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ANALYSIS OF THE TRANSPORT VOLUME OF PASSENGERS AND CARGO ON THE EXAMPLE OF THE WARSAW-OKĘCIE INTERNATIONAL AIRPORT (POLAND)

Summary. Currently, the branch of air transport is one of the most dynamically developing branches of transport. Modern air transport systems provide relatively high quality of services in terms of satisfaction, preferences, and tastes of potential recipients, passengers, and freight operators. Air transport systems use highly advanced technologies, equipment, infrastructure, and appropriate rules and procedures in order to ensure the desired quality of services. The article presents an analysis of the volume of passenger and cargo transport in air transport on the example of the Warszawa Okęcie International Airport (Poland). The analysis covered the years from 2011 to 2021. In addition, the market of air services, and air connections with Warszawa Okęcie International Airport were characterized.

Keywords: air transport, air transport service market, transport, traffic engineering

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1. INTRODUCTION

An efficiently functioning transport system guarantees the fast and stable economic development of each country. Transport needs arise as a result of the uneven distribution of resources and the geographical mismatch between the place of their creation and the place of their use. Transport needs can be met using various means of transport [27, 28, 29]. Many of the earlier research works emphasize the close relationship between the location of industrial centers and the role and importance of transport quality [8], [30], [40].

According to [20], [24, 25, 26], the basic and indisputably most important objective of the functioning of each airport is to guarantee the safe movement of aircraft in accordance with the flight schedule. The above activities involve the provision of transport services for passengers, goods, cargo, mail, etc. Hence, another, but already indirect feature of airports is responding to the needs reported by the public regarding their willingness to move from various points and transport goods. By making their infrastructure and human resources available to other entities that deal with air transport, airports allow indirectly to satisfy the desires and needs related to the transport and transfer of people and goods.

At the airport, aircraft perform different types of flights. These are [12], [16], [31]:
- a commercial flight which is closely related to commercial transport,
- an international flight in which the aircraft moves beyond the borders of the countries,
- a transit flight that takes place within the airspace of the Republic of Poland, but the beginning and end of the flight take place outside Poland,
- a long-haul flight, the duration of which is more than eight hours over a specified single-leg distance.

On the other hand, air transport is a flight or a series of flights where there is a specific remuneration and an agreement on the temporary commissioning or taking into use of the aircraft and the transport of passengers, goods, etc. Air transport can be divided into [5], [16], [34]:
- scheduled air transport, i.e., flights offered to the public for purchase, aircraft are designed to transport passengers, luggage, goods, etc., transport is carried out according to a published flight schedule at regular intervals with regular frequency and on fixed routes,
- charter transport carried out on the basis of an air charter agreement. In it, the carrier specifies the number of seats available or the capacity of the aircraft. The lessee is the charterer. The purpose of such a flight is to perform specific transport of passengers, luggage, goods or mail.

The article presents an analysis of the volume of passenger and cargo transport in air transport using the example of the Warszawa Okęcie International Airport (Poland). The analysis covered the years 2011-2021. In addition, the market of air services, and air connections with Warszawa Okęcie International Airport were characterized. After introducing the subject of the article, the second section describes the most important features of the air transport services market. The next, third section presents a short timeline of the functioning of the Frederic Chopin International Airport in Warsaw and lists the air connections with the Warszawa Okęcie International Airport. The fourth section contains an analysis of the volume of passenger and cargo transport at the Warszawa Okęcie International Airport in the last years of the airport's operation, i.e., from 2011 to 2021. This analysis covered both domestic and international flights. The last, fifth section contains a summary and conclusions from the analyses carried out in the article.

