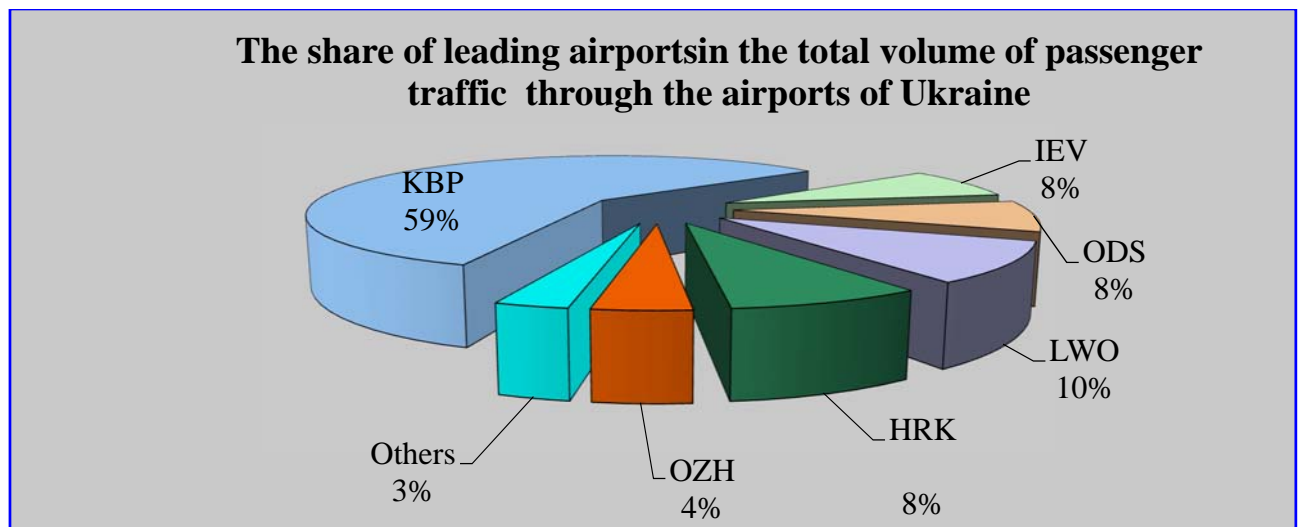


Figure 3 - Share of leading airports in total passenger traffic through Ukrainian airports  
Source: State Aviation Service, 2020 [10]

According to the results of the year, the number of passengers served by the main airport of the country Kyiv (Boryspil) decreased compared to the previous 2019 by 66.2 percent. Passenger traffic through Kyiv (Zhulyany) airport decreased by 73.1 percent, Lviv - by 60.4 percent, Odessa - by 58.8 percent, Kharkiv - by 50.8 percent, Zaporozhye - by 24.9 percent [10].

#### *Aviation works.*

In 2020, aviation companies processed 287.8 thousand hectares of agricultural land, the number of flights during aviation works amounted to 10.8 thousand hours (in 2019 - 360.7 thousand hectares and 8.8 thousand hours, respectively) [10].

#### *Air traffic service of Ukraine.*

During the reporting year, UkSATSE provided 142,000 flights with air navigation services, compared to 335.4 thousand a year earlier. The number of flights operated by airplanes and helicopters of Ukrainian airlines decreased by 54.7 percent, foreign airlines - by 59.1 percent [10].

**Conclusions.** Thus, the main challenges of Ukraine's air transport in the globalization of the air transportation market are the annexation of Crimea, the armed conflict in eastern Ukraine, the downing of Malaysia Airlines Boeing 777, the closure of airspace over Ukraine, the refusal to fly over the Russian Federation, the downing of Boeing 737 of Ukraine International Airlines in Iran and, to the greatest extent, the COVID-19 pandemic. These challenges are reflected in virtually all macro, meso and microeconomic performance indicators and main performance indicators of air transport infrastructure. However, air transport is not only an open system, but also an adaptive system. The current challenges of its activities indicate the need to develop strategic scenarios and work out a mechanism for institutional support for its further sustainable development, taking into account the dynamic external environment, constant changes in the structure and intensity of hazards and uncertainties.



