NATIONAL AVIATION UNIVERSITY

Air Transportation Management Department

PERMISSION TO DEFEND GRANTED

Head of the Department

_____D. O. Shevchuk

“_____”_____2020

MASTER THESIS

(explanatory notes)

Theme: “Forecast of international air transportation development in Ukraine”

Done by: Vladyslav Revin FTML 602(Ma)

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

Advisers on Individual Parts of the Notes:

Theoretical Part - Dr. Ivannikova V.Yu., Associate Professor

Analytical Part – Dr. Ivannikova V.Yu., Associate Professor

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Standards Inspector: Shevchenko Yu.V., PhD, 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 р.

ДИПЛОМНА РОБОТА

(пояснювальна записка)

випускника освітнього рівня

“**МАГІСТР”**

Тема: “Прогноз розвитку міжнародних авіаційних перевезень України”

Виконавець: Ревін Владислав, ФТМЛ 602(Ма)

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Київ 2020

NATIONAL AVIATION UNIVERSITY

Faculty of Transport Management and Logistics

Air Transportation Management Department

Major: 275 "Transport Technologies (by transport modes)"

APPROVED BY

Head of the Department

_____

“_____”_____2020

TASK

for completion the Master thesis

Revin Vladyslav

(name, surname)

1. Theme of the master thesis entitled “Forecast for the development of international air traffic in Ukraine” was approved by a decree of the Rector’s order № 2026/ст.. from 16.10.2020.
2. Terms of thesis performance: from 05.10.2020 to 31.12.2020
3. Initial data required for writing the bachelor thesis: basic information about the company, traffic volumes and financial indicators; concept of bussines plan, methodology of calculations of the warehouse.
4. Content of the explanatory notes: 1.1. The basic concepts on forecasting techniques of air traffic, COVID-19 impact on social-economic, analyzing ACI forecast air traffic from, Aviation during the COVID-19 pandemic, results of the aviation industry in Ukraine , IATA and ICAO scenarios and forecast of COVID-19 influences on aviation, aviation-as-a service: Five scenarios for 2035,
5. . List of the mandatory graphic materials: ICAO forecasting techniques tree; Monthly airport traffic figures from January to June 2020 versus 2019 (in millions), Passenger traffic volumes from January to June, 2020 versus 2019 (in millions); Multiple Layers of Safety Throughout the Journey; Global Estimates of Impacts in brief; Estimated impact on domestic passenger traffic and revenues by region for 2020; ICAO reports on the effect of Covid-19 on civil aviation; .

Passenger-kilometers performed, total scheduled traffic (2010 – 2019), Analysis of the activities of airlines and airports in Ukraine during 2018- 2019; . Share of leading airports in total passenger transportation through Ukraine's airports Forecast for global PRK before and after Covi19, Passenger numbers compared to Baseline & 2019: International, Results of using the decomposition methods of forecast for Boryspil airport for 3 scenarios**.**

6. Calendar

	Task	Термін виконання	Відмітка про виконання
1.	Collection and processing of statistical data	01.10.2020 – 05.10.2011	Done
2.	Writing of the theoretical part	06.10.2020 – 20.10.2020	Done
3.	Writing of the analytical part	21.10.2020 – 05.11.2020	Done
4.	Writing of the design part	06.11.2020 – 20.11.2020	Done
5.	Writing of the introduction and summary	21.11.2020 – 30.11.2020	Done
6.	Execution of the explanatory note, graphic materials and presentation	01.12.2020- 05.12.2020	Done

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

Supervisor of the master thesis: Dr. Ivannikova V.Yu., Associate Professor.

Task was accepted for completion: Revin V.V.

REPORT

Explanatory note to the thesis project “Forecast for the development of international air traffic in Ukraine” 127 pages, 47 figures, 11 tables, 26 references.

KEY WORDS: COVID-19, IATA, FORECAST, SHORT TERM, REGRESSION, MOVING AVARAGES, IMPACT,

Object of research – impact on possible models of forecasting during pandemic

Subject of research – traffic of Boryspil airport and social-economic impact on aviation

Aim of research – forecasting model of air traffic of Boryspil Airport during pandemic

Methodology such research methods as the method of extrapolation of time series, empirical methods of scientific research, namely the method of observation, moving averages forecast.

The obtained results and their novelty: forecast of airport traffic till December 2021.

Significance of the work done and conclusions: The main conclusions and results of the master's thesis can be used by air transport companies to evalueate its own risk to make routes at Boryspil airport

Recommendations for the use of results: The obtained economic, high-quality, technological results can be used in the organization of routes to airport Boryspil .

It is established that the research has scenarios and forecast of COVID-19 influences on aviation

Content

LIST OF ABBREVIATION

COVID-19 - pandemic of coronavirus disease 2019

ACI– Airport Council International

IATA – International Air Transport Association;

ICAO – International Civil Aviation Organization;

GDP – gross domestic product

UAH. – Ukrainian hryvnas;

ths. – thousands.

RPK - revenue passenger-kilometres

S - strengths

W - weaknesses;

O - opportunities;

T - threats;

EU – European Union

ARMA - auto regressive moving average

ILO - International Labour Organization

WHO - World Health Organization

WTTC - World Travel and Tourism Council

USD - USA dollars

LTF- long-term traffic forecasts

AI – artificial inelegance

INTRODUCTION

Air Transportation Management Department				NAU.20.10.14 001EN			
Done by:	Revin V.V.			Introduction	Letter	Sheet.	Sheets
Supervisor	Ivannikova V.Yu.				D	9	3
Standards Inspector	Yuliia V. Shevchenko				FTML 275 ОП-202Ма		
Head of the Department	Shevchuk D. O.						

Aviation - one of the most important sectors of the national economy, the effective functioning of which is a necessary condition for structural change, development and conduct of foreign economic activity, meeting the needs of the population and social production in transportation and more.

The purpose and main tasks of the passenger traffic forecast are to provide a strategic assessment of potential passenger traffic in potential destinations and to prepare a response plan in advance for possible changes.

Influenced by market demands and the needs of changing times, aviation companies are forced to adapt and create new business models - the introduction of business that would be adequate responses to the demands of the external market environment during COVID-19.

The COVID-19 coronavirus pandemic is the biggest test the world has faced since World War II. Appearing in Asia late last year, the virus has spread to every continent except Antarctica, and as of May 13, 4.17 million cases of coronavirus and 287,000 deaths have been confirmed worldwide. The first case of COVID-19 in Ukraine was recorded on April 4, 2020, and as of November 22, 624,744 cases and 10,951 deaths were confirmed in the country.

The crisis will have serious consequences in the global economy, and according to the IMF report, the projected decline in GDP from April 2020 in Ukraine will reach 7.7%. There are quite different assessments of the further recovery of the global economy - from the V-shaped scenario, which provides for economic recovery in 2019 in 2021, to a longer recovery and even a long-term recession. Tourism is one of the sectors of the world economy that has suffered the most from restrictions on movement, and the aviation situation is particularly difficult. As of April 20, 2020, due to a pandemic, 100% of all international destinations have imposed entry restrictions. The currently published scenarios predict a decrease in the number of international tourist arrivals from 58% to 78% per year, depending on the spreading of the virus, the duration of restrictions on movement and border closures, but it is extremely difficult to accurately determine the future.

Governments responded immediately to the need to minimize the economic impact of the COVID-19 pandemic, based on two general approaches: the first is to provide affordable credit lines for business and the second is to delay debt and tax arrears.

In Ukraine today, there is a significant lag in the pace of implementation of measures to support the tourism sector, which seriously jeopardizes the competitiveness of the industry in the global market during the projected recovery period of 2020 year.

Key industry players, including international airlines, are introducing a number of external and internal measures to minimize the effects of the COVID-19 pandemic, including market security guarantees (postponement or reimbursement of booked rooms, optimized loyalty programs, community support), health and safety measures and internal reorganization (reductions, unpaid leave, reductions / waivers of capital investments).

Countries are gradually lifting restrictions on business and services for businesses, but with regard to air transport, it is being restored locally (within one country). The next step in resuming air traffic will be to open borders between neighboring countries, where the situation is relatively similar (for example, Australia and New Zealand, Thailand and China, etc.).

The European Commission has issued a number of recommendations for the opening of borders in two stages: the first will gradually remove restrictions on border crossings between EU member states, and the second plans to lift all coronavirus-related restrictions between member states. The situation regarding the opening of the EU's external borders to third-country nationals (including Ukraine) remains uncertain.

The share of tourism in the overall economy of Ukraine is a topic of in-depth discussions and is, according to official statistics, about 3-4% of GDP, which is much lower than the international average (equal to 10%). Therefore, tourism is practically not taken into account in the formation of economic policy at the national level. However, the latest data from international organizations (primarily

the UN World Tourism Organization, UNWTO) confirm the own calculations of domestic experts, who determined this share at about 9% of Ukraine's GDP. This gives grounds to consider this indicator much more important for the Ukrainian economy than before.

In Ukraine, subsidies or cheap loans to airlines are not mentioned at all: state aid to quarantined businesses is aimed primarily at small and medium-sized businesses. This is forcing domestic airlines to look for a way out of the crisis on their own.

Company redesigning and forecasting traffic in certain destinations is becoming the most significant way for airlines to respond to reduce the impact of the pandemic on airline profits.

1. THEORETICAL PART

1.1. The basic concepts on forecasting techniques of air traffic

In general, forecasting techniques can be broken down into two different categories: qualitative or quantitative. Quantitative forecasting techniques consist of either time series analysis or causal models and rely heavily on historical data. Holt's Method, moving averages, and trend projection are just a few examples of time series techniques. Causal methods consist of many different regression models. To contrast, qualitative forecasting techniques are much less methodical and rely on judgement. Some examples are the Delphi Method and sales force composites.

There are a few well-known facts about forecasting that is important to always remember. First, forecasts, in general, are always wrong in some point. No forecast is perfectly accurate; therefore the goal is to achieve a forecast with minimal error. Second, long term forecasts are usually less accurate than short term forecasts. Third, aggregate forecasts, where data is drawn from various sources are generally more accurate than disaggregate forecasts.

Forecasting models consist of two components: a systematic component and a random component. The systematic component is what we are trying to predict, and often exhibits trends, cycles or seasonality. Trends are any steady growth or decline in the forecast. Seasonality is defined as up and down swings exhibiting a pattern in a short or intermediate time, generally a year. Cycles are up or down swings over a long time. With any forecast, there is always a random component that cannot be explained, but the goal is to minimize this element as much as possible. The basic approach to forecasting is to understand the objective, and then identify major factors that influence the variable in question. It is important to choose the appropriate forecasting technique and finally, evaluate performance and measure error. In this section, an overview of different forecasting methods and models will be presented, as well as methods to measure forecast accuracy.

An analysis of the experience of leading American, Japanese and Western European companies and corporations shows that one of the important forms of planning in companies in these countries is strategic planning. Features of strategic planning and their differences from existing approaches are that strategic planning is focused not on the detailed development of all aspects of the company's production and economic activities, but on the choice of the most promising areas of its development. The effectiveness and efficiency of strategic plans largely depends on the reliability of scientific foresight of quantitative and qualitative changes in social phenomena and processes. In turn, the reliability of forecast predictions significantly depends on how fully the consequences of structural changes occurring in the current and future planning periods are reflected in them, which is of particular relevance for the development of passenger transport systems.

The level of theoretical studies of various aspects of passenger transport does not yet correspond to its actual importance in the socio-economic life of the country, which is explained not only by the relatively small number of works in this area, but also by the greater complexity of this socio-economic phenomenon, the formation of which occurs under the complex influence of many different factors. Also, in forecasting and strategic planning of passenger transportation, the role of professional intuition and production experience is still important. To determine the predicted volumes of passenger traffic by various modes of transport, methods are used that are both similar in general terms and that have their own differences.

Calculating the total passenger flow using five-factor models, these scientists come to the conclusion that the greatest stability of the results is typical for the prediction of suburban flows, and the least for long-distance and local passenger flows.

Before the coronaviruses, the following methods were most widely used in the development of passenger traffic forecasts:

- mechanical extrapolation of the trends of change in time series identified by analytical alignment of these series;

- the method of analogy based on the average annual growth rate of the size of traffic, calculated for a number of past years;

In addition, research has been carried out to develop a methodology for predicting the demand of the population for transportation using the methods of regression-correlation analysis. Factors such as the country's population, the proportion of the urban population, national income, the capacity of the resort network, which were considered from the point of view of sources of potential passenger flows, passenger seats as a measure of the supply of air transport services, were considered as determining factors.

In addition, heuristic methods are also used, forecasts for which are made by individual economists and are based on individual opinion, intuition, without the use of mathematical methods. A common misconception among researchers who have developed models for prospective passenger departures is to develop one model for a wide forecast period from short-term to long-term.

The features of the implementation of this approach include:

- dividing the general forecasting interval of the research object into separate stages (forecasting horizons and time intervals);

- determination for each time horizon of the main forecasting parameters (goals, objectives, principles, methods, criteria, etc.);

- determination of a set of factors affecting the predicted indicator at each stage;

- determining the state of the analyzed objects or indicators and managing this state by verifying the developed models forecasting.

To develop the “integrated model”, the existing forecasting methods were divided into three time horizons:

- short-term forecast (from 1 month to 1 year);

- medium-term forecast (from 1 to 35 years);

- long-term forecast (over 35 years).

Long-term forecasts are also called promising.

For this division, the existing forecasting methods were analyzed by the number of variable variables in their equations. Variables include factors that affect the investigated value (dependent variable). The more variable variables in the equation, the more likely it is to obtain more accurate values in the medium and long term. Forecasting methods may not contain changeable variables (expert methods), if it is not possible to represent the dependent value from any specific factors. Most of the methods are presented in the form of simple equations with one or two variables. Thus, all the variety in the number of variable values is reduced to three varieties:

1) there are no mutable variables;

2) the number of variable variables in the equation is up to two, inclusive;

3) complex equations with more than two variable variables.

The forecasting horizon directly depends on the number of variable variables in the forecast equation. For example, expert methods where there is no mathematical equation (no variable variables) can give an accurate forecast (according to experts) only in the short term. The medium-term forecast using this method has the least accuracy, since the factors influencing the forecast object are uncertain.

Correlation-regression equations can be simple or complex equations. A simple equation is one-way (linear) regression with up to two variable variables inclusive, which can predict the forecast value with high accuracy in the short term, and can also give approximate values for the medium term with low accuracy. Adaptive forecasting methods represent similar forecasting results. Long-term perspective can be predicted with high accuracy by models that include more than two variable variables. These include only multivariate regression (correlation regression method).

As you know, most of the methods can be used for several forecast horizons. For example, when a forecaster develops a medium-term forecasting model, he can use it to forecast values for a short-term period. That is, this forecast model can be

used for two forecast horizons: short-term and medium-term. We propose to classify these equations according to the maximum forecast period, i.e., the short-term model will be attributed only to the medium-term one. Based on the proposed judgments, the classification of forecasting methods from the forecasting horizon is made.

Reliable forecasts of civil aviation activity play a critical role in the planning process of States, airports, airlines, engine and airframe manufacturers, suppliers, air navigation service providers and other relevant organizations.

The first consideration in terms of a forecast is its intended use. Forecasting has a short-term, medium-term or long-term time horizon depending on the intended use, the length of which can vary from industry to industry, as well as the particular application concerned. Forecasting is not an independent discipline but is a part of the overall aviation planning process. The form of the output, the level of the detail and the rigour of the method used will vary depending on the intended use of the forecast. In the civil aviation field, forecasts generally are used to:

- assist States in facilitating the orderly development of civil aviation and to assist all levels of government in the planning of airspace and airport infrastructure such as air traffic control, terminal facilities, access roads, runways, taxiways and aprons;
- assist airlines in the long-term planning of equipment and route structures; and
- assist aircraft manufacturers in planning future types of aircraft (in terms of size and range) and when to develop them.

Forecasting methods in general can be divided into three broad categories: quantitative or mathematical, qualitative or judgemental, and decision analysis, which is a combination of the first two methods, as illustrated in Figure 1-1.

Forecasting techniques that start with historical data and develop a forecast based on a set of rules fall into the category of quantitative methods. Situations in which such data are not readily available or applicable and in which experience and judgement have to be used are generally best suited for the application of

qualitative forecasting methods. Numerous methods exist for analysing time-series data. The methods, which are possible in particular circumstances, may be limited by a lack of data or resources. In general, however, a more reliable forecast may be obtained by employing more than one approach and consolidating differing results through judgement and knowledge of the markets concerned.

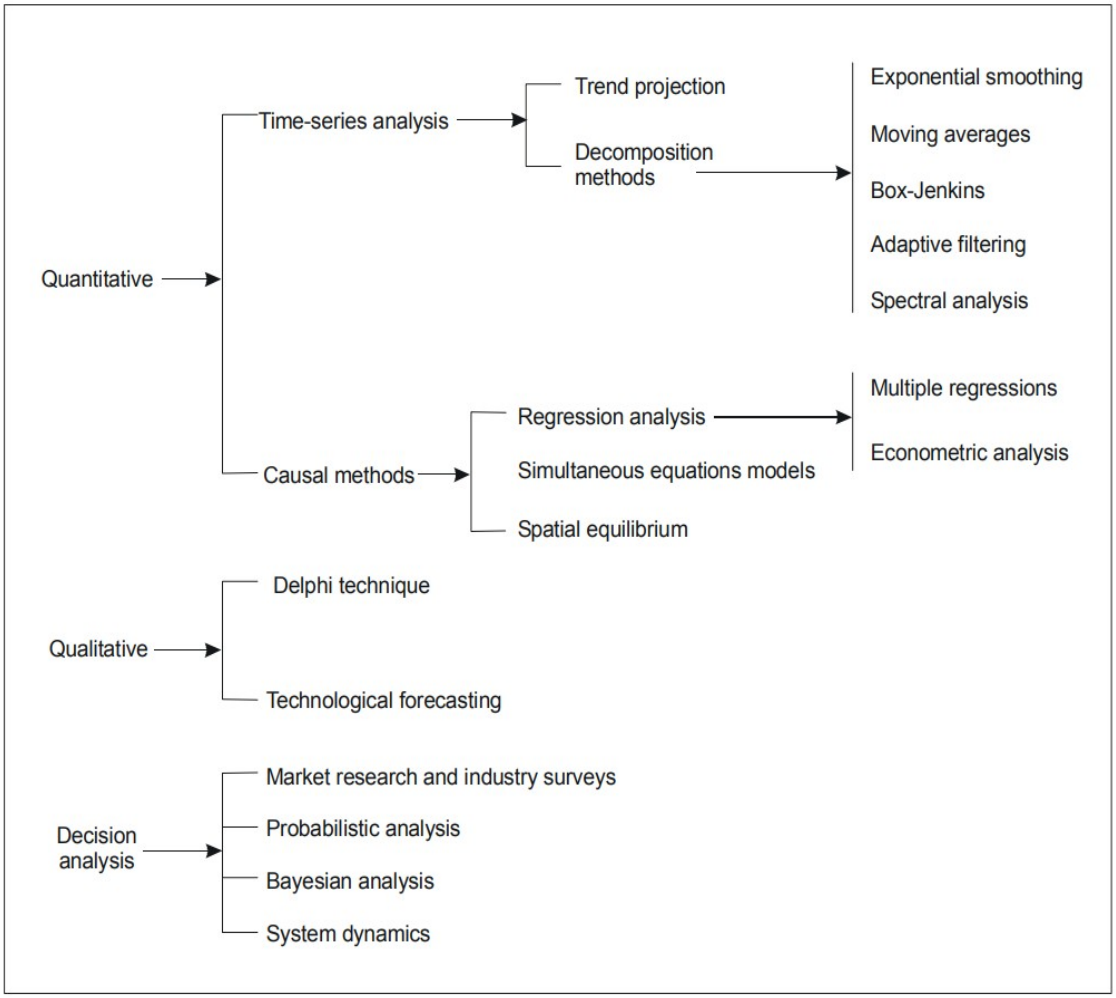


Fig 1.1. ICAO forecasting techniques tree

To understand what type should we choose for forecasting, it is need to be described each of them in short description.

The time-series analysis methods are largely based on the assumption that historical patterns will continue, and they rely heavily on the availability of historical data.

A first step when forecasting air traffic activity is usually to study the historical data (time series) and determine the trend in traffic development. In the context of medium-term or long-term forecasting, a traffic trend represents the

development in traffic over many years, isolated from short-term fluctuations in traffic levels. When deriving a medium-term or long-term forecast by extrapolating from the traffic trend, the forecaster assumes that the factors which determined the historical development of the traffic will continue to operate in the future as in the past, except that their impact may change gradually, and steady-state conditions will continue into the future. The appropriateness of using trend analysis in forecasting depends heavily on stability in past developments and the confidence of the forecaster that the assumption of continuing trends is appropriate to the particular operating environment.

In its simplest form, *trend projection* analysis is nothing more complicated than plotting the traffic data series on a graph. The traffic variable to be forecast (the dependent variable) is plotted on the vertical axis, and time (the explanatory or independent variable) is plotted on the horizontal axis. When each point in the time series is plotted, a smooth curve that seems to come close to all the points may then be drawn in freehand style, or a straight edge can be used to put a line through the data.

A trend may be stable in absolute terms (linear growth) or in percentage terms (exponential growth), but it can also suggest an ultimate limit to growth, particularly if the time span extends over several decades. The type of trend curve that best fits a given time series of traffic data may be determined by using different types of graph paper and different ways of plotting the data. Plotting the data on ordinary graph paper with even spacing (or arithmetic grid paper) will show a linear growth pattern as a straight line. An exponential growth pattern (constant percentage growth rate) will appear as a straight line on linear-logarithmic paper (linear timescale, logarithmic traffic scale), and the slope of the curve at any point will be proportional to the percentage rate of growth or decline at that point in time.

After the data are plotted on graph paper and a trend curve that appears to fit the data is established, the forecaster can then simply extend the visually fitted trend curve to the future period for which the forecast is desired. The forecast data

can then be read from the graph and presented in a table. This is considered to be a simple linear extrapolation of the data.

Trend projection analysis methods use mathematical techniques to determine the best fit line through the data, just as is done by using graph paper and a straight edge. In the more sophisticated trend projection methods, the mathematics and the shape of the line being fitted to the data are more complex. Illustrative examples of the use of trend projection can be found in paragraphs 116 to 126 and 143 to 151 of this part of the manual.

Decomposition methods involve the dissection of the problem into various components. These methods are particularly relevant when strong seasonality or cyclical patterns exist in the historical data. These methods can be used to identify three aspects of the underlying pattern of the data: the trend factor, the seasonal factor and any cyclical factor that may exist.

Exponential smoothing - a general class of widely used forecasting techniques that attempts to deal with the causes of fluctuations in a time series (trend, seasonality and cyclical factors) is that of smoothing. The two most common smoothing techniques are moving averages and exponential smoothing. Exponential smoothing, in general, draws upon the philosophy of decomposition. The exponential smoothing approach to time series is similar to the moving averages approach. However, it places more emphasis on the most recent data, to increase their influence on the forecast. In doing so, it is important to recognize the seasonality inherent in the airline traffic data if monthly or quarterly forecasts are considered. In such cases, depending upon the month of the year, data would have to be de-seasonalized. A smoothing factor would determine how much weight is to be placed on, for example, various months of the year. The notion of giving greater weight to more recent data is one that has strong intuitive appeal to the analyst, depending on the particular circumstances, and is straightforward to apply.

As mentioned above, the *moving averages* technique is similar to exponential smoothing. The only conceptual difference is that each observation is weighted equally.

Because of the equal weighting, moving averages tend to lag the current situation more than exponential smoothing. The advantage of the moving averages approach compared to exponential smoothing is that the former is much simpler. A disadvantage of the moving averages approach is that a longer data series is required for the analysis. Forecasts from moving averages can be used, as those from exponential smoothing, for short-term forecasts. This can be achieved by deviating from the standard formulation and assigning a relatively higher weight to the most recent observation, provided there is justification for doing so. A technique called auto regressive moving average (ARMA) can also be used, where the forecasts are expressed as a linear combination of past actual values and/or past computed error, since each new forecast based on a moving average is an adjustment of the preceding forecast.

Another approach in the analysis of time series is the *Box-Jenkins approach*. This method is suited to handle complex time-series data in which a variety of patterns exist such as a continuation of a trend, a seasonal factor and a cyclical factor. Typically, it uses the most recent data point as the starting value and then analyses the recent forecasting errors to establish the adjustment factors for future time periods. For example, if the forecast was 10 per cent lower in the previous period, the forecast for the next period might be adjusted by some fraction of this error (say 5 to 7 per cent) for the next period. This description also suggests that the Box-Jenkins method is only appropriate for very short-term forecasts. The method allows for much flexibility; however, it also calls for much subjectivity.

Extensive use has been made of trend forecasting by basing judgement on past growth trends, which the analyst simply extrapolates, based on the historical values. In the short term, this approach appears to be reliable, especially when the extrapolation procedure is applied with modified growth rates to account for short-term disturbance in underlying trends. In the long term, this type of extrapolation is likely to be unreliable and is theoretically difficult to substantiate. Consequently, forecasts derived by taking into account how economic, social and operational

conditions affect the development of traffic offer an alternative to time-series analysis.

Causal methods infer a cause-and-effect relationship, hence the name. When used successfully, causal methods can predict the ups and downs of the market. This mathematical process is actually a testing procedure. The procedure is designed to evaluate whether the relationship of the dependent variable (as expressed in the causal model) to the independent (explanatory) variables is significantly related to the movements of these variables.

Of the causal methods described in Figure 1.1, *regression analysis* is by far the most popular method of forecasting civil aviation demand. In regression analysis, the forecast is based not only on the historical values of the item being forecast but also on other variables that are considered to have a causal relationship. Multiple regression analysis takes into account more than a single explanatory variable, in contrast to the one variable used in simple regression analysis.

Econometric analysis

The use of multiple regression analysis with a price-income structure is generally referred to as econometric analysis or econometric modelling. The starting point for an econometric analysis is, in effect, a regression equation model that postulates a causal relationship between a dependent variable and one or more explanatory variables. Dependent variables in the analysis of traffic demand, in general, are historical traffic data measured in terms of passengers or revenue passenger-kilometres (RPK) and tonnes of freight or freight-tonne kilometres (FTK). The explanatory (or independent) variables are those variables which would have an influence on the demand for air travel. The econometric model attempts to explain the demand for air travel as being caused by the changes in the explanatory variables.

Using econometric analysis, the analyst tries to estimate the change in demand from year (1) to year (2). Under such conditions, the change in demand

can be explained by a change that occurs along the demand curve as well as a shift of the demand curve, as illustrated in Figure 1-3.

Advice is provided below on how to use econometric analysis to forecast air traffic demand as well as the procedures to be utilized in the development of traffic forecasting models using causal relationships.

Figure 1.2 illustrates the typical procedures to be followed and the steps involved in the development of a forecast using an econometric model.

As depicted in the figure, the main steps in the development of a forecast using an econometric model are:

a) Define the problem.

b) Select the relevant causal or explanatory variables.

c) After the relevant variables are selected, based on judgement or prior analysis, establish the availability of data or the selection of substitutes or proxy variables if such data are not available.

d) Once the data availability is established, formulate the model specifying the type of functional relationship between the dependent variable and the selected explanatory (causal) variables.

e) Carry out an analysis to test the relationship being hypothesized, including the estimation of the model coefficients, their magnitudes and signs and statistical measures.

f) When the foregoing criteria are achieved, establish the model in final form.

g) Develop forecasts of future scenarios for the explanatory variables from which the traffic forecast is subsequently derived.

It is important to keep in mind that the process is interactive and some of the later steps will have an impact on earlier steps and vice versa. For example, availability of data will influence the selection of causal variables.

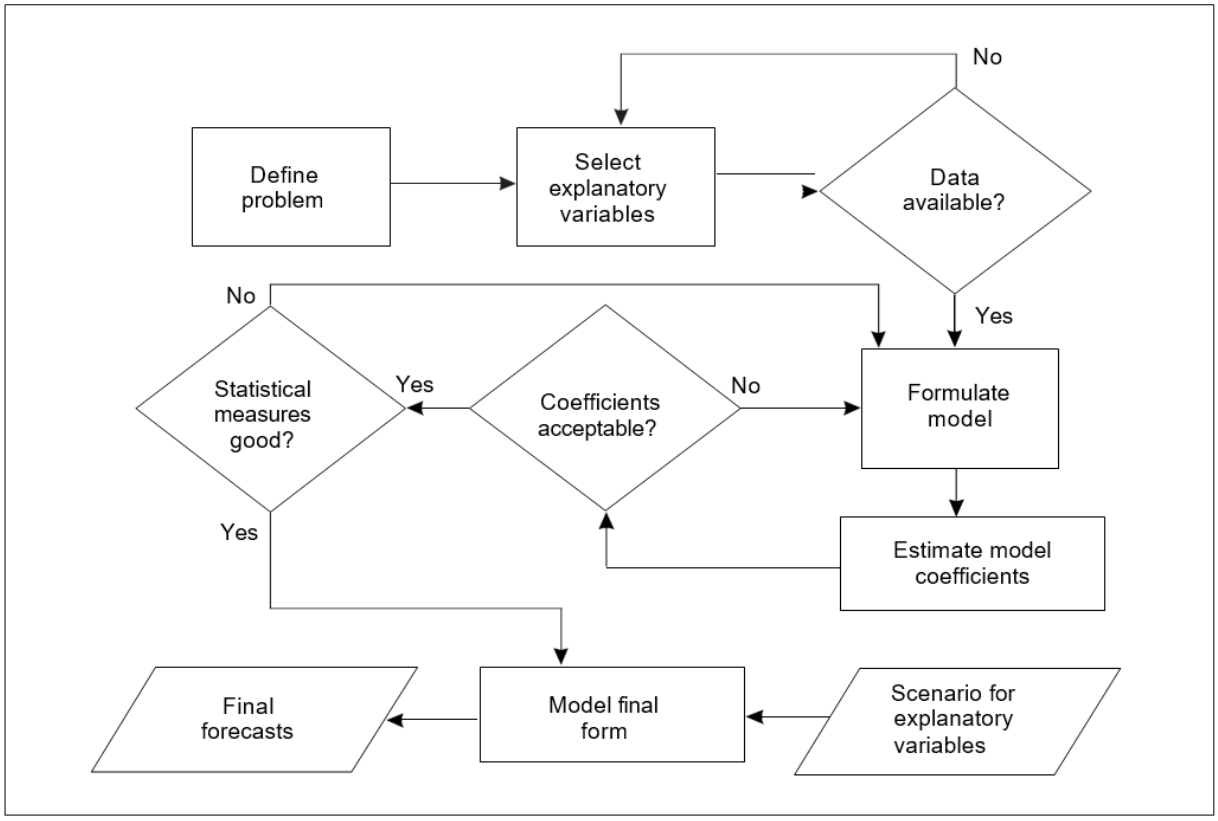


Fig. 1.2. Development of an econometric model

1.2. COVID-19 impact on social-economic

Airports Council International (ACI) World has published its fourth update analysing the economic impact of the COVID-19 pandemic, and its effects on the global airport business.

The month of August marked more than five months since COVID-19 was declared a pandemic on 11 March 2020 by the World Health Organization (WHO). Air transport has remained one of the hardest-hit global industries since the very beginning of the global health crisis. In March, the virus outbreak got out of control, with a rapid rise in daily confirmed cases across numerous countries.

By the middle of March, most countries went into lockdown. When the gradual reopening of many parts of the economy started and some early signs of recovery appeared, many States confronted the risk of a second wave of infections and the re- imposition of lockdowns, which has already happened in several jurisdictions.

The ongoing pandemic has already claimed hundreds of thousands of lives worldwide and resulted in dramatic economic impacts. Furthermore, it has created disruption that has affected virtually all aspects of social and economic activity.

With thousands of aircraft on the ground and airports nearly empty, the achievements of civil aviation in establishing global connectivity and convenient air transportation have been largely put on pause. The United Nations' Sustainable Development Goals (SDGs), particularly those that address poverty, inequality, and socioeconomic opportunities, which in many ways rely on efficient air transportation, have come under threat.

As air transport has always been an industry based on the interdependence of all its parts, the COVID-19 crisis devastated all stakeholders—from aircraft manufacturers and travel agents to retailers in airports—and resulted in mass furloughs and layoffs, business shutdowns, bankruptcies and other instances of economic destitution.

Beyond the immediate and apparent damages, the global economy feels the burden of vanishing indirect, induced and catalytic impacts arising from air transportation activity: according to the Air Transport Action Group (ATAG), aviation supports 65.5 million jobs worldwide and enables $2.7 trillion (figures in US Dollars) in global Gross Domestic Product (GDP).