2. THE AIR TRANSPORT SERVICES MARKET

The market of air transport services takes into account the relationship between demand and supply. It is a relationship where buyers aim to purchase an air service and services are offered by sellers aiming to make trade. There are also units of the competitive market here. According to [22, 23], [43], the air transport services market can be defined as a place, process, space, situations, mechanism, as well as a set of conditions in which air transport entities operate. This particular market has a global character and is characterized by heterogeneity, seasonality, dependence on external factors, and has an innovative nature of the services provided, a high level of security, and above all, a high quality of services provided. On the market of air transport services, there are entities in the form of sellers and buyers. The following criteria for classifying the aviation market are distinguished [7], [11], [22]:
- subject,
- subjective,
- spatial,
- organization of transport.

According to [32], [35], [41] the main components of any market are demand, supply, and price. With regard to the market for air transport services, it takes into account these elements through the prism of the air services provided. In turn, demand [15], [35], [38] is the amount of goods or services that consumers are willing and able to buy at a given price and at a given time. The creation of demand on the market for air transport services is influenced, among others, by the price and such features as the travel needs to be reported by consumers of air transport services, the number of passengers carried, the position of competition on the market and the prices of services offered by competing entities, the range of services offered, etc. [13], [22], [45].

The demand for the good, which is the air transport service has, its elasticity (price and income). Due to its inherent superiority, the demand for air transport is characterized by high price elasticity [21], [44]. Supply on the market of air transport services is the amount of air services that are offered for sale for the potential time space within this market. In the concept of air transport, it is the possibility of transferring people or cargo by transport companies at a given time and their ability to guarantee places at different prices [18], [22]. The last of the listed components of the market is the price, i.e., the market value of a good or service expressed in money [33]. In terms of the market for the provision of air transport services, it is tantamount to maintain analogous goals of service providers and service recipients. It is required that the elements of the market adapt to the prevailing environmental conditions. Prices may be determined by the relationship between the buyer and the seller. An additional variable that often affects the price is the services offered by competitors and their variety [22].

The formation of the air transport services market is also influenced by many stimuli, including the operating model, the possibility of raising and investing capital, as well as participation in various types of strategic analyses, mergers, ventures, etc. [22], [37]. On the other hand, the seasonality factor has the greatest impact on the passenger service market. Taking into account different periods of time, e.g., week, month, year, etc., there are large amplitudes in the transfer of passengers. Their highest rate is recorded in summer, when the peak of the holiday season occurs [6], [22].

Market and non-market phenomena also contribute to the impact on the market of air transport services. Market factors are related to achieving the highest possible competitive position on the market. On the other hand, non-market phenomena are associated with changing

weather and the impact of legal and administrative authorities [22], [36], [39]. The main institutions regulating the principles and laws of airport functioning and taking actions are:
- in Poland, the institution at the state level is the Civil Aviation Authority (CAA),
- at the continental level, the European Union (EU) is the regulatory institution,
- at the international level, regulations are made by two main institutions: International Civil Aviation Organization (ICAO), and International Air Transport Association (IATA).

The above-mentioned organizations standardize and create rules that give the appropriate character to the air transport services market. They define relations and legal norms between buyers and sellers. All standards are characterized by a control and intervention approach to the air services offered [19], [22], [46].

3. AIR CONNECTIONS TO AND FROM WARSAW OKĘCIE INTERNATIONAL AIRPORT

International Airport Fryderyk Chopin in Warsaw Okęcie was put into use in 1934. According to the data presented on the official website of the airport [42], the airport served 10,750 passengers in its first year of operation. In addition, before the outbreak of World War II, the airport regularly operated connections to six airports in the country, and to seventeen airports located outside Poland. The history of the airport covers many different periods of time that have influenced the way it operates. Historically, the airport has already served both social and military functions.

