Seta Filip, 0000-0001-6460-3060
Polish Air Force Academy, Dęblin, Poland, f.seta4493{at}wsosp.edu.pl
Tomaszewska Justyna, 0000-0001-6883-7235
Polish Air Force Academy, Dęblin, Poland, j.tomaszewska{at}law.mil.pl
Woch Marta, 0000-0003-4872-0720
Air Force Institute of Technology, Warsaw, Poland, marta.woch{at}itwl.pl
Zieja Mariusz, 0000-0003-1494-4099
Air Force Institute of Technology, Warsaw, Poland, mariusz.zieja{at}itwl.pl

Statistical analysis of passenger transport in European countries with large gross domestic product

Keywords

aviation, analysis, statistics, Zurich, Oslo, Luxembourg, airport, fixed base method, chain base method

Abstract

The aim of this chapter is to present, based on an analysis of collected monthly, quarterly and annual statistics, the changeover thirteen years in the capacity of airports in three European countries with the largest gross domestic product: Switzerland, Norway and Luxembourg. In these countries the airports with the highest number of passengers are located in Zurich, Gardermoen and Luxembourg City. Zurich-Kloten International Airport with 31.1 million passengers in 2018, Oslo-Gardermoen International Airport with 28 million passengers served in 2018 and Luxembourg International Airport as the only airport in Luxembourg with 1.9 million visitors in 2018. On the basis of selected airports and the annual, quarterly and monthly statistics, it is possible to determine the capacity situation at given airports and in which periods airports are least and most occupied by passengers.

1. Introduction

Aviation or air transport are activities related to mechanical flight and the aerospace industry. It began in the 18th century after the development of the hot air balloon. In 1804, the first full-size glider was developed. Since then, aviation has been technologically revolutionised with the introduction of the jet, which has enabled a major form of transport around the world.

For the purposes of this chapter, the most useful definition is that air transport is the movement of goods or people by air. This type of transport has many advantages, one of the main ones being the speed of movement, which is especially true for intercontinental flights. Another advantage is the very high level of safety. Air transport is considered to be the safest of all modes of transport. The service life of the machines is also important. Properly used and maintained aircraft can be operational and ready to fly for as long as 30 years. However, air transport, like any other mode of transport, is not perfect. The biggest disadvantage is the very large financial input needed to purchase and maintain aircraft and the entire aviation infrastructure. Dependence on weather and natural disasters also has a negative impact on its functioning.

The low availability of airports forces the use of other means of transport, which entails a significant loss of time. Air transport is based on complicated means of transport, navigation and ground service. It requires considerable financial

Safety and Reliability of Systems and Processes, Summer Safety and Reliability Seminar 2021.

DOI: 10.26408/srsp-2021-17.

outlays and widely qualified staff. However, it allows to safely, quickly and conveniently reach the designated destination, due to which it is becoming more and more popular every year, not only in Poland but also all over the world.

Interest in the topic stems from the desire to learn about the development of air transport over several years and the impact of certain seasons, weather conditions or crises on the capacity of airports at any given time. Selected airports are located in wealthy European countries, which encourages to visit them and find out more about their cultures and customs. This is an interesting challenge also due to the few publicly available and in-depth publications on the subject.

This chapter is divided into several sections. Section 2 presents the research methods that were used to conduct the capacity analysis, which can provide information regarding the periods when airline use is most popular. The next part is a description of the infrastructure of the countries studied and where they are located, what they are famous for and what climate they have. Also included is basic information about aviation and airports in the countries studied. Section 4 of the chapter is the analysis and interpretation of annual, quarterly and monthly statistics presented in graphs. Section 5 analyzes the dynamics of the phenomena using a single-basis and multiple-basis indicator. Forecasting of future passenger traffic is based on the SARIMA model and it is illustrated in which period and to what extent the capacity of given airports may change. A discussion of the results and conclusions are presented in the last section.

2. Research methods

In order to obtain monthly, quarterly and annual statistics on passenger air transport, several research methods have been used in this contribution, which have enabled a detailed analysis to be performed regarding airport capacity for the periods under consideration.

Our interest and desire to travel in the future motivated us to choose this chapter topic and make statistics about these countries in terms of airport capacity so that we can choose the right departure date, the right Airport in the destination country and the right airline for the fastest travel.

An Index Number is the method which is used to measure the change at the level of phenomena (Ralph et al., 2015). It is the relationship of the magnitude of a phenomenon at a particular time to the magnitude of the same phenomenon at another time. Index Number Base Methods are divided into Fixed Base Method and Chain Base Method.