Even though most countries have moved from all-encompassing lockdowns towards lighter restrictions with safeguards in place, most jurisdictions have retained either partially or totally restrictive regulations pertaining to international travel including 14- day self-quarantine on arrival. Africa and Latin America-Caribbean appear to have the greatest number of countries with borders shut and flights suspended.

The part seeks to highlights some key figures in terms of the impact of the COVID-19 pandemic and subsequent lockdown on airport traffic and revenues. It presents the fourth analytical assessment of the impact of coronavirus on the airport industry since the beginning of the year and the third one since the Great Lockdown marked recent history. In addition, the document amplifies some

fundamental shifts in the industry, discusses existential risks and touches upon selected policies airports are advocating for through the voice of the global airport community.

1.2.1. Macroeconomic context: a grim outlook—from virus to debt crisis

Since the release of the previous economic impact assessment in May which referenced the April 2020 World Economic Outlook of the IMF, the global economic institution downgraded its growth projections: according to the latest figures published in June, the decline in global GDP is now estimated at -4.9% for the year 2020, while the recovery is projected to be more gradual than previously forecasted. Global growth is projected at 5.4% for the year 2021.

Even though this projection might inspire optimism at first sight, one should understand that this would leave the global GDP for 2021 6.5 percentage points lower as compared to pre-COVID-19 projections as of January 2020. It is an uncomforting figure which reflects the decline in compensation of employees, corporate profits as well as other types of income including returns on investment and rents.

Each income component has been sharply reduced as normal economic activity has been severely impaired by national lockdowns all over the globe, with shut borders, reduced manufacturing, an annihilated service sector, the crash of financial markets and non-fulfillment of financial obligations producing an adverse chain reaction in the global economy. This is reflective of the precarious macroeconomic situation in most parts of the world.

The IMF policy responses tracker suggests that practically all of the 196 economies across the globe have been pursuing a combination of fiscal and monetary measures to keep their respective economic activity afloat—through tax cuts and increased government spending, wages su bsidies and targeted sectoral programs, government loans and guarantees, by lowering interest rates and embarking on foreign exchange operations.

All these measures are targeted towards keeping the global economy afloat by stimulating demand, providing income and liquidity cushions to various sectors of the economy, and keeping unemployment rates at socially acceptable levels. Nevertheless, such measures can only partially offset the declines in income and come at the cost of significantly rising debt levels.

The issue of declining global income cannot be isolated from the radical spike in global unemployment—a significant risk to the recovery of the global economy and air transport in particular.

According to the International Labour Organization (ILO), as of June 2020, 93% of people are employed in countries with workplace closures, while almost third (32%) live in countries with required workplace closures for all but essential workplaces. It is estimated that the global labour force saw a 14% decline in working hours, while an equivalent of 400 million full-time jobs vanished from the global economy, with the largest reduction occurring in the Americas (-18.3%). Finally, it is estimated that 510 million women, equivalent to 40% of all employed women, are employed in the hardest- hit sectors of the global economy, such as tourism, hospitality, and air transport.

The ongoing health crisis magnified the long-term yet rapidly unfolding socioeconomic phenomenon labeled as ‘precariat’ by some economists—the term describing the mass class under unstable labour arrangements, typically with little or no benefits, lack of job security and unclear professional continuity. Underemployment and unemployment are significant obstacles for the recovery of air transport.

Statistical evidence suggests that in the recent decade air transport demand has been growing at roughly double the rate of global GDP, testifying to the fact that air transport demand, by and large, is income-elastic (elasticity of 1 and above). However, high income elasticity of demand for air transport is a double-edged sword: when incomes are growing, the sector is benefitting from it at an accelerated pace.

When incomes are falling as is currently the case, demand for air transport shrinks at even a faster pace than the decline in income, as consumers reorient consumption towards necessity goods such as food and housing (income elasticity between 0 and 1) or even inferior goods with negative income elasticity of demand.

Finally, it is impossible to overlook the looming debt crisis. According to the Institute for International Finance—the global association of the financial industry, with close to 500 members from 70 countries including most of the world's largest commercial banks and investment banks, global debt hit a record high of 331% of global GDP in the first quarter of 2020, or over $258 trillion in absolute terms. The pace of global debt build-up by governments, the corporate sector and households is expected to further accelerate in the second and third quarters of 2020.

Out-of-control levels of debt unproportionate to the levels of income raise legitimate concerns with respect to sustainability. Many economists express that excessive debt levels may cause another global financial crisis and provoke a series of sovereign, corporate and private defaults, and bankruptcies.

1.2.2. Global passenger traffic

The most comprehensive traffic figures collected from the world’s airports reveal that the COVID-19 impact on aviation appeared as early as January. Global passenger traffic grew by just +2.1% in January 2020, 1.6 percentage points down from +3.7% a month prior and below the average growth rate recorded in the preceding six months (+2.6%). The recorded passenger traffic was also more than one percentage point lower vis-à-vis earlier monthly projection.

February was the first month to record a decline in global passenger traffic volumes of - 13.9% year-over-year—the first double-digit decline since the September 11 terrorist attacks.

As the COVID-19 outbreak rapidly progressed, the imposition of travel restrictions and national lockdowns brought aviation to a virtual standstill by the end of March. On a global scale, passenger traffic declined by -56.7% in the month

of March year-over-year and -58.2% under the business-as-usual (BAU) paradigm (projected baseline). The difference between the two figures reflects unrealized growth potential envisioned before the crisis.

The second quarter saw a record-deep decline in passenger traffic volumes. In April, passenger traffic on a global scale reached a rock bottom of -93.7% compared to the month of April 2019. In Europe, civil aviation activity practically ceased, as it recorded - 98.4% decline in passenger traffic volumes year-over-year.

The month of May marked a small rebound in commercial civil aviation activity as compared to previous months. Several markets, particularly those with a significant domestic base—typically countries with a large population and vast geography—started a gradual reopening of domestic routes. The decline in passenger traffic volumes for the month of May was estimated at -90.3% year-over-year.

In June, the mild recovery trend continued. As more countries started reopening selected international routes, the dip in traffic diminished to -84.3%.

Accordingly, the second quarter of 2020 recorded a -89.3% decline in passenger traffic volumes as compared to the year before and -89.6% decline against the projected baseline for 2020. See Table 1.

In absolute terms, the loss in passenger traffic for the first two quarters of 2020 was estimated at -2.6 billion, equivalent of -60%.

Table 1.1

Monthly airport traffic figures from January to June 2020 versus 2019 (in millions)

(figures in millions)	January	February	March	Q1 2020	April	May	June	Q2 2020
Passengers 2019	697	653	743	2,093	747	766	802	2,315
Passengers 2020	711	562	322	1,595	47	74	126	247

Table 1.1 is continued

Year-over-year change (%)	2.1%	-13.9%	-56.7%	-23.8%	-93.7%	-90.3%	-84.3%	-89.3%
Estimated decline versus projected baseline *	-1.2%	-17.2%	-58.2%	-26.4%	-93.9%	-90.7%	-84.6%	-89.6%
Cargo 2019	44021	43929	44084	44102	44052	43840	43991	43980
Cargo 2020	43899	43898	9.0	44008	43958	43898	43959	43914
Year-over-year change (%)	-4.4%	-0.4%	-16.9%	-7.9%	-23.8%	-17.3%	-11.3%	-17.5%
Estimated decline versus projected baseline *	-3.3%	-1.6%	-14.8%	-7.1%	-24.3%	-17.5%	-13.4%	-18.4%
Air transport movements 2019	8.0	43928	43959	24.0	43959	44051	44082	43887
Air transport movements 2020	44081	43837	44017	44063	43832	43984	43893	8.0
Year-over-year change (%)	-1.2%	-4.3%	-32.4%	-13.2%	-75.3%	-70.8%	-62.9%	-69.6%
Estimated decline versus projected baseline *	-1.5%	-5.6%	-32.7%	-13.8%	-75.4%	-71.0%	-63.2%	-69.8%

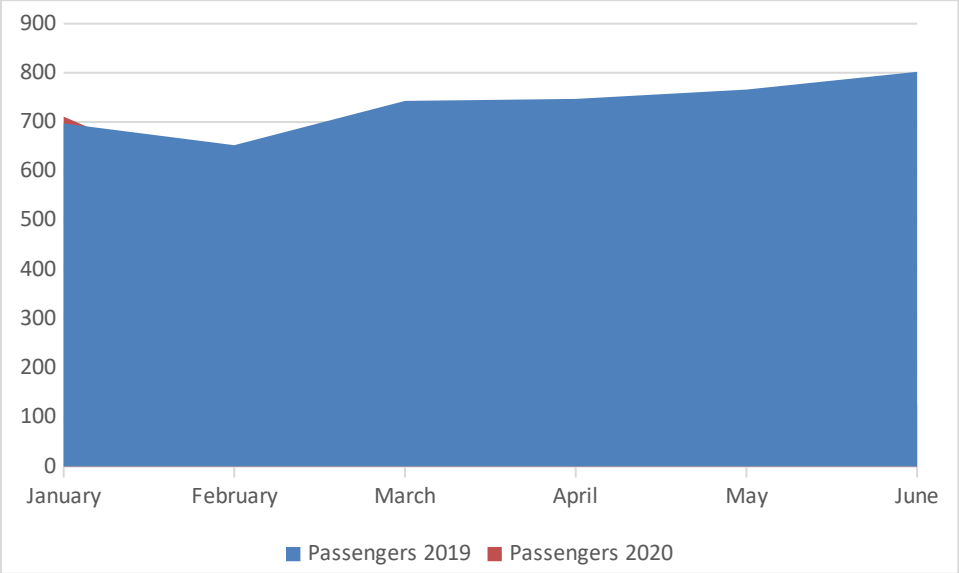


Fig.1.3. Passenger traffic volumes from January to June, 2020 versus 2019 (in millions)

1.2.3. Global Air cargo

Cargo traffic was not immune to the global health crisis either. Despite a significant demand for air cargo arising from the demand for the transportation of personal protective equipment (PPE), particularly in the months of March, April and May, the impact was short-lived and could not offset the bigger and longer declining trend.

Even before the start of the global pandemic, 2019 was the worst year for the air cargo business since the Great Recession and the year 2009 in particular. International trade grew by a marginal 0.9% in 2019, reflecting slowing GDP growth across many manufacturing-intensive economies.

With the escalation of trade wars, lower levels of consumer and corporate confidence as well as falling export orders, air cargo demand slowed down consequently.

Air cargo accounts for more than a third of the world's trade in goods in terms of value, making air freight levels a widely watched and key indicator of economic activity.

Traditionally, air cargo has shown a stronger relationship with GDP as opposed to passenger traffic.

Additionally, air cargo has shown to be more elastic as compared to passenger traffic with respect to income. While air cargo declined by -4.4% in January, it rebounded slightly in February (-0.4%). However, in March the volumes slipped by -16.9% year- over-year. In normal times, approximately half of all commercial air cargo is transported in the belly hold of passenger aircraft as opposed to dedicated freighters.

As the number of passenger flights fell, air cargo capacity diminished in a radical way, creating an upward pressure on rates. The cumulative fall in air cargo for the first three months of 2020 tumbled by -7.9% year-over-year.

Nevertheless, air freight rates were marked by volatility, rather than a univocal hike, testifying to the general volatility and uncertainty in both air transport and the global economy at large. Consistent with the uncertainty in air transport, air cargo continued the fall in April and reached -23.8% as compared to the year before.

The subsequent two months showed some recovery, as the decline was diminished to - 17.3% in May and -11.3% in June. As such, the decline in air cargo in the second quarter was estimated at -17.5% in contrast with the same period in 2019.

In absolute terms, air cargo volumes declined by an estimated -7.5 million tons in the first half of 2020 -12.8% From the airport industry perspective, the loss exceeded the annual cargo volumes handled by the world's busiest air cargo hub—Hong Kong International Airport—which recorded 4.8 million tons of cargo in 2019.

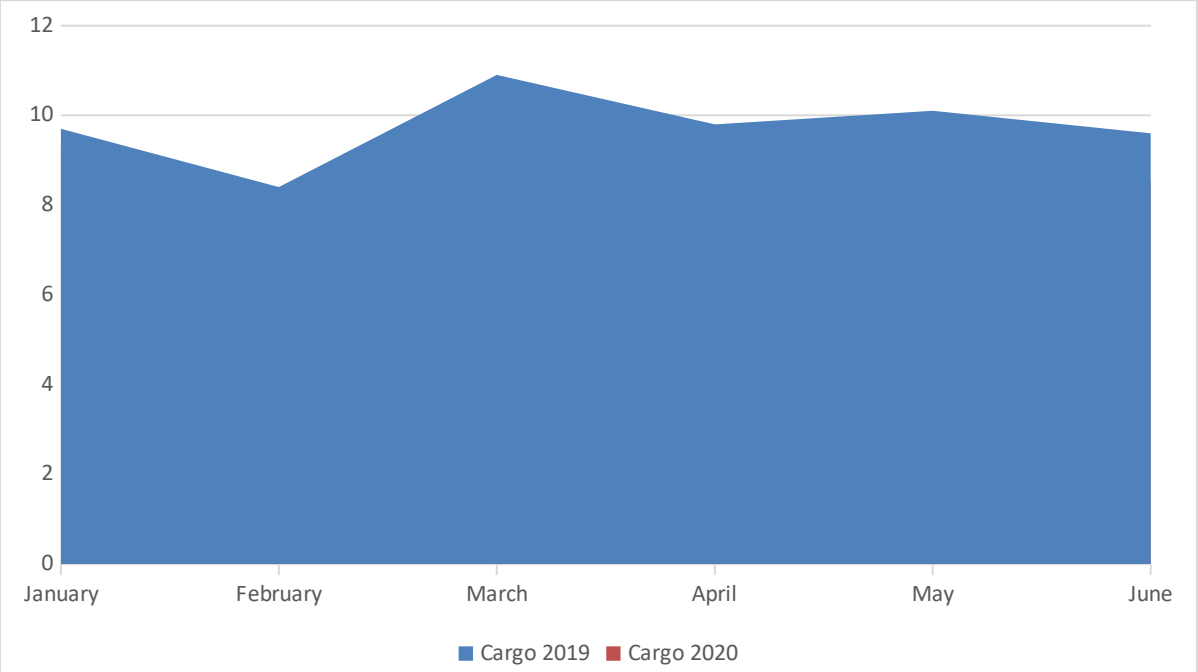


Fig.1.4. Air cargo traffic volumes from January to June 2020 versus 2019 (in millions)

The impact of the current crisis on commercial air transport movements appeared as early as in January, when the growth in the number of landings and takeoffs across the globe slipped into the negative territory at -1.2% as compared to the year before. While some airlines continued flying to China while monitoring the unfolding health crisis in the province of Hubei and its largest city Wuhan, others started avoiding the epicenter of the outbreak and reducing the number of flights to the country.

As the number of COVID-19 cases continued to grow in China, more countries started reporting infections, particularly in neighbouring countries in the Asia-Pacific region. An increasing number of flights connecting China with other countries were cancelled. In February, the health outbreak resulted in a sizable -4.3% reduction of air transport movements as compared to the year before.

By the middle of March, the majority of countries had imposed lockdowns implying restrictions that limit the free movement of people across borders in an effort to contain the spread of the virus, sharply curtailing aviation activity. Nevertheless, unlike passenger traffic that fell of a cliff by a sharp -56.7%, airlines

were still operating an approximate two-thirds of flights, reflected in a -32.4% decline in movements.

In the first quarter of 2020 air transport movements recorded a -13.2% decline year- over-year. In the second quarter, the dynamic was very similar to passenger traffic, even though with a 20% differential reflecting flights under social distancing measures and hence unusually low seat occupancy rates. In a number of countries, regulators mandated blocking the middle seat, resulting in a de-facto reduction of airline capacity by roughly a one-third.

As a significant proportion of the world's population spent all of April in strict lockdown, the number of air transport movements was reduced by three-quarters as compared to the year before (-75.3%). In the month of May, a slight uptick was recorded in the number of movements, as the figure recoiled slightly to -70.8%. The positive trend continued in June, as about one-third of flights were back, and the fall in air transport movements was reduced to -62.9%. In Q2 2020, the reduction of air transport movement totaled to -69.6% year-over-year.

Nevertheless, the industry recorded a considerable loss of -43% in air transport movements, equivalent of -21.4 million of landings and takeoffs combined. From the industry perspective, this would be also equivalent to a complete wiping out of about 26 airports comparable to the size of Hartsfield–Jackson Atlanta International Airport—the world's busiest airport by both movements and passenger traffic.

1.2.4. Impact on revenues

Air traffic is the very lifeblood of the airport business. Airports generate more than 95% of all revenue from two operating sources—the two primary business activities—namely aeronautical and non-aeronautical services. The residual 5% of income come from non- operating sources and are not directly related to the volume of traffic handled by airports.

Practically all aeronautical revenues are a direct function of traffic: passenger-related charges from passengers and aircraft-related charges from aircraft operators, respectively. An additional portion of aeronautical revenues may arise from the provision of ancillary aviation -related services such as ground handling, if performed by the airport operator itself. As traffic dried up, airports left off getting the charges proceeds.

Before the crisis, the airport industry was expected to generate about $172 billion in 2020. Consistent with the seasonality pattern whereby most of traffic is concentrated in second and third quarters, under normal circumstances the world's airports would have generated about 53% of annual revenues from April to September. On the contrary, these two quarters are estimated to suffer from record losses of $39.5 and $33.6 billion respectively—the figures consider foregone or reduced airport revenues.

The third quarter, referring to the northern hemisphere summer months of July, August, and September, have been traditionally considered the money-making season in the entire air transport value chain and related industries such as hospitality and tourism. A significant proportion of the world population, but particularly in Europe and North America, take vacations, many of which imply air travel.

However, the vacation season has largely eroded due to the epidemiological situation, administrative complications and uncertainties, fear to travel and bleak macroeconomic conditions. The hopes for air travel rebound during summertime did not materialize, and the recovery remained sluggish.

Airports in Europe and Asia-Pacific were hit particularly hard by the COVID-19-induced crisis in air transportation, falling short of $13.9 billion and $7.7 billion in Q3 alone.

Proportionate to the respective size of the three major aviation markets, airports of Europe, Asia-Pacific and North America are expected to incur a revenue deficit of $38.8, $27.6 and $21.0 billion accordingly in the full year 2020. The other aviation markets, namely Middle East, Latin America-Caribbean, and Africa,

follow suit with $8.0, $6.5 and $2.6 billion respectively. As such, the revenues shortfalls pull down the previously projected industry revenue figure by 60%.

The current assessment assumes constant airport revenues on a per-passenger basis, even though preliminary evidence suggests that unit revenues may both increase or decrease depending on a combination of airport-specific factors. Every airport has a unique portfolio of non-aeronautical activities , but as a rule of thumb, a higher proportion of passenger-related activities, such as retail or food and beverage concessions, lead to a steeper reduction in commercial revenues, while higher reliance on real estate income and rents acts as a cushion in times of crisis.

1.2.5. Covid-19 impact on Ukraine

The largest victim of quarantine measures is the type of transport. In January-July 2020, air traffic in Ukraine decreased by 69.3%.

In 2019, the total volume of air traffic will be about 24 million people. In 2020, according to optimistic forecasts, there will be 14-15 million people for excellent lists in August-September 2020. At the same time, Aerorukh captures almost the entire central zone of aviation over our country (97% drop).

The industry's losses will amount to about UAH 10-15 billion. Airlines have a strength of at least three months. Further space could lead to the bankruptcy of small and medium-sized airlines. There is a high risk of mass layoffs of workers working in this field. Yes, one option for downtime is 4-5 crews, or 36-50 people.

More domestic companies send staff on unpaid leave. Exit from the aviation crisis should be expected no earlier than 2021-2022.

1.3. Analyzing forecasts air traffic from ACI

Before the beginning of summer 2020, most experts in the field of aviation agreed that passenger traffic volumes would not reach 2019 levels before 2023. However, as the industry remains on the ground for much longer than anticipated

in the first months of the crisis coupled with ongoing quarantine measures, current projections on international market segments signal that passenger volumes will likely not return to 2019 levels until 2024. Markets that have significant domestic traffic, on the other hand, are expected to recover in 2023 back to pre-COVID-19 levels.

While the second quarter of 2020 was the worst the industry had seen, with a loss of almost 90% of global airport passenger traffic, the third and fourth quarter are expectedto show sustained—albeit partial—recovery. Compared to the business-as-usual forecast (pre-COVID-19 forecast for 2020), the loss in global passenger traffic for Q3 is expected to be close to 70%, and that of Q4 approximately 50%. This brings the full 2020 year at a 60% loss in global passenger traffic.

Much uncertainty still surrounds the situation of the aviation industry and projecting the path to recovery at this point is an exercise requiring prudence. A faster launch of a potential vaccine that can easily be mass-produced could bring us a much brighter future than we can now reasonably expect. Likewise, many factors could contribute to a more pessimistic turn of events— unsuccessful vaccine research, a large second wave resurging across the globe, supply side shocks such as escalating aviation -related bankruptcies, a deepening economic crisis, to name a few. This uncertainty is represented in Chart 4, which features low, mid and high projected scenarios.

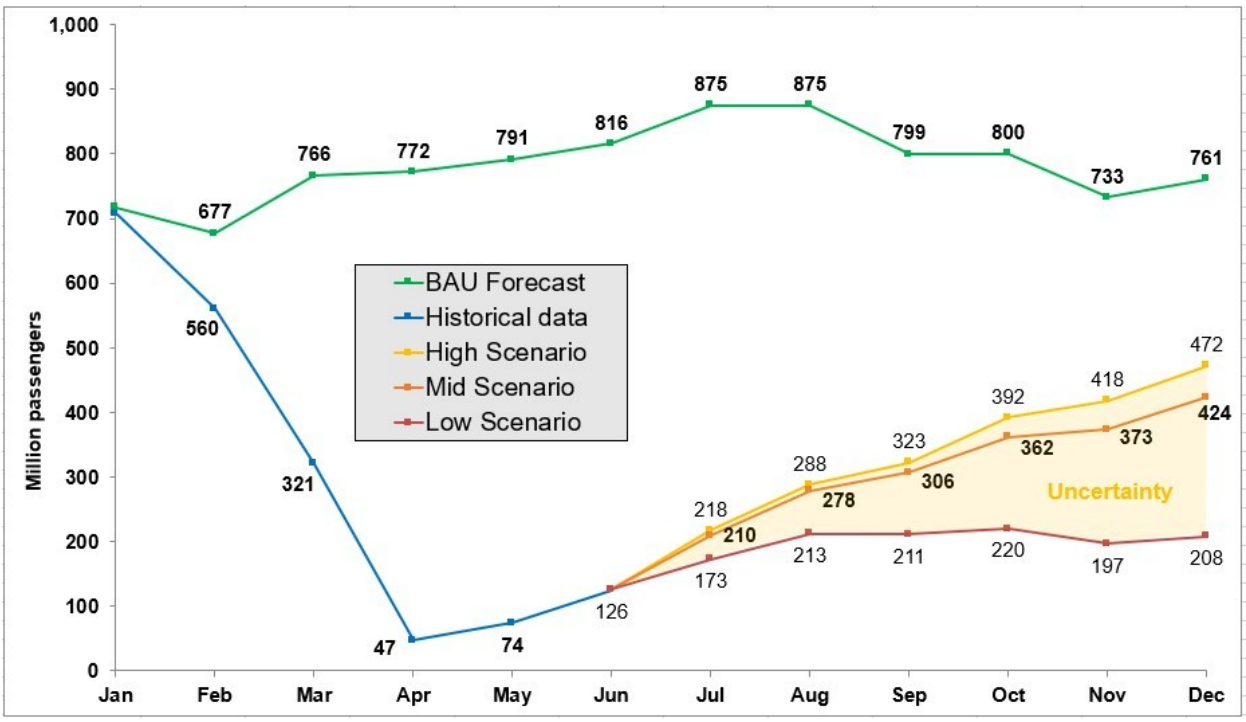


Fig 1.5. Global passenger traffic in 2020

The three scenarios suggest that by December 2020, monthly traffic may reach above 60% compared to the projected baseline for December 2020 under favourable conditions but may remain as low as 27% in a less favourable setting highlight the high degree of uncertainty in the forecast. The most likely mid scenario points towards the passenger traffic reaching 56% of the projected baseline for December 2020.

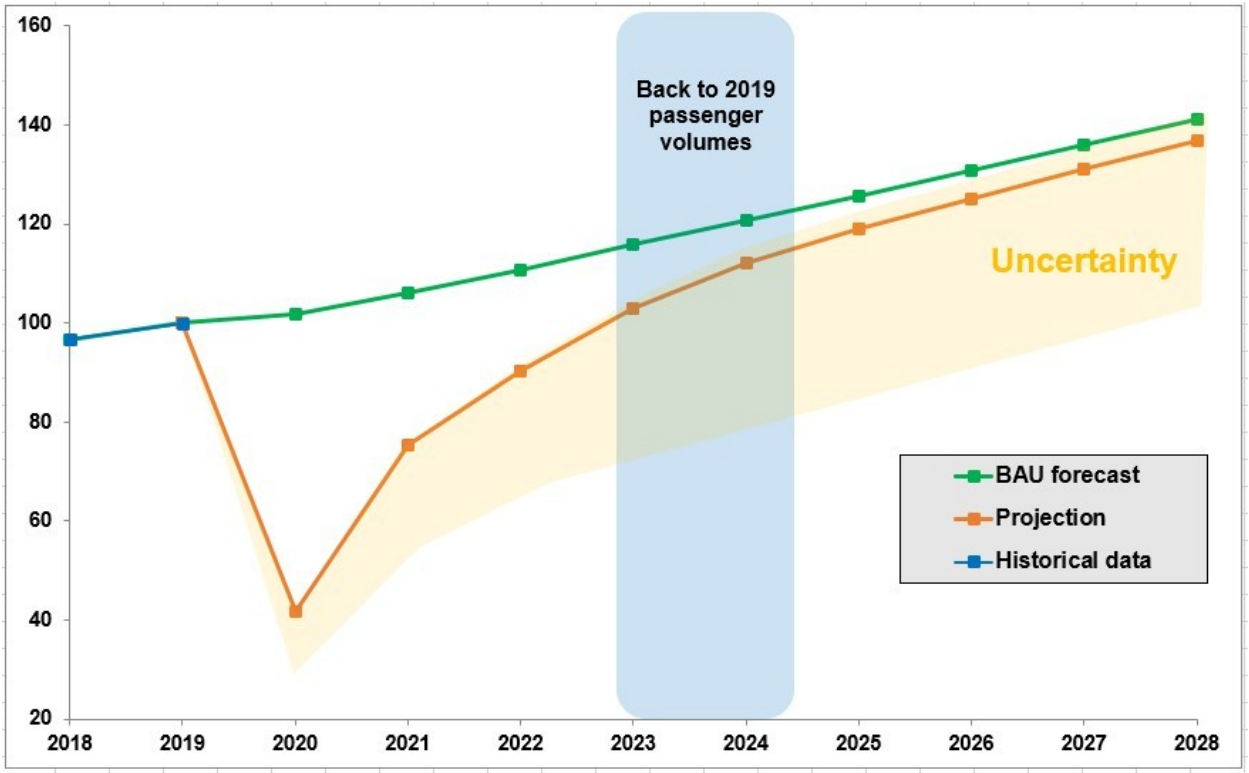
For the full year, the high and mid scenarios show that passenger traffic volumes will reach around 42% of the projected baseline volumes for 2020. The low scenario brings the passenger volume to 34% of the 2020 volumes under normal circumstances.

After international travel restrictions are relaxed along with quarantine measures, recovery is expected to be strong after this, reflecting the industry's restart from almost nothing.

However, given the mid- to long-term adjustments that will need to be made to many well-established processes, a full recovery to 2019 levels of traffic is likely not going to happen for several years. As shown in Chart 5, global passenger traffic is not expected to recover to 2019 levels before 2023 with international

traffic likely not returning to 2019 levels until 2024. Markets that have significant domestic traffic are expected however to recover in 2023 to pre-COVID-19 levels. On the longer run, it is predicted that the global traffic will not return to previously projected levels within the next two decades, pointing to a potential structural change.

Fig 1.6 Global passenger traffic projection long-term



2. ANALYTICAL PART

2.1. Global trends in the aviation industry

In the last few years, airlines seem to have reined in the challenges to some extent. They continue to expand their top-line and bottom-line at a healthy pace, by overcoming the barriers posed by growing competition, rising fuel prices, changing regulatory norms and rapidly evolving passenger expectations.

The International Air Transport Association (IATA) forecasts the sector's net profit to rise to USD 38.4 Billion in 2018 making this the fourth consecutive year of sustainable profits. As airlines pursue wider market share, and adopt new technologies to re-imagine their offerings and operations, here are six technology trends that will have a significant impact on their business outcomes. Fig. 2.1 presents the main trends in the aviation industry, according to IATA.

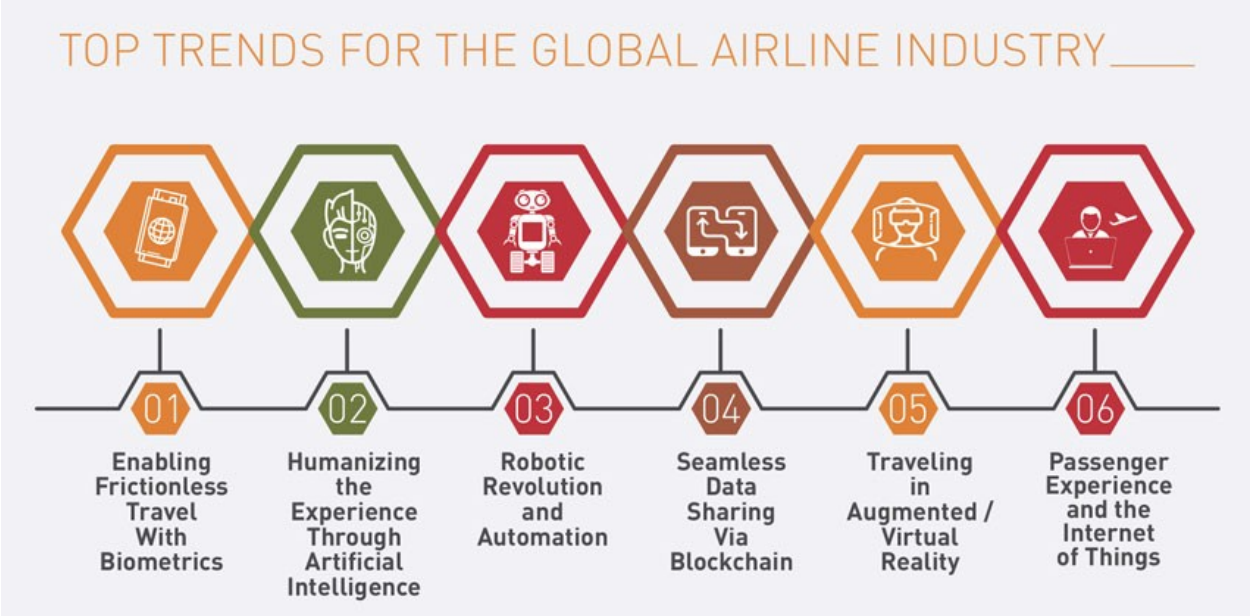


Fig. 2.1. Top trends for the global airline industry

Trend 1: Enabling Frictionless Travel With Biometrics.

The adoption of biometrics is still at a nascent stage in the industry. But a few airlines have already begun investing in fingerprint and facial recognition technology. Currently, the technology is being tested in areas such as check-in, security, lounge access and boarding.

Long queues for security check or at the baggage carousel continue to be the foremost pain point for passengers. Also, having to constantly show their passports, identity cards or boarding passes for verification add to their frustrations. Airlines are increasingly experimenting with biometrics to address these issues and make the journey as frictionless as possible for passengers.

In the long run, paper and mobile boarding passes will become obsolete as airlines use facial, iris or fingerprint scans to identify passengers. A European airline has already piloted facial-recognition programs to reduce check-in and boarding time. The U.S. Transportation Security Administration (TSA) has unveiled an initiative across 30 domestic airports to use passengers' fingerprints for identification and issuing boarding passes.

If the associated privacy concerns around data are addressed by airlines, biometrics will deliver multiple benefits including shorter waiting time for passengers.

Trend 2: Humanizing the experience through artificial intelligence.

Globally, the market for Artificial Intelligence (AI) in airlines is expected to touch USD 2.2 Billion by 2025. Different use cases for AI adoption across the industry are gradually taking shape. The most common one, of course, are chatbots that are becoming increasingly sophisticated in resolving passenger queries.