In the years 1990-2000, International Airport Fryderyk Chopin in Warsaw Okęcie underwent intensive activities in the field of modernization of the airport and activities related to the development of navigation systems supporting the operation of the airport. As a result of these activities, the number of air operations performed at International Airport Fryderyk Chopin in Warsaw Okęcie has significantly increased. In the following years of the 21st century, many infrastructural investments and modernization of the airport were carried out. These were mainly [42]:
- 2004 - 2010 - expansion of the "Etiuda" terminal,
- 2005 - modernization of the National Airport, official opening of the VIP Aviation Terminal, which is dedicated to handling smaller business aircraft,
- 2010 - unification of the names of the buildings previously referred to as Terminals 1 and 2, which were given one common name "Terminal A",
- 2011 - expansion of the piers with a central pier and completion of the renovation of the southern pier. As a result of the modernization, a panoramic hall was opened to passengers. It was possible to use eleven new sleeves for passenger service,
- 2013 - 2015 - modernization works were carried out, as a result of which a new communication system serving the airport was created, among others, a railway line was brought to the airport, and a new observation deck was put into use. In addition, a solar power plant has been installed on the roof of the airport building, which allows for additional electricity.

International Airport Fryderyk Chopin in Warsaw Okęcie is the main airport in Poland. It serves both domestic flights as well as international and intercontinental ones. International Airport Fryderyk Chopin in Warsaw Okęcie performs flights in regular, charter and cargo air traffic. International Airport Fryderyk Chopin in Warsaw Okęcie provides a significant number

of passenger and cargo transport services and provides connections with all major airports in Poland. There are flights to and from the following other airports:
- International Airport in Cracow,
- Katowice International Airport,
- Rzeszow Airport,
- Wroclaw Airport,
- Poznan Airport,
- Zielona Góra Airport,
- Bydgoszcz International Airport,
- Szczecin Airport,
- Gdansk Airport,
- Lublin airport.

4. AIR TRAFFIC AT INTERNATIONAL FREDERIC CHOPIN AIRPORT IN WARSAW IN NATIONAL AND INTERNATIONAL RELATIONSHIPS IMPLEMENTED IN THE YEARS FROM 2011 TO 2021

Air traffic at each airport is usually measured in three parameters per unit of time (usually a year or a day). These are:
- the number of passengers transported,
- the number of total aircraft operations. The arrival and departure of the aircraft are counted as one complete flight operation. Pax operations are the arrivals and departures of passenger planes,
- the number of metric tons of transported goods (cargo).

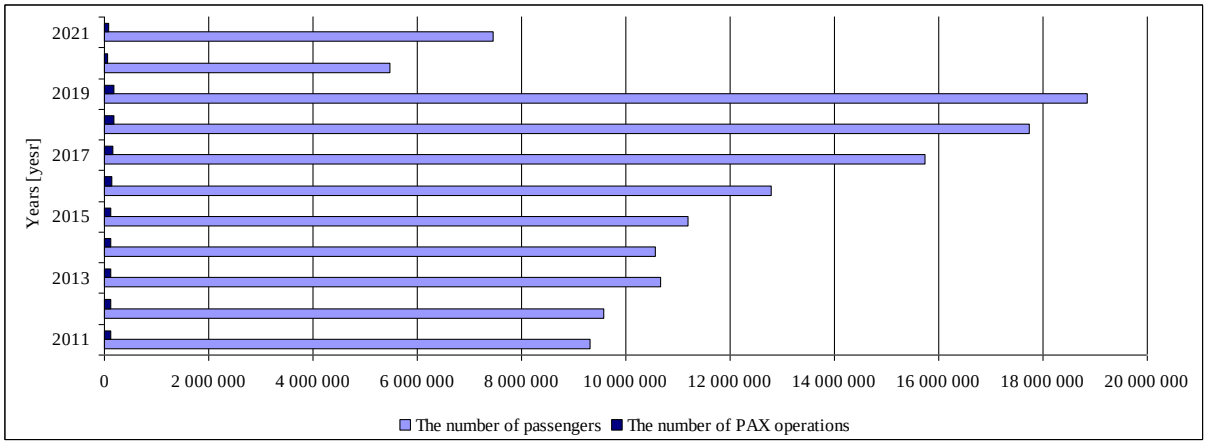
The largest airports in the world currently perform from just over 976,000 total aircraft operations per year to just over 509,000 total aircraft operations per year. Currently, most air operations are carried out at the Atlanta-Hartsfield-Jackson airport (USA). In general, the first eleven airports with more than 500,000 total aircraft operations per year are mainly airports located in the USA, and Paris-Roissy-Charles de Gaulle Airport (France).

