

IMPACT OF COVID-19 ON EUROPEAN AND TURKEY AIR TRAFFIC NETWORKS

IMPACTO DE COVID-19 EN LAS REDES DE TRÁFICO AÉREO DE EUROPA Y TURQUÍA

Arif TUNCAL¹ *; Suat USLU²; Erdal DURSUN³.

1. PhD Candidate, Eskisehir Technical University, Institute of Graduate Programs, Turkey. arif.tuncal@dhmi.gov.tr
2. Assoc. Prof. Dr., Eskisehir Technical University, Faculty of Aeronautics and Astronautics, Turkey. suslu@eskisehir.edu.tr
3. Asst. Prof. Dr., Nisantasi University, School of Civil Aviation, Turkey. erdal.dursun@nisantasi.edu.tr

*Corresponding author: Arif TUNCAL, correo electrónico: arif.tuncal@dhmi.gov.tr

ABSTRACT

Covid-19, which was defined as a result of research conducted in a group of patients developing respiratory symptoms in late December 2019 in Wuhan province of China, spread to other countries in a very short time by infecting from people to people. On January 30, 2020, the World Health Organization declared the “International Public Health Emergency” due to the Covid-19 pandemic. Travel restrictions have been imposed by countries to prevent the pandemic. With these restrictions, air traffic has come to a halt, only health, humanitarian, military, repatriation and cargo flights have been carried out. Due to the Covid-19, more than 6 million traffic losses occurred in the European air traffic network. There were 0.2 million flight losses in the 9/11 attacks and 0.8 million flight losses in the great financial crisis. It is not known how long the recovery will take to reach traffic data in 2019. In this study, the impact of Covid-19 on the European and Turkey air traffic networks in 2020 was analyzed compared to the 2019 data. Within the scope of forecasts published by aviation authorities, assessments regarding the recovery process are also included. It is predicted that the impact of the Covid-19 pandemic on the air traffic networks will not be compensated for a long time in line with current data and predictions for the pandemic.

Keywords: European Air Traffic; Turkey Air Traffic; Covid-19; Pandemic; Aviation.

Cómo citar:

TUNCAL, Arif; USLU, Suat; DURSUN, Erdal. (2021). IMPACT OF COVID-19 ON EUROPEAN AND TURKEY AIR TRAFFIC NETWORKS. *Revista de Investigaciones Universidad del Quindío*, 33(2), 45-55. <https://doi.org/10.33975/riuiq.vol33n2.603>

Información del artículo:
Recibido: 23 junio 2021; Aceptado: 19 agosto 2021

Revista de Investigaciones Universidad del Quindío,
33(2), 45-55; 2021.

ISSN: 1794-631X e-ISSN: 2500-5782

Esta obra está bajo una licencia Creative Commons Atribución-
NoComercial-SinDerivadas 4.0 Internacional.



RESUMEN

Covid-19 se definió como resultado de una investigación realizada en un grupo de pacientes que desarrollaron síntomas respiratorios a fines de diciembre de 2019 en la provincia china de Wuhan, se propagó a otros países en muy poco tiempo al infectar de persona a persona. El 30 de enero de 2020, la Organización Mundial de la Salud declaró la “Emergencia de Salud Pública Internacional” debido a la pandemia Covid-19. Los países han impuesto restricciones de viaje para prevenir la pandemia. Con estas restricciones, el tráfico aéreo se ha detenido, solo se han realizado vuelos sanitarios, humanitarios, militares, de repatriación y de carga. Debido al Covid-19, se produjeron más de 6 millones de pérdidas de tráfico en la red europea de tráfico aéreo. Hubo 0,2 millones de pérdidas de vuelo en los ataques del 11 de septiembre y 0,8 millones de pérdidas de vuelo en la gran crisis financiera. No se sabe cuánto tardará la recuperación en alcanzar los datos de tráfico en 2019. En este estudio, se analizó el impacto de Covid-19 en las redes de tráfico aéreo de Europa y Turquía en 2020 en comparación con los datos de 2019. Dentro del alcance de los pronósticos publicados por las autoridades aeronáuticas, también se incluyen evaluaciones sobre el proceso de recuperación. Se prevé que el impacto de la pandemia Covid-19 en las redes de tráfico aéreo no se compensará durante mucho tiempo de acuerdo con los datos y predicciones actuales para la pandemia.

Palabras clave: tráfico aéreo europeo; tráfico aéreo de Turquía; Covid-19; pandemia; aviación.

INTRODUCTION

Mobility on a global scale has been increasing at a faster rate than world population growth in recent years (Recchi et al., 2019). Air traffic has shown a great improvement with the increase in mobility. However, according to the International Civil Aviation Organization (ICAO) data, it is seriously affected by various external factors. These external factors may be classed as financial crises, natural disasters, armed conflicts, and pandemics, notably oil crises and currency rates affecting fuel costs (ICAO, 2021a). Pandemics included in this classification have had a negative impact on the aviation sector since the early 2000s. Severe Acute Respiratory Syndrome (SARS) in 2003 and Middle East Respiratory Syndrome (MERS) in 2015, which caused significant pandemics in the world, showed a strong correlation between air traffic and pandemics (IATA, 2021). The border closures and flight restrictions implemented to prevent the spread of pandemics all over the world caused a serious decrease in air traffic.