Some airlines are looking beyond chatbots to leverage the true potential of AI. For example, a leading Asian airline is using AI to estimate the average lifespan of the parts on its planes. The airline has been able to quicken inspections, optimize the inventory for parts and improve operational efficiency. Airlines are also using AI and predictive analytics to create personalized promotional campaigns to improve upsell / cross-sell opportunities. Airline revenue management is another area where AI and machine learning are expected to drive transformation in the long term.

Trend 3: Robotic revolution and automatization.

Over the next decade, the global robotics and automation market is expected to touch USD 1.2 Trillion. The airline industry is expected to make up a significant

chunk of this rapidly growing market. Automation of workflows has been a major focus area for the industry in recent years. And, this focus is only accelerating with the early-stage adoption of robots.

For instance, a Korean airport has tied up with a leading electronics company to test two prototype robots that will deliver boarding information and directions to passengers. A global IT company that offers services to the air transport industry has designed an intelligent check-in kiosk that can autonomously move to congested areas of the airport to reduce the waiting time for passengers. Robots at a Japanese airport, meanwhile, are automating several tasks including flagging security risks and transporting luggage.

Trend 4: Seamless data sharing via blockchain.

The airline industry is characterized by data sharing among multiple players across the entire value chain. At every touchpoint of the passengers' journeys, complex data reconciliations happen in the background. However, given airlines' siloed systems for storing data, this data exchange is rarely seamless. This is one area where blockchain – often referred to as the “Internet of Trust” - can enable airlines to conduct smoother data sharing and eliminate multiple transaction costs.

Often, in the event of flight delays, passengers get inaccurate status updates. Blockchain's inherent ability to provide a single source of truth can help airlines provide accurate flight updates in real time across multiple channels during delays.

A prominent German airline has formed an alliance with many companies to explore blockchain-centric distribution, while other airlines are figuring out use cases for retail, distribution and baggage handling. A leading South Asian airline has launched a blockchain-based loyalty wallet that allows members to redeem airline miles at point-of-sale.

Trend 5: Traveling in augmented / virtual reality.

The excitement around Augmented Reality (AR) and Virtual Reality (VR) cuts across industries — market research firm IDC pegs the worldwide revenue from AR / VR at USD 162 Billion by 2020.5 Airlines are also exploring different

implementation scenarios for AR and VR ranging from airport wayfinding to remote airport operational control centers to immersive in-flight entertainment.

Gatwick airport in the U.K., for instance, has launched a beacon-based AR wayfinding tool that shows direction to passengers through their mobile phone cameras.6 The AR tool makes it easier for passengers to navigate within the terminal and locate check-in desks, departure gates and baggage carousels.

Passengers aboard Airbus A380 flights are using the AR-led iOS app iflyA3807 to take 360-degree virtual tours of the cabin, have a closer look inside the cockpit or to know more about landmarks they are flying over. At New York's JFK airport, passengers waiting for budget flights are given VR headsets by a European airline to 'show' them its competing offerings for upselling opportunities.

With increasing adoption, airline mechanics will most likely use AR to carry out quick, accurate repairs and maintenance that can be signed off remotely by supervisors. This improvement in efficiency and accuracy will translate into faster repairs, minimal equipment breakdowns and fewer delayed flights for airlines.

Trend 6: Passenger experience and the Internet of things.

Though airlines are still struggling to bring their legacy systems up-to-speed, many have rolled out Internet of Things (IoT) initiatives to re-define the passenger experience. Airlines are looking at leveraging IoT for operational areas ranging from baggage management to in-flight entertainment.

A leading U.S. airline has invested millions of dollars for the deployment of IoT to track baggage in real time thereby improving both reliability and transparency. Airlines are also offering personalized navigation at airports by integrating their native mobile apps with airports' beacons. As passengers move across terminals, their locations can be used to guide them toward departure gates, push customized offers, or direct them to lounges at discounted rates.

IoT combined with advanced analytics can also open up several upsell / cross-sell opportunities for airlines. Historical data around passengers' preferences can be used to make personalized in-flight offers such as upgrades. Curated entertainment

content can also be made available with all charges seamlessly debited from digital payment accounts.

Summarizing it may be noted, as digital technologies continue to transform the industry and re-shape consumer expectations, airlines will have to regularly re-visit their core operating assumptions to stay relevant. They will have to re-imagine key operations and functions to deliver compelling and differentiated passenger experience. With the 'consumerization' wave transforming many service sectors including media, transportation and retail, airlines too will have to harness cutting-edge technologies in a 'smart' way. They will have to aggressively experiment with different use cases to address pressing passenger pain points and use the learnings to continuously refine their approach.

2.2. Aviation during the COVID-19 pandemic

Perhaps the biggest blow the coronavirus pandemic has dealt to airlines. The quarantine and the ban on international passenger transportation left airlines without their main source of income, forcing them to freeze their activities and "burn" the reserves they had put off for years so as not to go bankrupt.

The travel and tourism industry has been one of the biggest victims of the coronavirus crisis. The first decisions made by the governments of the countries in connection with the pandemic concerned precisely the closure of passenger flights and borders for foreigners. Therefore, millions of people around the world have had to cancel vacations or work trips and return tickets.

According to the calculations of the World Travel and Tourism Council (WTTC), the tourism industry and the passenger transportation sector by the end of 2020 may receive less than $ 2.1 trillion. This amount is equivalent to the GDP of the Netherlands and Mexico combined.

Because of lost profits and the inability to run a business, companies are starting to lay off workers. All in all, travel companies could lay off 75 million workers because of the pandemic.

The impact of the coronavirus on airlines will also be significant. According to the calculations of the International Civil Aviation Organization (ICAO), losses of passenger airlines from the pandemic could range from $ 160 billion to $ 253 billion, depending on the scenario of the exit from quarantine. The total passenger traffic of airlines in the world could fall by more than 1 billion passengers.

According to the International Air Transport Association (IATA), due to the coronavirus, the passenger turnover of world aviation may be halved, and the revenues of passenger airlines may fall by $ 314 billion.

The drop in airline activity has already affected other industries, for example, the energy sector: due to the fact that planes do not fly and do not consume fuel, the demand for oil has dropped to a record, which has led to a drop in the price of American oil to negative values.

Airports were also affected. The blow was especially painful for Ukrainian airports, which have been increasing passenger traffic and actively developing over the past few years. In particular, the Boryspil airport was forced to send 70% of its employees to idle time, and the losses due to quarantine are estimated there at UAH 380 million ($ 13.9 million) per month.

In connection with the coronavirus, the state even had to reconsider its plans to attract investments in the aviation industry: if earlier the government planned to transfer at least 4 regional airports to private investors, now this idea has been abandoned, because they do not expect that such assets will be able to anyone something to interest.

Over the years, most of the passenger airlines have been able to accumulate enough reserves that allow them to stay “afloat” during the coronavirus crisis. However, the volumes of these reserves are not unlimited.

Back in March, experts from the analytical company CAPA, which specializes in the aviation industry, predicted that due to quarantine, most of the world's airlines could go bankrupt by the end of May. According to analysts, only large airlines can survive and only if they are supported by the governments of the countries.

Such decisions are already being made. In particular, the US government recently allocated $ 9.5 billion in support to ten large and 83 small carriers. The governments of the EU countries also plan to allocate about 20 billion euros to the two largest airlines - Air France and Lufthansa.

However, not everyone can count on state aid, because the aviation industry, despite its importance, employs relatively few people, so the amount of its support is still limited.

In Ukraine, they don't talk about subsidies or cheap loans to air carriers at all: state aid to businesses affected by quarantine is aimed primarily at small and medium-sized businesses. This forces domestic airlines to seek a way out of the crisis on their own.

One of the options is conversion for freight transportation. Moreover, there is a demand for them now, because the governments of not only Ukraine, but all over the world are actively transporting medical supplies on airplanes.

Thus, Ukraine's largest airline, UIA, announced the start of air cargo transportation by passenger aircraft. Now the cargo is carried by two UIA aircraft, but they claim that they are ready to allocate 10 aircraft for these purposes.

SkyUp, a relatively new company on the Ukrainian aviation market, is much more active in transporting goods. Before the quarantine, the company operated according to the low-cost airline model, but due to the crisis, they quickly received a license to carry out cargo transportation. Carrying out cargo transportation as part of its activities was planned by the airline even before the start of the coronavirus pandemic. The introduction of quarantine measures on a global scale, as well as the related crisis in the passenger air transportation market, accelerated the internal preparation processes and gave impetus to the more rapid development of a new direction in the work of SkyUp.

Now, out of 11 planes of the Ukrainian low-cost airline, 7 have been converted for cargo transportation, 4 more planes are used for irregular special flights, on which Ukrainians are evacuated from different parts of the world. The airline, despite the crisis, did not mothball any of its aircraft.

Despite the fact that passenger airlines operate cargo or evacuation flights, the volume of such traffic is incomparably lower than before the coronavirus crisis. According to the Flightradar system, which tracks the movements of aircraft, the number of flights in the world has dropped from 176 thousand to 67 thousand per day (when comparing the beginning of March and mid-April 2020). The size of the workload of airlines dropped significantly, so many of them had to lay off their employees.

In particular, the Hungarian low-cost airline Wizz Air announced that it will lay off 1,000 of its employees - this is almost every fifth employee of the company. The decision was made due to the fact that the airline is using only 3% of its operating capacity, which was before the COVID-19 pandemic.

Potential cuts have also been reported at Europe's largest low-cost airline, Ryanair.

The reduction of workers was also reported in Ukrainian airlines, in particular in SkyUp: despite everything, unfortunately, these are not the volumes of traffic that the fleet counted on and collected the flight personnel. And today there is no clear understanding of when passenger traffic will be restored and to what extent it will be carried out. Therefore, the company has to take a step with the reduction of flight personnel.

At the same time, the airline expects a gradual restoration of jobs after quarantine.

They do not exclude staff cuts at UIA. When regular air traffic begins to recover, it will be possible to analyze the demand, respectively - the number of aircraft, the frequency of flights, the directions in which they will be operated, and the like. Thus, it will become clear how much staff is needed. Today we cannot rule out restructuring in the airline's divisions and the reduction of individual positions. The airline loses $ 14.5 million monthly due to downtime and quarantine.

The situation is not so dramatic in the company "Windrose", which is mainly engaged in charter air transportation. "Windrose" is more of a charter company and

receives the main income in the summer season, starting in May. However, the longer the quarantine is, the more dramatic the situation will become.

The company is preparing for the crisis by negotiating with partners. In particular, Windrose managed to agree on the extension of the payment terms for aircraft leasing and other property lease.

The situation with coronavirus and quarantine restrictions in the world is very dynamic, therefore experts, international organizations, and airlines themselves do not undertake to predict when and how the industry will return to normal.

Now the Ukrainian government has extended the quarantine until May 11. Until that time, the ban on air travel will also be in effect. Most likely, this ban will remain in effect after May 11, because Ukraine's exit from quarantine will be gradual, and they plan to restore, first of all, urban and suburban transport.

ICAO predicts two options for the world aviation to overcome the crisis. According to the first, the restoration of air transportation may occur at the end of May 2020. In this scenario, the losses of the aviation industry could reach $ 218 billion, and the drop in passenger traffic - to 963 million people (based on the results of 9 months of 2020).

In a less optimistic scenario, ICAO expects the restoration of air traffic according to a scheme similar to the Latin letter U: after a sharp drop, the period during which air traffic will be at a minimum level will continue. In this case, the restoration of the aviation industry should be expected no earlier than September 2020, the drop in passenger traffic will be 1.11 billion people, and the industry's losses will be $ 218-253 billion.

Covid-19 changed main role of personal safety. Multiple Layers of Safety throughout the Journey are presented in fig. 2.2.

Fig. 2.2. Multiple Layers of Safety Throughout the Journey

When assessing the economic impacts on civil aviation, ICAO works with many different scenarios in order to reflect the very uncertain nature of the current situation and the rapidly changing environment. The actual path will eventually depend upon various factors, inter alia, duration and magnitude of the outbreak and containment measures, availability of government assistance, consumers' confidence and economic conditions.

1. Baseline: hypothetical situation without COVID-19 outbreak with forecasts as originally planned;

2. Indicative Scenario 1 – «V-Shaped»: follows the normal shape for recession where a brief period of contraction is followed by quick/smooth recovery - most optimistic path indicated with a down

3. Indicative Scenario 2 – «U-Shaped» : indicates prolonged contraction and muted recovery with a possibility of no return to trend line of growth (L-shaped) - most pessimistic path indicated with a down.

Global Estimates of Impacts in brief is presented in fig. 2.3.

The analytical focus revolves around two scenarios, which shall not be considered as forecasts of what is likely to happen, but merely indicators of possible paths or consequential outcomes out of many. Each scenario considers

4 different paths to take into account differentiated terms of supply (output) and demand (spending).

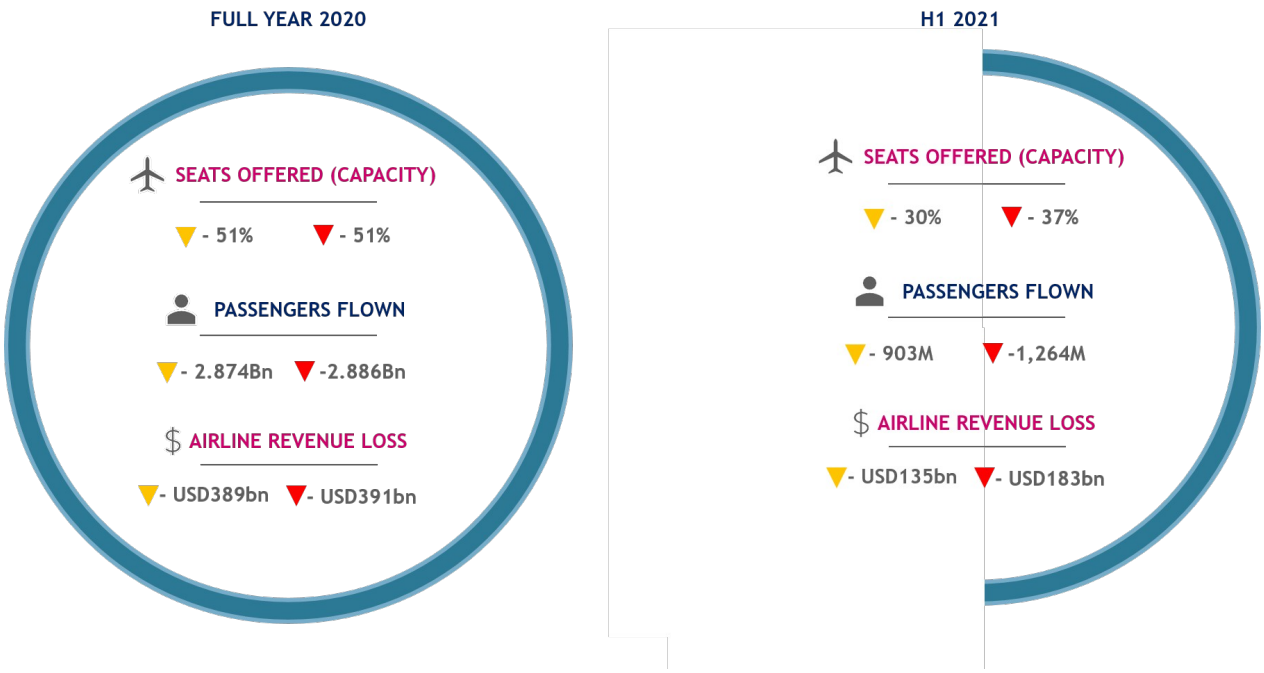


Fig. 2.3. Global Estimates of Impacts in brief

The analytical timeframe has now been extended to Mar 2021 and therefore covers the full year of 2020 and Q1 2021.

ICAO is working alongside the Airport Council International (ACI) in monitoring the developments and to leverage their expertise and analysis conducted on the economic impacts of COVID-19 on airports. Global-level Analysis of Impacts on International Traffic and Domestic Traffic are shown in fig. 2.4 – 2.5.

The COVID-19 virus has spread worldwide without acknowledging borders. It has impacted all industries, all sectors and all aspects of our lives with devastating economic and financial losses and significant uncertainties.

Within the spirit of collaboration, the below chart gathers information from international organizations representing the impacted industries. This information is subject to frequent change and you are invited to visit the official website of each organization for most up-to-date figures.

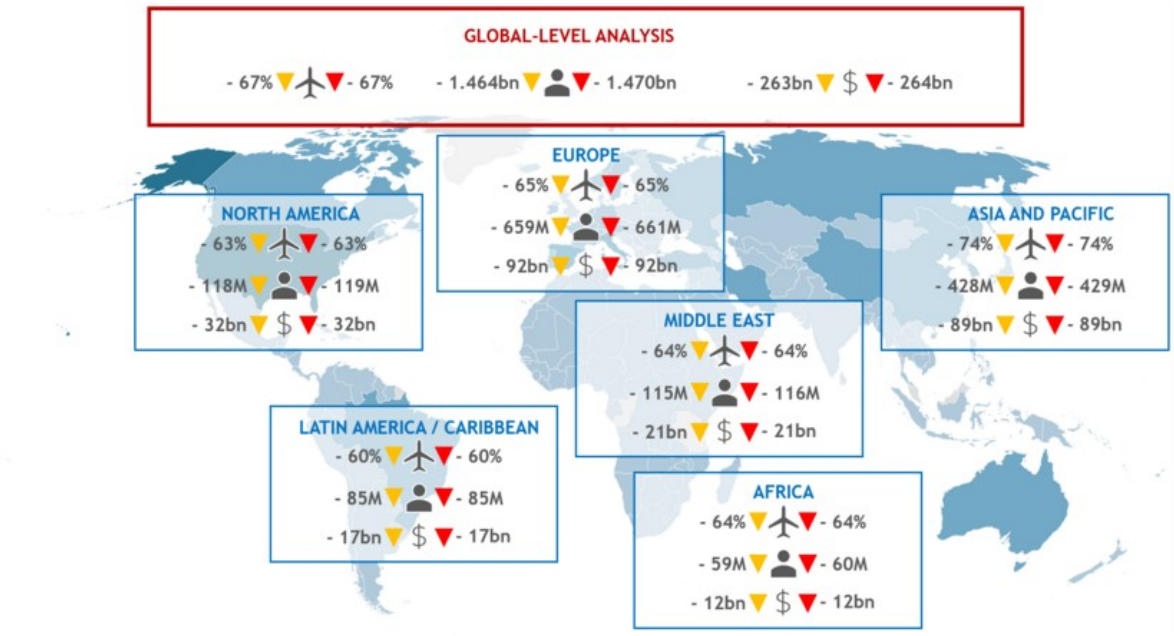


Fig. 2.4. Global-level Analysis of Impacts on International Traffic

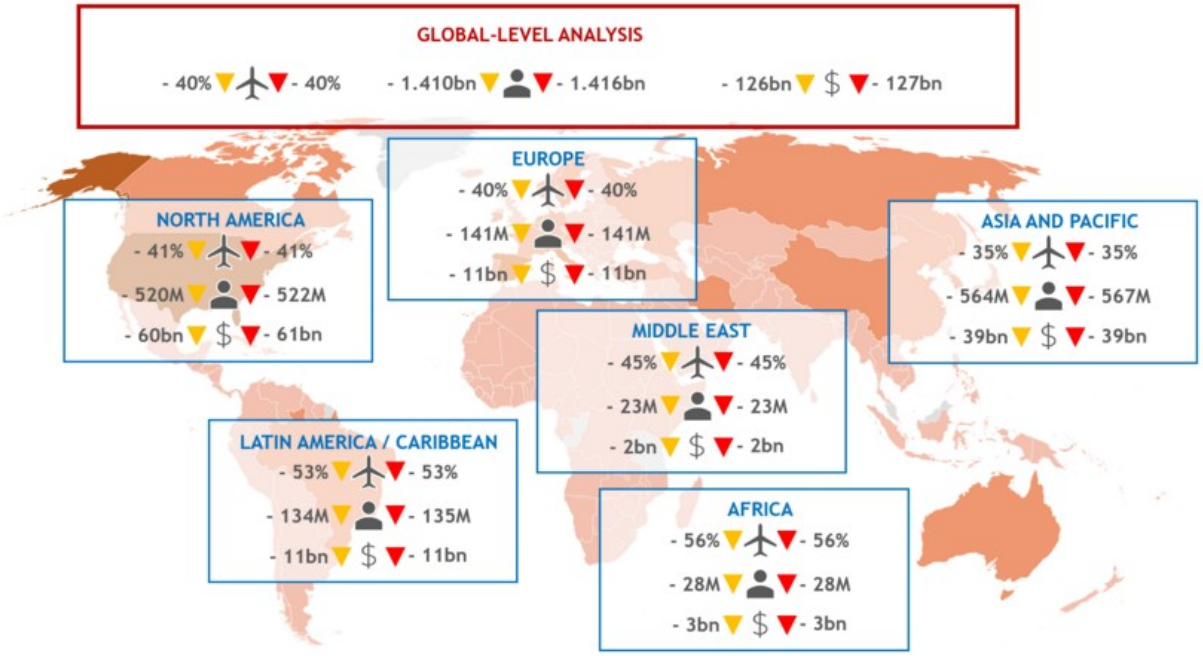


Fig. 2.5. Global-level Analysis of Impacts on Domestic Traffic

Figures are sourced from the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), the Airports Council International (ACI), the UN World Tourism Organization (UNWTO), the World Trade Organization (WTO) and the International Monetary Fund (IMF).

ICAO reports on the effect of Covid-19 on civil aviation during 2020 we can see in fig. 2.6.

Fig. 2.6. ICAO reports on the effect of Covid-19 on civil aviation

Let's consider the global impact of COVID-19 on aviation, tourism, trade and economy in 2020. Analytical data can be seen in fig. 2.7.

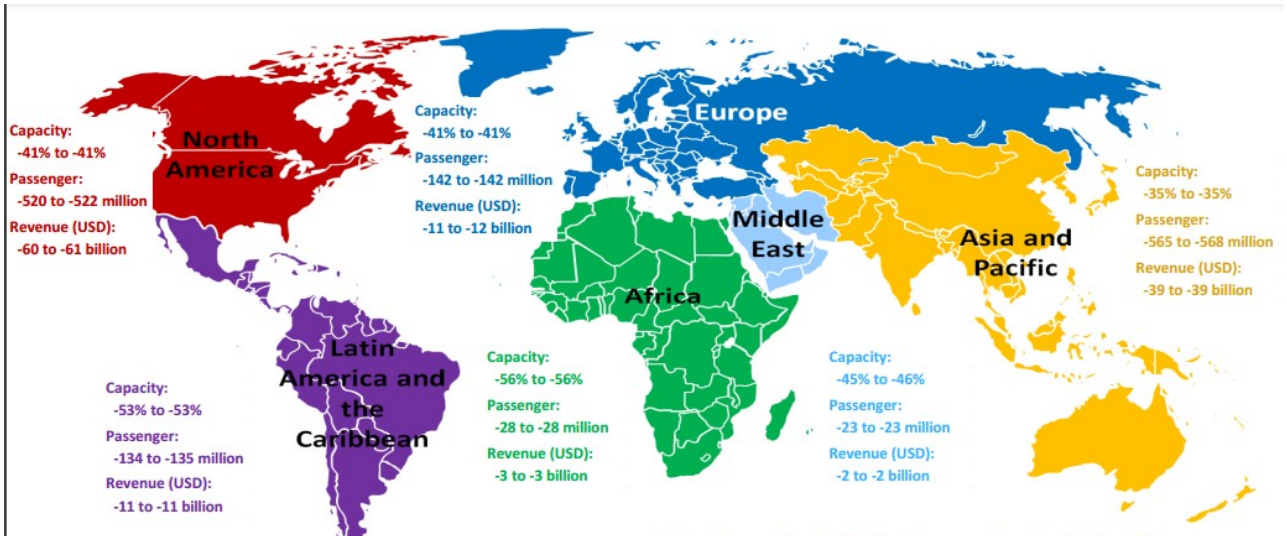


Fig. 2.7. Estimated impact on domestic passenger traffic and revenues by region for 2020

Air passenger traffic: An overall reduction of air passengers (both international and domestic) ranging from 59% to 60% in 2020 compared to 2019 (by ICAO).

Airports: An estimated loss of approximately 60% of passenger traffic and 61% or over USD 104.5 billion airport revenues in 2020 compared to business as usual (by ACI).

Airlines: A 54.7% decline of revenue passenger kilometres (RPKs, both international and domestic) in 2020 compared to 2019 (by IATA).

Tourism: A decline in international tourism receipts of between USD 910 to 1,170 billion in 2020, compared to the USD 1.5 trillion generated in 2019, with 100% of worldwide destinations having travel restrictions (by UNWTO).

Trade: A fall of global merchandise trade volume by 9.2% in 2020 compared to 2019 (by WTO).

Global economy: A projected -4.4% to -5.2% contraction in world GDP in 2020, far worse than during the 2008–09 financial crisis (by IMF and World Bank).

2.3. Analysis of passenger and freight traffic in the world

According to ICAO's preliminary compilation of annual global statistics, the total number of passengers carried on scheduled services rose to 4.1 billion in 2019, which is 7.2 per cent higher than the previous year, while the number of departures reached 36.7 million in 2019, a 3.1 per cent increase compared to 2018.

Passenger traffic, expressed in terms of total scheduled revenue passenger-kilometres performed (RPKs), posted an increase of 7.9 per cent, with approximately 7 699 billion RPKs performed in 2019. Asia/Pacific remained the largest region with 34 per cent of world traffic, posting a 10.7 per cent growth in 2018, followed by Europe with 27 per cent of world traffic and a growth of 8.6 per cent. North America, which accounts for 23 per cent of world traffic, grew at 4.1 per cent. The Middle East region, representing 9 per cent of world traffic, recorded

a growth rate of 6.5 per cent. The Latin America/Caribbean region accounted for 5 per cent of world traffic and grew at 7.4 per cent. The remaining 2 per cent of world traffic was undertaken by African region airlines, which recorded a growth of 7.2 per cent (fig. 2.8).

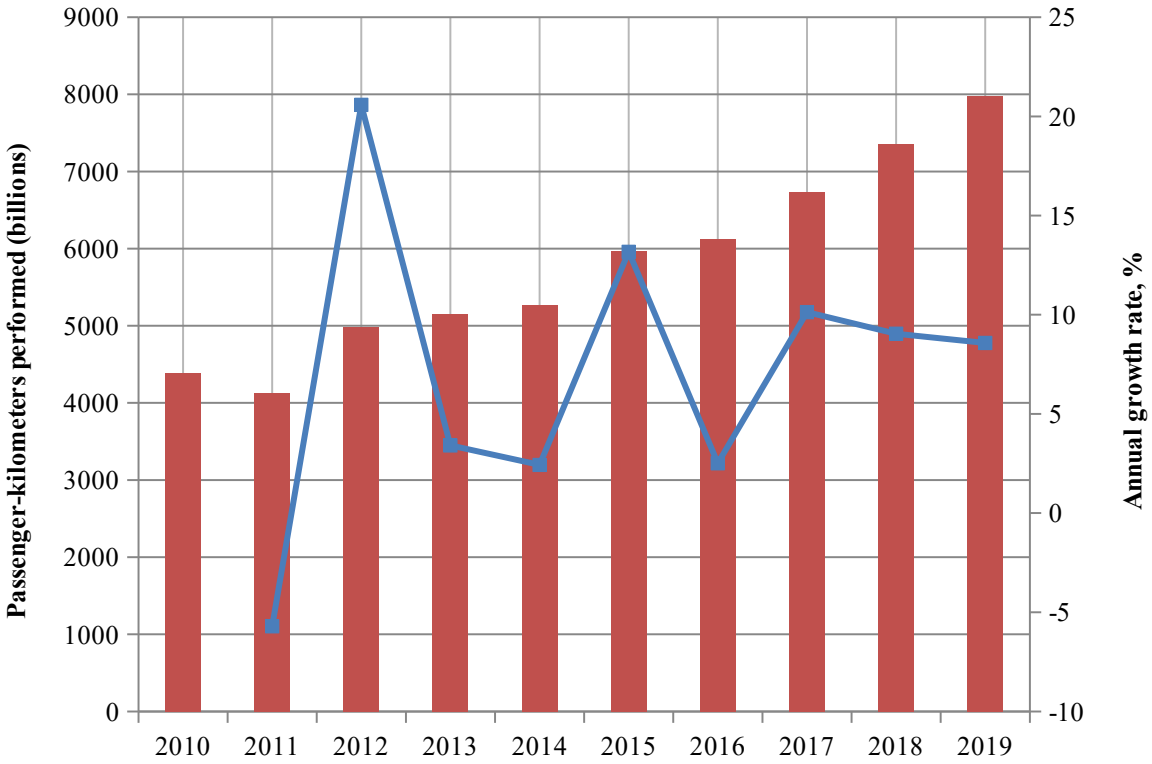


Fig. 2.8. Passenger-kilometers performed, total scheduled traffic (2010 – 2019)

International scheduled passenger traffic grew by 8.4 per cent in RPKs (Revenue passenger kilometres (RPKs) in 2019, compared to the 7.7 per cent growth recorded in 2018. European air carriers saw growth of 8.8 per cent and accounted for the largest share of international RPKs, at 37 per cent of the total. Asia/Pacific retained the second largest share at 29 per cent. The growth for this region was 10.5 per cent. The Middle East accounted for 14 per cent of international RPKs and recorded a growth of 6.5 per cent in 2019, significantly lower than the double-digit growth recorded in 2018. North America which accounts for a share of 13 per cent of international RPKs, grew by 4.9 per cent.

African carriers, which account for 3 per cent of international RPKs, grew by 8.1 per cent. Carriers of Latin America/Caribbean which account for a share of 4 per cent of international RPKs experienced a 9.1 per cent growth in 2019.

Domestic scheduled passenger traffic grew by 7.1 per cent in RPKs in 2019, up from the 6.9 per cent growth recorded in 2018. The main drivers of this growth were the carriers of the United States, China and India which saw increased growth by 3.6, 13.2 and 17.7 per cent, respectively. The Asia/Pacific region, with a share of 42 per cent, overtook North America to become the world's largest domestic market and grew strongly by 11.0 per cent in 2019. North America, with a 41 per cent share of domestic RPKs, experienced a 3.7 per cent growth in 2019. Carriers of Europe, accounting for 9 per cent of domestic RPKs, saw a growth of 7.3 per cent in 2019. The Latin America/Caribbean region, which accounts for a 7 per cent share, saw growth of 5.6 per cent while carriers of the Middle East and Africa, saw a growth of 5.9 per cent and 2.2 per cent, respectively.

Low-cost carriers carried an estimated 1.2 billion passengers in 2019, which was approximately 30 per cent of the world total scheduled passengers. This indicated a 11.4 per cent growth when compared to the number of passengers carried by low-cost carriers in 2018, around one and a half times the rate of the world total average passenger growth.

Capacity offered by the world's airlines, expressed as available seat-kilometers, increased globally by 6.5 per cent in 2019. The capacity growth ranged from 3.8 per cent in Africa to 8.8 per cent in the Asia/Pacific. The average 2019 global passenger load factor at 81.3 per cent was a per cent higher than achieved in the previous year, and ranged from 70.8 per cent for Africa to 83.6 per cent for Europe.

Approximately 56 million tons of freight was carried in 2019. Growth of scheduled total freight traffic, expressed in terms of scheduled total freight tons-kilometers performed (FTKs), was at 9.5 per cent in 2019, significantly higher than the 3.6 per cent recorded in 2018. This growth was mainly due to the improving trade activity in 2019 (fig. 2.9).