On the Fig. 1, data on the number of passengers, passenger operations, and the number of cargo flights at International Airport Fryderyk Chopin in Warsaw Okęcie in 2011-2021 for domestic and international traffic have been presented. Based on data presented in the Fig. 1, it can be concluded that both the volume of passenger transport and cargo transport was growing in the period of analysis. A visible decrease in both cases was recorded in 2020, i.e., during the Covid-19 pandemic around the world. The decrease in the handled cargo transports was related to the logistic paralysis resulting from the rigorous and still underdeveloped restrictions related to the outbreak of the Covid-19 pandemic. In 2021, there was a renewed increase in the number of passengers transported, and a sharp increase in the number of transported cargo.

In turn, Fig. 2 presents a comparison of the quarterly volumes of the number of passengers served in charter and regular domestic and international traffic at International Airport Fryderyk Chopin in Warsaw Okęcie in 2018-2021. Analyzing the results, it can be concluded that, with the exception of 2020, when the Covid-19 pandemic had a strong impact on the reduction in the number of passengers transported, both in domestic and international traffic, there is an increasing trend in the number of passengers transported in individual years in each quarter. In 2021, an increase in the number of passengers transported is visible compared to the previous

year, marked by the pandemic. In 2021, International Airport Fryderyk Chopin in Warsaw Okęcie has already served 7,445,468 passengers in domestic and international traffic.

a)



b)

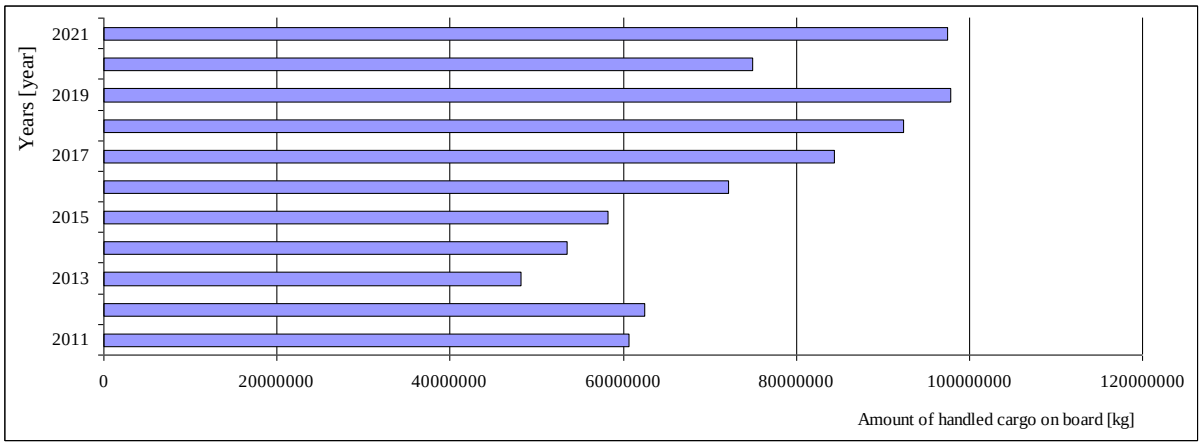


Fig. 1. Domestic and international transport at International Airport Fryderyk Chopin in Warsaw Okęcie in 2011-2021: a) The number of passengers and the number of PAX operations, b) Amount of handled cargo on board [kg]
Source: Own research based on data presented by the civil aviation authority in Poland [9]

In the Fig. 3, changes in the volume of domestic passenger traffic and changes in the number of PAX operations in regular and charter traffic at International Airport Fryderyk Chopin in Warsaw Okęcie in the years 2011-2021 are presented. On the basis of Fig. 3a, it can be stated that in 2017 there was a significant increase in the number of passengers served, which amounted to over 2 million. In the following years, 2018 and 2019, despite a slight decrease, International Airport Fryderyk Chopin in Warsaw Okęcie still served a significant number of passengers (over 1.75 million passengers/year). In 2020, and in 2021, the number of passengers handled was slightly more than 600,000 passengers/year. In 2020, this decrease was caused by the Covid-19 pandemic and, as can be see, in 2021 the number of passengers served remained at a similar level as in 2020. As can be seen, the Covid-19 pandemic had a significant impact on many sectors of the economy. The air transport sector serving business travel and tourism was among those branches of the economy that were the first to feel its direct negative effects.