A new pandemic emerged as a series of new cases of pneumonia in Wuhan, China in December 2019 was called “Coronavirus Disease 2019 (Covid-19)” by the World Health Organization (WHO) on February 11, 2020. Covid-19 spread rapidly and affected many countries and regions such as China, South Korea, Italy, and Iran caused by major pandemics in a short time (Ding et al., 2020). On March 11, 2020, the WHO evaluated Covid-19 as a pandemic following more than 118,000 cases in 114 countries all across the world (WHO, 2021a).

Air transportation with over 4 billion passengers annually is a tool that poses a great risk in the spread of infectious diseases such as influenza, which have pandemic characteristics, both by the potential of transmission of diseases during flight and by the transportation of infected people from origin to other locations (Young et al., 2014). Despite the fact that the global response to the Covid-19 pandemic was more transparent and effective compared to the SARS (Sohrabi et al.,

2020), Covid-19 spread rapidly at the global level with a late response in the rest of the world after its first appearance in Asia. Most airlines tried to operate their scheduled flights until prohibited by the states implementing severe restrictions. With the border closures and quarantine implements by the dominant political decisions in Europe and America, sudden decreases in the number of flights occurred as of mid-March 2020 (Suau-Sanchez et al., 2020). Due to the high risk of infection and asymptomatic cases, Covid-19 is predicted to have greater impacts than any past pandemics and seriously affecting on the aviation industry (Mhalla, 2020).

PURPOSE, SIGNIFICANCE AND METHODOLOGY

The aim of the study is to focus on the vulnerability of European and Turkey air traffic networks to pandemics. Although the Covid-19 pandemic and its impacts are a current issue, the first-period response to the unprecedented situation is important for the aviation industry. The next reaction will differ from the initial reaction of the industry. A comprehensive understanding of the reactions given in the process will make it possible to minimize the impact of the sector in case of similar situations from now on.

In order to reveal the impact of the pandemic on the aviation sector, first of all, the extent of the pandemic at the global level and its impact on aviation, then the country-level measures taken against the pandemic in the European region and the reaction of air traffic against it were examined; then, the measures taken by Turkey in the aviation sector and the change of air traffic were examined. In the last part of the study, comprehensive assessment were made with the help of a literature criticism within the scope of these reviews and forecasts for national and international air traffic.

Data provided by WHO, ICAO, European Organization for the Safety of Air Navigation (EUROCONTROL) were used in this study. The

air traffic data, which are the basis of the study, were drawn from the Performance Review Unit-PRU database of EUROCONTROL.¹ Notices to Airmen (NOTAMs) were checked by DHMI AIS Portal.²

1. Impact of Covid-19 pandemic on the global air traffic network

The Covid-19 pandemic has had a major direct impact on airline operations as many flights have been canceled by airlines or authorities due to restrictions on airports and flight routes (Mhalla, 2020). The regulations published for the sector within the scope of Covid-19, periodic restrictions, and as a result, the dropping in passenger demand caused the mentioned impact on the sector to be long-lasting (Dursun, 2021).

In the report prepared by ICAO, it is stated that there was a 60% decrease in the number of passengers in 2020 (both international and domestic flights) compared to 2019, and the world air passenger traffic collapsed with an unprecedented decrease in history due to the Covid-19 pandemic (ICAO, 2021a). As shown in Figure 1, this decrease has been sharper and more devastating compared to any crisis the world aviation industry has faced before.

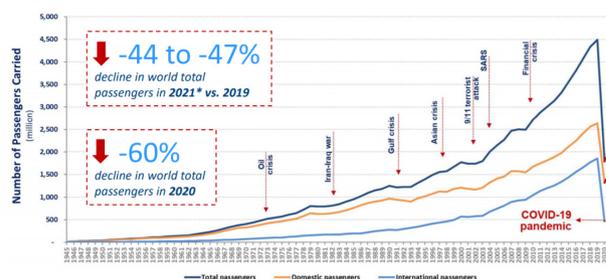


Figure 1. Variation of passenger numbers from 1945 to 2021 against crises
Ref.: ICAO, 2021a

As of the end of 2020, there was a decrease of 33.81% in flights worldwide and a decrease of 52.61% in the European region compared to the same period of 2019. Figure 2 shows the

- 1 <https://ansperformance.eu/>
- 2 <https://ais.dhmi.gov.tr/>

reductions in traffic numbers from other parts of the world that were severely affected by the pandemic (ICAO, 2021b).