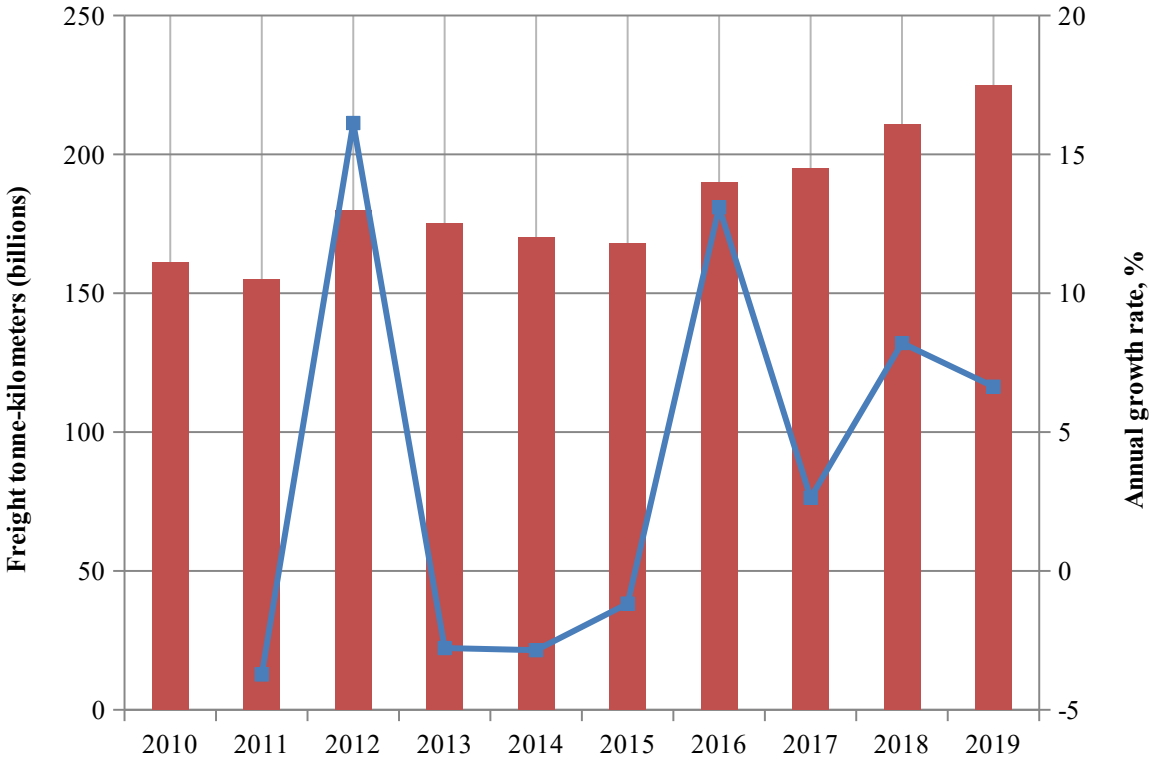


Fig. 2.9. Freight ton-kilometers (billions), total scheduled traffic (2010 – 2019)

Scheduled international FTKs posted an increase of 10.4 per cent in 2019, compared to the 3.5 per cent growth of 2018. International air freight represented around 87 per cent of total scheduled FTKs. Air carriers in Asia/Pacific carried nearly 40 per cent of scheduled international FTKs; the figure was 26 per cent for carriers in Europe, 16 per cent for the Middle East, and 14 per cent for those in North America. This indicated that nearly 80 per cent of long-haul freight traffic flowed on the East-West trade lane that connects Asia to Europe, Asia to North America, and Europe to North America.

Scheduled international freight capacity in 2019, expressed in available freight ton-kilometres, was approximately 351 billion, a 6.1 per cent growth compared to 2018. The scheduled international freight load factor increased from 53.2 per cent in 2017 to 55.4 per cent in 2019. A combination of improving

economic activity, trade and growth in e-commerce contributed to the net positives for air freight in 2019.

In 2019, the operating profit of scheduled airlines of Member States was estimated at about 7.9 per cent of operating revenues. The operating profit was expected to be around USD 60 billion in 2019 based on operating revenues of USD 758 billion. Nearly 49 per cent of the net profits came from the performance of air carriers in North America, followed by carriers of Asia/Pacific and Europe with 25 and 26 per cent, respectively. The 24 per cent increase in jet fuel price in 2018 led to an increase in unit costs compared to the decline seen in 2018. Higher traffic growth, a more efficient utilization of capacity and slowing of the decline in yields compared to previous years offset the negative of the increase in unit costs and contributed to another profitable year for the air carrier industry in 2019.

After an estimated 3.1 per cent growth in real Gross Domestic Product (GDP) in 2018, the World Bank has forecasted the growth to remain unchanged at 3.1 per cent GDP for 2019. Accordingly, ICAO has forecasted that total passenger traffic will grow by about 7.5 per cent in 2019. The operating profit for the industry is expected to be around USD 56 billion in 2019 due to the combined effects of improving economic growth, continuing traffic growth and better capacity utilization that is expected to offset the increase in jet fuel prices in 2019.

According to the latest ICAO long-term air traffic forecasts, the 4.1 billion airline passengers carried in 2018 are expected to grow to about 10.0 billion by 2040, and the number of departures is projected to rise to some 90 million in 2040.

With regard to aircraft, the world's major manufacturers delivered 1 481 new commercial aircraft in 2019 and recorded 2 131 new aircraft net orders. Book-to-bill ratios for two of the largest aircraft manufacturers increased to around 1.4:1 in 2019 from 1:1 in the previous year, providing an indicator of the increasing pace of aircraft orders. Strong traffic growth projections, low to stable borrowing costs, improving airline profitability, growth of low-cost carriers and the fleet replacement programs of carriers are expected to maintain the strength of the aircraft market.

As for aviation safety, there were 88 aircraft accidents for scheduled commercial air transport operations in 2019, an increase of 17 per cent from 2018, when 75 accidents were reported. This is according to an analysis of global accident data involving commercial air transport aircraft with a maximum certificated take-off mass of more than 5 700 kilograms. The number of fatalities in scheduled operations worldwide decreased to 50 fatalities, which represents a substantial decrease from 182 in 2018 and the lowest level on record of the past ten years. The number of fatal accidents decreased from 7 in 2018 to 5, also the lowest in recent records. The global accident rate increased to 2.4 accidents per million schedule departures versus 2.1 accidents per million scheduled departures in 2018.

IATA has launched an industry Simplifying the Business (StB) Cargo Transformation program in 2016. StB Cargo is the umbrella for transformational initiatives in air cargo. The 6 projects under StB Cargo are:

- e-freight & e-AWB, led by the Digital Cargo team;
- ONE Record, led by the Digital Cargo team;
- Interactive Cargo;
- Smart Facility, led by the Cargo Operations team;
- ACID – Air Cargo Incident Database;
- Cargo Connect, led by the Digital Cargo team.

The Interactive Cargo project aims at developing responsive air cargo services based on intelligent systems that are able to self-monitor, send real-time alerts, respond to deviation to meet customers' expectations and report on the cargo journey to allow data-driven improvements.

In addition to global forecasts, regional estimates have been developed for Asia-Pacific, Africa, Europe, Latin America-Caribbean, Middle East and North America. Airport traffic projections are also presented for major economic groupings such as emerging versus advanced economies, BRICS (Brazil, Russia, India, China and South Africa), G7 (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States), MINT (Mexico, Indonesia, Nigeria and Turkey) and more.

2.4. Results of the aviation industry in Ukraine

Statistics on the activities of the aviation industry in 2019 indicate its stable development. So, during the reporting year, the transportation of passengers, cargo and mail was carried out by 34 domestic airlines, which carried out 100.3 thousand commercial flights (as of 2017 - 93 thousand flights). At the same time, the number of transported passengers increased compared with 2018 by 18.7 percent and amounted to 12529 thousand people. At the same time, the volume of cargo and mail transportation by the air transport of Ukraine increased by 19.7 percent and amounted to 99.1 thousand tons (table 2.1).

Table 2.1

Analysis of the activities of airlines and airports in Ukraine during 2018-2019

Indicators	Units of measurement	Total			including international		
		2018	2019	% 2019/ 2018	2018	2019	% 2019/ 2018
1	2	3	4	5	6	7	8
Airline activities							
Passengers transported	ths. people	10556,3	12529,0	118,7	9614,9	11446,1	119,0
including on regular lines	ths. people	6768,2	7867,6	116,2	5837,2	6796,2	116,4
Performed passengers-kilometers	billion pass km	20,3	25,9	127,6	19,9	25,4	127,6
including on regular lines	billion pass km	12,6	15,6	123,8	12,1	15,1	124,8
Transported cargo and mail	ths. tons	82,8	99,1	119,7	82,6	98,8	119,6
including on regular lines	ths. tons	19,2	21,1	109,9	18,9	20,8	110,1
Performed tons-kilometers (cargo + mail)	million ton-km	275,3	339,7	123,4	275,2	339,6	123,4
including on regular lines	million ton-km	70,5	92,0	130,5	70,4	91,9	130,5
Performed commercial flights	ths. units	93,0	100,3	107,8	78,1	84,1	107,7
including regular	ths. units	63,3	67,0	105,8	49,9	52,3	104,8
Airports activities							
Aircraft Departure / Arrival	ths. units	159,9	182,8	114,3	125,6	145,6	115,9
including on regular lines	ths. units	121,4	140,3	115,6	95,0	111,5	117,4
Passenger traffic	ths. people	16498,9	20545,4	124,5	14591,1	18357,5	125,8
including on regular lines	ths. people	12646,1	15811,1	125,0	10770,3	13658,7	126,8
Mail and cargo traffic	ths. tons	52,3	56,4	107,8	51,1	55,2	108,0
including on regular lines	ths. tons	47,3	51,3	108,5	46,0	50,1	108,9

It should be noted that since 2017, the passenger market has developed quite dynamically. Thus, the number of passengers who used the services of Ukrainian airlines grew annually by an average of a quarter. Over the three years, the volume of passenger traffic has almost doubled compared with the 2016 figure, and at the same time, it exceeded the level of the “pre-crisis” level by more than one and a half year 2014.

Passengers were transported by 21 domestic airlines, among which the leading position was occupied by Ukraine International Airlines, Windrose, Azur Air Ukraine, YanEyr and Bravo (fig. 2.10). At the end of the year, 5,220.6 thousand people were transported by the five largest passenger airlines, which is 20.2 percent more than in 2018 and accounts for almost 93 percent of the total passenger traffic of Ukrainian airlines.

More than half (54.2 percent) of all passenger traffic of domestic airlines are international scheduled flights. In 2019, in accordance with the approved timetable, regular international flights were carried out by 10 domestic airlines in 46 countries of the world, the number of passengers who used the services of Ukrainian air carriers increased by 16.4 percent and amounted to 6796.2 thousand people. Simultaneously with the increase in the intensity of flights in many developed directions, a network of routes of domestic airlines developed. Thus, during the year, 17 new regular routes were opened by Ukrainian carriers. At the same time, the average occupancy rate of passenger seats on international regular flights of Ukrainian airlines increased from 77.7% in 2018 to 78.8% in 2019.

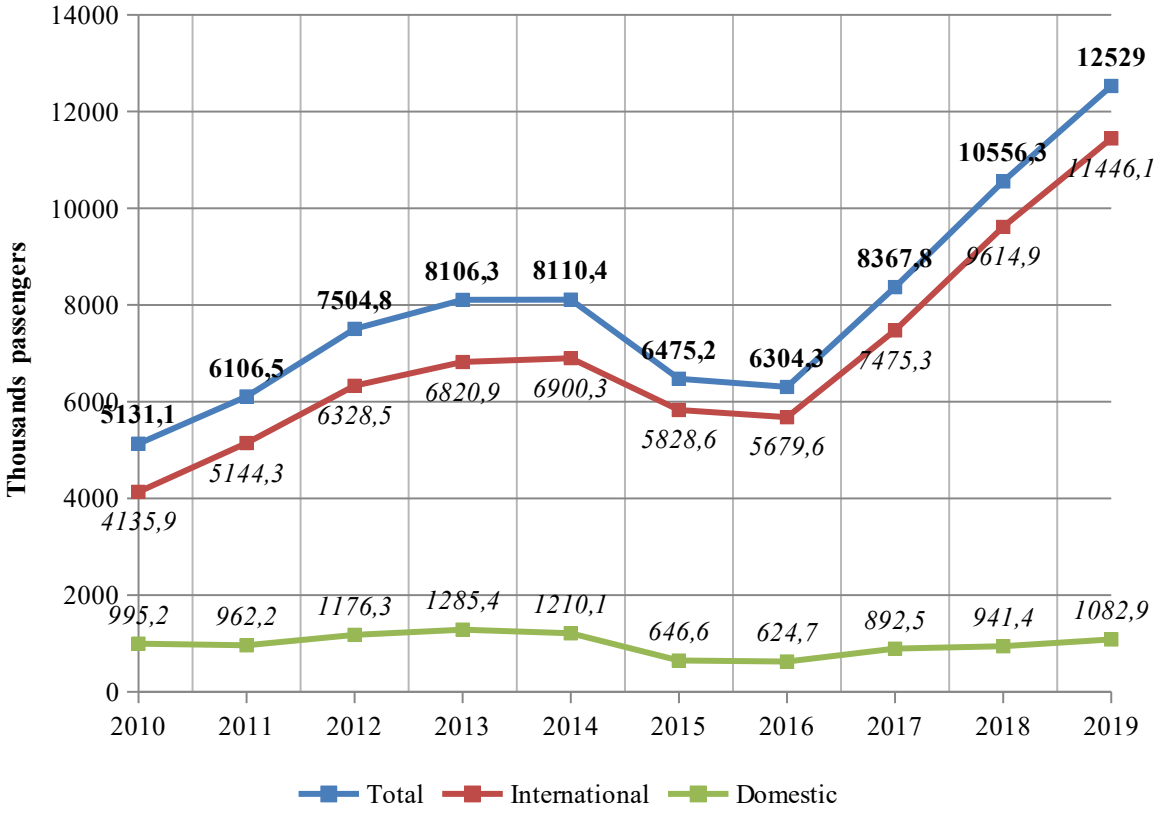


Fig. 2.10. Dynamics of passenger transportation by air transport in Ukraine during 2010 – 2019 years

At the same time, there was an expansion of activity on the Ukrainian market of foreign airlines, and 5 new foreign airlines began to operate regular flights to Ukraine. 2019 also distinguished itself by the development of the route network of foreign airlines, which began operating 27 international airlines. In general, during 2019, 38 foreign airlines from 37 countries of the world operated flights to our country. 6,857.3 ths. passengers used their services, which is 37.8 percent more than in 2018 and accounts for 50.2 percent of the total regular passenger traffic between Ukraine and the countries of the world.

A significant increase (by 23.1 percent) was observed in this segment of the passenger airline market as international flights on an irregular basis, during the reporting period, 4649,9 ths. passengers were transported by 16 Ukrainian airlines. At the same time, almost 84 percent of such traffic was carried out by the five aforementioned leading airlines.

During the year, the intensification of regular shipments within Ukraine continued. Domestic passenger traffic on a regular basis was performed 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 percent more than in the previous 2018. At the same time, the average employment rate of passenger seats on domestic scheduled flights increased from 73.5% in 2017 to 79.3% in 2019.

This year, 22 domestic airlines carried cargo and mail. It should be noted that most of the cargo transportation has traditionally been charter flights to other states within the framework of UN humanitarian and peacekeeping programs, as well as in accordance with contracts and agreements with other customers. The leaders of transportation are “Antonov” (an increase of 15.3 percent compared to 2018), Ukraine International Airlines (an increase of 10.2 percent), ZetAvia (an increase of 36.8 percent), “Maximus Flight” (2.2 times increase). In the reporting period, these airlines carried out 78 percent of the total freight and mail traffic (fig. 2.11).

Commercial flights of domestic and foreign airlines served 20 Ukrainian airports and airfields, for the reporting period, the total number of aircraft departure and arrived was 182,800 units, which is 14.3 percent more than in 2018. At the same time, passenger traffic through the airports of Ukraine, exceeding the 20-million mark, reached 20,545.4 thousand people, which ensured an increase of 24.5 percent. Post-freight flows increased by 7.8 percent and amounted to 56.4 thousand tons.

According to statistics, in 2019 there was an increase in the number of served passengers at all major airports in Kiev (Zhuliany) (by 51.9 percent), Lviv (by 47.9 percent), Boryspil (by 19.4 percent), Kharkiv (by 19, 3 percent), Odessa (by 17.8 percent), Zaporizhia (by 14.9 percent) and Dnipropetrovsk (by 8.1 percent). Also, a significant increase in passenger traffic was recorded at the airports of the cities of Chernivtsi (by 53 percent) and Kherson (by 41.8 percent) (fig. 2.12).

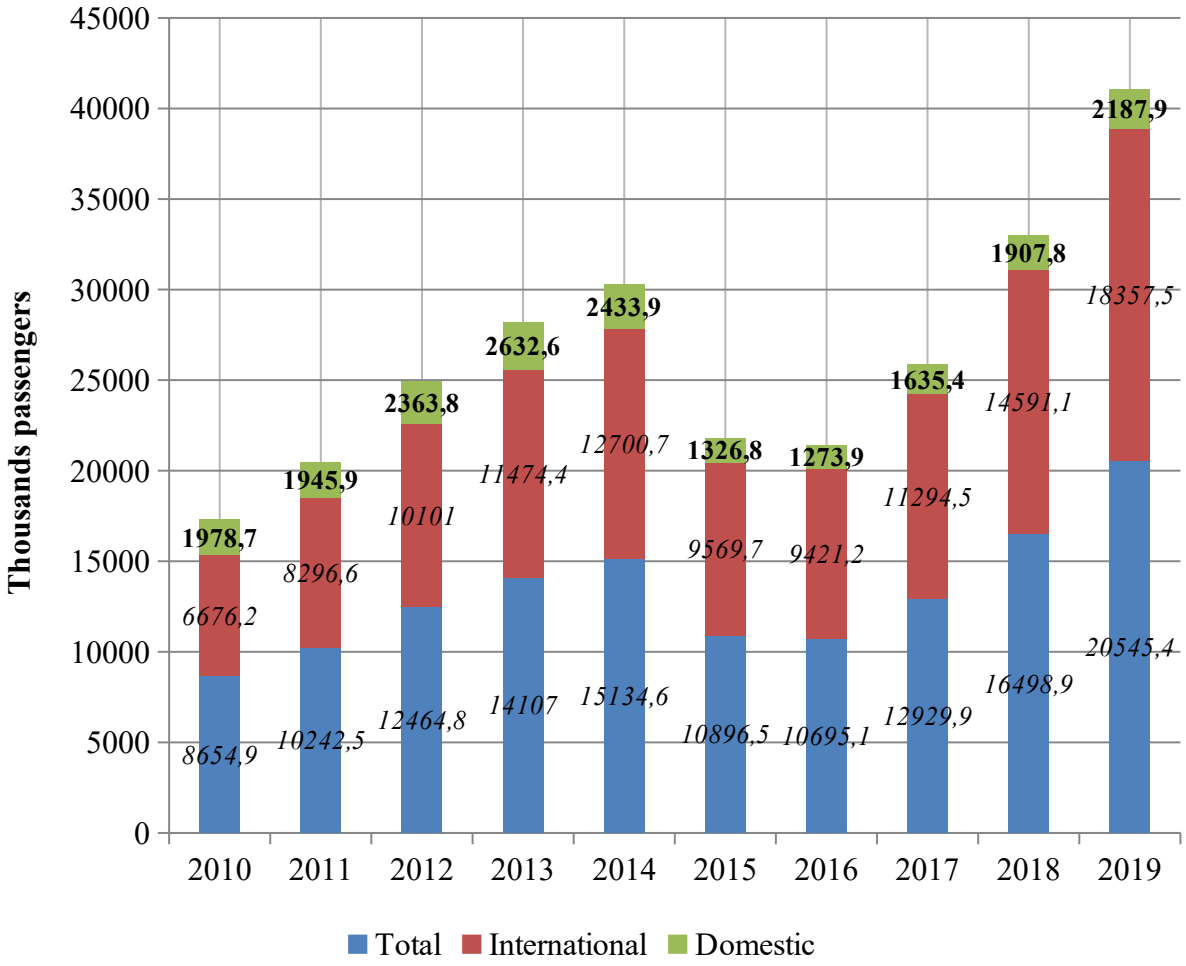


Fig. 2.11. Passenger traffic through the airports of Ukraine, thousand pas

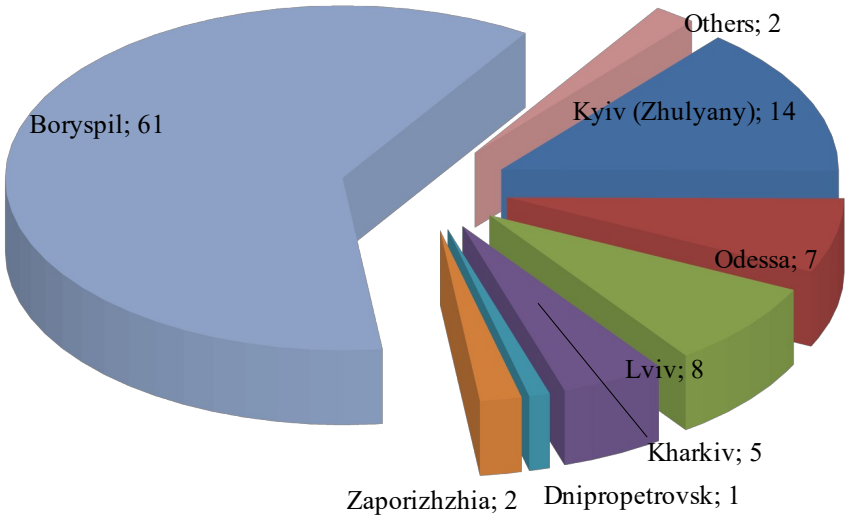


Fig. 2.12. Share of leading airports in total passenger transportation through Ukraine's airports

It should be noted that today almost 98 percent of total passenger traffic and 99 percent of cargo traffic flows are concentrated in 7 airports of the country - Boryspil, Kiev (Zhulyany), Lviv, Odessa, Kharkiv, Zaporozhye and Dnipropetrovsk.

Summing up, we can say that aviation is developing in Ukraine. The annual growth rate of passenger and cargo traffic increases by an average of 7%, which is a good trend.

Statistical data on the activities of the aviation industry in 2019 indicate its stable development despite the negative trends in the entire transport sector. Significant promotion of the positive dynamics of activity of enterprises of aviation industry introduced the introduction of a visa-free regime with EU countries, which led to an increase in the mobility of Ukrainian citizens. Greatly popular trips abroad for the weekend is given to aviation transport to save time in such trips.

Thus during the reporting year 34 domestic airlines performed transportation of passengers, cargo and mail which carried out 100.3 thousand commercial flights (2019 - 93 thousand flights).

Cargo and mail transportation.

The cargo and mail traffic in 2019 was carried out by 22 domestic airlines. It should be noted that most of the freight was traditionally charter flights in other states within the framework of the UN humanitarian and peacekeeping programs, as well as in accordance with contracts and agreements with other customers. Transportation leaders - ATP Antonov (growth by 15.3 percent compared to 2018), International Airlines of Ukraine (growth - by 10.2 percent), ZetAvia (growth - by 36.8 percent), "Maximus Airlines" (growth - 2.2 times). The aforementioned airlines in the reporting period carried out 78 percent of the total volume of cargo and mail.

Activities of airports.

Commercial flights of domestic and foreign airlines served 20 Ukrainian airports and airfields (Table 2.2), during the reporting period, the total number of

shipments and arrivals of aircraft amounted to 182.8 thousand units, which is 14.3% higher than the figure for 2018.

Table 2.9

List of airports in Ukraine

№	City of location	Official name
1	Kyiv	State Enterprise "Boryspil International Airport"
2	Lviv	State Enterprise "Lviv International Airport" Danila Galitsky
3	Dnipro	Limited Liability Company "International Airport Dnipropetrovsk"
4	Zaporizhzhia	Communal Enterprise "International Airport of Zaporozhye"
5	Mykolayiv	Communal Enterprise "Nikolaev International Airport"
6	Ivano-Frankivsk	International airport Ivano-Frankivsk (Scorzonera)
7	Kyiv	Communal Enterprise "International Airport Kyiv (Zhulyany)"
8	Kryviy Rih	Municipal Enterprise "International Airport Kryviy Rih"
9	Odessa	Communal Enterprise "Odessa International Airport"
10	Rivne	Regional Municipal Enterprise "International Airport Rivne"
11	Sumy	Oblast utility company "Airport Sumy"
12	Uzhhorod	Transcarpathian Regional Utility Enterprise "Uzhhorod International Airport"
13	Ternopil	Ternopil Oblast Municipal Enterprise "Ternopil Avia Avtotrans")
14	Kharkiv	Limited Liability Company "New Systems AM" (International Airport Kharkiv)
15	Chernivtsi	Communal Enterprise "Chernivtsi International Airport named after Leonid Kadenyuk"
16	Kherson	Communal Enterprise of Kherson Oblast Council "Kherson Airlines"
17	Poltava	Poltava Oblast Municipal Enterprise "Poltava Airport"
18	Vinnytsia	Communal Enterprise "Airport Vinnitsa"
19	Cherkasy	Communal Enterprise "Cherkasy Regional Airport Cherkasy Regional Council"
20	Zhytomyr	Subsidiary Enterprise "International Airport Zhytomyr named after SP" Koroleva "Limited Liability Company" Accord "

At the same time, passenger traffic through Ukraine's airports, exceeding the 20-millionth milestone, reached 20545.4 thousand people, which provided a growth of 24.5 percent. The cargo turnover increased by 7.8 percent and amounted to 56.4 thousand tons.

It should be noted that today almost 98 percent of total passenger traffic and 99 percent of postal traffic flows are concentrated in 7 airports of the country - Boryspil, Kyiv (Zhulyany), Lviv, Odessa, Kharkiv, Zaporizhia and Dnipro.

Application of aviation in the branches of the economy.

In 2019, aviation enterprises processed 569.2 thousand hectares of agricultural land, the total flight during aviation works in the economic sectors was 11.8 thousand hours (540.9 thousand hectares and 9 thousand hours respectively, in the previous year).

Air Traffic Service of Ukraine.

Ukrainian State Air Traffic Services Enterprise “UkSATSE” for the reporting year served 300.9 thousand flights versus 254 thousand for 2019. The number of serviced flights performed by aircrafts and helicopters of airlines of Ukraine (by 9.7 percent) and foreign airlines increased (by 23.9 percent).

2.5. Analysis of operating and financial activity of “Boryspil International Airport”

Boryspil International Airport is the largest and most powerful in Ukraine. It provides over 67% of aviation passenger transportation in Ukraine and serves over 10 million passengers per year.

The main activities: auxiliary service of aviation transport; activities of intermediaries in food, beverages and tobacco products trade; activities of intermediaries in the trade of goods of a wide range; other kinds of education; retail sale of beverages in specialized stores; warehousing; activities of hotels and similar means of temporary placement; leasing and exploitation of own or leased property; supply of steam, hot water and air-conditioned air.

Organizational and Legal Form: State Enterprise.

Subjects of management: Ministry of Infrastructure of Ukraine.

According to the resolution of the Cabinet of Ministers of Ukraine dated December 23, 2004 No. 1734 "On approval of a list of enterprises of strategic importance to the economy and security of the state", the State Enterprise "Boryspil" is included in the list of enterprises that are strategically important for the state's economy and security.

Boryspil is well located at the intersection of many air routes connecting Asia with Europe and America. More than 25 national and foreign airlines carry from Boryspil passenger and cargo transportation on 75 regular routes around the world.

The airport has two runways. The technical capabilities of the airport "Boryspil" remain unique for Ukraine, CIS countries and Eastern Europe. A runway length of 4000 m and a width of 60 m allows receiving aircrafts of all types round the clock, including in conditions of limited visibility. Boryspil is also the only airport in Ukraine that operates regular transcontinental flights.

The airport is a member of the International Association of International Airports of the European Regions (ACI EUROPE), the Club of Quality Leaders of Ukraine, the Association of Airports of Ukraine CA (AAUCA), the Kyiv Chamber of Commerce and Industry and the Ukrainian Chamber of Commerce and Industry, the Ukrainian Association of Excellence and quality ", Public Association" Ukrainian Air Transport Association ", Association of hotel associations.

Boryspil International Airport is the hub airport of Ukraine International Airlines. In the early 50's of the 20th century, the development of civil aviation in the Soviet Union was at an extremely high pace. The transition to the era of jet passenger aircraft, discovered by the Soviet Tu-104 on June 17, 1955, required new approaches to the construction of airports and runways.

In order to comply with safety standards and overcome the limitations that existed for airports within cities, a project for the joint use of a military airfield near the city of Boryspil was proposed. After obtaining a permit for civilian aircraft based on a military aerodrome preparation of the airport before the opening was very fast. The opening of the airport was carried out around the clock.

On June 30, 1959, an order was signed on the creation of the airport by the head of the General Directorate of the State Tax Inspectorate No. 265. Already on July 7, 1959, the first flight was accepted. During the first year of its activity, which was initially carried out in field conditions (six tents), and later in temporary premises, Boryspil Airport was ranked third in terms of passenger traffic among

Ukrainian airports (after Simferopol airport and Zhulyany airport). Since 1960, Boryspil Airport has begun to take international flights.

The project of the terminal was developed already in 1961 by the Kyivproekt Institute. And in 1965 the premises were solemnly opened and put into operation. Capacity, at the time, was 1,400 passengers on domestic flights and 200 on international flights. The terminal was the second largest after the Moscow Domodedovo Airport and one of the largest in Europe.

Every year the number of passengers grew rapidly. This necessitated the construction of a second runway, which was opened in 1971. In addition, there were built radio electrical workshops, laboratory building ATB, emergency rescue station, a set of secondary radar equipment, and others.

In 1982 the construction of the "Arrow" center for the automated air traffic control system in Ukraine was launched. It significantly facilitated the work of air traffic controllers and crews and covered almost the entire territory of Ukraine.

Until 1990, Boryspil Airport had the best production performance among Ukrainian airports. The crisis, caused by the collapse of the Soviet Union, could not but affect the activity of the airport. However, the company does not close, but begins to seek investors. The Cabinet of Ministers of Ukraine issued a resolution that had historical significance about the reconstruction of the Boryspil airport. The regulation stipulated that 60% of the funds would be drawn from investor firms. This gave a new impetus to the development of the company: March 11, 1993, the airport "Borispil" receives the status of a state international airport.

April 1, 1993 was the second legal establishment of the airport "Boryspil". According to the order of the Minister of Transport of Ukraine on the basis of Boryspil Air Company, the Boryspil State International Airport was created as a legal entity, the regional directorate of Ukraine Airlines and Kyivcentraero.

In 1995, Terminal C was opened to service VIP passengers. In 1998, the President of ICAO (International Civil Aviation Organization) President Dr. Assad Kotait officially confirmed the status of the airport training center as the ICAO

Aviation Safety Training Center (today, this airport division is one of the 21 similar centers in the world).

The runway №1 was reconstructed to the 10th anniversary of Independence of Ukraine. The funds were attracted by the European Bank for Reconstruction and Development. Incidentally, this was the first EBRD loan for Ukraine. The previous RW, which was designed for liners weighing up to 47 tons, can now accept any type of aircraft, even promising. Runway No.1 meets the requirements of ICAO Category III A.

On September 21, 2010, a new terminal F (ap. A) was opened, with an hourly capacity of 900 passengers per arrival flights and 900 f per departure flights. Enterprise development does not stop there. May 28, 2012, the largest passenger terminal D in Ukraine with the capacity of 3000 passengers on the departure and 3000 on arrival (addendum B) was opened. The general airport plan is shown in fig. 2.13.

Terminal F was closed in October 2013, having worked only three years (the opening took place in September 2010). The reason was the passenger traffic at the airport - for its maintenance is enough only one terminal D, which is designed for 15 million passengers.

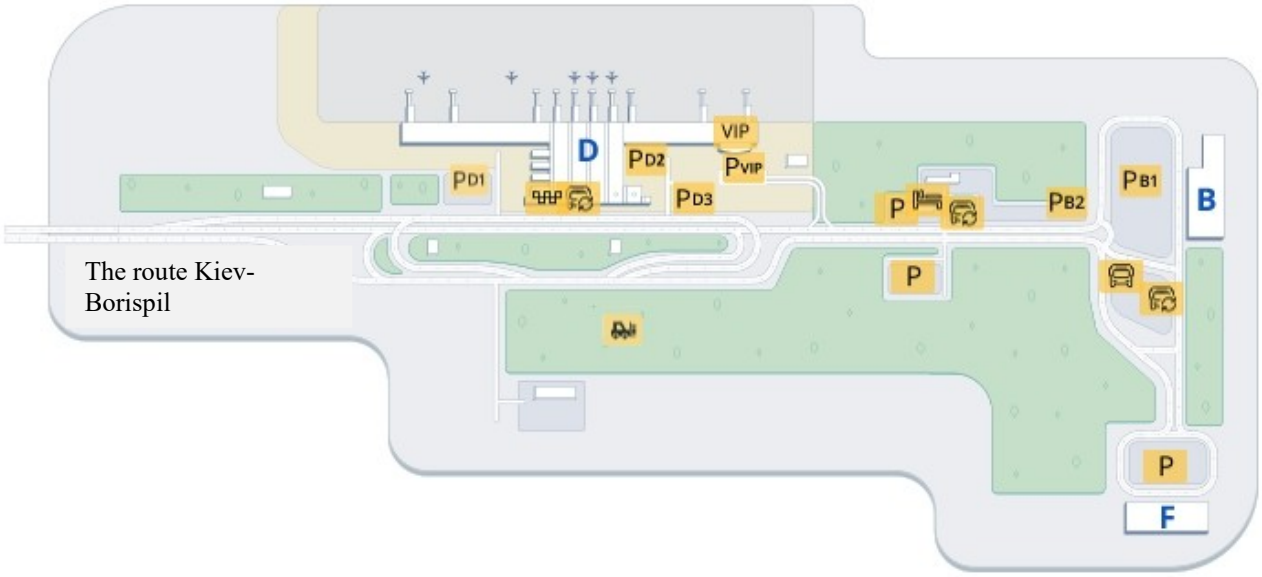


Fig. 2.13. General plan of Boryspil airport

During Euro 2012, on the day of the final match in Kiev, Boryspil Airport set a new record - served 630 flights. The total number of passengers who took advantage of this day's airport services amounted to 39,317 people (the previous record was set in 2008 - then the airport received 423 flights).