The Covid-19 pandemic has led to massive travel disruptions and has contributed to the cancellation of many flights.

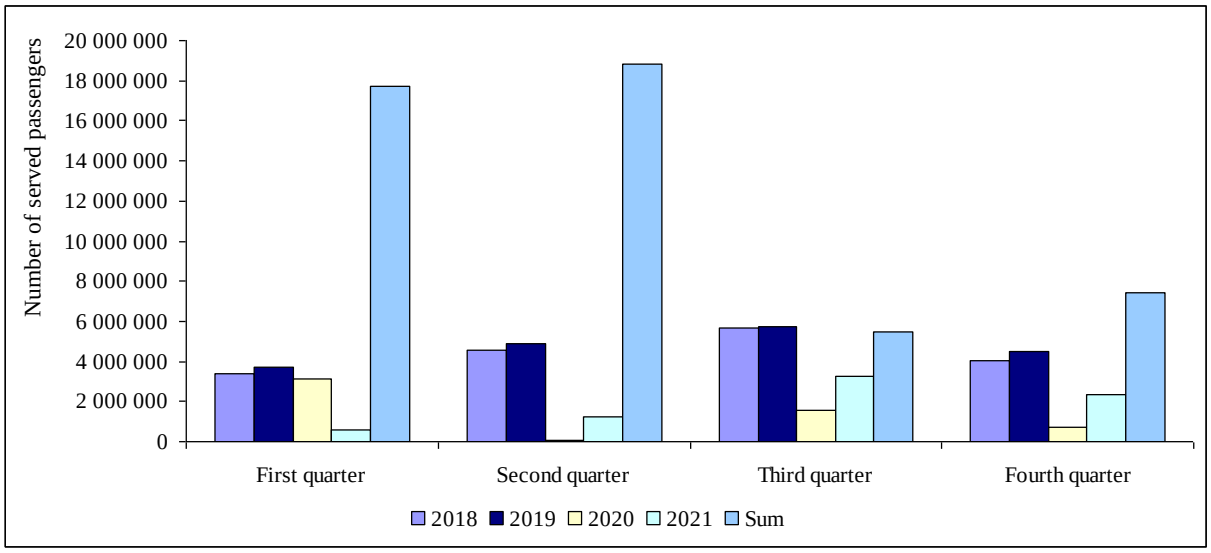
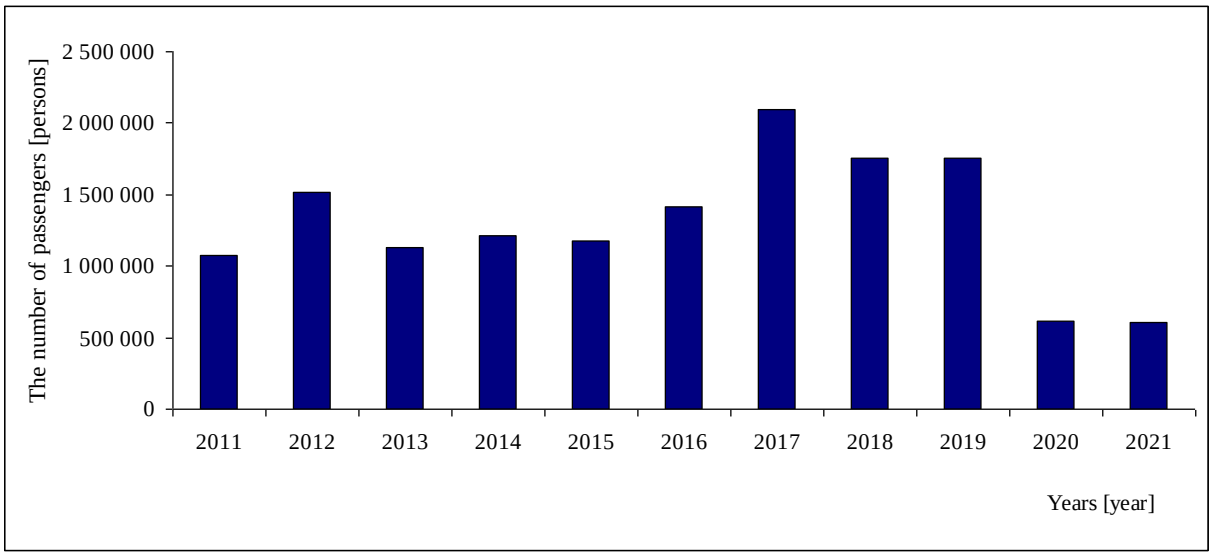