Fixed Base Method describes the change in the value of the analysed phenomenon in relation to the base period. The calculation of a given indicator consists of dividing the successive values of the survey period by the baseline value starting in the survey period, which can be represented by the following relationship:

$$X = \frac{P_i}{P_0}, i = 1,2,\dots n, \quad (1)$$

where:

P_0 – baseline,

P_i – subsequent value,

n – number of observation, period.

The initial value determines the line against which the rest of the results should balance either positively or negatively, depending on whether there has been an increase or decrease in the number during the period.

Chain Base Method – the changes presented are obtained on the basis of successive values of the examined phenomenon in relation to the values immediately preceding the analysed period. The assessment of a given indicator consists of dividing each number in the statistics directly by the previous one. By presenting a given indicator on a graph, it is possible to observe changes in relation to the preceding value. Chain Base Method indicators can be calculated by the following relationship:

$$Y = \frac{P_i}{P_{i-1}}, i = 1,2,\dots n, \quad (2)$$

where:

P_i – subsequent value;

P_{i-1} – prior value,

n – number of observation, period.

SARIMA model (Seasonal Autoregressive Integrated Moving Average) (Adhikari & Agrawal, 2013) is a model that considers many different structures that are difficult to observe in a simple analysis. Due to this model it is possible to show existing trends and seasonal fluctuations. SARIMA models are ARIMA models with a seasonal component. According to the SARIMA formula:

$$(p, d, q) \times (P, D, Q, m) \quad (3)$$

the parameters for these types of models are defined as follows (Etuk, 2016).

References citation in the text make in the following way:

- p – trend autoregression order,
- d – trend difference order,
- q – trend moving average order.

These parameters are the same as in the ARIMA model. There are also four seasonal elements that are not part of ARIMA that must be configured; they are defined as follows:

- P – seasonal autoregressive order;
- D – seasonal difference order;
- Q – seasonal moving average order;
- m – the number of time steps for a single seasonal period.

3. Infrastructure of selected countries

Switzerland is one of the world's most important financial centres, the industrial and construction sectors are of great importance to the country. Norway bases its economy on the extraction of oil, natural gas and metal ores. The electrochemical industry and metallurgy are also important. Luxembourg, on the other hand, benefits from services. It is also a country where the iron and metal industry are highly developed. All these aspects make these countries the ones with the highest gross domestic product in Europe.

This chapter presents statistical data on air passenger transport in order to analyse the dynamics of transport and to discuss and present models for forecasting the number of passengers in selected European countries.

This study focuses on civil aviation, which is divided into aviation works, general aviation and communication aviation. This contribution describes communication aviation and more specifically the analysis of passenger air transport on the example of selected airports.

The motivation for choosing this chapter topic is an interest in the changes that have taken place in air transport over the years and predictions of future changes. These airports were chosen because of frequent visits during the holiday season and an interest in the history of Norwegian, Swiss and Luxembourg aviation.

3.1. Norway's infrastructure

Norway is a northern European country, occupying the western and northern parts of the Scandinavian Peninsula. Just under half of the population lives in regions in the far south, in the region around the capital, Oslo. About two-thirds of Norway is mountainous, the coast is characterized by numerous deep bays carved by glaciers, the so-called fjords, and the country also includes about 50,000 islands. Flights made in Norway have good meteorological conditions because Norway, despite occupying almost the same degree of latitude as Alaska, owes its warm climate to the Norwegian Current, which carries four to five million tons of tropical water per second to the surrounding seas. This current usually prevents fjords from freezing. Even more important are the air currents brought in from the south, especially in winter. Norway is a partner in the Scandinavian Airlines System (SAS), which pioneered commercial flights in the Arctic. Several private airlines increase domestic services between more than 50 airports in Norway with scheduled civil traffic. The main airports for international flights are located near Oslo, Stavanger and Bergen (Christensen et al., 2021).

Gardermoen Airport, near Oslo, began construction in 1994 to accommodate air traffic to the growth of Oslo. The location of the airport required much discussion due to its controversial nature. It was designed with expansion in mind to avoid future disputes over relocation. It is located at Gardermoen in Ullensaker, Norway, 48 km north of Oslo. The airport transport infrastructure is served by the city's European route E6, and the connection to Oslo is by train, which takes 19 minutes to reach its destination. Gardermoen was adopted as Oslo's main airport in October 1998. The construction cost about 3 billion dollars. The airport has two parallel runways of 2950 and 3600 m, 34 passenger and five commuter bridges, 64 check-in desks and 71 aircraft stands. A third runway has been proposed, but expansion has been put on hold until 2030 (Airport Technology, 2021).