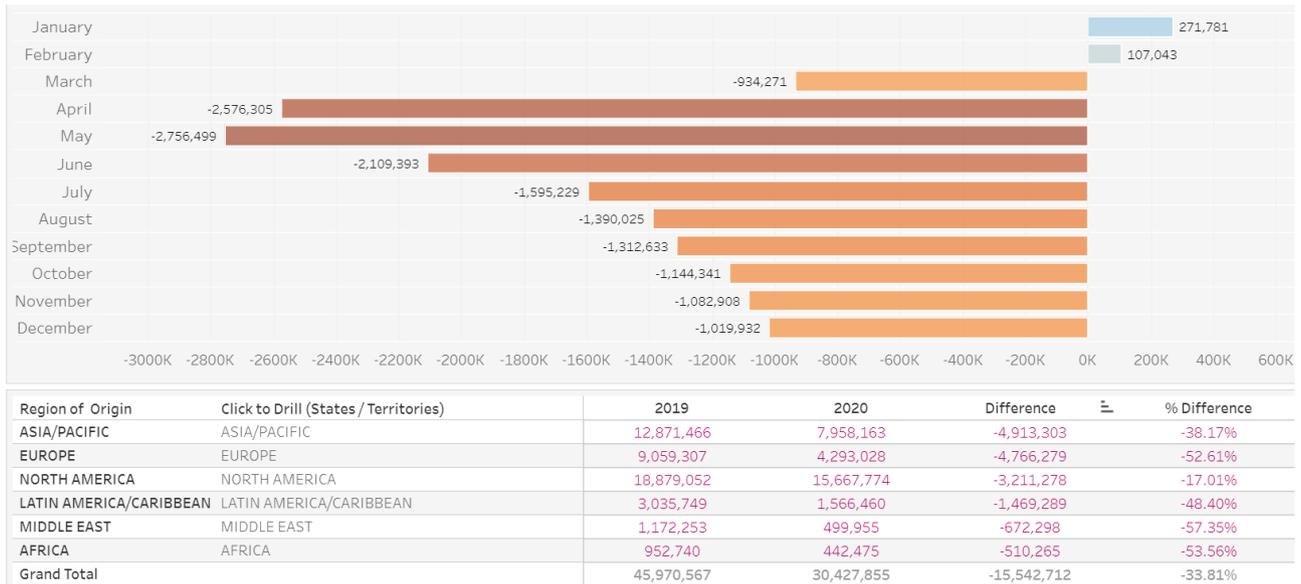


Figure 2. The numbers of global air traffic 2020 vs. 2019.
Ref.: ICAO, 2021b

The decrease in the total number of passengers and related traffic has affected all areas of the aviation industry. In 2020, a loss of 1.8 trillion dollars occurred in all economic activities supported by the aviation industry, especially employment, with a decrease of 51.5% compared to the pre-Covid-19 pandemic (ATAG, 2020). Airline losses amounted to approximately 372.5 billion dollars (ICAO, 2021c).

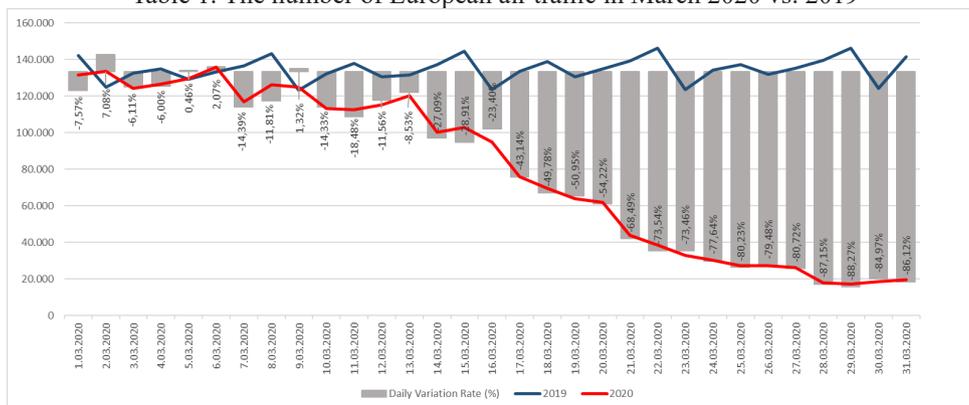
2. Impact of Covid-19 pandemic on European air traffic network

On March 13, 2020, WHO announced that Europe was the epicenter of the Covid-19

pandemic, representing over 40% of global cases (WHO, 2021b).

The borders and Schengen area were closed by the European Union (EU) on March 17, 2020. United Kingdom (UK) suspended all international flights on March 17, 2020. Germany closed its borders on March 18, 2020, in line with the EU decision. Italy declared a national quarantine and closed 57 airports on March 27, 2020. France declared quarantine on March 27, 2020, and closed the borders for arriving passengers except for some countries. Spain declared quarantine on March 30, 2020 (EUROCONTROL, 2021a).

Table 1. The number of European air traffic in March 2020 vs. 2019

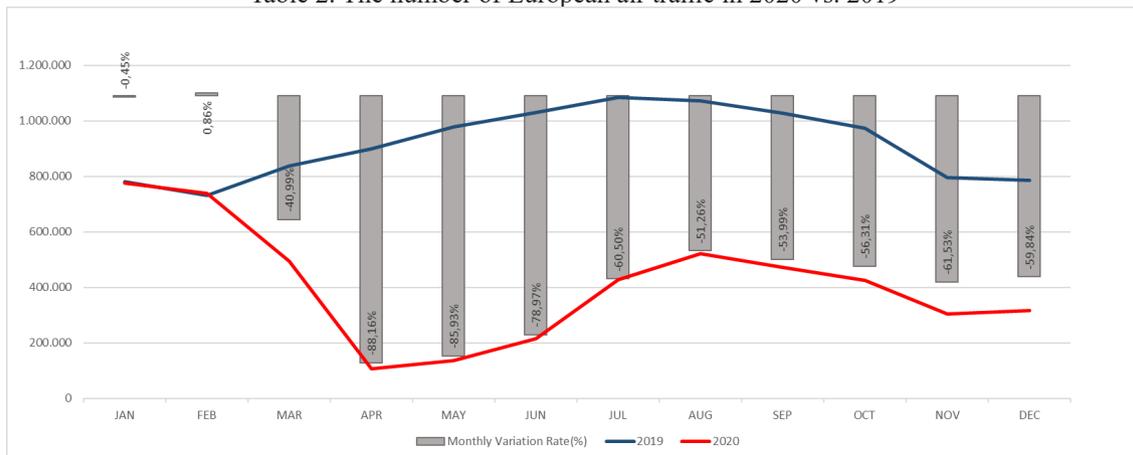


European air traffic network responded late to the Covid-19 outbreak. As shown in Table 1, the first serious decrease in European air traffic occurred on March 14, 2020, with a decrease of 27.09% compared to the previous year. From this date, the decreases continued and reached a value of 86.12% as of the end of March 2020.