Fig. 2. Number of passengers served in charter and regular domestic and international traffic at International Airport Fryderyk Chopin in Warsaw Okęcie in 2018-2021 in individual quarters of the year
Source: Own research based on data presented by the Civil Aviation Authority in Poland [9]

Restoring the normal functioning of air transport will be an important aspect of the EU's economic recovery after the crisis caused by the Covid-19 pandemic in air transport. In turn, analyzing the data in Fig. 3b, it can be stated that during the analysis period, the number of PAX operations performed fluctuated. The maximum number of operations was performed in 2017 (over 28,000). There was a significant decrease in the years 2020 and 2021. The decrease in the number of transported passengers and passenger transport operations visible in 2013-2015 was related to the intensive work carried out in that period to modernize the International Airport Fryderyk Chopin in Warsaw Okęcie.

In the Fig. 4, a quarterly summary of the number of passengers served in domestic charter and regular traffic at International Airport Fryderyk Chopin in Warsaw Okęcie in 2018-2021 has been presented. Based on the presented figure, it can be concluded that in individual quarters in 2018, and 2019 the number of passengers served in domestic charter and regular traffic was similar. A significant decrease in domestic traffic in the number of passengers transported took place in the second quarter of 2020. The number of passengers transported decreased to 20,987 people. The reason was the Covid-19 pandemic. In 2021, despite the higher number of passengers transported compared to 2020, there was another decrease in the number of passengers in domestic traffic compared to the period before 2020. The registered number of passengers carried in 2021 was 607,745 passengers.

a)



b)