3.2. Switzerland's infrastructure

Switzerland is a federated country in Western Europe. The administrative capital is Bern, and Lausanne serves as the judicial center. Switzerland is a small country, with a total area of

41,000 km^2 and a population of nearly 9 million. Landlocked, it is a country of high mountains, deep alpine lakes, grassy valleys dotted with clean farms and small villages, and thriving cities. Switzerland is a combination of the diverse physical and cultural geography of Western Europe. Aspects of the country's beauty have become synonymous with it, and its name evokes the glacier-carved Alps, beloved by writers, artists, photographers and outdoor sports enthusiasts from around the world. The four main European climates affecting Switzerland are: mild and humid air masses arrive from the west, influenced by the North Atlantic Drift; dry and cold air arrives from areas of the northern Arctic; continental air from the east brings dry colder air in winter and warmer air in summer; and relatively moist and warm air flows from the Mediterranean Sea to the north. The mixing of these air masses in Switzerland produces weather patterns that not only change according to the air masses involved, but are also characterized by large changes in temperature and precipitation due to local relief. Swissair, established in 1931 as the national airline, was one of the world's major commercial carriers until financial weakness caused it to stop flying in 2002. Much of Swissair's extensive worldwide operations were sold to other airlines or taken over by Crossair, a former regional unit of Swissair, which was later renamed Swiss International Air Lines (Maissen et al., 2021).

Zurich Airport is Switzerland's largest international airport and the main link to Swiss International Air Lines. It serves Zurich, the largest city in Switzerland, and with its surface transportation links, the rest of the country. The airport is located 13 km north of Zurich's city center. It has received the “Leading Airport in Europe” award for seventeen years. The Skytrax Award also places it among the top 10 airports in the world. The airport has three small airport piers, known as Terminals A, B and E. These are connected to a central building. The above-ground terminal complex consists of several buildings and includes airline check-in counters, a shopping center, railroad, parking lots, and a bus and streetcar terminal. Terminal A was opened in 1971 and is used exclusively by flights to and from Schengen destinations, including domestic flights in Switzerland. It will be demolished and replaced with a completely new facility in 2021. Terminal B was opened in 1975 and again in 2011 after a major renovation lasting three years. Since then it has been able to accommodate both Schengen and non-Schengen flights at the same gates. Each gate has two numbers, one with a B prefix and the other with a D, with different routes to and from the gates to separate passengers. Terminal E is known as the auxiliary terminal. It is a stand-alone satellite terminal located on the opposite side of the runway. It is fully used by international flights outside the Schengen zone. It was opened in 2003. Zurich airport has three runways, 16/34 with 3700 m, 14/32 with 3300 m and 10/28 with 2500 m. Runway 14 is used for landings and runways 16 and 28 for takeoffs (Airport Technology, 2021).

3.3. Luxembourg's infrastructure

Luxembourg is a country in Western Europe. One of the smallest countries in the world, it shares borders with Belgium to the west and north, France to the south, and Germany to the east. Luxembourg has been under the control of many states and ruling houses in its long history, but has been a separate, though not always autonomous, political entity since the 10th century. Luxembourg has a mild climate with significant rainfall. The north is slightly cooler and wetter than the south. The sheltered Moselle valley benefits from a milder and sunnier climate than the rest of the principality. The country has a Findel Airport outside the city of Luxembourg and it has become the main air terminal served by airlines of many countries. Luxair is the flag carrier airline with its headquarters and hub at Luxembourg Airport. It operates scheduled flights to destinations in Europe, North Africa, the Mediterranean and the Middle East, with additional charter and seasonal services. It is the only airline carrying passengers in Luxembourg with scheduled services (Biel et al., 2021).

Luxembourg Airport is the country's only international airport, located about 6 km east of the capital Luxembourg. The airport handled 3.02 million passengers in 2016 recording an increase of 12.4% compared to 2.69 million in 2015. The capacity of the existing passenger terminal A was exceeded due to the rapid growth of traffic at the airport, attributed to the entry of new airlines and the rapid expansion of existing airlines. Construction of a new Terminal B was an-

nounced by the airport operator in 2016. Planning, preparation, and construction work began in the same year. The opening took place in July 2017. The new terminal is used for regional and Schengen zone flights. Terminal A has 18 aircraft gates from A1 to A18 after reconstruction in 2008 and can accommodate any aircraft with a capacity of more than 50 passengers. The airport has one runway, designated 06/24, which is 4000 meters long and 60 meters wide (Airport Technology, 2021).