In 2019, at the Boryspil airport, a railway station was opened, and a rail link was introduced between the airport and the central railway station of Kyiv.

In the State Enterprise "Boryspil" there are the following high-risk objects:

- The warehouse of the centralized refueling of aircraft, located at the address: Ukraine, Kiev region, Boryspil-7, the code in the state register of increased danger - 32.20572069.02.2, which has a category of danger 2 (the second).

- The basic structure of the FL (fuel and lubricants), located at the address: Ukraine, Kiev region, Boryspil-7, the code in the state register of increased danger - 32.20572069.01.2, which has a category of danger 2 (the second).

- Gas station №1, located at the address: Ukraine, Kiev region - Boryspil-7, the code in the state register of increased danger - 32.20572069.02.2, which has a category of danger 2 (the second).

- Gas station №2, located at the address: Ukraine, Kiev region, Boryspil-7, the code in the state register of increased danger - 32.20572069.02.2, which has a category of danger 2 (the second).

We will conduct an analysis of the financial indicators of the Boryspil airport. The analysis is based on the financial plan for 2019 (table 2.3).

The increase in the cost of production is due to an increase in production volumes, the introduction of an additional terminal, which leads to an increase in the cost of purchasing materials and raw materials (spare parts for special equipment of foreign production, a liquid for processing runway and aircraft (TYPE-2), etc.). The growth of the planned passenger flow, improvement of the services quality, as well as the opening of an additional terminal to ensure growing demand leads to an increase in the cost of food for passengers, cleaning, etc.

Table 2.3

Financial plan of the airport "Boryspil" for 2019, ths. UAH

№	Name of indicator	2017 y.	2018 y.	2019 y.
1.	Net income from sales of goods (goods, works, services)	3 870 048	3 930 861	4 501 215
2.	Cost of sold products (goods, works, services)	.1 350 288	1 774 770	2 579 272
3.	Gross profit / loss	2 519 760	2 156 091	1 921 943
4.	Administrative expenses	95 627	152 965	217 141
5.	Selling expenses	5 504	9 587	12 009
6.	Other operating income	151 694	109 202	103 310
7.	Other operating expenses	209 761	77 767	86 341
8.	Financial result from operating activities	2 360 562	2 024 974	1 709 762
9.	Other financial income	10 787	13 627	16 865
10.	Financial expenses	283 270	301 721	388 222
11.	Other income	64 015	53 120	65 487
12.	Other expenses	37 803	62 366	59 064
13.	Financial result before tax	2 114 291	1 727 634	1 344 828
14.	Income tax expense	382 871	312 457	243 137
15.	Net financial result	1 731 420	1 415 177	1 101 691
16.	Profit	1 731 420	1 415 177	1 101 691

At the same time, an increase in the cost of services purchased in the currency (SITA services, baggage handling and other specialized infrastructure services, etc.) and increase in their volumes as a result of the opening of an additional terminal. Other expenses include the costs of compulsory airport liability insurance, which were previously accounted for in other operating expenses and travel expenses of production personnel.

The dynamics of the main financial indicators is shown in fig. 2.14.

In table 2.4 data on the financial condition of the Boryspil airport are given. Due to modernization of the airport, financial borrowings and liabilities increase.

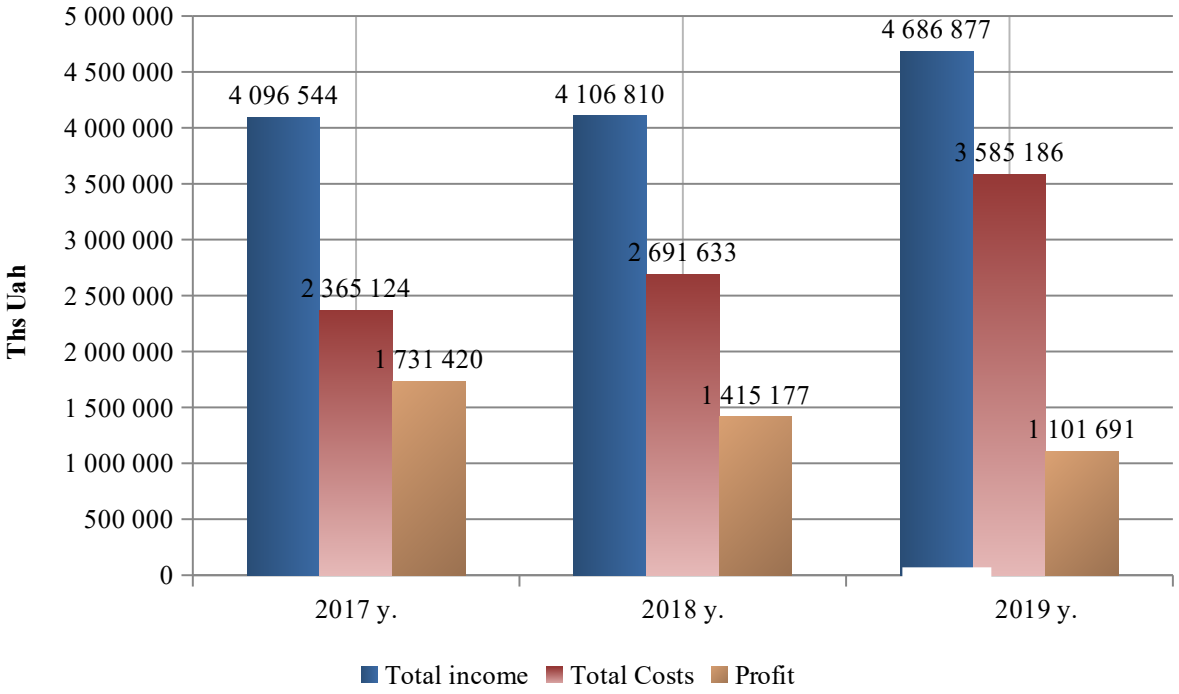


Fig. 2.14. Dynamics of total income, expenses and profit of Boryspil airport, ths. UAH.

Table 2.4

Report on the financial condition of the Boryspil airport, ths. UAH

№	Name of indicator	2017 y.	2018 y.	2019 y.
1	Non-current assets, total, including:	7 578 406	9 555 902	11 086 520
2	fixed assets	5 484 605	7 255 902	7 260 213
3	initial value	13 157 436	15 144 893	15 926 228
4	wear and tear	7 672 831	7 888 991	8 666 015
5	Total current assets, including:	1 381 493	1 339 033	1 550 771
6	money and their equivalents	479 146	106 292	192 038
7	Total assets	8 959 899	10 894 935	12 637 291
8	Long-term liabilities and collateral	1 401 901	1 918 080	3 332 486
9	Current liabilities and security	1 345 994	1 264 623	1 420 160
10	Total commitment and security	2 747 895	3 182 703	4 752 646
11	Including financial borrowing	1 799 249	2 749 258	3 920 378
12	Equity capital	6 212 029	7 712 232	7 884 645

The airport staff has increased by 9.1% in 2018 compared to last year; in 2019, it is planned to increase staff by 7.6% (see table 2.5).

Table 2.5

Data on staff and labor costs

№	Name of indicator	2017 y.	2018 y.	2019 y.
1.	Average number of employees (full-time employees, external contractors and employees working under civil contracts), including:	3 937	4 295	4 623
2.	Head	1	1	1
3.	Administrative and managerial staff	319	342	354
4.	Employees	3 617	3 952	4 265
5.	Salary expenses	578 318	757 710	1 114 810
6.	Average monthly labor costs per employee (UAH), total, including:	12 241	14 701	20 095
7.	Member of the supervisory board	-	-	114 167
8.	Head	318 809	588 750	588 750
9.	Administrative and managerial staff	25 685	35 173	48 892
10.	Employee	10 971	12 785	17 506

The wages of workers in 2018 were increased by 16.5% compared to 2017, wages of administrative and managerial personnel increased by 36.9%. In fig. 2.14 and 2.15 shows the dynamics of the average number of Boryspil airport employees and their wages.

On July 28, 2015, the order of the Ministry of Infrastructure of Ukraine approved an order for a strategic plan for the development of the Boryspil airport.

The main factors for implementing the strategy are:

- a strong base air carrier that follows the hub strategy;

- flexible system of motivation of air carriers, aimed at developing new directions, long-distance program, transfer passenger traffic;

- development of the sphere of non-aeronautical activity;

- ensuring operational efficiency primarily in the service of transfer passengers, ensuring a minimum connection time.

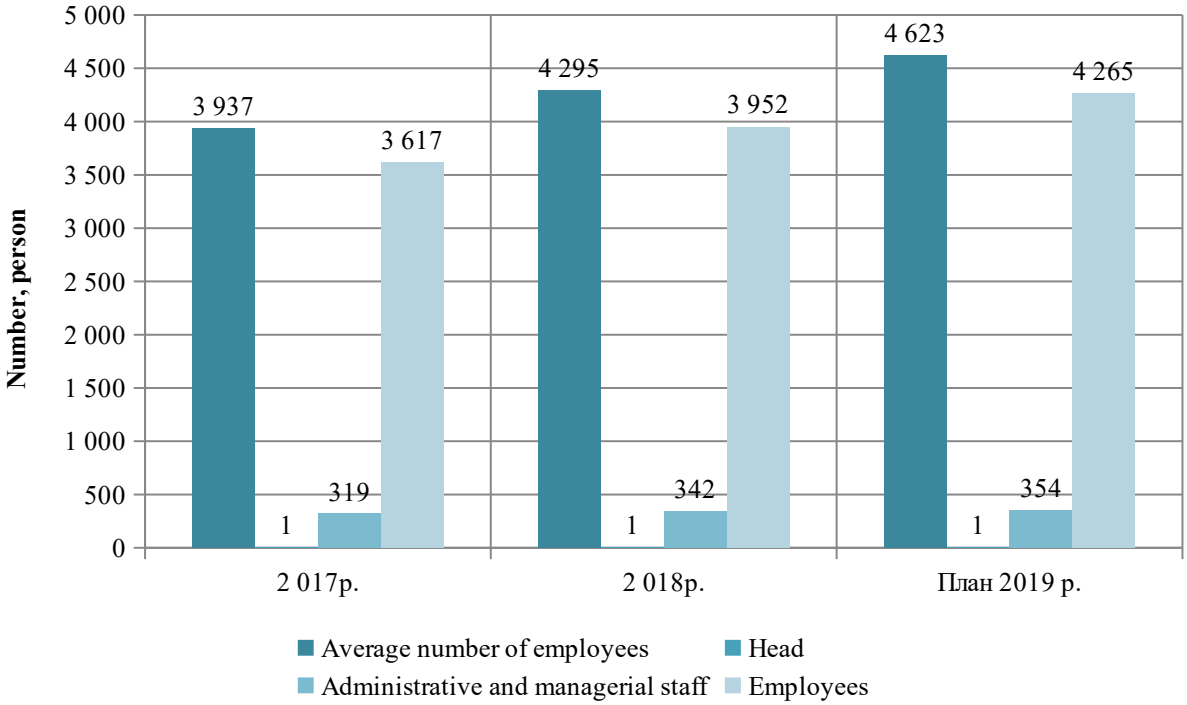


Fig. 2.15. Dynamics of the number of employees of the airport "Boryspil"

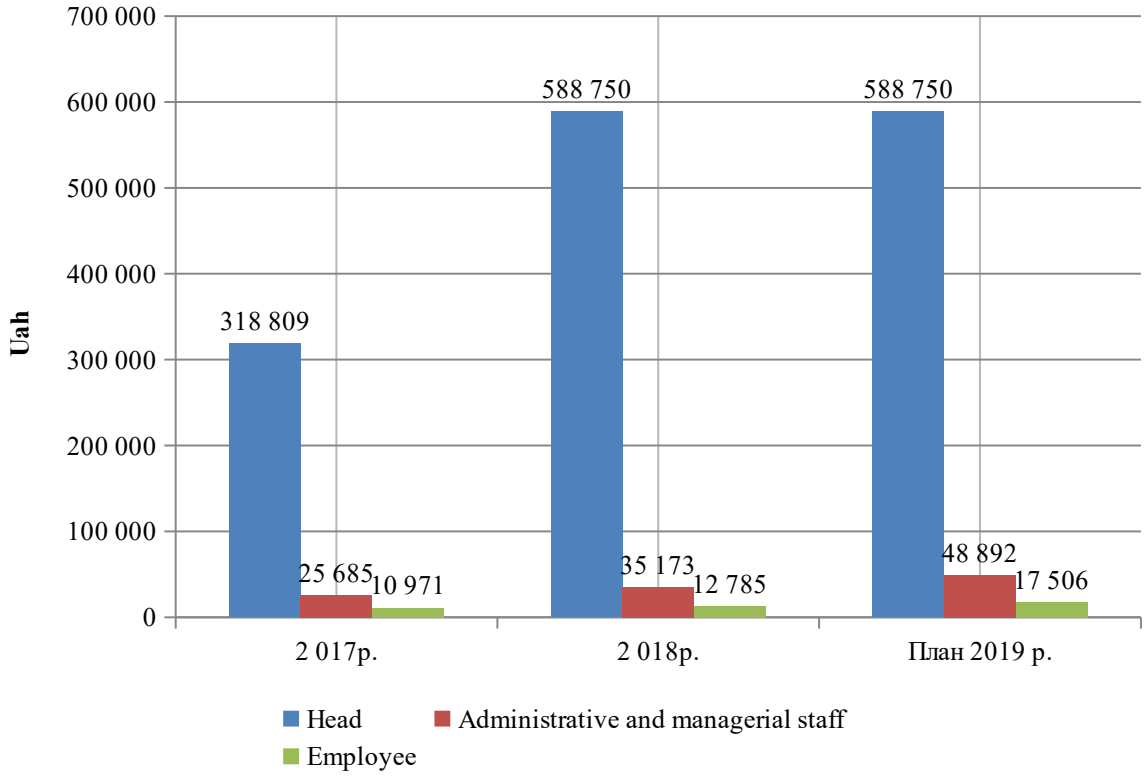


Fig. 2.16. Dynamics of wages of employees of Boryspil airport

Implementation of the airport development strategy will allow passenger traffic to reach 8.0 million passengers in 2019, which is 22.6% higher than the 2015 target. The airport in 2019 will receive income in the amount of 3.2 billion UAH. and according to the financial model, it will be able to obtain net profit of UAH 760 million in 2019, which is more than UAH 593 million exceeds the 2015 plan. The critical element of the airport strategy is the introduction of a system of motivation of air carriers, which will be aimed at the development of new destinations and transfer air transportation.

The following is a SWOT analysis of the Boryspil airport, based on the analysis of the market and airport development opportunities (table 2.6)

Table 2.6

SWOT - analysis of Boryspil airport

Strong side	Weak side
- Possibilities of a flight field (RW № 1 allows to serve long-distance flights); - Hub airport for the leading Ukrainian airlines;	- High level of formalities when crossing the State border (border and customs), which prevents an increase in transfer passenger traffic;
- Possibilities for expanding the infrastructure without significant additional costs; - A large share of international air transportation; - Availability of a network of transcontinental flights.	- Insufficiently developed transfer infrastructure; - Relatively high cost of services provided by the airport; - Insufficient development of affordable commercial infrastructure (shops, catering, transport)
Opportunities	Threats
- Geographical position that facilitates the development of a network of routes; - Strengthening the position of the basic airline (increase of volumes of transportations and connecting flights); - Visa-free regime with the countries of the European Union; - Delayed demand for air transportation, which will be satisfied after the stabilization of the situation in the country.	- The fall of Ukraine's attractiveness for potential passengers as a result of combat operations, a complex socio-political situation in the country; - Economic crisis, falling consumer purchasing power; - More successful and dynamic development of competitive airports.

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

– cooperation with airlines in terms of encouraging the opening of new destinations and preserving existing routes in order to restore passenger flows and increase the share of transfer passenger traffic;

– development of infrastructure for servicing transfer passengers;

– introduction of measures to improve the level of passenger service, in the first place, in the provision of non-aviation services;

– enhancement of security measures;

– cost cutting (cost cutting), including reduction of the cost of services;

– approaching the profile of successful foreign airports without increasing debt burden (application of outsourcing).

In the plans of the management of the airport "Borispil" to open the terminal F in the spring. This may provide an opportunity to continue the construction of the road to terminal D. Also, it is planned to begin construction of the cargo terminal in May and complete the construction in 8 months. In the spring of 2018, the reconstruction of the runway began, which turned into a modernization of the aerodrome infrastructure.

Among the plans for the development and modernization of the airport are intentions to build a bus station on 16 platforms near the Boryspil Airport.

3. DESIGN PART

Air Transportation Management Department				NAU.20.10.14 004EN			
Done by:	Revin V.V.			DESIGN PART	Letter	Sheet.	Sheets
Supervisor	Ivannikova V.Yu.				D	78	42
Standards Inspector	Yuliia V. Shevchenko				FTML 275 ОП-202Ма		
Head of the Department	Shevchuk D. O.						

3.1. IATA and ICAO scenarios and forecast of COVID-19 influences on aviation

Experts of IATA calculated, UATA Airlines Expect Slow Return To Growth, With Demand Down 41% In 2021. Also IATA presented forecasts Wednesday for a slow recovery for the airline industry, with demand expected to be up to 41% below previously projected levels in 2021, and the industry lagging 10% behind previous growth projections as far off as 2025. Forecast for global PRK before and after Covid is presented in fig. 3.1.

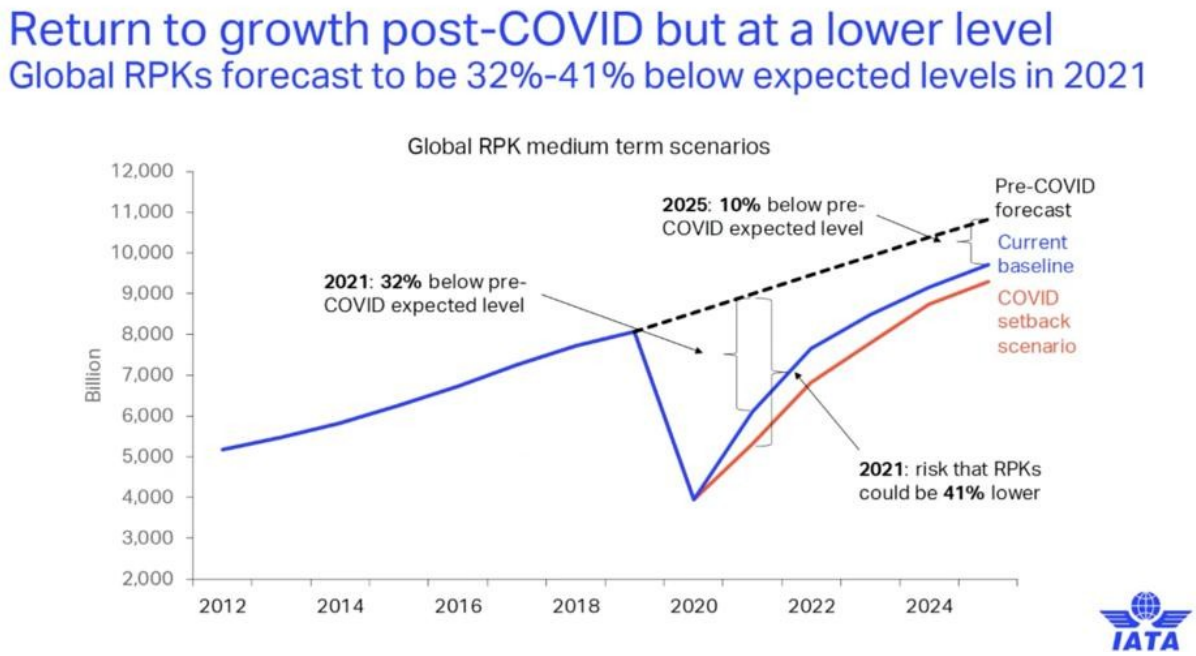


Fig. 3.1. Forecast for global PRK before and after Covi19

[Sourse: IATA report Economic-Impacts-of-COVID-19]

IATA's Chief Economist, Brian Pearce, presented new figures that show the average trip length falling sharply, favoring domestic markets opening first.

A barrier to the recovery of the aviation sector continues to be the need to establish universal protocols for safe air travel that are agreed upon by governments. Instead, recent developments, like the new imposition of a 14-day

quarantine period for visitors announced in the UK and in Spain, are likely to have a dampening effect on demand.

Average trip length in fig. 3.2 shows that domestic market open first and initial preference for short-haul trips.

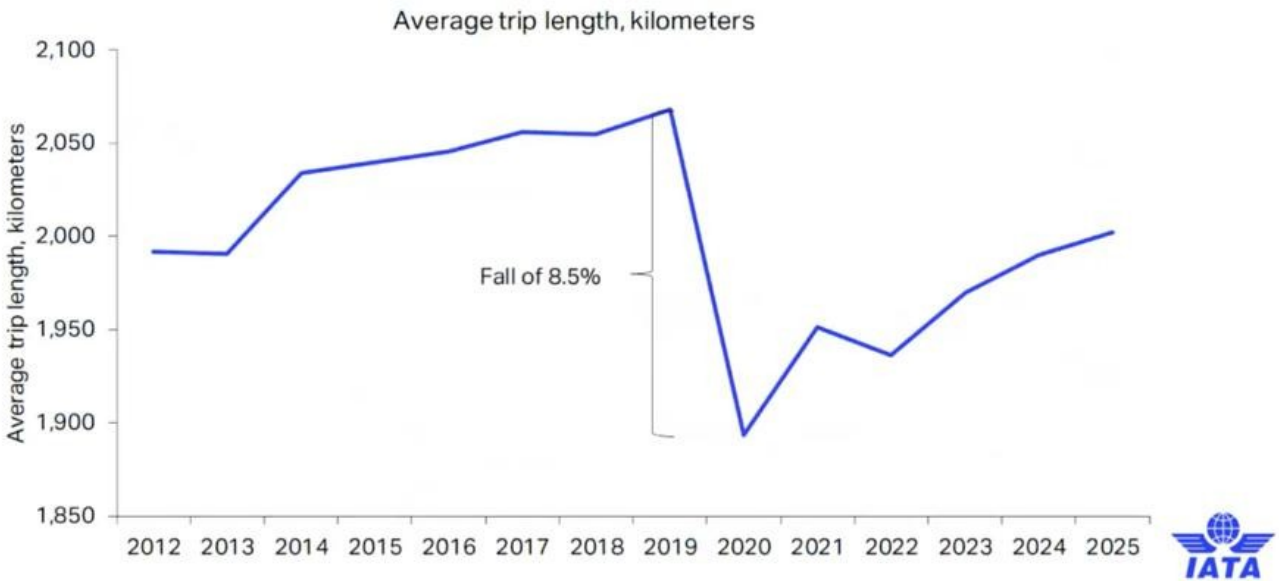


Fig. 3.2. Avaerage trip length

[Sourse: IATA report Economic-Impacts-of-COVID-19]

IATA specialist note that International PRKs will lag domestic air travel markets, that shown in fig. 3.3.

Airlines will lose $100 billion through 2021 due to coronavirus: IATA

With Europe beginning the process of reopening to air travel, the European Commission granted airlines an important win, of sorts, by not requiring that airlines keep an empty seat between passengers on aircraft, leaving the decision to individual EU governments instead. But there are still many details for airlines to sort out as each government considers what is in their best interest and for the time being the burden is falling on airlines to draft individual health and safety protocols.

IATA has been working with ICAO to draft a common approach to ensuring passenger health and safety, while the pandemic is still ongoing. However, it will

be up to governments to decide how they will best protect their citizens and prevent new spikes in coronavirus infections as air travel resumes. Airlines argue that the lack of a harmonized approach will only discourage and confuse passengers.

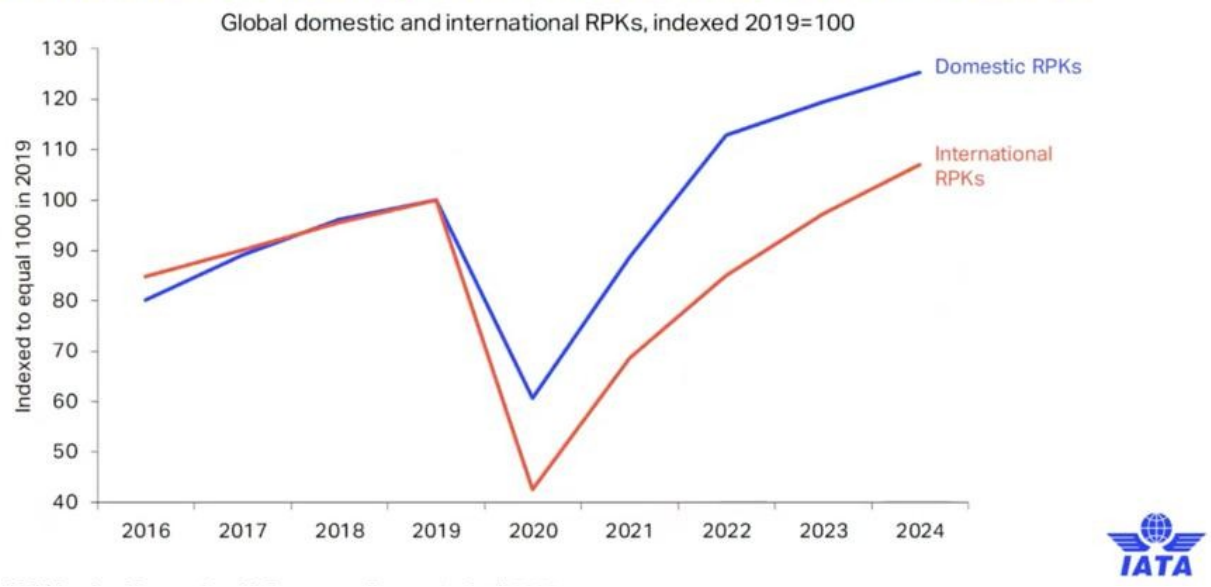


Fig. 3.3. International demand is not expected to return to 2019 levels until 2023-24

[Sourse: IATA report Economic-Impacts-of-COVID-19]

The return of transatlantic travel, particularly between North America and Europe, which is a strong driver of profitability for airlines on both sides of the pond, will still be delayed.

That's going to depend on what we see happening to travel restrictions..on agreed protocols to ensure that there isn't a risk. One would think that European nations and European economies, which are very close to North American economies on trade, would be open in the near future, but it does depend on governments agreeing on these protocols.

The impact of COVID-19 has already surpassed the 2003 SARS (Severe acute respiratory syndrome-related coronavirus) outbreak which had resulted in reduction of annual RPKs by 8% and USD 6 billion revenues for Asia/Pacific

airlines. The 6-month recovery path of SARS might not apply to today's situation (fig. 3.4).

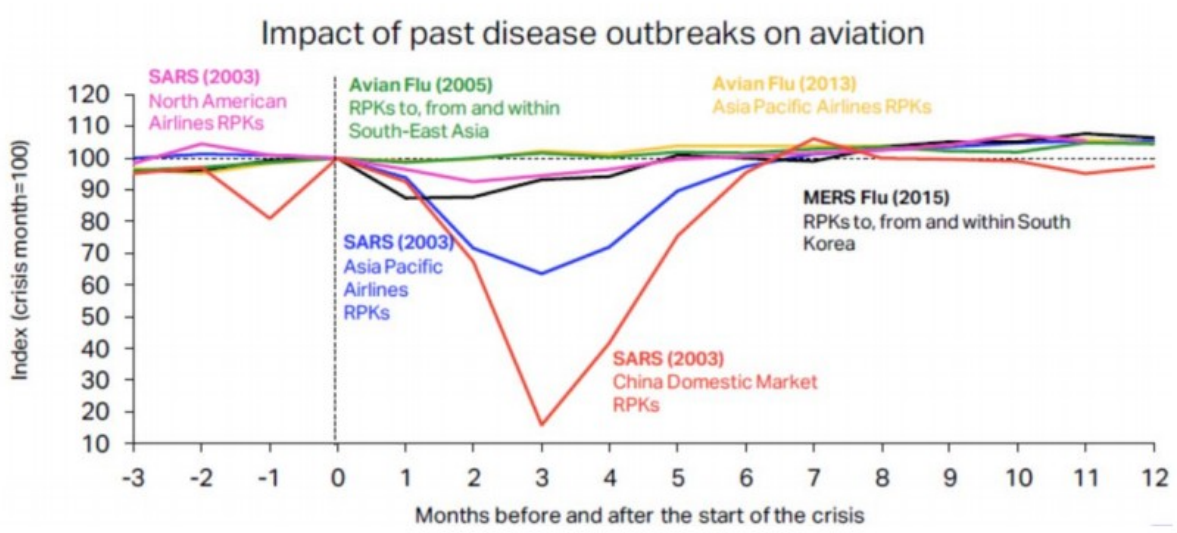


Fig. 3.4. Impact of past disease outbreaks on aviation

As overall severity and duration of the COVID-19 pandemic are still uncertain, four (4) different recovery paths under two (2) indicative scenarios are developed:

Baseline: counterfactual scenario, in which the COVID-19 pandemic does not occur, that is, originally-planned or business as usual

- Scenario 1: two (2) different paths (similar to Nike swoosh- and W-shaped).

- Scenario 2: two (2) different paths (similar to U- and L-shaped)

Reference: information only, based on latest airline schedules (similar to V-shaped).

Let's consider what Scenario means.

Notwithstanding the elevated uncertainty surrounding the outlook, a scenario analysis could help gauge potential economic implications of the pandemic.

Scenarios are not forecasts of what is most likely to happen. Given rapidly changing circumstances, they are merely indicative of possible paths or consequential outcomes out of many.

The exact path (depth, length and shape) will depend upon various factors, inter alia, duration and magnitude of the outbreak and containment measures,

availability of government assistance, consumer confidence, and economic conditions

With the situation evolving and more information available, scenarios will be adjusted as necessary.

International and domestic passenger traffic has separate scenarios/paths

Scenarios/paths are differentiated in terms of supply and demand, i.e.

– Scale of output or seat capacity change.

– Degree of consumer confidence that can be translated into demand or load factor as a proxy.

Supply and demand are influenced by:

– Different timing and speed of recovery by region, international/domestic, and intra-/inter-region.

No consideration is made to social distancing requirements on aircraft, etc.

Baseline: originally-planned or business as usual.

– Counterfactual hypothesis that are expected to occur in the absence of COVID-19 pandemic

– Supply: airlines' originally-planned schedules supplemented by trend line growth

– Demand: trend line growth of demand from 2019 (pre-COVID-19) level

Reference: V-shaped

– Information-only scenario that reflects airlines' most recent expectation or a "signal" of airlines' plan to the market (not necessarily realistic)

– Supply: based on latest update of airline schedules filed, which are adjusted weekly by airlines according to the expectation of the evolving situation (quite often managing capacity for a short period due to the uncertainties)

– Demand: quickly returning to Baseline level.

Scenario 1: Nike swoosh- and W-shaped

• International

– Path 1: Smooth capacity recovery by picking up pent-up demand but at a diminishing rate of growth

– Path 1a: Capacity to start with smooth recovery but then turn back down due to over-capacity

• Domestic

– Path 1: Swift capacity rebound pushed by pent-up demand but at a diminishing rate of growth

– Path 1a: Capacity to start with smooth recovery but then turn back down due to over-capacity

Scenario 2:

U- and L-shaped

• International

– Path 2: Accelerating the return to trend growth after slow progression of capacity recovery

– Path 2a: Capacity recovery at diminishing speed due to respite and continuous demand slump

• Domestic

– Path 2: Gradual capacity recovery, followed by the acceleration of growth.

– Path 2a: Capacity recovery at diminishing speed due to sluggish demand growth.

In the following analysis, international and domestic scenarios having the same path number are linked with each other, although different combination of scenarios/paths would be possible.

Scenario Estimates: Global.

Estimation based on actual results of January to October 2020 re used for the key impact indicators.

• Three (3) key impact indicators under four (4) paths of two (2) scenarios:

– Change of passenger seat capacity (supply, %)

– Change of passenger numbers (demand)

– Change of gross passenger operating revenues of airlines

• Comparison to:

– Baseline scenario

– 2019 level

– 2020 level (for 2021 estimates)

• Break-down by:

– International and domestic.