April 12, 2020 was recorded as the day when the pandemic showed the most impact on European air traffic, with a decrease of 93.69% compared to 2019 with 2060 traffic. In June 2020, when the prohibitions started to be lifted, an increasing trend was observed in air traffic. Table 2 shows the change in European air traffic by all months in 2020 compared to the previous year. It has been determined that the Covid-19 pandemic did not have a significant impact on European air traffic in January 2020 and February 2020,

its impact started to be seen as of March 2020 and showed its greatest impact with a decrease of 88.16% in April 2020. Afterward, it was observed that there was a recovery due to the gradual lifting of restrictions as a result of the decrease in the number of cases and the summer period activity. However, the increase in the number of Covid-19 cases that occurred with the autumn/winter in Europe reached an alarming level. In the statement made by WHO Europe on October 15, 2020, it was stated that with the number of approximately 700,000 cases, it reached the highest weekly number of cases since the beginning of the pandemic, the total number of cases in Europe increased from 6 to 7 million in just 10 days and broke a record in the number of daily cases (WHO, 2021c). As a result, air traffic increasing in the summer period decreased again with autumn.

Table 2. The number of European air traffic in 2020 vs. 2019



Compared to 2019, flights in the European region, which experienced serious fluctuations in 2020, decreased by 62% and intercontinental flights by 60%. The flights from Europe to the Asia/Pacific region, where the pandemic first started, decreased by 55%. (EUROCONTROL, 2021b).

3. Impact of Covid-19 pandemic on Turkey air traffic network

The first Covid-19 case in Turkey was confirmed on March 10, 2020. In line with the decisions

of the Scientific Committee established by the Republic of Turkey Ministry of Health within the scope of Covid-19, flights to China on February 3, 2020, to Iran on February 23, 2020, and to South Korea, Iraq, and Italy on February 29, 2020, were mutually canceled.

Flights from Turkey to Germany, France, Spain, Norway, Denmark, Belgium, Austria, Sweden, the Netherlands, Azerbaijan, and Georgia (Republic of Turkey Ministry of Transport and Infrastructure, 2021) on March 14, 2020, and England, Switzerland, Saudi Arabia, Egypt on

March 17, 2020, Ireland and the United Arab Emirates were suspended (SHGM, 2021).

With the Notice to Airmen (NOTAM) numbered G1552/20 (A1676/20) effective from 14:50 UTC (Coordinated Universal Time) on March 19, 2020, all flights regardless of seat configuration from/to Austria, Azerbaijan, Belgium, China, Denmark, Egypt, France, Germany, Iran, Iraq, Ireland, Italy, Netherlands, Norway, Saudi Arabia, South Korea, Spain, Sweden, Switzerland, United Arab Emirates and United Kingdom (including Georgia with NOTAM G1554/20) were prohibited within the scope of the Covid-19 except flights to be made for the purpose of the evacuation from/to Turkey could be permitted. In addition, cargo, state, emergency medical, and emergency landing for technical reasons were excluded from the scope of the restriction.

As of 14.00 UTC on March 21, 2020, with the NOTAM numbered G1569/20 (A1695/20), Algeria, Angola, Bangladesh, Cameroon, Canada, Chad, Colombia, Czechia, Djibouti, Dominican Republic, Ecuador, Equatorial Guinea, Finland, Guatemala, Hungary, India, Ivory Coast, Jordon, Kazakhstan, Kenya, Kosovo, Kuwait, Latvia, Lebanon, Mauritania, Moldova, Mongolia, Montenegro, Morocco, Nepal, Panama, Niger, North Macedonia, Peru, Philippines, Poland, Portugal, Slovenia, Sri

Lanka, Sudan, Sultanate of Oman, Taiwan, Turkish Republic of Northern Cyprus (TRNC), Ukraine, Tunisia, and Uzbekistan were added to the countries previously prohibited.

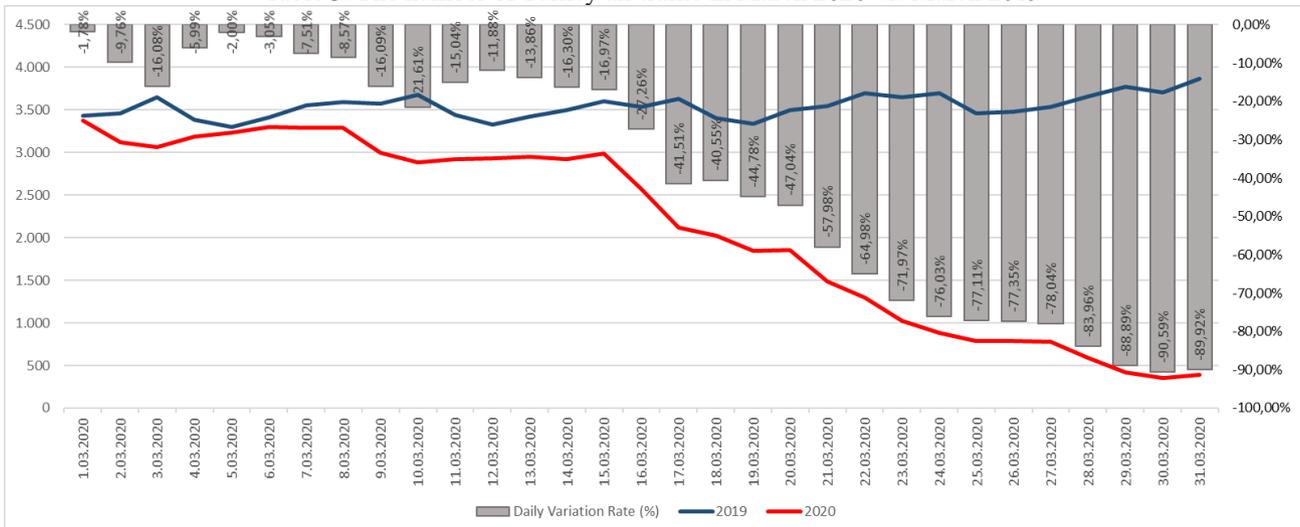
With the NOTAM numbered G1737/20 (A1839/20) on March 27, 2020, starting from 23:45 UTC, all international flights from/to Turkey were prohibited, except for the flights mentioned previously.