4. Data analysis

The Section presents graphs and analysis of passenger traffic on an annual, quarterly and monthly basis, for the three main airports in the European countries with the highest gross domestic product.

The statistics used for the research were collected from the databases of the Eurostat website (EuroStat, 2021). From the overall increase in passenger numbers over the years, conclusions can be drawn about the rapid growth of passenger transport. Safety, ever-cheaper tickets, an ever-increasing number of aircraft and the opening up of new air routes allowing a greater variety of destinations are the biggest factors contributing to the rapid development of this mode of transport around the world.

Figure 1 and Table 1 show an annual graph of the number of passengers using airlines from 2005 to 2018.

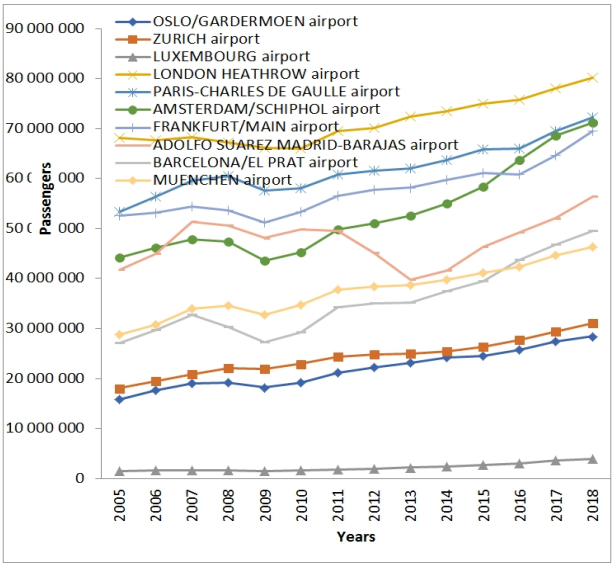

Figure 1. Annual capacity development of the studied airports from 2005 to 2018 against the background of airports with the highest capacity.

Table 1. Annual capacity development of the studied airports from 2005 to 2018 (EuroStat, 2021)

Year	Oslo	Zurich	Luxembourg
2005	15793317	18037459	1538152
2006	17619274	19554733	1597177
2007	19043914	20810318	1634465
2008	19216227	22112923	1692580
2009	18186307	21985156	1535066
2010	19140382	22912553	1605293
2011	21109086	24371404	1836356
2012	22196044	24864615	1893318
2013	23078240	24929249	2167927
2014	24157050	25503081	2433498
2015	24559625	26289396	2651238
2016	25666388	27655834	2983609
2017	27349690	29387619	3553823
2018	28406796	31097730	3988224

It can be noticed that passenger air transport has grown in popularity over the 13 years. In every year, with the exception of 2009, the capacity has gradually increased. As for 2009, it was a difficult year due to the global economic and financial crisis, which resulted in unstable aviation fuel prices and currency fluctuations. From the beginning of the study period, i.e. from 2005 to 2018, the number of passengers has increased by almost 80% at Gardermoen Airport, which is located in Norway's state capital, Oslo. In 2018, Zurich Airport's capacity passed the 30 million passenger mark, and since 2005, the start of the research period, capacity has increased by 72%. Luxembourg airport's capacity crossed the 1.9 million passenger mark in 2018. Despite the low popularity of the airport, it is growing at a very high rate, the increase in capacity from the beginning to the end of the study period was as high as 159%.

Figure 2 and Table 2 show a quarterly graph of passenger numbers from 2005 to 2018 at Oslo-Gardermoen, Zurich-Kloten and Luxembourg airports.

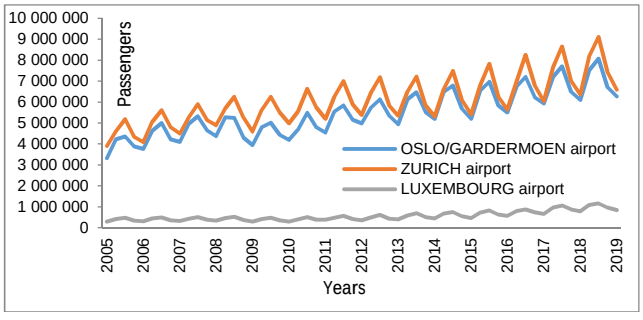

Figure 2. Quarterly capacity development of the studied airports from 2005 to 2018.