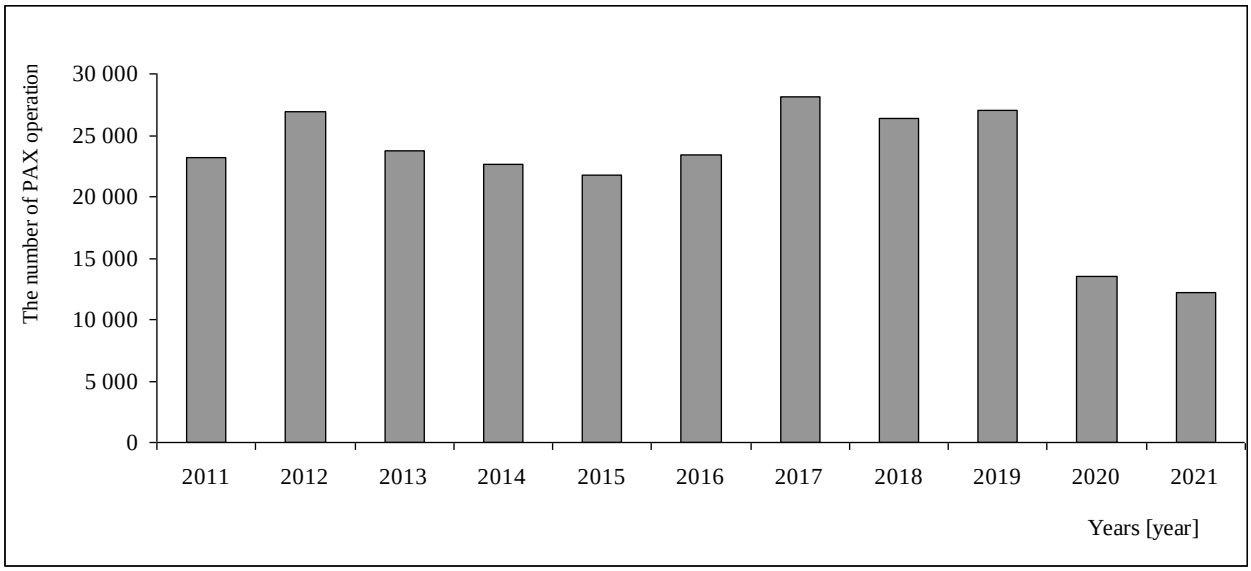


Fig. 3. Domestic transport at International Airport Fryderyk Chopin in Warsaw Okęcie in 2011-2021: a) The number of served passengers, b) The number of PAX operations
Source: Own research based on data presented by the Civil Aviation Authority in Poland [9]

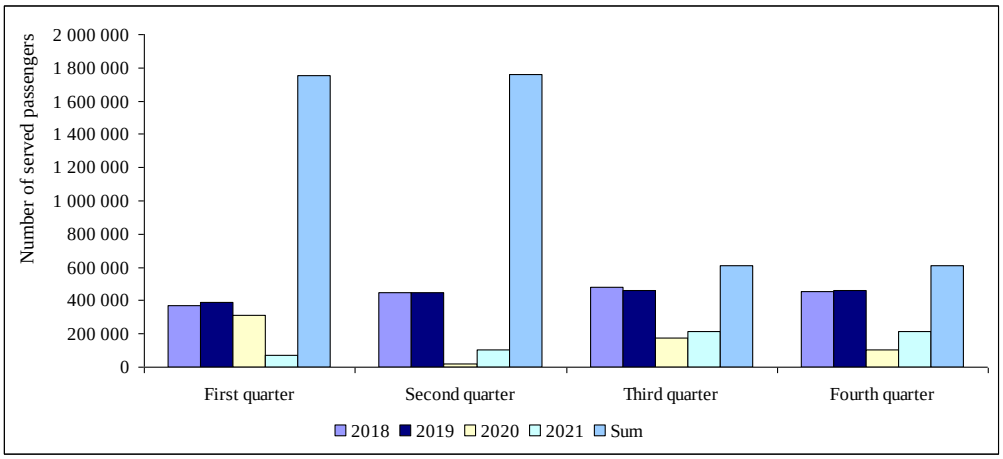


Fig. 4. Number of passengers served in domestic charter and regular traffic at International Airport Fryderyk Chopin in Warsaw Okęcie in 2018-2021 in individual quarters of the year
Source: Own research based on data presented by the Civil Aviation Authority in Poland [9]

5. SUMMARY AND CONCLUSIONS

The article presents an analysis of the volume of passenger traffic and transported cargo at International Airport Fryderyk Chopin in Warsaw Okęcie in the years 2011-2021. During the analysis period, the successful development of the airport in terms of the number of passengers served, and passenger operations in domestic and international traffic, clearly visible in 2011-2019, was seriously disrupted by the Covid-19 pandemic, which saw a significant reduction in the volume of passenger traffic and transported cargo. The impact of the Covid-19 pandemic on passenger traffic and cargo transport was strong and widespread worldwide, as confirmed by many published scientific papers [1-4], [10], [17]. The initial, total ban on air traffic caused by the Covid-19 pandemic primarily affected the results of the first and second quarters of 2020. However, even after the pandemic eased, International Airport Fryderyk Chopin in Warsaw Okęcie continued to struggle with severe air traffic restrictions. While the volume of passenger traffic partially increased in the holiday months (with a visible peak in August 2020), the second, much higher wave of infections at the end of October 2020 had a very negative impact on the level of interest in air transport in the last quarter of 2020. In the last quarter of 2020, Polish airports recorded the number of passengers lower by 84% than the number of passengers in the fourth quarter of 2019. In 2020, International Airport Fryderyk Chopin in Warsaw Okęcie served a total of 5.5 million passengers, which is almost 13.4 million less than in 2019. The number of passengers served in 2020 was slightly lower (by 1.5%) than the number of passengers served by comparable airports associated in ACI Europe.