Between March 28 – June 1, 2020, Sabiha Gökçen Airport was closed and Pegasus Air Transport Inc. flights were suspended (EUROCONTROL, 2021a).

As of 20:59 UTC on June 11, 2020, with the NOTAM numbered G2836/20 (A2858/20), prohibition of all flights from/to Turkish airports was canceled.

By the spread of the pandemic, there was a 1.78% decrease in air traffic in Turkey at the beginning of March 2020 compared to 2019 data. With the declaration of flight restrictions to 11 countries, including Germany and France on March 14, 2020, in addition to the previously announced countries, serious decreases began to occur in the number of traffic, and as shown in Table 3, it was up to a decrease of 89.92% at the end of March 2020.

Table 3. The number of Turkey air traffic in March 2020 vs. March 2019

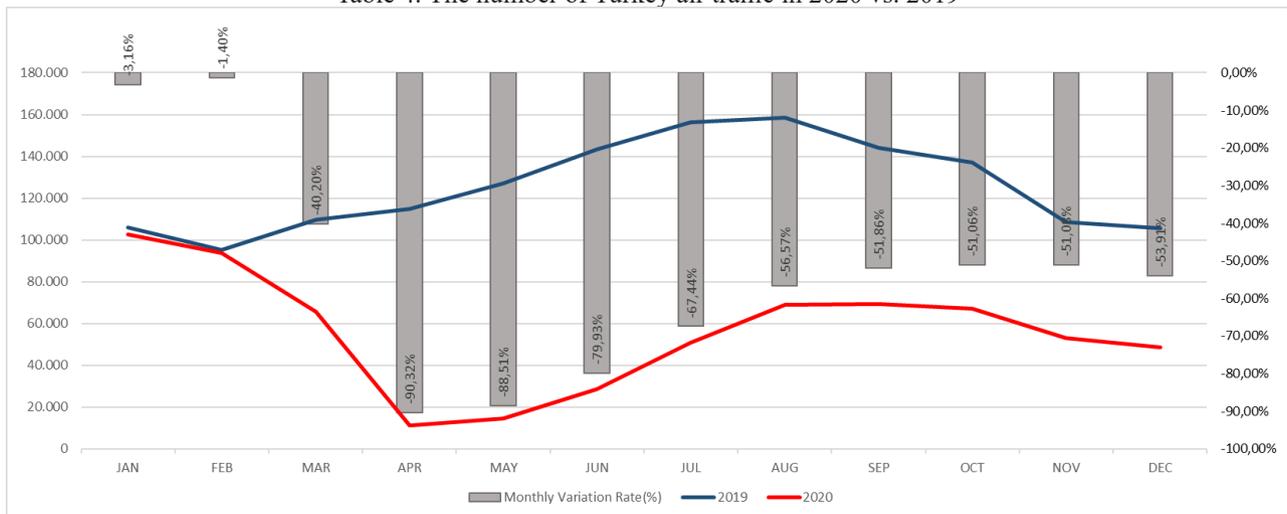


Similar to the European air traffic, the biggest collapse of the pandemic period occurred with a decrease of 92.91% in Turkey air traffic compared to the previous year, on April 13, 2020. Domestic flights suspended as of April 3, 2020, by Turkish Airlines were resumed on June 4, 2020. In addition to cargo transportation, which gained importance during the pandemic period, Turkish Airlines continued operations for the evacuation of citizens of the Republic of Turkey at the beginning of the Covid-19 pandemic. On April 13, 2020, with only 46 flights, a decrease of 96.37% occurred compared to 2019, and the biggest decrease of Turkish Airlines flights was

experienced (EUROCONTROL, 2021c).

In May 2020, there was an increase in air traffic compared to the previous month. With the lifting of the restrictions as of June 1, 2020, an increasing trend occurred in air traffic network. While there were serious decreases in Turkey air traffic in April 2020 and May 2020, with the lifting of the restrictions in June 2020 and the starting of the summer season the increasing trend of air traffic trend continued as shown in Table 4. However, the trend went down in the autumn with an increase in the number of cases, similar to Europe.

Table 4. The number of Turkey air traffic in 2020 vs. 2019



4. Assessments and forecasts for the Covid-19 pandemic

Air transportation preferred by people as a fast and safe transportation method with the developing technology and transportation networks is an effective factor in the spread of pandemics today. The study of the Covid-19 pandemic in the Pacific islands is shown that although the island countries and the region are relatively isolated, they are vulnerable to global disease threats due to the interconnectedness of their air transport networks (Craig et al., 2020).