Table 2. Quarterly capacity development of the studied airports from 2005 to 2018 (EuroStat, 2021)

Year	Oslo	Zurich	Luxembourg
2005	3326734	3907397	300122
	4222383	4608022	419724
	4361907	5184523	478768
	3882293	4337517	339538
2006	3765199	4079476	304282
	4635609	5058774	438718
	5000738	5615979	494551
	4217728	4800504	359626
2007	4106191	4501534	316782
	4968910	5274733	428772
	5323245	5900539	507355
	4645568	5133512	381556
2008	4380928	4892319	334156
	5283412	5707265	465872
	5251262	6257725	528470
	4300625	5255614	364082
2009	3946636	4595415	285036
	4796201	5631467	421533
	5012463	6256834	474335
	4431007	5501440	354162
2010	4187634	4979778	299123
	4673374	5547094	403993
	5484167	6631621	512695
	4795207	5754060	389482
2011	4547059	5200013	386510
	5556234	6271901	480163
	5848812	7007167	560983
	5156981	5892323	408700
2012	4981546	5379344	354730
	5731738	6459962	498356
	6136897	7179849	607041
	5345863	5845460	433191
2013	4936010	5357509	393006
	6131932	6506178	575884
	6469009	7212078	694806
	5541289	5853484	504231
2014	5192320	5305270	450918
	6488712	6599452	676980
	6782766	7499714	745728
	5693252	6098645	559872
2015	5203843	5416373	468401
	6538288	6791331	726087
	6975445	7823200	823276
	5842049	6258492	633474
2016	5505528	5637158	574551
	6738559	6982050	795256
	7203392	8251427	874498
	6218909	6785199	739304
2017	5940573	6043343	652502
	7207499	7659657	969797
	7709405	8660526	1057016
	6492213	7024093	874508
2018	6101280	6367758	775222
	7521623	8198285	1089861
	8069471	9106580	1162545
	6714422	7425107	960596

It can be observed from the graph that at all these airports, the third quarter each year has the highest number of passengers. This is due to the holiday period when most people go on holiday. This shows that passengers are keen to choose air transport when going on holiday because of its safety and speed. The lowest number of visitors to an airport is in the fourth quarter of each year. This is due to the winter period, when passenger air transport loses its popularity.

Figure 3 shows the monthly statistics for passenger air transport in the Norwegian capital Oslo-Gardermoen, in Switzerland Zurich-Kloten and in Luxembourg carries again disappeared because of financial trouble.

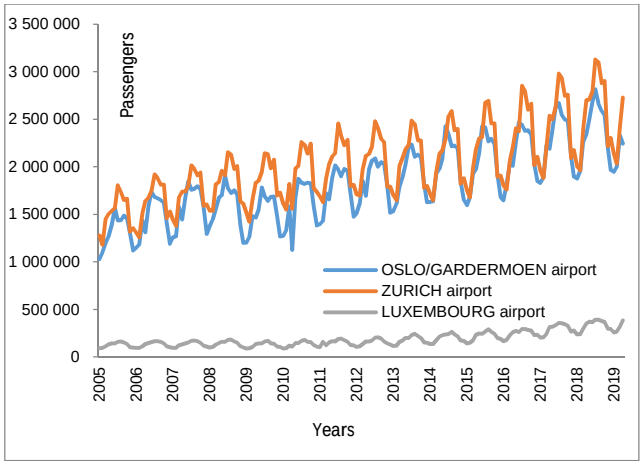

Figure 3. Monthly development of capacity of the studied airports from 2005 to 2018.

It can be concluded that the most popular months for passenger numbers are the summer months, where most people go on holiday during this period. The busiest months are June, July and August. The biggest drop in capacity is noticed in the winter months: December, January and February. Generalizing the graph, the growing popularity of aviation can be observed. Every year more and more people are choosing this mode of transport. This may be due to its safety, convenience and swiftness. Various airlines, cheaper flight tickets and constantly opening new destinations have the greatest influence on the rapid development and popularity of aviation.

5. Analysis of dynamics of phenomena

Figure 4 and Table 3 show a single-based indicator for the studied airports from 2005 to 2018.