In 2020, the number of passengers served on international flights decreased by 70.7% compared to 2019. However, this is 3.8% more than the number of passengers served at airports associated with ACI Europe. The number of air operations decreased in this period by as much as 63.1%. As part of international regular transport, 27.9 million passengers were transported less than in the corresponding period of 2019, and almost 4 million passengers less as part of charter transport.

In domestic transport in 2020, the number of passengers transported decreased by 65.4%. This is almost 2.6 million passengers less than in 2019. This result was 10.3% worse than the result for airports associated with ACI Europe.

As part of regular transport, in 2020 the number of passengers decreased by 69.5%, i.e. almost 30.5 million passengers less than in 2019. Most passengers traveled on routes to/from such countries as Great Britain, Germany and Italy. Among Polish airports, the largest number of passengers in regular traffic was served by Warsaw Chopin Airport (5.1 million passengers), followed by Kraków-Balice airport (2.6 million passengers), and Gdańsk im. L. Wałęsa airport (1.6 million passengers) [9].

In 2020, the number of passengers in charter traffic decreased by 77.3%, i.e. over 4 million passengers less than in 2019. The largest number of passengers traveled on routes from/to such countries as Greece, Turkey and Egypt.

Among the airports, the leaders in terms of the number of charter passengers served were: International Airport Katowice in Pyrzowice (429,000), International Airport Warszawa Okęcie (405,000 passengers), and Poznań-Ławica Airport (133,000).

In 2020, at International Airport Fryderyk Chopin in Warsaw Okęcie 101,000 tonnes of air cargo were transported. This is 18.1% less than in 2019. This decrease is mainly due to the decrease in the volume of flights of passenger planes, on which a large part of the cargo handled by Polish airports is usually carried. The number of cargo air operations in 2020 increased by 8.9% compared to 2019, which shows that cargo traffic not only did not suffer because of Covid-19 pandemic, but even expanded due to the greater accessibility of airports, in particular Warsaw Chopin Airport, which traditionally handles the most air cargo in Poland. At the same time, on routes where cargo transport was carried out on board passenger planes, transport capacity decreased due to air traffic restrictions. Examples include flights to Qatar or the United Arab Emirates.

In 2019, International Airport Fryderyk Chopin in Warsaw Okęcie served 18,844,591 passengers in domestic and international passenger transport. In 2020, this number decreased to 5,473,224 served passengers (a decrease by as much as 13,371,367 passengers). So far, the period of the Covid-19 pandemic has been the worst period of operation for the International Airport Fryderyk Chopin in Warsaw Okęcie. In contrast to passenger traffic, no such large losses were recorded in the case of cargo transport. Cargo transport in 2019 amounted to 97,784,243 kg, while in 2020, a slight decrease was recorded to 74,983,486 kg. In the following year, 2021, cargo transport amounted to 97,453,465 kilograms, which can be compared to the value of cargo transport in 2019.

In the case of cargo transport at International Airport Fryderyk Chopin in Warsaw Okęcie, a decrease is visible in the years 2013-2015, which resulted from modernization works carried out at the airport in that period (i.e., renovation of the old part of Terminal A, construction of a new apron for cargo transport, etc.). At that time, a railway station was connected to the airport, which enabled a quick and efficient connection between the airport and the city center.

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