– Month, quarter and year.

Estimated impacts compared to Baseline & 2019 presented in fig. 3.5. Seat capacity changes we can see in fig. 3.6 – 3.9.

Compared to Baseline	Seat capacity (%)			Passenger number (million)			Passenger revenue (USD, billion)		
	Total	International	Domestic	Total	International	Domestic	Total	International	Domestic
1Q 2020	-18%	-20%	-17%	-287	-111	-176	-35	-20	-15
2Q 2020	-79%	-92%	-69%	-1,044	-488	-556	-136	-86	-50
3Q 2020	-56%	-75%	-42%	-884	-478	-406	-122	-86	-36
4Q 2020	-49% to -49%	-75% to -75%	-30% to -31%	-662 to -673	-388 to -393	-274 to -280	-96 to -97	-71 to -72	-25 to -25
Total 2020	**-51% to -51%**	**-67% to -67%**	**-40% to -40%**	**-2,877 to -2,888**	**-1,465 to -1,470**	**-1,412 to -1,418**	**-389 to -391**	**-263 to -264**	**-126 to -127**
1Q 2021	-38% to -46%	-64% to -74%	-21% to -27%	-525 to -621	-330 to -371	-196 to -250	-78 to -91	-61 to -68	-17 to -23
2Q 2021	-26% to -44%	-46% to -70%	-11% to -25%	-417 to -658	-295 to -413	-122 to -244	-62 to -94	-52 to -72	-10 to -22

Compared to 2019	Seat capacity (%)			Passenger number (million)			Passenger revenue (USD, billion)		
	Total	International	Domestic	Total	International	Domestic	Total	International	Domestic
1Q 2020	-15%	-17%	-13%	-240	-93	-147	-30	-17	-13
2Q 2020	-78%	-92%	-68%	-1,003	-470	-533	-130	-82	-48
3Q 2020	-55%	-74%	-40%	-839	-459	-380	-117	-82	-34
4Q 2020	-47% to -48%	-74% to -75%	-29% to -29%	-631 to -642	-375 to -380	-256 to -262	-92 to -93	-69 to -70	-23 to -23
Total 2020	**-49% to -50%**	**-66% to -66%**	**-38% to -38%**	**-2,713 to -2,724**	**-1,396 to -1,401**	**-1,317 to -1,323**	**-368 to -370**	**-251 to -252**	**-118 to -118**
1Q 2021	-35% to -42%	-62% to -72%	-16% to -22%	-453 to -548	-303 to -344	-149 to -204	-69 to -82	-56 to -63	-13 to -18
2Q 2021	-22% to -41%	-43% to -68%	-7% to -21%	-341 to -582	-261 to -380	-80 to -202	-52 to -85	-46 to -66	-6 to -18

Fig. 3.5. Estimated impacts compared to Baseline & 2019

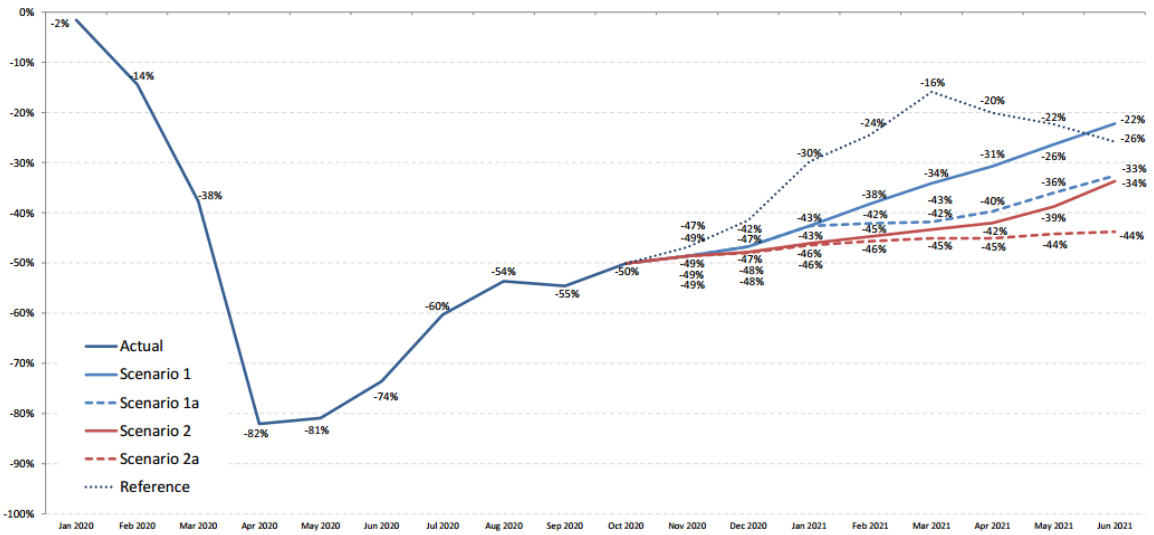


Fig. 3.6. Seat capacity change compared to Baseline: International + Domestic

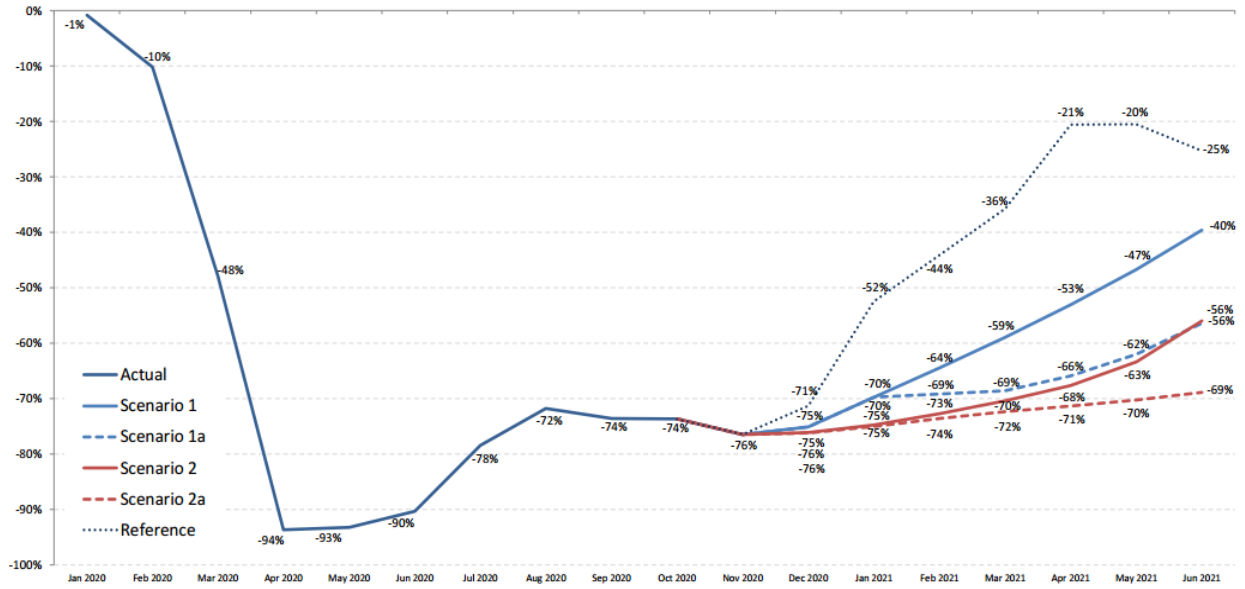


Fig. 3.7. Seat capacity change compared to Baseline: International

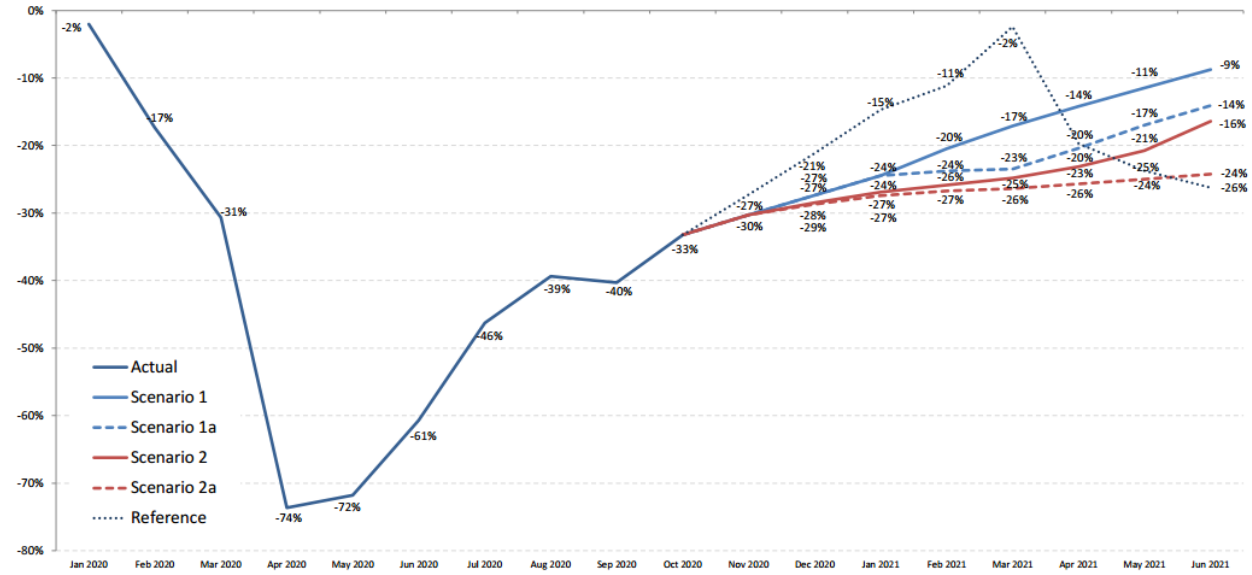


Fig. 3.8. Seat capacity change compared to Baseline: Domestic

Passenger numbers compared to Baseline & 2019 and Passenger revenues presented in fig. 3.9- 3.13.

Scenario Estimates: Region Breakdown. Breakdown by ICAO statistical region.

Breakdown by ICAO statistical region.

• Regional breakdown follows ICAO's six (6) statistical regions (Doc 9060).

Seat Capacity (%) - World Total International + Domestic																		
Month	**Baseline**		**Scenario 1**			**Scenario 1 - Path a**			**Scenario 2**			**Scenario 2 - Path a**			**Reference**		
Compared to:	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020
January 2020	3.2%	-	-1.6%	1.6%	-	-1.6%	1.6%	-	-1.6%	1.6%	-	-1.6%	1.6%	-	-1.6%	1.6%	-
February 2020	5.7%	-	-14.4%	-9.6%	-	-14.4%	-9.6%	-	-14.4%	-9.6%	-	-14.4%	-9.6%	-	-14.4%	-9.6%	-
March 2020	3.1%	-	-37.7%	-35.7%	-	-37.7%	-35.7%	-	-37.7%	-35.7%	-	-37.7%	-35.7%	-	-37.7%	-35.7%	-
April 2020	2.8%	-	-82.1%	-81.6%	-	-82.1%	-81.6%	-	-82.1%	-81.6%	-	-82.1%	-81.6%	-	-82.1%	-81.6%	-
May 2020	3.0%	-	-80.9%	-80.3%	-	-80.9%	-80.3%	-	-80.9%	-80.3%	-	-80.9%	-80.3%	-	-80.9%	-80.3%	-
June 2020	3.4%	-	-73.6%	-72.7%	-	-73.6%	-72.7%	-	-73.6%	-72.7%	-	-73.6%	-72.7%	-	-73.6%	-72.7%	-
July 2020	3.4%	-	-60.3%	-58.9%	-	-60.3%	-58.9%	-	-60.3%	-58.9%	-	-60.3%	-58.9%	-	-60.3%	-58.9%	-
August 2020	2.7%	-	-53.6%	-52.4%	-	-53.6%	-52.4%	-	-53.6%	-52.4%	-	-53.6%	-52.4%	-	-53.6%	-52.4%	-
September 2020	3.1%	-	-54.6%	-53.2%	-	-54.6%	-53.2%	-	-54.6%	-53.2%	-	-54.6%	-53.2%	-	-54.6%	-53.2%	-
October 2020	2.0%	-	-50.1%	-49.1%	-	-50.1%	-49.1%	-	-50.1%	-49.1%	-	-50.1%	-49.1%	-	-50.1%	-49.1%	-
November 2020	1.9%	-	-48.6%	-47.7%	-	-48.6%	-47.7%	-	-48.6%	-47.7%	-	-48.6%	-47.7%	-	-46.8%	-45.8%	-
December 2020	3.1%	-	-46.8%	-45.1%	-	-46.8%	-45.1%	-	-47.8%	-46.2%	-	-48.0%	-46.4%	-	-41.5%	-39.7%	-
January 2021	5.8%	4.2%	-42.6%	-39.3%	-40.2%	-42.6%	-39.3%	-40.2%	-46.1%	-42.9%	-43.8%	-46.5%	-43.4%	-44.2%	-29.8%	-25.7%	-26.9%
February 2021	8.1%	19.5%	-38.2%	-33.2%	-26.1%	-42.1%	-37.4%	-30.8%	-44.8%	-40.3%	-34.0%	-45.6%	-41.2%	-35.0%	-24.5%	-18.3%	-9.7%
March 2021	4.7%	63.0%	-34.1%	-31.0%	7.4%	-41.8%	-39.1%	-5.2%	-43.3%	-40.7%	-7.7%	-45.1%	-42.5%	-10.5%	-15.9%	-12.0%	37.0%
April 2021	5.5%	473.2%	-30.7%	-26.9%	297.1%	-39.7%	-36.4%	245.5%	-42.0%	-38.9%	232.3%	-45.1%	-42.0%	214.9%	-20.1%	-15.7%	358.1%
May 2021	5.6%	437.0%	-26.4%	-22.3%	295.3%	-36.0%	-32.5%	243.4%	-38.8%	-35.4%	228.6%	-44.2%	-41.1%	199.7%	-22.3%	-18.0%	317.0%
June 2021	6.5%	289.8%	-22.3%	-17.2%	203.0%	-32.6%	-28.3%	162.6%	-33.7%	-29.4%	158.3%	-43.8%	-40.2%	119.1%	-25.8%	-21.0%	189.1%
1Q 2020	3.9%	-	-18.0%	-14.8%	-	-18.0%	-14.8%	-	-18.0%	-14.8%	-	-18.0%	-14.8%	-	-18.0%	-14.8%	-
2Q 2020	3.0%	-	-78.8%	-78.1%	-	-78.8%	-78.1%	-	-78.8%	-78.1%	-	-78.8%	-78.1%	-	-78.8%	-78.1%	-
3Q 2020	3.1%	-	-56.2%	-54.9%	-	-56.2%	-54.9%	-	-56.2%	-54.9%	-	-56.2%	-54.9%	-	-56.2%	-54.9%	-
4Q 2020	2.3%	-	-48.5%	-47.3%	-	-48.5%	-47.3%	-	-48.9%	-47.7%	-	-48.9%	-47.8%	-	-46.2%	-44.9%	-
Total 2020	3.1%	-	-51.0%	-49.5%	-	-51.0%	-49.5%	-	-51.1%	-49.6%	-	-51.1%	-49.6%	-	-50.4%	-48.9%	-
1Q 2021	6.2%	24.6%	-38.3%	-34.5%	-23.1%	-42.2%	-38.6%	-27.9%	-44.7%	-41.3%	-31.1%	-45.7%	-42.4%	-32.4%	-23.4%	-18.7%	-4.5%
2Q 2021	5.9%	384.2%	-26.4%	-22.0%	256.5%	-36.1%	-32.3%	209.6%	-38.1%	-34.5%	199.7%	-44.3%	-41.1%	169.5%	-22.8%	-18.3%	273.8%
Grand total	4.0%	-	-44.7%	-42.5%	-	-47.0%	-44.9%	-	-47.8%	-45.7%	-	-49.1%	-47.0%	-	-41.3%	-38.9%	-

Fig. 3.9. Seat capacity change: International +Domestic

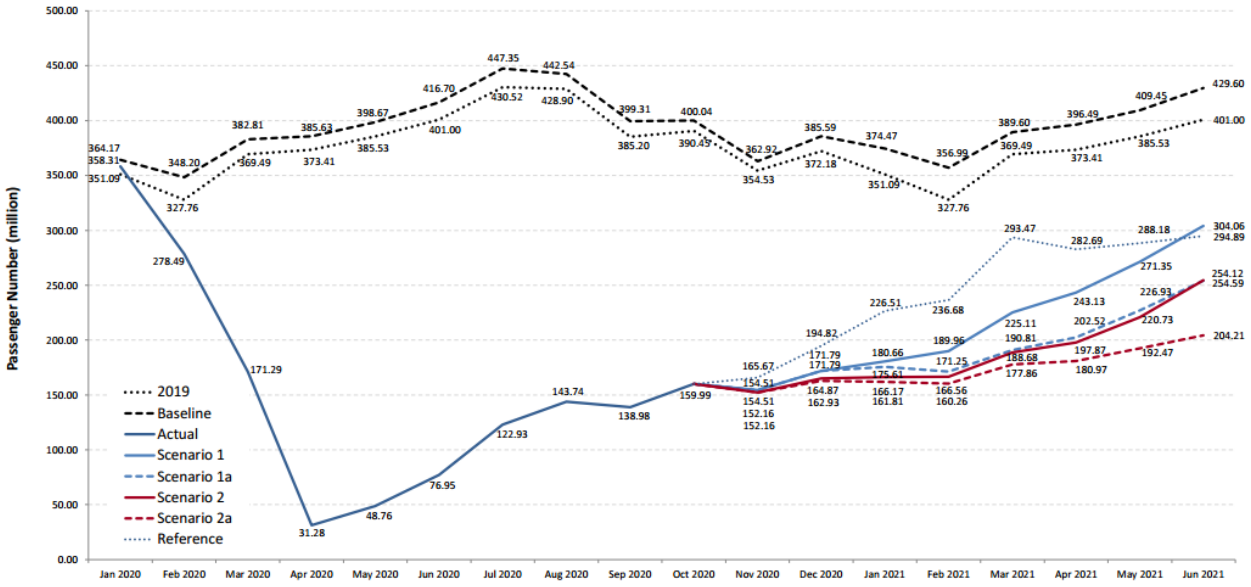


Fig. 3.10. Passenger numbers compared to Baseline & 2019: International +Domestic

• The same key impact indicators are presented under four (4) paths of two (2) scenarios, in comparison to Baseline scenario, 2019 level and 2020 level, and by international and domestic, as well as month, quarter and year.

• To avoid double counting:

– Number of "international" passengers departing from each country and territory are aggregated in each region.

– Gross passenger operating revenues of all airlines serving “international” routes from each country and territory are aggregated at regional level.

Passenger Number (thousand) - World Total International + Domestic																		
Month	Baseline		Scenario 1			Scenario 1 - Path a			Scenario 2			Scenario 2 - Path a			Reference		
Compared to:	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020
January 2020	13,081	-	-5,856	7,225	-	-5,856	7,225	-	-5,856	7,225	-	-5,856	7,225	-	-5,856	7,225	-
February 2020	20,443	-	-69,712	-49,268	-	-69,712	-49,268	-	-69,712	-49,268	-	-69,712	-49,268	-	-69,712	-49,268	-
March 2020	13,322	-	-211,522	-198,200	-	-211,522	-198,200	-	-211,522	-198,200	-	-211,522	-198,200	-	-211,522	-198,200	-
April 2020	12,214	-	-354,351	-342,137	-	-354,351	-342,137	-	-354,351	-342,137	-	-354,351	-342,137	-	-354,351	-342,137	-
May 2020	13,133	-	-349,905	-336,772	-	-349,905	-336,772	-	-349,905	-336,772	-	-349,905	-336,772	-	-349,905	-336,772	-
June 2020	15,701	-	-339,753	-324,052	-	-339,753	-324,052	-	-339,753	-324,052	-	-339,753	-324,052	-	-339,753	-324,052	-
July 2020	16,829	-	-324,419	-307,590	-	-324,419	-307,590	-	-324,419	-307,590	-	-324,419	-307,590	-	-324,419	-307,590	-
August 2020	13,641	-	-298,799	-285,159	-	-298,799	-285,159	-	-298,799	-285,159	-	-298,799	-285,159	-	-298,799	-285,159	-
September 2020	14,105	-	-260,331	-246,226	-	-260,331	-246,226	-	-260,331	-246,226	-	-260,331	-246,226	-	-260,331	-246,226	-
October 2020	9,586	-	-240,044	-230,458	-	-240,044	-230,458	-	-240,044	-230,458	-	-240,044	-230,458	-	-240,044	-230,458	-
November 2020	8,391	-	-208,414	-200,024	-	-208,414	-200,024	-	-210,759	-202,368	-	-210,759	-202,368	-	-197,256	-188,865	-
December 2020	13,417	-	-213,801	-200,384	-	-213,801	-200,384	-	-220,718	-207,301	-	-222,667	-209,250	-	-190,776	-177,359	-
January 2021	23,386	16,161	-193,816	-170,430	-177,655	-198,867	-175,482	-182,706	-208,303	-184,918	-192,142	-212,662	-189,276	-196,501	-147,964	-124,578	-131,803
February 2021	29,227	78,495	-167,022	-137,796	-88,527	-185,739	-156,512	-107,244	-190,427	-161,200	-111,931	-196,724	-167,497	-118,229	-120,310	-91,083	-41,815
March 2021	20,105	218,305	-164,484	-144,379	53,821	-198,784	-178,678	19,521	-200,915	-180,809	17,390	-211,732	-191,627	6,573	-96,128	-76,022	122,177
April 2021	23,071	365,207	-153,358	-130,287	211,850	-193,965	-170,894	171,243	-198,619	-175,548	166,589	-215,518	-192,447	149,690	-113,792	-90,722	251,415
May 2021	23,922	360,695	-138,103	-114,180	222,592	-182,529	-158,607	178,166	-188,722	-164,800	171,973	-216,981	-193,058	143,714	-121,279	-97,357	239,416
June 2021	28,594	352,645	-125,536	-96,943	227,109	-175,475	-146,881	177,171	-175,003	-146,409	177,643	-225,388	-196,794	127,258	-134,707	-106,113	217,939
1Q 2020	46,847	-	-287,090	-240,243	-	-287,090	-240,243	-	-287,090	-240,243	-	-287,090	-240,243	-	-287,090	-240,243	-
2Q 2020	41,048	-	-1,044,009	-1,002,961	-	-1,044,009	-1,002,961	-	-1,044,009	-1,002,961	-	-1,044,009	-1,002,961	-	-1,044,009	-1,002,961	-
3Q 2020	44,575	-	-883,549	-838,975	-	-883,549	-838,975	-	-883,549	-838,975	-	-883,549	-838,975	-	-883,549	-838,975	-
4Q 2020	31,394	-	-662,259	-630,866	-	-662,259	-630,866	-	-671,521	-640,127	-	-673,469	-642,076	-	-628,075	-596,682	-
Total 2020	163,863	-	-2,876,908	-2,713,045	-	-2,876,908	-2,713,045	-	-2,886,169	-2,722,306	-	-2,888,118	-2,724,255	-	-2,842,724	-2,678,861	-
1Q 2021	72,718	312,961	-525,322	-452,605	-212,361	-583,390	-510,672	-270,429	-599,644	-526,927	-286,683	-621,118	-548,400	-308,157	-364,402	-291,684	-51,441
2Q 2021	75,587	1,078,548	-416,996	-341,410	661,551	-551,968	-476,382	526,579	-562,344	-486,757	516,204	-657,886	-582,299	420,661	-369,778	-294,192	708,769
Grand total	312,168	-	-3,819,227	-3,507,059	-	-4,012,266	-3,700,098	-	-4,048,158	-3,735,990	-	-4,167,122	-3,854,955	-	-3,576,904	-3,264,737	-

Fig. 3.11. Passenger number change: International +Domestic

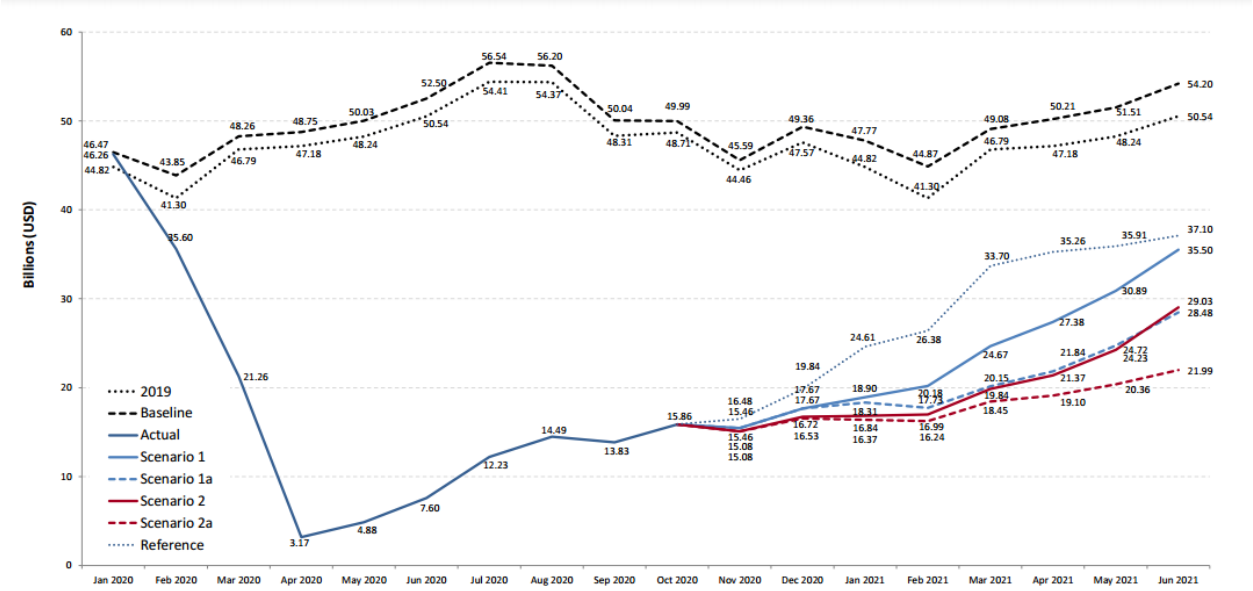


Fig. 3.12. Passenger revenues compared to Baseline & 2019: International + Domestic

Consider assumptions underlying Scenarios.

Baseline (Originally-planned, business as usual).

Seat capacity: Airlines' winter schedules filed with OAG as of 6 January 2020. Maximum number of seats taken from airlines' summer schedules filed with OAG during the period from 6 January 2020 to 20 April 2020. Maximum number of seats taken from airlines' summer schedules filed with OAG during the period from 6 January 2020 to 20 April 2020. Using 2019 winter schedule as the base, and applying the pre-COVID-19 trend line growth, i.e. growth rate of 2019/2018 as proxy. Using "2020 Baseline "as the base, and applying the baseline growth of 2020/2019, or growth rate of 2019/2018, whichever is smaller.

Passenger Number (thousand) - Africa International + Domestic																	
Month	Baseline		Scenario 1			Scenario 1 - Path a			Scenario 2			Scenario 2 - Path a			Reference		
Compared to:	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020	Baseline	2019	2020
January 2020	693	-	-424	269	-	-424	269	-	-424	269	-	-424	269	-	-424	269	-
February 2020	932	-	-820	112	-	-820	112	-	-820	112	-	-820	112	-	-820	112	-
March 2020	664	-	-5,169	-4,505	-	-5,169	-4,505	-	-5,169	-4,505	-	-5,169	-4,505	-	-5,169	-4,505	-
April 2020	635	-	-10,207	-9,572	-	-10,207	-9,572	-	-10,207	-9,572	-	-10,207	-9,572	-	-10,207	-9,572	-
May 2020	651	-	-9,343	-8,692	-	-9,343	-8,692	-	-9,343	-8,692	-	-9,343	-8,692	-	-9,343	-8,692	-
June 2020	767	-	-10,093	-9,326	-	-10,093	-9,326	-	-10,093	-9,326	-	-10,093	-9,326	-	-10,093	-9,326	-
July 2020	581	-	-10,317	-9,736	-	-10,317	-9,736	-	-10,317	-9,736	-	-10,317	-9,736	-	-10,317	-9,736	-
August 2020	460	-	-10,063	-9,603	-	-10,063	-9,603	-	-10,063	-9,603	-	-10,063	-9,603	-	-10,063	-9,603	-
September 2020	538	-	-8,789	-8,252	-	-8,789	-8,252	-	-8,789	-8,252	-	-8,789	-8,252	-	-8,789	-8,252	-
October 2020	488	-	-7,751	-7,262	-	-7,751	-7,262	-	-7,751	-7,262	-	-7,751	-7,262	-	-7,751	-7,262	-
November 2020	594	-	-7,177	-6,584	-	-7,177	-6,584	-	-7,317	-6,724	-	-7,317	-6,724	-	-6,898	-6,304	-
December 2020	816	-	-7,358	-6,542	-	-7,358	-6,542	-	-7,732	-6,916	-	-7,804	-6,987	-	-6,684	-5,867	-
January 2021	1,088	819	-6,393	-5,306	-5,574	-6,598	-5,511	-5,779	-7,087	-5,999	-6,268	-7,263	-6,175	-6,444	-5,427	-4,340	-4,608
February 2021	1,290	1,179	-5,376	-4,086	-4,197	-6,025	-4,734	-4,846	-6,266	-4,976	-5,088	-6,537	-5,247	-5,359	-4,741	-3,451	-3,562
March 2021	873	5,378	-5,201	-4,327	178	-6,244	-5,371	-866	-6,391	-5,518	-1,013	-6,842	-5,969	-1,464	-4,446	-3,573	932
April 2021	1,093	10,665	-4,901	-3,807	5,765	-6,067	-4,974	4,598	-6,206	-5,113	4,459	-6,897	-5,804	3,768	-4,446	-3,353	6,219
May 2021	1,123	9,815	-4,150	-3,027	5,664	-5,244	-4,121	4,571	-5,303	-4,180	4,512	-6,321	-5,198	3,493	-3,956	-2,833	5,859
June 2021	1,425	10,751	-4,178	-2,753	6,573	-5,328	-3,902	5,424	-5,058	-3,633	5,693	-6,856	-5,431	3,895	-4,666	-3,240	6,086
1Q 2020	2,289	-	-6,414	-4,125	-	-6,414	-4,125	-	-6,414	-4,125	-	-6,414	-4,125	-	-6,414	-4,125	-
2Q 2020	2,053	-	-29,642	-27,590	-	-29,642	-27,590	-	-29,642	-27,590	-	-29,642	-27,590	-	-29,642	-27,590	-
3Q 2020	1,579	-	-29,169	-27,590	-	-29,169	-27,590	-	-29,169	-27,590	-	-29,169	-27,590	-	-29,169	-27,590	-
4Q 2020	1,898	-	-22,286	-20,388	-	-22,286	-20,388	-	-22,800	-20,902	-	-22,872	-20,973	-	-21,332	-19,434	-
Total 2020	7,819	-	-87,511	-79,692	-	-87,511	-79,692	-	-88,026	-80,207	-	-88,097	-80,278	-	-86,557	-78,738	-
1Q 2021	3,251	7,376	-16,970	-13,719	-9,594	-18,867	-15,616	-11,491	-19,744	-16,493	-12,368	-20,643	-17,391	-13,266	-14,615	-11,363	-7,238
2Q 2021	3,642	31,231	-13,229	-9,588	18,002	-16,638	-12,997	14,593	-16,567	-12,926	14,664	-20,074	-16,433	11,157	-13,068	-9,426	18,163
Grand total	14,712	-	-117,710	-102,999	-	-123,017	-108,305	-	-124,338	-109,626	-	-128,814	-114,102	-	-114,240	-99,528	-

Fig. 3.13. Passenger number change: International + Domestic

Passenger load factor: Forecasted 2020 load factor by region/route group, based on ICAO long-term traffic forecasts (LTF), which was adjusted monthly by difference between 2019 actual monthly results (ICAO, IATA) and 2019 LTF forecasted load factor; Forecasted 2021 load factor by region/route group, based on ICAO long-term traffic forecasts (LTF), which was adjusted monthly by difference between 2019 actual monthly results (ICAO, IATA) and 2019 LTF forecasted load factor.

Assumptions underlying Scenarios for Baseline (Originally-planned, business as usual) and for Scenarios 1/1a, 2/2a we put in table 3.1-3.2.