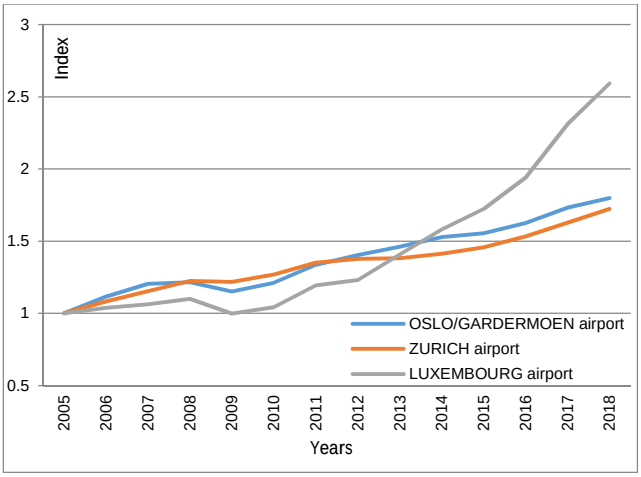

Figure 4. Single-based indicator for the studied airports from 2005 to 2018.

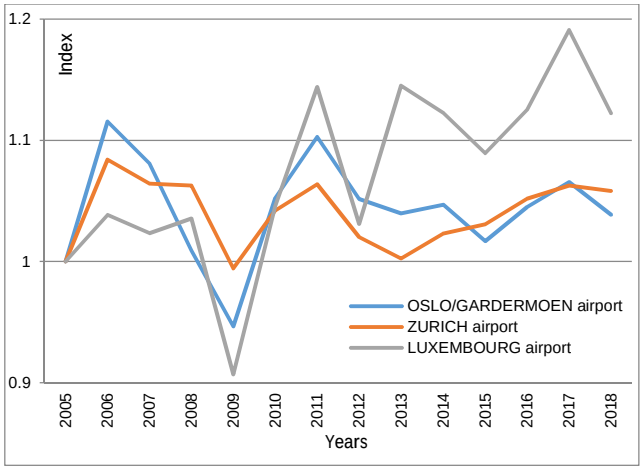

Figure 5. Chain Base Method indicator for the studied airports from 2005 to 2018.

Table 3. Single-based indicator for the studied airports from 2005 to 2018

Year	Oslo	Zurich	Luxembourg
2005	1.000	1.000	1.000
2006	1.116	1.084	1.038
2007	1.206	1.154	1.063
2008	1.217	1.226	1.100
2009	1.152	1.219	0.998
2010	1.212	1.270	1.044
2011	1.337	1.351	1.194
2012	1.405	1.378	1.231
2013	1.461	1.382	1.409
2014	1.530	1.414	1.582
2015	1.555	1.457	1.724
2016	1.625	1.533	1.940
2017	1.732	1.629	2.310
2018	1.799	1.724	2.593

Table 4. Chain Base Method indicator for the studied airports from 2005 to 2018

Year	Oslo	Zurich	Luxembourg
2005	1.000	1.000	1.000
2006	1.116	1.084	1.038
2007	1.081	1.064	1.023
2008	1.009	1.063	1.036
2009	0.946	0.994	0.907
2010	1.052	1.042	1.046
2011	1.103	1.064	1.144
2012	1.051	1.020	1.031
2013	1.040	1.003	1.145
2014	1.047	1.023	1.122
2015	1.017	1.031	1.089
2016	1.045	1.052	1.125
2017	1.066	1.063	1.191
2018	1.039	1.058	1.122

As can be observed from the graph of the single-base indicator obtained from the airport statistics, a clear upward trend can be observed over the study period. Since the beginning of the research, in none of the annual periods has the indicator fallen below the base value on which the whole graph is built. It can therefore be deduced that passenger transport is developing to a significant degree at the selected airports. The only downward trend can be seen in 2009. This is due to the global financial and economic crisis. However, even so, this is not a drastic decline, as the indicator has still remained above its initial value.

Compared to 2005, in 2018 the indicator increased its value by approx. 72% for Zurich-Kloten airport, approx. 80% for Oslo-Gardermoen and approximately 159% for Luxembourg Airport.

The corresponding graph (Fig. 5) shows the annual differences according to the Chain Base Method indicator at Oslo-Gardermoen, Zurich-Kloten and Luxembourg airports. With the Chain Base Method indicator it is possible to illustrate the number of passengers in a given year in relation to the number in the previous year (Table 4). The biggest decreasing trend can be seen after 2006. It lasted as long as 3 years. The year 2009 had the lowest value of the index with decreases of 6%, 6% and 12% for Oslo-Gardermoen, Zurich-Kloten and Luxembourg airports respectively. Only 2010 brought better results compared to 2009, with an upward trend reaching 11%. After 2011, a downward trend began again and continued until 2013. In the following years there were no significant differences, both upward and downward trends, but they were not very high.