In another study, it is determined that the flight network and the total passenger volume are some

of the very important risk factors for the spread of Covid-19. Within the scope of the study, it is concluded that multiple regions in Asia, as well as North America and Europe, are at serious risk of continued exposure to Covid-19 by China, and other highly infected countries, while in South America and Africa the risk of Covid-19 may be relatively low (Lau et al., 2020). The number of confirmed cases reported to WHO as of the date of the study also confirmed this situation. While the number of cases in Africa, which constitutes 17.2% of the total world population, constitutes only 2.38% of the cases in the world, the number of cases in Europe, which constitutes 9.6% of the world population, constituted 30.52% of the cases in the world (Worldmeter, 2021; WHO, 2021d).

Considering the political measures implemented by states in all regions of the world, including the European region severely affected by the pandemic, and the different infection times and levels, recovery times may vary by the region. While the recovery is faster in the Asia-Pacific region, it is predicted that it will be slower in Europe and North America, the average number of passengers will not reach 2019 levels until 2023, and in the most pessimistic scenario, the recovery will remain after 2024 (Gudmundsson et al., 2020). According to the forecasts made by EUROCONTROL on different dates, it has been modeled that the recovery in air traffic will be realized in 2024 by the most optimistic scenario, and these studies have been confirmed.

In the first scenario created by EUROCONTROL on April 24, 2020, a gradual recovery from April 2020 to the end of August 2020 and with a decrease by 45% or less than 5 million in February 2021 was predicted to reach a decrease of 15% compared to 2019. However, with the expected flights in Europe being less than 55% compared to 2019, 1 million fewer flights than previously estimated, and the re-emergence of Covid-19 in mid-August, the scenario previously created by EUROCONTROL was updated by the report published on November 4, 2020. In this report; widespread availability of the vaccine (or end of a pandemic) by Summer 2021 was called scenario

1; widespread availability of the vaccine (or end of a pandemic) by Summer 2022 was called scenario 2; lingering infection and low passenger confidence were called scenario 3. According to scenario 1 seen as the most optimistic among the scenarios, it is estimated that air traffic will return to 2019 levels by 2024, and in the second scenario to most likely occur, the traffic in 2024 will be only 92% of the 2019 level. According to the third scenario, it is predicted that the number of traffic in 2024 will be 75% of 2019 and that the numbers of traffic in 2019 will not be reached until 2029 (EUROCONTROL, 2021d).

Taking into account the expected development of the Covid-19 pandemic, EUROCONTROL has published a new report on May 21, 2021, which includes forecasts for the possible development of air traffic in Europe for the years 2021-2024. In the report prepared to consider the speed of recovery in the pandemic, the progress in the vaccine, and the support of the States to the aviation industry 3 scenarios were created similar to the previous one. According to Scenario 1 accepted as optimistic, it is predicted that 2019 traffic levels will be reached with 97% in 2023 and 105% in 2024 (EUROCONTROL 2021e). As shown in Figure 3, in the worst-case scenario, it is estimated that the recovery will take place in 2029.

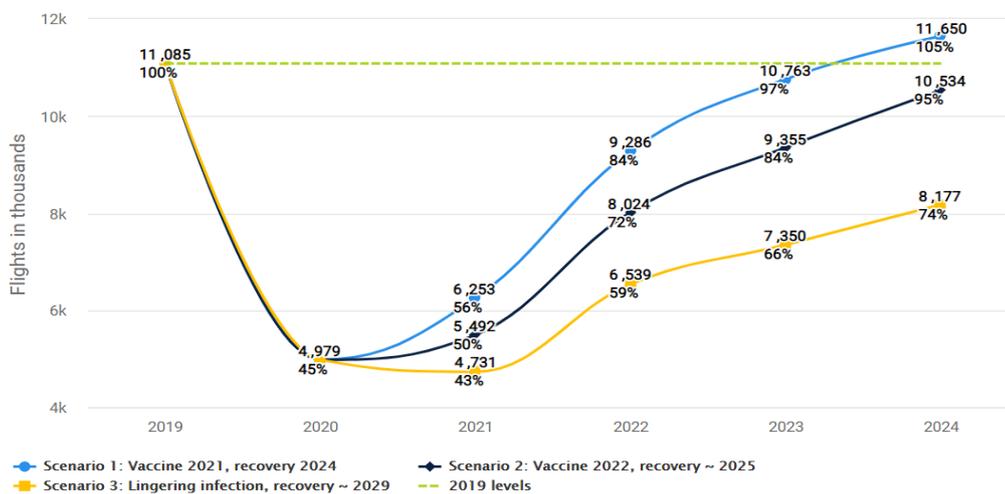


Figure 3. Europe 2021-2024 actual and future IFR movements, % traffic compared to 2019
Ref.: EUROCONTROL, 2021e

For Turkey, similar estimations were made in both reports. However, with 693,000 actual flights in 2021, Turkey exceeded the predicted 681,000 traffic numbers according to the most optimistic scenario of the report dated on November 4, 2020. In the most optimistic scenario of the latest

report, it is estimated that Turkey will perform better than European air traffic and reach a traffic level of 109.70% in 2024 compared to 2019. Table 5 shows the predicted number of traffic (in thousands) for Turkey according to all scenarios.