## References

1. Suslova GA, Bugayko DO ICAO's new strategies for civil aviation security. Civil aviation of Ukraine of the XXI century: materials of scientific-practical. conf. (Kyiv, April 12, 2018). Kyiv: NAU, 2018. P. 11-13.
2. D. Bugayko, Yu. Kharazishvili. Theoretical principles of strategic aviation safety management in the context of ensuring sustainable development of the national economy. Bulletin of Economic Science of Ukraine. 2020. № 1 (38). P. 166-175. Institute of Industrial Economics of the National Academy of Sciences of Ukraine, Academy of Economic Sciences of Ukraine.
3. D. Bugayko, Yu. Kharazishvili, M. Hryhorak, Z. Zamiar. Economic Risk Management of Civil Aviation in the Context of Ensuring Sustainable Development of the National Economy. Logistics and Transport – Wrocław: International School of Logistics and Transport in Wrocław. – 2020. - №1-2(45-46). – P.71– 82.
4. Ovdienko O., Hryhorak M., Marchuk V., Bugayko D. An assessment of the aviation industry's impact on air pollution from its emissions: worldwide and the Ukraine. Environmental & Socio-economic Studies. [Katowice]. 2021. Vol. 9. № 2. P. 1-10.
5. Yu Kharazishvili, D Bugayko, V Lyashenko, V Sokolovskiy, V Baranov. Strategizing for sustainable development of transport systems in the safety dimension. IOP Conference Series: Earth and Environmental Science. IOP Publishing. P. 012025.
6. Dmytro Bugayko, Yuliya Ierkovska. Institutional Measures of Air Transport Safety Strategic Management at the Level of State Regulation. Intellectualization of Logistics and Supply Chain Management. The electronic scientifically and practical journal v.9 (2021). P.6 – 19. ISSN 2708 - 3195. <https://smart-scm.org>.
7. Dmytro Bugayko, Yuliya Ierkovska, Fariz Aliev, Mariia Bahrii. The Concept of National Integrated Risk Management of Aviation Transport of Ukraine. Intellectualization of Logistics and Supply Chain Management. The electronic scientifically and practical journal v.10 (2021). P.6 – 18. ISSN 2708-3195 <https://smart-scm.org>.
8. Statistical collection "Transport and Communications of Ukraine" 2020: stat. coll. Kyiv: State Statistics Service of Ukraine, 2021. 116 p.
9. [https://www.kmu.gov.ua/storage/app/sites/1/17-civik-2018/zvit\\_2019/zvit-2019-avia.pdf](https://www.kmu.gov.ua/storage/app/sites/1/17-civik-2018/zvit_2019/zvit-2019-avia.pdf)
10. CAA Ukraine (2021). <https://avia.gov.ua/pro-nas/statistika/periodychna-informatsiya>.
11. "Analysis of the state of aviation safety based on the results of the investigation of aviation accidents and incidents with civil aircraft of Ukraine and foreign-registered aircraft in 2020". National Bureau for Investigation of Aviation Accidents and Incidents with Civil Aircraft: [http://www.nbaai.gov.ua/uploads/pdf/Analysis\\_2020.pdf](http://www.nbaai.gov.ua/uploads/pdf/Analysis_2020.pdf)
12. Flight safety management manual. Document 9859. 4th ed. / International Civil Aviation Organization. Montreal, 2018. 218 p.
13. Cabinet of Ministers of Ukraine. About approval of the state program on flight safety. Order of June 16, 2021 № 656-r Kyiv. URL: <https://zakon.rada.gov.ua/laws/show/656-2021-%D1%80#Text>.

14. Aviation Benefits Report 2019. The Industry High Level Group (IHLG). 2019. 76 p. URL: <https://www.icao.int/sustainability/Documents/AVIATION-BENEFITS-2019-web.pdf>.

15. ICAO/Economic Development – Air Transport Bureau (2021). Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis. Montréal, Canada. 2021. 17 February / Economic Development – Air Transport Bureau. 2021. URL: <https://www.icao.int/sustainability/Documents/COVID-19/ICAO%20COVID%202021%2002%2017%20Economic>.

16. IATA. WATS World Air Transport Statistics 2021. URL: <https://www.iata.org/contentassets/a686ff624550453e8bf0c9b3f7f0ab26/wats-2021-mediakit.pdf>