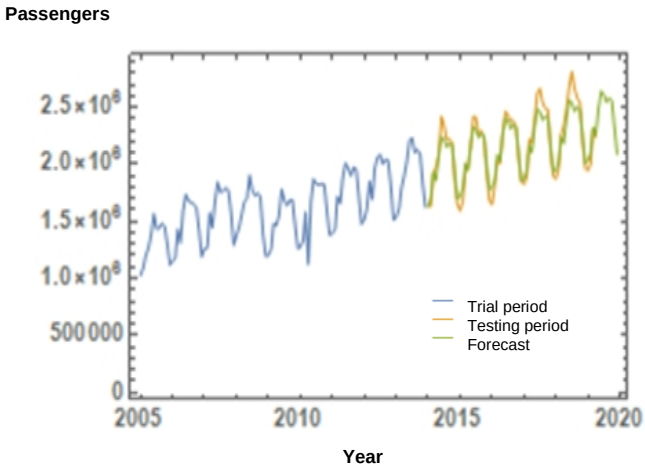

Figure 6. Capacity forecast model for Oslo-Gardermoen Airport from 2005 to 2020.

Figure 6 shows the graphs for Oslo-Gardermoen Airport. It shows the trial period, the test period and the forecast for the number of passengers visiting the airport in the future. The forecast obtained after calculations made since 2015 apparently overlaps with the test period, so it may be concluded that the forecast is reliable.

Figure 7 shows the graphs for Zurich-Kloten International Airport. It presents the trial period, the test period and the forecast for the number of passengers visiting the airport in the future. The forecast shown from 2015 does not coincide very much with the tested data. Traffic at the airport is higher than the forecasts indicate. Reasons for this may include insufficient data in the graph and so-called movable holidays whose celebrations are not linked to a specific date.

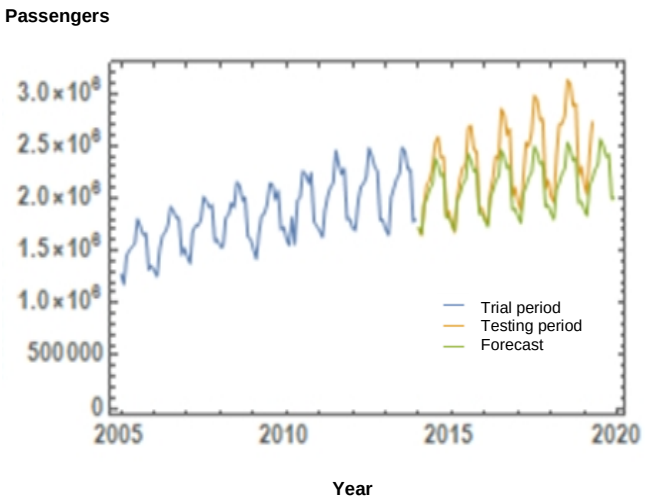

Figure 7. Capacity forecast model for Zurich-Kloten Airport from 2005 to 2020.

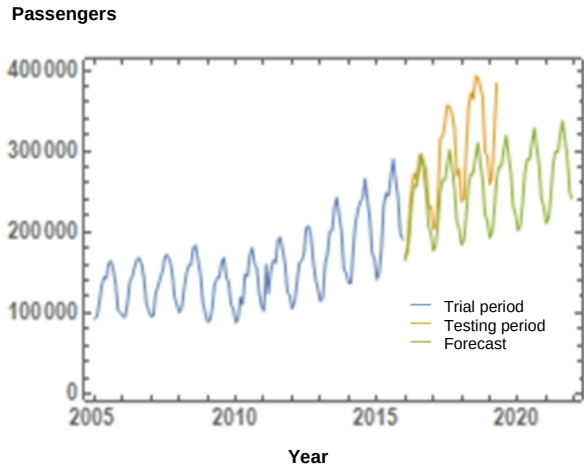

Figure 8. Capacity forecast model for Luxembourg International Airport from 2005 to 2020.

Figure 8 shows the graphs for Luxembourg International Airport. It shows the trial period, the test period and the forecast for the future of the airport, how many and how often passengers will visit the airport. The forecast applied to passenger traffic is much lower than the actual capacity of the airport. Reasons for this may be insufficient data collection and, for example, holidays that are not linked to any specific date, which have the effect of postponing the dates of passenger visits.

6. Conclusion

In summary, over the last 13 years there has been a rapid and significant development in passenger air transport. From the considerations made so far for the three airports described, it is evident that more and more individuals are choosing this type of travel. From 2005, the beginning of the research period, until 2018 the number of people who used airline services increased.