Table 5. Turkey air traffic network per 4-year forecast reports

	Forecast- November 4, 2020.			Forecast –May 21, 2021.		
	Scenario. 1	Scenario. 2	Scenario. 3	Scenario. 1	Scenario. 2	Scenario. 3
2019	-	1547	-	-	1547	-
2020	681	659	655	-	693	-
2021	1.091	760	741	918	801	686
2022	1.394	1.126	892	1.258	1.084	886
2023	1.552	1.322	1.057	1.530	1.312	1.038
2024	1.689	1.525	1.213	1.697	1.515	1.200
2020-2024 (vs. 2019)	109,18%	98,58%	78,41%	109,70%	97,94%	77,57%

CONCLUSION AND DISCUSSION

Covid-19 emerged at the end of 2019 has affected the whole world in an unprecedented way. This effect had long-term negative consequences on many sectors. In particular, the aviation industry has faced problems that cannot be compensated due to the risk of contamination and restrictions. There has been a serious decrease in air traffic around the world. Considering the current data on the Covid-19 pandemic and the predictions regarding the vaccination processes, it is predicted that the negative impact of the pandemic on air traffic will continue for a long time.

Considering that the recovery process took 8 years in the major economic crises in 2008 and 2011, where 0.6 million traffic losses occurred, and the uncertainties regarding when the pandemic will end, the Covid-19 pandemic with more than 6 million traffic losses, for now, will cause irreparable losses to European air traffic for a long time. As a matter of fact, although the strict measures against the pandemic (quarantine, flight cancellations, travel restrictions) can significantly reduce the risks, it will come with a huge social, economic and political risk cost (Christidis et al., 2020). The industry should be supported by all stakeholders in order to minimize these risks in terms of aviation and to enable airline companies to overcome the financial problems they face.

Continues Descent Operation (CDO) and Continuous Climb Operation (CCO) can be among the solutions for fuel costs, which are among the most important expenses in the process of supporting the industry. It has been determined that CDO and CCO providing an economic benefit by the optimal descent/climbing of the aircraft and the reduction in fuel consumption made a profit of 150 million euros as a result of a study conducted according to the traffic data of 2017 in the European airspace (EUROCONTROL, 2021f). For this reason, the optimal use of operations called CCO and CDO in air traffic management will also benefit airline companies economically during the Covid-19 pandemic.

In addition to CDO and CCO, another operational benefit element is en-route charges. Air traffic en-route charges for the use of facilities and services operated by the State during flights over airspace are an economic cost for industry (Uslu and Cavcar, 2002). After the Covid-19 outbreak caused up to 90% reductions in flights in European airspace, airlines sought support from EUROCONTROL member states to deal with a sudden and serious cash flow crisis. In this context, the financial package allows the postponement of en-route charges up to 1.1 billion euros, which must be paid by the airline companies to the European air traffic management,

was accepted by the EUROCONTROL member states (EUROCONTROL, 2021g). Continuing to support airline companies with similar packages will help them overcome the pandemic crisis.

The purpose of this study was to assess the impact of Covid-19 on European and Turkish air traffic by analyzing traffic statistics of 2020 compared to 2019 and by reviewing the latest forecasts for

the industry. In view of the persistence of the pandemic and probable accessibility challenges in the vaccination process, it is advisable for research on the aviation industry to continue regularly with the impact of the Covid-19 pandemic. In order to halt the pandemic and to limit the impacts in the future, comprehensive analyses will contribute to the future of the aeronautical sector.

REFERENCES

1. Air Transport Action Group (ATAG) (2020). Aviation: Benefits Beyond Borders report for 2020. <https://www.atag.org/our-publications/latest-publications.html> Date of Access: 15.07.2021
2. Christidis, P., Christodoulou, A. (2020). The Predictive Capacity of Air Travel Patterns during the Global Spread of the COVID-19 Pandemic: Risk, Uncertainty and Randomness. *International Journal of Environmental Research and Public Health*, 17(10), 3356.
3. Craig AT., Heywood AE., Hall J. (2020). Risk of Covid-19 importation to the Pacific islands through global air travel. *Epidemiology and Infection* 148, e71, 1–5. <https://doi.org/10.1017/S0950268820000710>
4. Ding, Q., Lu, P., Fan, Y., Xia, Y., Liu, M. (2020). The clinical characteristics of pneumonia patients coinfecting with 2019 novel coronavirus and influenza virus in Wuhan, China. *J Med Virol*. 2020;92:1549–1555. <https://doi.org/10.1002/jmv.25781>
5. DURSUN, S. B. (2021). THE EFFECT OF COVID-19 ON THE AVIATION SECTOR. *International Journal of Early Childhood Special Education (INT-JECSE)*, 30(1), 2034.
6. EUROCONTROL (2021a). State and Airline Response to Covid-19, <https://www.eurocontrol.int/publication/summary-state-and-airline-responses-covid-19> Date of Access: 15.07.2021
7. EUROCONTROL (2021b). Comprehensive Assessment. 7 Jan 2021. <https://www.eurocontrol.int/sites/default/files/2021-01/covid19-eurocontrol-comprehensive-air-traffic-assessment-14012021-.pdf> Date of Access: 15.07.2021
8. EUROCONTROL (2021c). Daily Traffic Variation - Aircraft Operators (2020) <https://www.eurocontrol.int/Economics/2020-DailyTrafficVariation-AOs.html> Date of Access: 15.07.2021
9. EUROCONTROL (2021d). Five-Year Forecast 2020-2024 European Flight Movements and Service Units Three Scenarios for Recovery from COVID-19. November 2020. <https://www.eurocontrol.int/sites/default/files/2020-11/eurocontrol-five-year-forecast-europe-2020-2024.pdf> Date of Access: 15.07.2021
10. EUROCONTROL (2021e). Forecast Update 2021-2024 European Flight Movements and Service Units - Three scenarios for recovery from COVID-19 <https://www.eurocontrol.int/publication/eurocontrol-forecast-update-2021-2024> Date of Access: 15.07.2021
11. EUROCONTROL (2021f). Continuous climb and descent operations, Date of Access: 15.07.2021
12. EUROCONTROL (2021g). Press Release; EUROCONTROL States agree a €1.1 billion deferral package to assist airlines, <https://www.eurocontrol.int/press-release/eurocontrol-states-assist-airlines-11bln-deferral> Date of Access: 15.07.2021
13. Gudmundsson, S. V., Cattaneo, M., & Redondi, R. (2020). Forecasting recovery time in air transport markets in the presence of large economic shocks: COVID-19. Available at SSRN 3623040.
14. International Air Transport Association (IATA) (2021). What can we learn from past pandemic episodes? <https://www.iata.org/en/iata-repository/publications/economic-reports/what-can-we-learn-from-past-pandemic-episodes/> Date of Access: 15.07.2021
15. International Civil Aviation Organization (ICAO) (2021a). Effects of Novel Coronavirus (Covid-19) on Civil Aviation: Economic Impact Analysis. https://www.icao.int/sustainability/Documents/COVID-19/ICAO_Coronavirus_Econ_Impact.pdf Date of Access: 15.07.2021