Table 3.1

Assumptions underlying Scenarios for Baseline (Originally-planned, business as usual)

(International and domestic)	Baseline (Originally-planned, business as usual)	
	Seat capacity	Passenger load factor
January to March 2020	Airlines' winter schedules filed with OAG as of 6 January 2020	Forecasted 2020 load factor by region/route group, based on ICAO long-term traffic forecasts (LTF), which was adjusted monthly by difference between 2019 actual monthly results (ICAO, IATA) and 2019 LTF forecasted load factor
April to September 2020	Maximum number of seats taken from airlines' summer schedules filed with OAG during the period from 6 January 2020 to 20 April 2020	
October to December 2020	Using 2019 winter schedule as the base, and applying the pre-COVID-19 trend line growth, i.e. growth rate of 2019/2018 as proxy.	
January to June 2021	Using "2020 Baseline "as the base, and applying the baseline growth of 2020/2019, or growth rate of 2019/2018, whichever is smaller	Forecasted 2021 load factor by region/route group, based on ICAO long-term traffic forecasts (LTF), which was adjusted monthly by difference between 2019 actual monthly results (ICAO, IATA) and 2019 LTF forecasted load factor

Table 3.2

Assumptions underlying Scenarios for 1/1a, 2/2a

(International and domestic)	Scenarios 1/1a, 2/2a	
	Seat capacity	Passenger load factor
January to September 2020	Actual capacity based on ICAO ADS-B data	Actual estimated results by region/route group
October 2020		Average 35 (international) and 13 (domestic) percentage points lower than October 2019 load factor with adjustment of GDP impact by region/route group
November 2020 to June 2021	Scenarios 1/1a & 2/2a: Application of monthly "base percentage" which incorporates impacts of intra-/inter-regional share difference (2019) Reference: Most recent airlines' schedules filed with OAG	Application of "base percentage" which incorporates GDP impact by region/route group

Data usd for scenario analysis:

• Base percentages of seat capacity already take into consideration short/long haul (intra/inter region) impacts and will be applied ton Baseline level of seat capacity.

• Base percentages of load factor already take into consideration economic (GDP) factors and will by added ton 2019 load factor %.

• Seat capacity (seats available for sale): OAG airlines schedule data; Route Online; airline websites and ICAO ADS-B operational data.

• Load factor (RPKs/ASKs): ICAO long-term traffic forecasts (LTF); ICAO statistical reporting forms; IATA economics data; and airline news release.

• Historical passenger traffic (including ASKs, RPKs, passenger numbers and operating revenues): ICO Annual Report of the Council; and ICAO statistical reporting forms.

• Yield (passenger revenues/RPK): ICAO revenue-cost analysis of airlines (RCA); and ICAO-ICM Marketing Information Data Transfer (MIDT passenger origin-destination).

• Macroeconomic factors (GDP impact): Income elasticity of demand estimated for ICAO LTF; and IMF and World Bank economic outlook data.

3.2. Scenarios of forecast and economic modeling approach in aviation

Aviation will transform more between today and 2035 than it has over its first 80 years as a commercial industry By 2035, Aviation will experience a greater change than it went through over its first 80 years as a commercial industry. It has already been through three strategic eras, from the era of monopolies (until the 1980s), to the eras of continental competition, until the mid-2000s. Then it entered the era of hyper-competition, which is now at its peak. The industry will soon go through a transition phase between hyper-competition and the next era, hyper-cooperation, which we can foresee now thanks to early signs.

The previous eras saw great changes, such as hub & spoke and low-cost airline operations, new generations of narrow and widebody aircraft, the

emergence of commercial activities at airports, and the first cooperation between "different species" (e.g., interline agreements between low-cost carriers and legacy airlines, joint ventures to develop new aircraft programs). But the pace of change is much faster now, and most of all, none of the previous changes triggered major changes among the different (a) clusters and (b) players in each cluster that compose the aviation industry ecosystem.

In 2035 we will see a fundamentally different aviation industry in terms of business and operating models, driven by demand evolution, technological breakthroughs and changes in regulation.

We scrutinized the above-listed megatrends in order to estimate their potential impact on the growth or value sharing of the majority of players within the aviation industry and the degree of likelihood or uncertainty of each. This categorization is the second step of our scenario-building approach.

Our scenario and economic modeling approach shows very different total revenue and value creation for the aviation industry by 2035 – and possibly even more differentiated revenue and value sharing among players of the ecosystem.

Indeed, the total revenue growth of aviation will be driven by demand evolution, which will mostly be impacted by regulation (competition law, allowance of last-mile aviation, environmental tax, etc.) and pricing power of airlines. Profit for aviation players in 2035 will be also driven by new operating models, enabling reduction of CAPEX and OPEX – up to the point that each player will be able to retain profit instead of sharing it with its customers.

This value capture will be driven by the ability of players to expand in the value chain and consolidate their own industry while keeping away new entrants. Hence, the very different revenue and profit pools associated with each scenario:

Lets highlights key factors that aviation stakeholders (clients, regulators and industrial players) should monitor and influence in order to shape the future of aviation:

- Overall, environmental performance is key to ensuring long-term growth for the entire ecosystem, with new energy storage, AI, cybersecurity and connectivity as cornerstones for “last-mile aviation”

- Airlines must keep control of scarce resources and clients due to a new perspective of “mediatization”/“platform play”. In addition, Ownership and personal data regulation will be key for transport providers to transfer data from airlines to gatekeepers and consolidate the industry.

- Aircraft-as-a-service is the new goal of aircraft providers, and cooperation is the best way to achieve it.

- Economic regulation of infrastructure providers will be key to driving profit sharing with clients, while automation and concentration will create a larger profit pool.

Our aviation 2035 scenarios are a basis from which to identify actions to be taken at industry and organization levels, in order to facilitate and take advantage of a preferred scenario (thanks to bold strategic moves) or mitigate potential risks (by grasping “strategic insurance”).

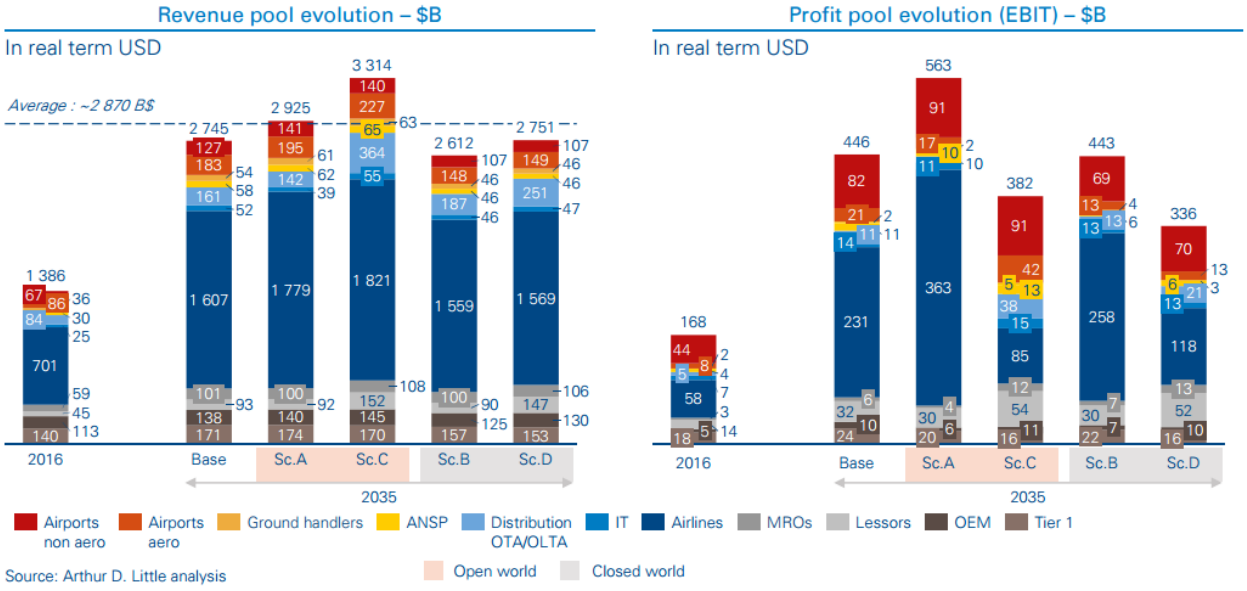


Fig. 3.14. Key economics

Five-step methodology (fig. 3.15). Our approach is thus based on five key steps:

Step 1: drafting a panorama of the ecosystem today: its key players, their economics and their revenue and value shares. We actually considered three strategic clusters and the main players within them: aircraft providers (tier 1s, OEMs, MROs, lessors), air transport service providers (airlines, IT & distribution) and infrastructure providers (airports, air navigation services, ground handlers and caterers).

Step 2: Identifying key trends and disruption that could impact players by 2035 in several domains: demand, competitors' strategies, offerings, regulations, and technology.

Step 3: Assessing the potential impact of each megatrend and disruption in terms of strategic positioning and value capture for players of the ecosystem, and their likelihood of occurrence.

Step 4: Framing scenarios based on those trends from a 2035 perspective.

Step 5: Evaluating the impact of those scenarios on the strategic added value of each player in the aviation ecosystem, and how the revenue and value shares among players could be transformed.

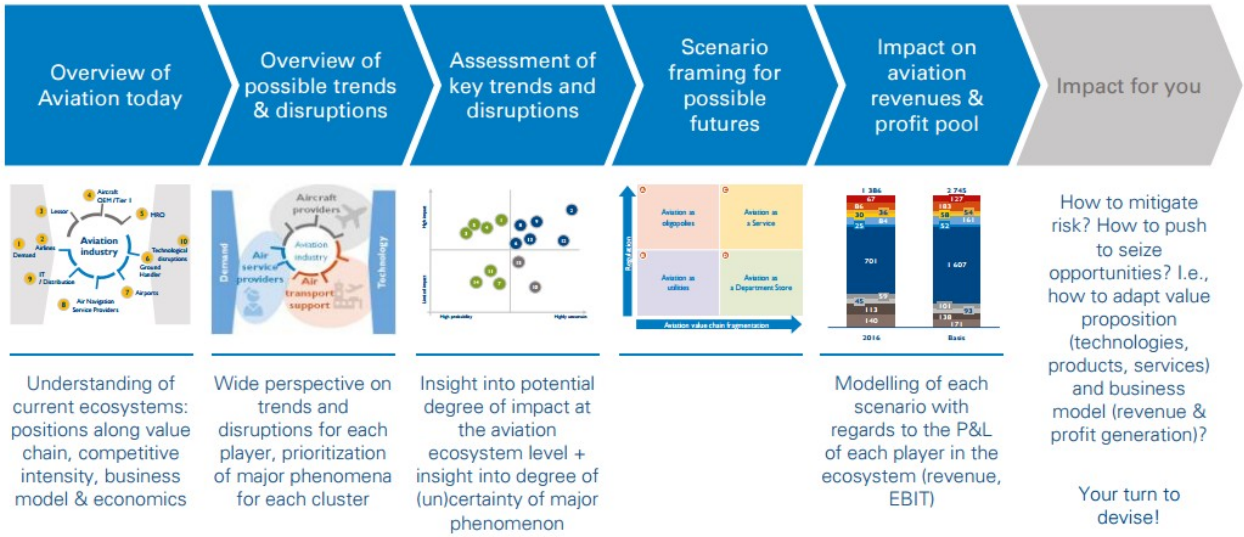


Fig. 3.15. Scenario building Methodology to imagine Aviation in 2035

Today, aviation is a major global industry accelerating growth and socio-economic development across the planet. But since its debut 70–80 years ago, the commercial civil aviation industry has been through three strategic eras: it has evolved from (1) local monopolies to (2) continental competition, and is now in the middle of (3) the era of hyper-competition.

Today's era of hyper-competition is the result of entry barriers for new airlines being at a historical low, thanks to easier-than-ever accessibility to scarce resources (namely airport slots, traffic rights, aircrafts, IT solutions, qualified crew and technicians, and capital).

Of course, some tensions will arise for the supply and control of some resources (such as airport slots at mega-hubs, technicians and pilots), but looking long-term, these have never been as abundant as they are today, and neither has supply been so "fluid". In this era of hyper-competition, a growing number of competitors are addressing all strategic and tactical segments of the commercial air transport market: medium-haul or long-haul markets, point-to-point or connecting flows, premium or ultrabasic customers. No niche is immune.

Coming up now and certainly enduring until 2025–2030 is (4) the era of hyper-cooperation, in which all clusters in the aviation industry will try to limit internal competitive intensity thanks to consolidation.

Strategic clusters and key players in the aviation industry presented in fig. 3.16.

Fig. 3.16. Strategic clusters and key players in the aviation industry

[Source: aviationbenefits.org , Oxford Economics]

In fig. 3.17 we can see the four eras of the commercial aviation industry.

	1950 1960 1970	1980 1990 2000	2010 2015	2020 2025 2030
	Era of monopolies	Era of continental competition	Era of hyper-competition	Era of hyper-cooperation
Dominant geo-economic zones	Nations	Larger continental free-trade zones (NAFTA, UE, etc.)	Global megacities	Global megacities
Wealth & mobility	"Jet set" Airport traffic: from 2% => to 30% of world population	"Mass transportation" Airport traffic: 30% => 80% of world population	"Hybrid and fragmented clients" Airport traffic: 80% => +100% of world population	"Hybrid and fragmented clients" Airport traffic: 80% => +100% of world population
Traffic & ownership rights	National airlines, bilateral agreements, with traffic rights down to airport-to-airport level	Deregulation at continental level (USA, Europe, India, China, etc.)	ASEAN opens skies Global open skies	Lifted ownership rights
Aircrafts	Long-haul jets	Efficient medium-haul jets and short-haul turboprops	Next-generation long-haul jets enable tapping into smaller markets	Last-mile aviation
Airlines	Local & national flag carriers	National flag carriers & global alliances	New entrants ("LCCs")	Multi-brand airline holdings
Infrastructure providers	State-owned players/ subsidiaries of airlines	State-owned players/ subsidiaries of airlines	Global independent leaders, but long tail of local players	Global independent leaders
Aircraft providers	US "oligopoly"	US-EUR duopoly	US-EUR duopoly	US-EUR-China JVs for specific programs

Fig. 3.17. The four eras of the commercial aviation industry

We thus see aircraft tier 1s and OEMs consolidating. It will be the same with top 10 players in industries such as MRO, ground handling and airline catering, as these already control between 50 and 80 percent of the accessible market and are pursuing dynamic merger & acquisition strategies.

Airlines themselves are initiating a movement towards consolidation because of market exit, acquisition and creation of multi-airline groups and new forms of alliances and cooperation, such as medium-haul, low-cost airlines feeding long-haul operations of peers or even legacy airlines.

Each "cluster" of the aviation industry has its own economics. They can be labor- or capital intensive, and they can be exposed to the increasing number of units composing the commercial aviation fleet, the actual asset utilization, or the

number of passengers transported. Each of these must also deal with very different internal competitive intensity.

However, the fight between parties to capture the largest share of the industry's revenues and profit pools is intense, and so far the battle has ended up at the expense of airlines: their share of the profit pool has been much lower than their revenue share, as shown above.

Although they are the cornerstone of the industry, airlines have not managed to protect their share of value. They have seen aircraft suppliers preserving their margins and infrastructure providers converting their rather small share of revenues into a large share of profits.

3.3. Aviation-as-a service: Five scenarios for 2035

Three groups of trends were built (see illustration fig. 3.17):

- All macro-trends that we believed had high certainty were considered to create a "base scenario".

- Macro-trends with low impact and high uncertainty of occurrence were not considered.

- Macro-trends with high impact but high uncertainty of occurrence were considered to derive future scenarios for aviation 2035.

Our base scenario comprised all highly probable trends, and disruption is very unstable. This cannot be a possible future for aviation in 2035 that will be changed by other, more uncertain megatrends and disruptions.

The top six key disruptions in the blue area are therefore the critical ones to be considered. They all correspond to two major themes: (a) aviation (de)regulation and (b) strategic moves of players along the value chain of the aviation industry, within existing clusters or beyond the frontiers of current clusters (fig. 3.18).

To embrace the full scope of the future of aviation de-regulation, the two extreme possible scenarios, Open World and Closed.

Fig. 3.17. Mapping of megatrends and disruptions

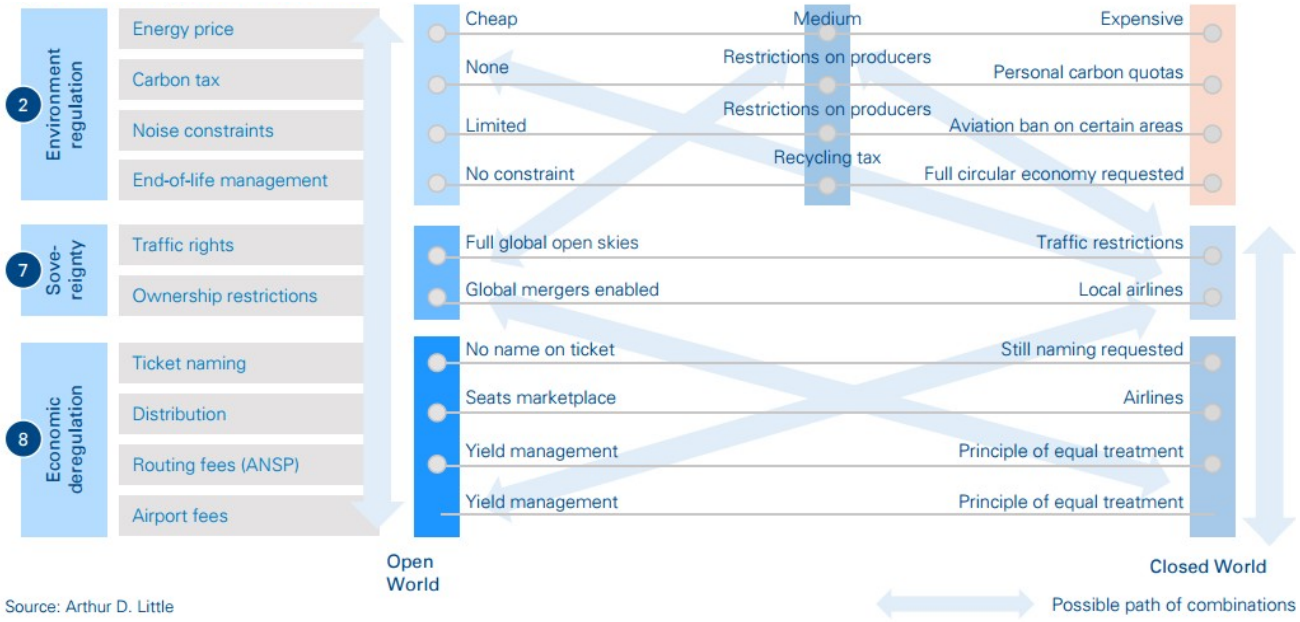


Fig. 3.18. Deregulation scenarios

World, are proposed, combining different options among the following parameters:

2. Environmental regulation: High (or low) carbon tax or quotas.

6. Sovereign deregulation: Lifting traffic rights and ownership rights (or not)

7. Economic deregulation: allowing (or not) a seats marketplace and yield management for infrastructure pricing (airports, ANSPs, etc.)

In this option space, we excluded a scenario in which environmental regulations would no longer only apply to goods & services producers (as they do today by imposing better environmental performance), but also directly to consumers. In such a scenario each individual would be allocated a yearly quota of pollution/CO2 emissions and be free to arbitrate how to use it without going over the limit, or they would be heavily taxed. This scenario would be a major rupture to aviation growth, but we consider it improbable by 2035 from a global perspective. Aviation value chain recomposition scenarios is presented in 3.19.

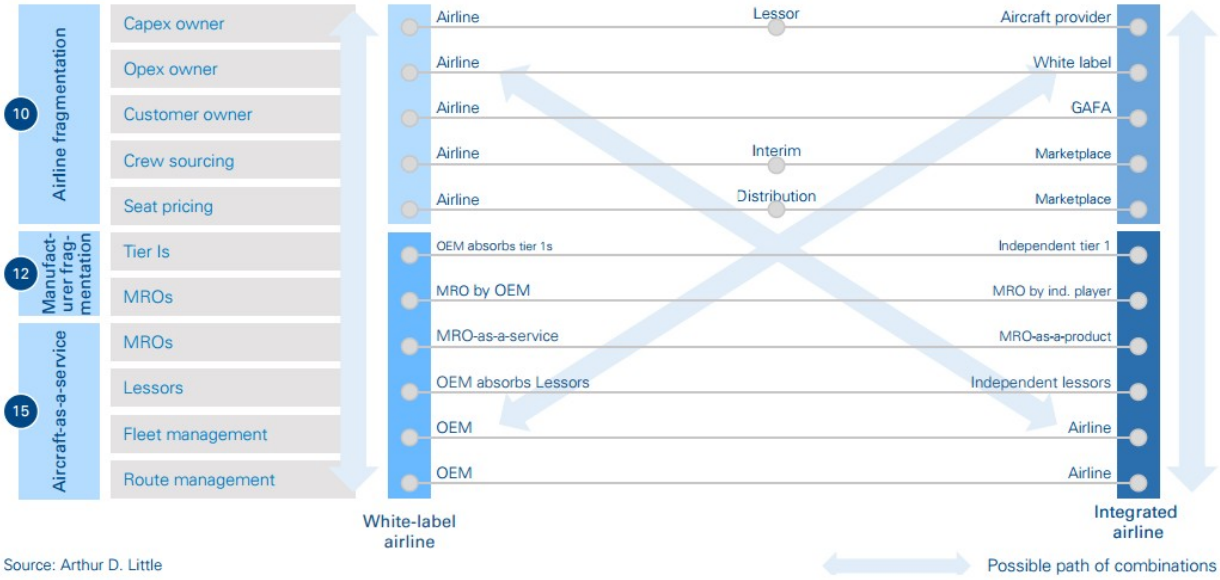


Fig. 3.19. Aviation value chain recomposition scenarios

Aviation value chain recomposition patterns can be grouped into four possible scenarios that combine options for either air transport providers or aircraft providers:

10. Airline fragmentation: Breakdown (or not) of airlines into capex, opex and customer owners

12. Manufacturers' vertical integration: OEMs, tier 1s, MROs and lessors becoming single players (or not)

13. Aircraft-as-a-service: Manufacturing pivoting towards services and full management (even operation) of airlines' fleets.

To embrace the full scope for the future of the aviation value chain recomposition, the two possible extreme scenarios were taken into account in the report. White-label airlines and integrated aircraft-as-a-service were considered on one side, and integrated airlines and fragmented aircraft suppliers on the other.

An integrated airline would look at technology blocks aiming to differentiate, and should resist OEM/MRO integration. Conversely, in a fragmented air service industry, white-label airlines, reduced to only operating aircrafts, would most likely need integrated OEMs to provide aircraft-as-a-service.

Combining uncertain megatrends and disruptions to define five scenarios.

The combination of the “certain” and “uncertain” megatrends and disruptions described above leads to five scenarios for aviation in 2035 (fig. 3.20).

Fig. 3.20: 5 possible scenarios for Aviation in 2035

Base scenario: lean through automation.

In this scenario, the whole industry moves towards automation of processes and improves margins by leveraging new technologies (data analytics, AI, 3D printing, etc.). Cybersecurity and connectivity enablers become critical for the

industry and facilitate UAV emergence. Consolidated regional, multi-brand airline groups cover numerous customer segments. Airlines have also twisted their revenue generation models towards becoming media platforms, with the most advanced players offering free tickets. Aircraft OEMs compete with mega-tier 1s to capture value-add in the aircraft supply cluster and in the market for last-mile aviation. Infrastructure providers are becoming more efficient, but keeping a stable role and value in the ecosystem.

A. Aviation as oligopolies: Integrated global airlines and fragmented aircraft production industry in a deregulated world In this scenario, limited environmental regulations, coupled with low energy prices, stimulate aviation demand and growth. Thanks to (de)regulated ownership rights, airlines are concentrated into a few groups of global players, which enables them to meet the competitive challenge with distribution service providers and regain huge bargaining power versus the rest of the value chain. However, infrastructure providers are still able to diversify profit generation sources thanks to deregulation. In this scenario, aircraft providers are in a tougher situation, as they are still fragmented and have failed to regain added value against their clients.

B. Aviation as utilities: Integrated regional airlines and a fragmented aircraft production industry in a constrained environment

In this scenario, heavy carbon and energy taxation limits aviation growth and pressures producers. Consequently, the aviation industry is structured around regional groups – limited by national or regional control. Customers still value differentiated experience to a certain extent, although environmental concerns moderate expectations. Intense competition exists between airlines that must deal with lower growth and higher cost bases, although operating according to different models (LCC versus customer experience). In any case, airlines remain in control of the customer relationship.

Infrastructure service providers are strictly regulated and can’t aggressively capture value, while aircraft providers focus on green and autonomous products to make a difference.

C. Aviation-as-a-service: White-label airlines and OEMs offering aircraft-as-a-service in a deregulated world.

In this scenario, limited environmental regulations coupled with low energy prices stimulate aviation growth. Low entry barriers stimulate competition, while the lifting of ownership restrictions enables the emergence of global players in each segment of the value chain. The market is embracing “mass-customization”, with price as a key selection criterion, while customers are still looking for personalized add-ons and experience. Thanks to economics and personal data deregulation, distribution players have succeeded in owning the customers. OEMs are concentrated into a few total fleet provider and manager groups, providing modular assets as services. The cost of infrastructure is getting higher, with airports disrupted on non-aero revenues and ANSPs introducing yield management on routes. As a result, airlines are cornered, as pure asset operators and their economics are thus under strong pressure from both downstream and upstream stakeholders

D. Aviation-as-a-department store: White-label airlines and OEMs integrated as services in a constrained environment.

In this scenario, heavy carbon and energy taxation limits aviation growth and pressures producers. The aviation industry is structured around regional groups – and limited by national controls. The market is commoditized with standard products to which customers can add handpicked options.

Air transport has become a media provider through which various brands express themselves in different parts of the cabin. This is just like today, when luxury hospitality or cosmetics brands “franchise” the first class of airlines.

Air transport service providers procure aircrafts from total fleet providers and managers, which capture an even greater profit pool versus infrastructure providers.

Major moves along the value chain ahead. The illustration summarizes the major shifts in the value-chain positioning of key players that correspond to each scenario. It is thereafter explicit which clusters and players are gaining strategic

added value. In the base case no major shift is expected; today's situation continues. (For players such as airlines and OEMs, the landscape might change significantly, but we are looking at this from the ecosystem perspective.)

In other scenarios, the strategic roles fulfilled by airlines, OEMs, distributors and infrastructure providers can change a lot. This can include associated impact on their economic models, revenue generation and profit capture.

3.4. Impact of the five scenarios on value sharing in the aviation industry

Our scenario and economic modeling approach shows very different total revenue and value creation for the aviation industry by 2035 – and possibly even more differentiated revenue and value sharing among players in the ecosystem. Indeed, by 2035, aviation will experience a greater change than it has already gone through over its first 80 years as a commercial industry.

Demand will continue to grow at a fast pace, but "masscustomization" that travelers expect, emergence of "last-mile aviation for people and goods", and regulation could shape very different growth trajectories.

Technology will also play a leading role in enabling the future of aviation. Connectivity, cyber-security, block-chain, artificial intelligence and automation have the greatest impact at the ecosystem level, because they are key enablers of moves along the value chain and reinventing operations and revenue generation models. Other technologies, such as green energy and new materials, are important, of course, but have more limited impact; this stimulates the emergence of "new products".

However, most possible changes are to be considered within the aviation ecosystem itself.

	0 Lean through automation *Macro-trends with high degrees of certainty*	A Aviation as oligopolies *Integrated regional airlines & fragmented aircraft production industry in a deregulated world*	B Aviation-as-a-utility *Integrated regional airlines & a fragmented aircraft production industry in a constrained environment*
Air service providers *(Airlines, IT, distributors)*	▪ Airlines consolidate regionally around 7-8 key players and some smaller niche players, but concentration remains limited by traffic rights/ownership regulations ▪ Airlines leverage new techno. to optimize costs of cockpit and cabin crew ▪ Ancillary share increases to 40%	▪ Airlines consolidate globally around 7-8 key players and some smaller niche players ▪ Airlines' integrated services are becoming global, multimodal and door-to-door (i.e., airlines are eventually included in large "mobility providers") ▪ Integrated airline groups retain control over value chain & value, thus differentiate on product	▪ Integrated airlines retain control over their regional strongholds ▪ Airlines further invest in product/ service differentiation to compete within regional battlefield ▪ Limited competition between airlines within regions: multiple adjacent monopolies & oligopolies ▪ Global distribution and IT have some leverage against regional airlines
Aircraft providers *(OEMs, tier 1s, lessors, MROs)*	▪ "Legacy" OEMs & tier 1s consolidate horizontally in response to new players (Comac, etc.) ▪ OEMs & tier 1s move toward industry 4.0 models & MROs adopt predictive maintenance, enabling major jumps in profitability ▪ Despite the UAV emergence, aircraft providers do not face any major disruptions except single-pilot operations	▪ OEMs are barred from entering service markets by "integrated airlines" counterparts ▪ Pricing power against globally consolidated airlines is limited ▪ OEMs turn to tier 1s for cost-cutting to retrieve profitability ▪ OEMs possibly consolidate horizontally in response to airlines	▪ Airlines retain control over MROs and decision power to design aircrafts and systems ▪ OEMs and tier 1 manufacturers do not consolidate further vs. today and fail overtaking independent MRO players… ▪ … and are forced to innovate towards green, silent and recycled products to comply with regulations and enable differentiation of airline value propositions
Infrastructure providers *(Airports, ANSPs, handling)*	▪ All players benefit from automation & improve margins ▪ Pressure for green operations is significant ▪ Airports face disruptions to their non-aero revenues (retail & car parks) and must find other ways to monetize ("toll" instead of "duration fee")	▪ Airports and handling players need to offer differentiated services to attract global airlines (even to propose fully customized airports)… ▪ … Margins are somehow squeezed by stronger airlines, but yield management of scarce resources triggers the appetites of globally consolidated private operators	▪ The business models of "infrastructure service providers" are pressured by oligopolistic airlines at regional level, which try to dictate their conditions + by stringent economic regulation ▪ Airlines invest in regional airports – they both manage customer experience regionally

3.21. Impact of the five scenarios on value sharing in the aviation industry

C Aviation-as-a-service *White-label airlines & OEMs integrated as services in a deregulated world*	D Aviation-as-a-dept. store *White-label airlines & OEMs integrated as services in a constrained environment*	
▪ Customers are owned by gatekeepers (such as Google or a new "mobility platform") ▪ Gatekeepers are asset-less, but capture most of their value by distributing door-to-door, multimodal, global solutions operated by multiple partners … with gatekeepers pushing airlines to become media providers to enable new sources of revenues (with ticket prices falling sometimes to zero) ▪ Airlines also tend to cost+ model (white-label air transport provider)	▪ Airlines are regionally consolidated but globally fragmented ▪ Airline brands can "fade away" to let other brands express themselves in the aircraft ("branded cabins"); airlines operate like department stores and must be able to "quickly" reconfigure their assets (i.e., terminals & aircrafts) ▪ Airlines thus are driven to emphasize monetization of the customer base through a "media" model	Air service providers *(Airlines, IT, distributors)*
▪ OEMs seize the opportunity of weakened airlines to support them with services from MROs up to fleet and route management ▪ Aircraft "hardware design" is heavily standardized but connected components are key for gatekeepers' mass-customization (e.g., Google's connectivity ecosystem)	▪ To support "white-label" airlines, aircraft providers move towards full-services scope, from MROs to fleet and route management ▪ Value & risk are thus transferred from airlines to manufacturers ▪ Manufacturers pressure regulators to relieve green constraints so they can focus their investments in the move towards service (capital intensive in the transition phase)	Aircraft providers *(OEMs, tier 1s, lessors, MROs)*
▪ Ground products are standardized but can support customization ▪ Economic deregulation allows for innovative congestion pricing for airport slots and air routings, bringing additional value to support providers… which can consolidate and also benefit from weak airlines	▪ Infrastructure services providers focus on optimizing services to serve "branded airlines" ▪ Very strong pressure to innovate for greener operations	Infrastructure providers *(Airports, ANSPs, handling)*

Fig. 3.22. Impact of the five scenarios on value sharing in the aviation industry (continue)

Airlines' business models could move from fully integrated and consolidated players or white-label aircraft operators, generating revenues and profits from selling transportation services, towards becoming media offering "free tickets" but monetizing their client bases to third parties.

Aircraft providers are seeking to offer aircraft-as-a-service while investing to consolidate horizontally and offer nextgeneration smarter and more versatile flying machines.

Finally, infrastructure providers will see fundamental changes in their operating models to cope with anticipated growth and price pressures.