When it comes to the monthly analysis of airport data, it can be observed that the months in which airports are most crowded are the summer months. Due to the time of year many people decide to go on holiday, which results in increased traffic at airports. The situation is different in winter, when airports are empty. Comparing one of the least busy months, i.e. January, with one of the most busy ones, i.e. August, the difference ranges from 60% to even 100%.

One of the most important pieces of information is that aviation can and will grow even more than it has done so far. The introduction of new air routes, for example, would lead to hundreds of

new airports and countless aircraft, which would further increase the growth trend. Cheaper tickets, both through more efficient aircraft and competition, would also increase and facilitate the availability of flights.

By 2020, COVID-19 has evolved into a full-scale pandemic that poses a global threat to human health and the world economy. The long-term effects of COVID-19 are still unpredictable, but the impact in 2020 alone is remarkable. There are estimates that the pandemic caused the largest global recession since the severe global economic downturn of the 1930s (Sumner et al., 2020; Sun et al., 2021)

Figure 9 shows the annual capacity development of the studied airports from 2005 to 2020.

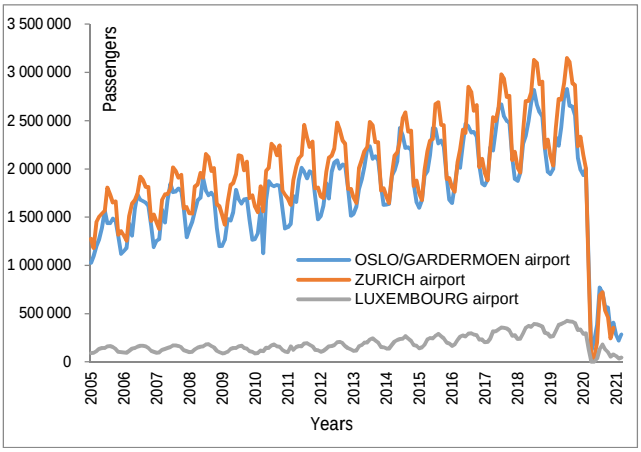

Figure 9. Monthly development of capacity of the studied airports from 2005 to 2020.

When discussing aviation, we are dealing with the safest means of transport, which does not exclude that it can become even less risky. Increased training of pilots and navigators, frequent servicing of machines and equipment and in-depth analysis of air accidents in order to prevent similar situations in the future are just some examples that can significantly increase the safety of air traffic.

Aviation provides very significant commercial and social benefits and as the global economy grows, demand for air transport is expected to increase. It has a significant impact on the world economy's strength and the well-being of its citizens. It facilitates trade and connects families, friends and cultures across borders and oceans like no other mode of travel. Civil aviation is also vital to global humanitarian missions, carrying life-saving equipment and personnel.

References

Adhikari, R. & Agrawal, R.K. 2013. *An Introductory Study on Time Series Modeling and Forecasting*. LAP Lambert Academic Publishing.

Airport Technology, https://www.airport-technology.com (accessed 01 June 2021).

Biel, V.J.P., Gehring, J.M., Lambert, V. & Erpelding, J.-P. 2021. Luxembourg. *Encyclopedia Britannica*, https://www.britannica.com/place/Luxembourg (accessed 01 Jun 2021).

Christensen, J., Joys, C., Weibull, J., Sandvik, G. & Enander, H. 2021. Norway. *Encyclopedia Britannica*, https://www.britannica.com/place/Norway (accessed 01 Jun 2021).

Etuk, E. 2016. A novel algorithm for sarima model fitting: modelling pound-euro exchange rates as case study. *The Journal of Scientific and Engineering Research*.

EuroStat, https://ec.europa.eu/eurostat/data/database (accessed 28 May 2021).

Maissen, T., Wachter, D., Egli, E. & Diem, A. 2021. Switzerland. *Encyclopedia Britannica*. https://www.britannica.com/place/Switzerland. (accessed 01 Jun 2021).

Ralph, J., O'Neill, R. & Winton, J. 2015. *A Practical Introduction to Index Numbers*. Wiley.

Sumner, A., Hoy, C. & Ortiz-Juarez, E. 2020. *Estimates of the Impact of COVID-19 on Global Poverty*. UNU-WIDER.

Sun, X., Wandelt, S., Zheng, C. & Zhang, A. 2021. COVID-19 pandemic and air transportation: successfully navigating the paper hurricane. *Journal of Air Transport Management* 94, 102062.