16. International Civil Aviation Organization (ICAO) (2021b). Operational Impact on Air Transport. Flights among Months Including Passenger& Cargo- Domestic &International <https://data.icao.int/Covid-19/operational.htm> Date of Access: 15.07.2021
17. International Civil Aviation Organization (ICAO) (2021c). Revenue/Pax/Seat Losses By Region of Air Carrier Registration & Route Groups, Comparison of Months 2019 vs. 2020 <https://data.icao.int/coVID-19/economic.htm> Date of Access: 15.07.2021
18. Lau, H., Khosrawipour, V., Kocbach, P., Mikolajczyk, A., Ichii, H., Zacharski, M., ... & Khosrawipour, T. (2020). The association between international and domestic air traffic and the coronavirus (Covid-19) outbreak. *Journal of Microbiology, Immunology and Infection*
19. Mhalla, M. (2020). The Impact of Novel Coronavirus (Covid-19) On The Global Oil And Aviation Markets. <https://doi.org/10.18488/journal.2.2020.102.96.104>
20. Recchi, E., Deutschmann, E., Vespe, M. (2019). Estimating transnational human mobility on a global scale. Robert Schuman Centre for Advanced Studies Research Paper No. RSCAS 30, 1–10.
21. Republic of Turkey Ministry of Transport and Infrastructure (2021). Basın Açıklaması 14 Mart 2020. <https://www.uab.gov.tr/basin-aciklamalari/basin-aciklamasi-coronavirus-hakkinda> Date of Access: 15.07.2021
22. Sivil Havacılık Genel Müdürlüğü (SHGM) (2021). Duyurular, <http://web.shgm.gov.tr/tr/genel-duyurular/6323-saglik-bakanligi-bilim-kurulunun-16-mart-2020-tarihli-kararlari-kapsaminda-havacilikla-ile-ilgili-tedbirlerin-uygulanmasina-yonelik-shgm-basin-aciklamasi> Date of Access: 15.07.2021
23. Sohrabi, C., Alsafi, Z., O'Neill, N., Khan, M., Kerwan, A., Al-Jabir, A. & Agha, R. (2020). World Health Organization declares global emergency: A review of the 2019 novel coronavirus (Covid-19). *International Journal of Surgery*.
24. Suau-Sanchez, P., Voltes-Dorta, A., & Cugueró-Escofet, N. (2020). An early assessment of the impact of COVID-19 on air transport: Just another crisis or the end of aviation as we know it?. *Journal of Transport Geography*.
25. Uslu, S. & Cavcar, A. (2002). A Cost Item In Airlines: Air Traffic En-Route Charges In European Airspace. *Anadolu University Journal of Social Sciences*, 2(1), 81-94.
26. Young, N., Pebody, R., Smith, G., Olowokure, B., Shankar, G., Hoschler, K., ... & Oliver, I. (2014). International flight-related transmission of pandemic influenza A (H1N1) pdm09: an historical cohort study of the first identified cases in the United Kingdom. *Influenza and other respiratory viruses*, 8(1), 66-73.
27. World Health Organization (WHO) (2021a). Director-General's opening remarks at the media briefing on Covid-19 - 11 March 2020. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-Covid-19---11-march-2020> Date of Access: 15.07.2021
28. World Health Organization (WHO) (2021b). Statement – We can beat COVID-19 virus through solidarity-19 March 2020, <https://www.euro.who.int/en/media-centre/sections/statements/2020/statement-we-can-beat-covid-19-virus-through-solidarity> Date of Access: 15.07.2021
29. World Health Organization (WHO) (2021c). Statement – Covid-19: an update on the Covid-19 situation in the WHO European Region, <https://www.euro.who.int/en/media-centre/sections/statements/2020/statement-covid-19-an-update-on-the-covid-19-situation-in-the-who-european-region> Date of Access: 15.07.2021
30. World Health Organization (WHO) (2021d). Coronavirus Disease (Covid-19) Dashboard. <https://Covid19.who.int/> Date of Access: 15.07.2021
31. Worldmeter (2021). World Population by Region. <https://www.worldometers.info/world-population/> Date of Access: 15.07.2021