3.5. Forecast of passenger traffic at Boryspil airport depending on the development scenarios impact of the pandemic in the world

Due to the spread of the coronavirus, airlines around the world are rapidly reducing passenger traffic. Widespread border closures are putting carriers at risk of bankruptcy. The British IAG is forced to cut the volume of traffic by 75%, Ryanair - by 80%, Air France-KLM - by 90%, American Airlines Group announced a 75% reduction in international flights. In connection with the closure of borders, United Airlines predicts a drop in bookings of air tickets by $ 1.5 billion in March. The salaries of top managers will be cut by 50% at least until the end of spring, and possibly until the end of summer.

Companies operating mainly in Europe have suffered the most from the situation around the coronavirus. Due to the dire consequences for the industry, European states will discuss subsidies or direct assistance to bail out some airlines before the end of the six months. Due to the shutdown of flights around the world, the industry will suffer major losses. We assume that the average annual profit will fall from at least 24% to 40 - 55%. In addition, a number of airlines will receive negative free cash flow for 2020. For example, for Air France, this figure will go into the negative by almost a billion dollars. We advise long-term investors not to consider buying assets from this sector. However, the right moment may come

after three to six months against the backdrop of a decline in the spread of the virus in developed countries.

To make a forecast and to choose a right model we need input data of traffic passenger flaw in Boryspil for last period with comparison of the same period in previous year (table 3.3 and fig. 3.23).

Table 3.3

Passenger traffic at Boryspil airport in 2020 compared to the same months of 2019

	January	February	March	April	May	June	July	August	September
2020	798,7665	906,6	486,5	900,6	28,2	48,4	328,7	656	554,5
2019	897,2	793,4	727,3175	1155,1	1357,8	1512,5	1625,3	1648,6	922,688

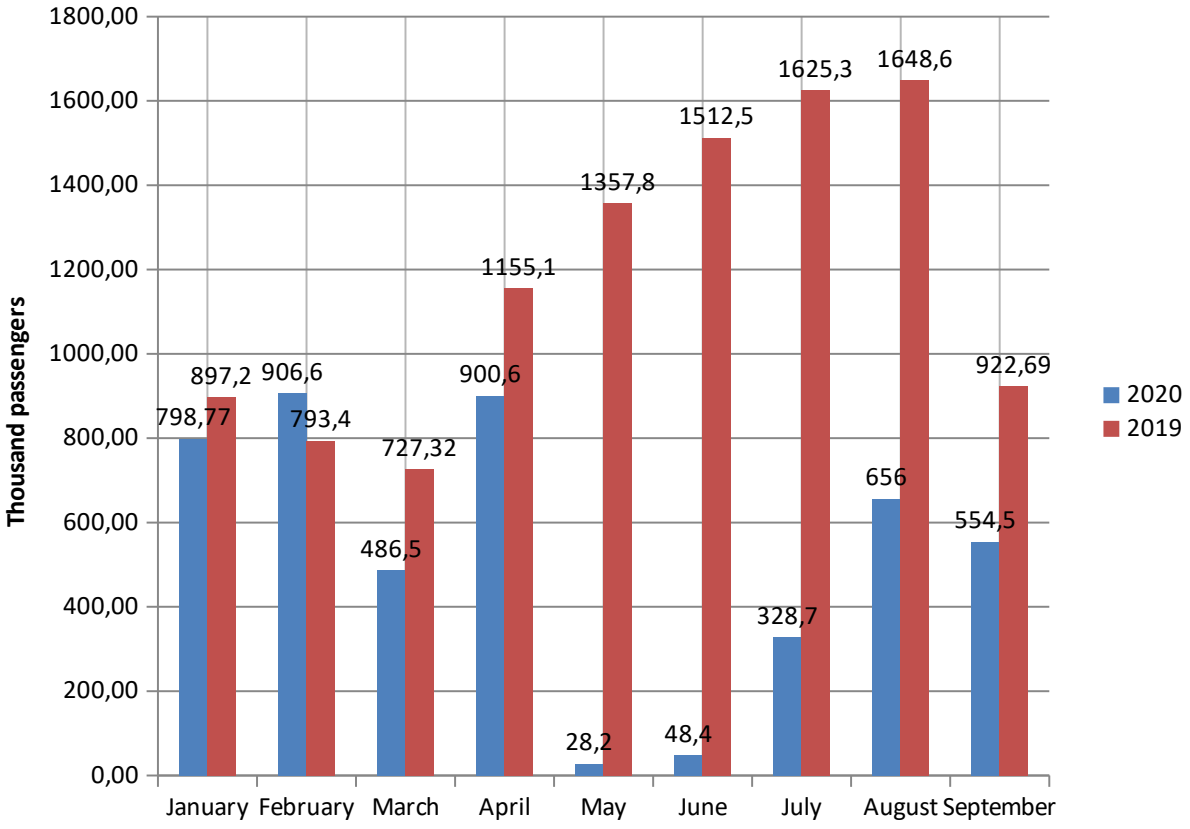


Fig. 3.23. Passenger traffic at Boryspil airport in 2020 compared to the same months of 2019, ths

Boryspil Airport in July 2020 increased passenger traffic almost 7 times compared to June to 328.7 thousand people, the press service of the enterprise reported to avianews.com.

This happened against the background of a gradual increase in the number of regular and charter flights from Kiev, both on domestic and international routes. Tourist flights were resumed to Bulgaria, Turkey, Egypt, Montenegro and Croatia.

However, compared to July 2019, the drop in passenger traffic at Boryspil airport was 79.8%.

International flights in July 2020 were used by 284.9 thousand people, domestic - 43.8 thousand people, which is 81.2% and 60.4% less compared to July 2019.

A more intensive restoration of flights on domestic routes was due to the deployment of the regional program "Wind Rose" on small aircraft.

According to the State Aviation Administration, the forecast of passenger traffic at Ukrainian airports in 2020 is about 27 million, of which about 2.5-3 million are passengers on domestic flights. The passenger traffic will be supported by attracting new airlines and modernizing regional airports. MIU plans to abolish VAT on domestic flights. the airline wants to remove VAT on domestic flights (this document has already been approved by the committees of the Verkhovna Rada), and the excise tax on aviation fuel (the document is still under consideration). It is also planned to remove certification of air ticket sales.

The passenger traffic of Boryspil International Airport from January to September 2020 fell to 4.058 million passengers. This figure is 65% less than for the same period in 2019. Moreover, the indicators for September also decreased: if this year the airport served almost 555 thousand passengers, then last year there were more than 1.6 million of them. Due to the restrictions adopted by the Ukrainian government in August, the September Hasidic program did not take place. , together with which "Borispol" received less than 30% of the passenger traffic.

The hub model has become unrealistic - the Borispol airport missed about 3 million transfer passengers. The aviation industry has cut its costs as much as possible in order to withstand a difficult period. Quarantine restrictions continue to be a stop factor for passengers. By analyzing the statistics for January - September 2020, we can more accurately predict the expected passenger traffic, which will end the year: it will fall to the level of 2009, which will lead to a multiple decrease in airport revenues compared to 2019.

The American airline American Airlines has begun to simulate the transportation of the COVID-19 vaccine. The tests took place in late November using Boeing 777-200 aircraft based in Miami. All relevant protocols were followed prior to approval of the COVID-19 vaccine.

Recall that companies around the world are working on the certification of vaccines against COVID-19. It is hoped that such vaccines will provide immunity and end the pandemic. However, once the vaccine is available, it will need assistance with transportation around the world. This is where airlines come to the rescue, which can quickly distribute such cargo, maintaining the right temperature on board so that vaccines do not spoil.

At American Airlines, a dedicated team of employees works exclusively to ensure that such temperature-sensitive cargo can travel thousands of kilometers without problems. Before such difficult flights, the crew on board had to prepare thoroughly. After all, if something goes wrong during the flight, it's best to deal with it before the vaccine itself is at stake. As such, the airline worked in tandem with its cargo and pharmaceutical partners. Stress tests were carried out on the packaging in which vaccines will be shipped, as well as the cargo handling process at airports.

Traffic forecasting is an integral part of the Decision Support System (DSS); it is a systematic review of the company's resources, allowing you to more fully exploit its advantages and identify potential threats in a timely manner. The company must constantly monitor the dynamics of the volume of traffic and alternative opportunities for the development of the situation in the air

transportation market in order to best allocate available resources and choose the most appropriate areas of its activities.

Forecasting the volume of passenger traffic (both long-term and short-term) is one of the aspects of management activities for a modern airline. Long-term forecasting takes into account the tendencies of the world air transportation market, which are reflected in the increase or decrease of the frequency of flights on various directions when drawing up the flight schedule. Short-term forecasting allows you to quickly respond to changes in the situation on the air transportation market and build an airline strategy based on the expected volume of passenger traffic (for example, change the degree of "aggressiveness" of booking, prepare and conduct special promotions to attract passengers, etc.).

The total volume of air transport traffic is formed from individual passenger flows between corresponding points in the forward and backward directions. The volume of traffic for a certain period of time and the distance of transportation determine the most important indicator - passenger turnover.

It is almost impossible to identify the influence of numerous factors on passenger traffic and take into account the transport needs of each individual passenger due to the enormous scale of such work, therefore, they resort to establishing the determining integral factors that can serve as the basis for predicting the population's demand for transportation.

The initial passenger-forming factors are the population size and its needs for spatial movement (potential factor). Potential travel needs are determined by goals (personal or government), the balance of free time, the availability of funds and other factors that cannot be predicted in a pure form.

In modern conditions, when justifying the volume of passenger traffic, two types of forecast are used: a forecast of demand for air transportation and a forecast of possible traffic volumes (passenger turnover), obtained on the basis of data on actual demand. The difference between these values is the volume of unmet demand. In the practice of planning air transportation, in most cases, they are guided by data on actually performed transportation. Further improvement of

methods for forecasting passenger traffic is aimed at identifying unmet demand, and planning is aimed at meeting it in an economically justified amount.

There are the following most famous forecasting software on the market: STATISTICA, STATGRAPHICS, SPSS, Forecast Expert, STADIA, MetaStock, Statistica Neural Networks, Neuro Shell, Poly Analyst, Matlab & Simulink, Forecast PRO, etc.

To predict the demand for passenger transportation, various methods of economic and mathematical modeling can be applied, which are built in the form of equations characterizing the dependence of the consumption of goods or services on certain factors (economic, natural). Such models can be univariate and multivariate. An example of one-factor models for passenger transportation can be the dependence of sales volumes on advertising costs, as well as the dependence of sales volumes on prices. As a result of processing hypothetical data with graphical models and the least squares algorithm, an equation for the dependence of sales volume on advertising costs and an equation for the dependence of sales volumes on the price of passenger transportation were obtained.

In world and domestic practice, there are models used to predict the passenger traffic of airlines, based, as a rule, on a regression analysis of retrospective dynamics of passenger traffic and a set of macroeconomic indicators. However, the degree of applicability of such models for the Ukrainian market turned out to be limited both due to the lack of the required volume of statistical data and the long period of stabilization of the air services market in Ukraine.

The simplest way to predict the traffic volume is extrapolation, i.e. propagation of past trends into the future. The method of linear extrapolation is used in cases where it is necessary to determine the indicator of the prospective period and at the same time, fundamental changes in the nature and conditions of the action of factors affecting passenger traffic are not expected. The established objective tendencies to a certain extent predetermine their size in the future. In addition, many market processes have some inertia. This is especially evident in short-term forecasting. At the same time, the forecast for the long-term period

should take into account as much as possible the likelihood of changes in the conditions in which the airline will operate.

The use of the extrapolation method for forecasting assumes that the pattern that was in effect in the past will continue in the forecast period, but it is expected that the general trend in the development of transportation in the airline should not undergo major changes in the future (for example, the schedule parameters should remain relatively stable), since the theoretical basis for the spread of the trend to the future is the inertia property, which allows one to identify the existing relationships between the levels of the time series. But this is true only when building short-term forecasts, since in a short period the conditions for the development of the phenomenon and the nature of its dynamics do not have time to change significantly. With long-term forecasts, the dynamism of processes comes into conflict with the inertia of their development, therefore, in these cases, the extrapolation method is not enough.

Methods of analysis and forecasting of time series are associated with the study of indicators isolated from each other, each of which consists of two elements: the forecast of the deterministic component and the forecast of the random component. The development of the first forecast does not present great difficulties if the main development trend is determined and its further extrapolation is possible. The prediction of the random component is more difficult, since its appearance can be estimated only with a certain probability.

At the heart of casual methods is an attempt to find the factors that determine the behavior of the predicted indicator. The search for these factors leads actually to economic and mathematical modeling - the construction of a model of the behavior of an economic object, taking into account the development of interrelated phenomena and processes. It should be noted that the use of multivariate forecasting requires solving a complex problem of choosing factors, which cannot be solved purely by statistical means, but is associated with the need for a deep study of the economic content of the phenomenon or process under consideration.

Casual forecasting methods require determining factor indicators, assessing their changes and establishing a relationship between them and the volume of traffic.

Of all the casual forecasting methods, we will consider only those that can be used with the greatest effect to predict the traffic volume.

These methods include:

- correlation and regression analysis;
- method of leading indicators;
- the method of surveying the intentions of consumers, etc.

Among the most widely used casual methods is correlation and regression analysis.

Each of the considered groups of methods has certain advantages and disadvantages. Their application is more effective in short-term forecasting, since they simplify to a certain extent real processes and do not go beyond the present day. The simultaneous use of quantitative and qualitative forecasting methods should be ensured.

These factors, as well as changes in the structure of traffic at airports and a sharp fluctuation in their volumes, do not make it possible to use simple methods for forecasting and analyzing econometric dependencies (models).

Thus, the main task for Boryspil Airport is to develop a decision support system for air transportation management, which, based on the analysis of statistical data on the airline's passenger traffic, will make it possible to make forecasts on the size of passenger traffic, revenue and profitability. Thus, this system will enable the airline's management to make decisions regarding the number of flights operated, requests for transport, ticket prices, etc.

Conclusions:

1. The use of the extrapolation method for forecasting is not suitable, since the trend in the past is not related to the existing factors in connection with the Covid-19 pandemic.

2. Methods of analysis and forecasting of time series are difficult to apply without the use of special information systems; it also contains a probabilistic factor for the development of aviation in the future, for example, the emergence of a vaccine against Covid-19 can have a positive effect on the growth of passenger traffic due to vaccination of the population around the world.

Today IATA annalists commonly used quantitative forecasting methods and decomposition methods.

Quantitative forecasting methods can be broadly classified into two major subcategories: timeseries analysis and causal methods. Some of the more widely used techniques in these two subcategories include trend projections, decomposition methods and regression analysis (fig. 3.24).

The time-series analysis methods are largely based on the assumption that historical patterns will continue, and they rely heavily on the availability of historical data.

A first step when forecasting air traffic activity is usually to study the historical data (time series) and determine the trend in traffic development. In the context of medium-term or long-term forecasting, a traffic trend represents the development in traffic over many years, isolated from short-term fluctuations in traffic levels. When deriving a medium-term or long-term forecast by extrapolating from the traffic trend, the forecaster assumes that the factors which determined the historical development of the traffic will continue to operate in the future as in the past, except that their impact may change gradually, and steady-state conditions will continue into the future. The appropriateness of using trend analysis in forecasting depends heavily on stability in past developments and the confidence of the forecaster that the assumption of continuing trends is appropriate to the particular operating environment.

In its simplest form, trend projection analysis is nothing more complicated than plotting the traffic data series on a graph. The traffic variable to be forecast (the dependent variable) is plotted on the vertical axis, and time (the explanatory or independent variable) is plotted on the horizontal axis. When each point in the time

series is plotted, a smooth curve that seems to come close to all the points may then be drawn in freehand style, or a straight edge can be used to put a line through the data.

A trend may be stable in absolute terms (linear growth) or in percentage terms (exponential growth), but it can also suggest an ultimate limit to growth, particularly if the time span extends over several decades. The type of trend curve that best fits a given time series of traffic data may be determined by using different types of graph paper and different ways of plotting the data. Plotting the data on ordinary graph paper with even spacing (or arithmetic grid paper) will show a linear growth pattern as a straight line. An exponential growth pattern (constant percentage growth rate) will appear as a straight line on linear-logarithmic paper (linear timescale, logarithmic traffic scale), and the slope of the curve at any point will be proportional to the percentage rate of growth or decline at that point in time.

After the data are plotted on graph paper and a trend curve that appears to fit the data is established, the forecaster can then simply extend the visually fitted trend curve to the future period for which the forecast is desired. The forecast data can then be read from the graph and presented in a table. This is considered to be a simple linear extrapolation of the data.

Trend projection analysis methods use mathematical techniques to determine the best fit line through the data, just as is done by using graph paper and a straight edge. In the more sophisticated trend projection methods, the mathematics and the shape of the line being fitted to the data are more complex.

The different types of trend curves can be represented by various mathematical relationships. The mathematical formulations, which correspond to the trend curves illustrated in Figure 1-2, are given below. In each case, the dependent variable Y is traffic, the explanatory variable T is time (normally measured in years) and a, b and c are all constants (sometimes called coefficients) whose values can be estimated from the data (fig. 3.25).

a) Linear (or straight line):

$$Y = a + bT, \qquad (3.1)$$

This implies a constant annual increment b in the traffic level, and a declining rate of growth.

b) Exponential:

$$Y = a(1 + b)\ T \log Y = \log a + T \log (1 + b), \qquad (3.2)$$

With b positive and normally less than one, this implies a constant annual percentage increase in traffic at a rate 100b.

By taking logarithms, the exponential formulation can be converted to a linear formulation.

c) Parabolic:

$$Y = a + bT + cT^2 \qquad (3.3)$$

With three constants, this family of curves covers a wide variety of shapes (either concave or convex). For c greater than zero, growth curves of this type have the characteristics that growth in absolute terms per unit time increases linearly with time while the rate of growth decreases with time.

d) Gompertz:

$$T\ c\ Y\ ab- = \log Y = \log a – c\ T \log b,\ 0 < c < 1 \qquad (3.4)$$

This curve eventually approaches a saturation level a and may be found appropriate to represent traffic developments over very long time periods.

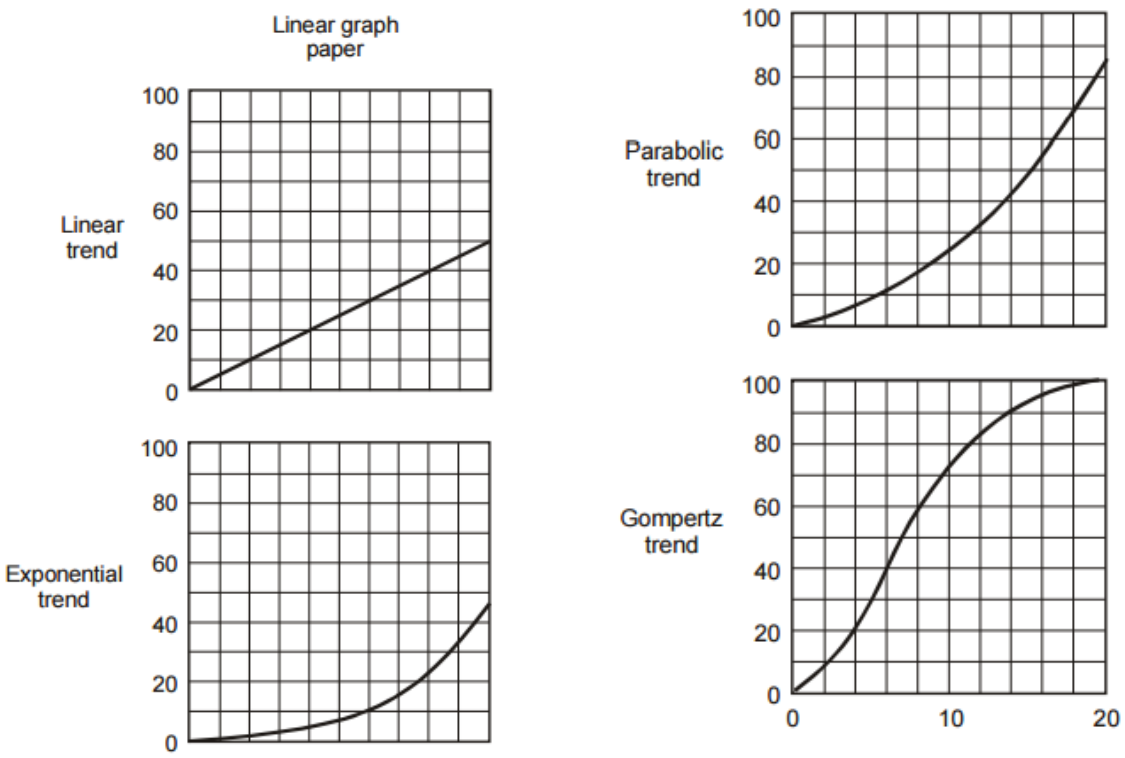


Fig. 3.25. Typical trend curves

During the appearance of a pandemic, IATA specialists use short-term forecasts using and correcting given every week and month. IATA in forecasting aviation in time for Covid - 19 uses decomposition methods. Decomposition methods involve the dissection of the problem into various components. These methods are particularly relevant when strong seasonality or cyclical patterns exist in the historical data. These methods can be used to identify three aspects of the underlying pattern of the data: the trend factor, the seasonal factor and any cyclical factor that may exist.

Exponential smoothing. A general class of widely used forecasting techniques that attempts to deal with the causes of fluctuations in a time series (trend, seasonality and cyclical factors) is that of smoothing. The two most common smoothing techniques are moving averages and exponential smoothing. Exponential smoothing, in general, draws upon the philosophy of decomposition. The exponential smoothing approach to time series is similar to the moving averages approach. However, it places more emphasis on the most recent data, to increase their influence on the forecast. In doing so, it is important to recognize the

seasonality inherent in the airline traffic data if monthly or quarterly forecasts are considered. In such cases, depending upon the month of the year, data would have to be de-seasonalized. A smoothing factor would determine how much weight is to be placed on, for example, various months of the year. The notion of giving greater weight to more recent data is one that has strong intuitive appeal to the analyst, depending on the particular circumstances, and is straightforward to apply.

Moving averages. As mentioned above, the moving averages technique is similar to exponential smoothing. The only conceptual difference is that each observation is weighted equally. For example, a moving average of four observations would be:

$$Y_{t+1} = \frac{Y_{t-3} + Y_{t-2} + Y_{t-1} + Y}{4} \tag{3.4}$$

Decomposition methods of forecast for Boryspil airport for 3 scenarios presented in table 3.4 and fig. 3.26.

Because of the equal weighting, moving averages tend to lag the current situation more than exponential smoothing. The advantage of the moving averages approach compared to exponential smoothing is that the former is much simpler.

Table 3.4.

Decomposition methods of forecast for Boryspil airport for 3 scenarios, thousand passengers

Parameters/ factors of forecast	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sept 2021	Oct 2021	Nov 2021	Dec 2021
Moving averages. Pessimistic forecast. Closing borders and sky for tourists and businesses.	396,9	484,025	522,8563	489,5703	473,3379	492,4474	494,553	487,4771	486,9538	490,3578	489,8354	488,6561	488,9508	489,45	489,2231
Moving averages. Realistic forecast. The emergence of a vaccine and vaccination of 30-50% of the population.	515,97	531,4491	547,3926	563,8144	580,7288	598,1506	616,0952	634,578	653,6154	673,2238	693,4205	714,2232	735,6498	757,7193	780,4509
Moving averages. Optimistic forecast. The emergence of a vaccine and vaccination of 50-80% of the population. (Increase in passenger traffic by 40%)	555,66	583,443	612,6152	643,2459	675,4082	709,1786	744,6375	781,8694	820,9629	862,011	905,1116	950,3672	997,8855	1047,78	1100,169

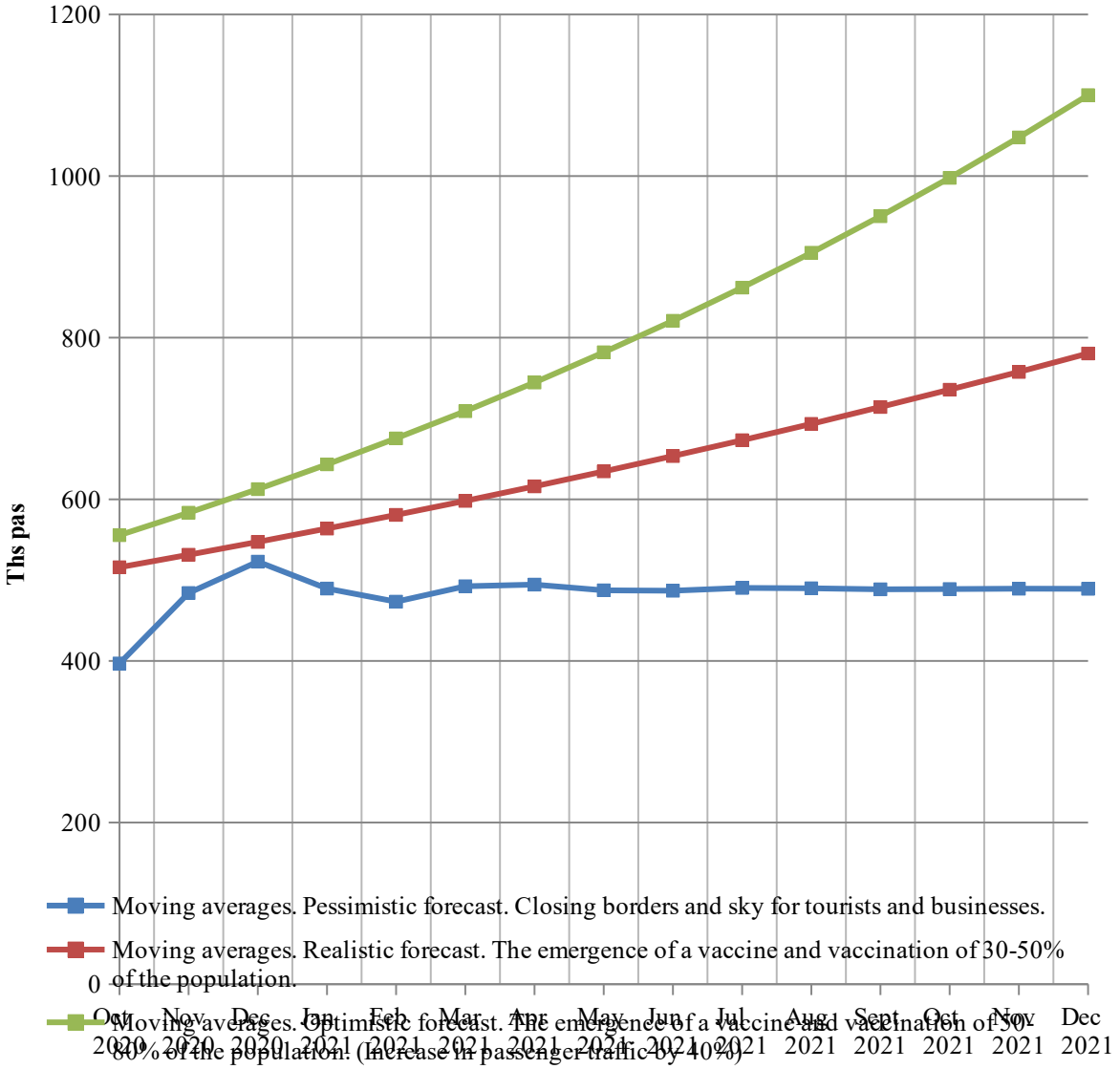


Fig. 3.26. Results of using the decomposition methods of forecast for Boryspil airport for 3 scenarios

A disadvantage of the moving averages approach is that a longer data series is required for the analysis. Forecasts from moving averages can be used, as those from exponential smoothing, for short-term forecasts. This can be achieved by deviating from the standard formulation and assigning a relatively higher weight to the most recent observation, provided there is justification for doing so. A technique called auto regressive moving average (ARMA) can also be used, where the forecasts are expressed as a linear combination of past actual values and/or past

computed error, since each new forecast based on a moving average is an adjustment of the preceding forecast .

The crisis triggered by the coronavirus pandemic dealt a severe blow to civil aviation. Airlines around the world are cutting staff, and some have already filed for bankruptcy. The governments of the world's leading countries are allocating enormous funds to help one of the key industries. International flights from Ukraine should not be expected before mid-June.

It is difficult to imagine what will happen to airlines and airports during this time. After all, Ukrainian passenger aircraft have been on standby since the end of March, when the borders were closed for regular passenger flights due to the threat of the spread of the coronavirus. As a result, the number of flights in the airspace of Ukraine decreased by 96 percent. And according to the results of April, air traffic decreased by 90 percent.

Such a tremendous fall has befallen not only our state. Due to the coronavirus pandemic, the number of daily flights has dropped many times around the world. For example, in Europe, according to the International Air Transport Association (IATA), air traffic fell by 90 percent compared to the previous year.

SUMMARY

Air Transportation Management Department				NAU.20.10.14 001EN			
Done by:	Revin V.V.			Summary	Letter	Sheet.	Sheets
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The impact of the Covid-19 crisis on all aspects of the economy and society is well known. Aviation has been particularly acutely impacted, accumulating the effects of previous shocks (9/11, SARS, the global financial crisis and eruption airspace closure) into one 'black swan' event which will have farreaching implications on the industry for many years. There have been reductions in passenger traffic caused by shocks in the past, but never a near total shutdown of the global system. At the peak of the stoppage in mid-April 2020, the number of flights operating globally was a quarter the number operating just six weeks earlier (and many of these flights were operating with very limited passengers: revenue passenger kilometres fell some 94% compared with April 2019). This has had a devastating impact on travel and tourism and on the frontline companies operating the aviation system and the rest of the supply chain. However, shocks to air traffic growth in the past have always been followed by a rebound in traffic and, while this may take longer than in previous crises, traffic will come back. In order to make that happen more rapidly and get back to the level of jobs and economic activity provided by aviation, governments must ensure that air transport is given appropriate levels of assistance and support so that aviation's benefits can bounce back strongly, once the pandemic is under control. The aviation sector welcomes the support governments around the world have provided to the industry so far to help reduce the impacts of the Covid-19 crisis**.**

Ukraine government did not support aviation sector during pandemic. If we assess the impact of the pandemic on passenger traffic in Ukraine, Ukraine suffered devastating losses in the second quarter of 2020.

At the beginning of the year, in January 2020, passenger traffic in Ukraine showed an increase (+ 8.9%) compared to January 2019. Although, it was already clear that the increase is not as active as the average for 2019, namely 19.45%.

In February, passenger traffic was even higher than in the same month in 2019, but the increase was only 3.8%.

At the end of March, a full lockdown was introduced by the Ukrainian government and international flights were suspended, which almost immediately

affected passenger traffic in Ukraine. In April, losses amounted to -99.3% compared to April for 2019, May -97%, in June -98%. Although domestic flights were restored on June 5 and international flights on June 15, the European Union and most other countries did not open their borders, which prevented the revival of commercial aviation.

Slow growth began in the 3rd quarter. In July, the main destinations with 15 countries were restored, which allowed to slightly increase passenger traffic to 556.3 thousand passes, which is -81% less than in July 2019.

The best result was in August and September 1376 thousand passes and 1198 thousand passes, respectively, during the high season.

The scenarios are based on both observed routes and flights cancellation using a mix of flight tracking data and on-line booking data, as well as hypotheses based on previous pandemic experience that affected aviation.

The use of the extrapolation method for forecasting is not suitable, since the trend in the past is not related to the existing factors in connection with the Covid-19 pandemic.

Methods of analysis and forecasting of time series are difficult to apply without the use of special information systems; it also contains a probabilistic factor for the development of aviation in the future, for example, the emergence of a vaccine against Covid-19 can have a positive effect on the growth of passenger traffic due to vaccination of the population around the world.

the forecast seems to portrait not-unrealistic figures. Among the caveats list the following cavets that could happen in future:

1) The duration of the Covid-19 pandemic is not known. In our analysis we assume that, in most scenarios, by December 2021 the aviation recovers its previous business levels in Boryspil airport ;

2) Measures such as national and regional lock-downs have a major impact on the aviation and the temporal length of these measures cannot be foreseen and may vary across different regions and countries. Countries have different lock-down strategies from extreme lock-downs as in Ukrainian, mild lock-downs in Europe

and (early) light lock-downs in the UK, USA. Lock-downs aims at postponing the epidemic wave ("flattening the curve") to reduce pressure on the health system. Different lock-down strategies impact the duration of pandemic and thus the impact on the aviation. Our scenarios should be intended as the result of an average of all these measures on a global scale;

3) in our scenarios we assume that no second wave of Sars-CoV-2 epidemic will happen building on the past experience from Sars-2003 and Mers-2013. However, this is a new virus and could have a different seasonal behaviour;

4) the start and the end of the impact of Covid-19 pandemic on aviation differs and it will differ (given the different strategies in place) across different countries. Once again, our scenarios should be considered as average effects.

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