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# Structural analysis of air passenger flow in the Republic of Croatia from the COVID-19 pandemic impact perspective

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## ABSTRACT

Air transport is a globally significant mode of transport that carries people and goods over relatively long distances in a relatively short time. In the case of the Republic of Croatia there are some relevant geographical factors that make it necessary to connect the country to domestic and international airlines, such as territorial division (Dubrovnik's disconnection from the rest of the Croatian mainland), rugged shape and mountainous terrain. In addition, as a tourist destination, the country should offer good transport links to provide the best experience for tourists. The aim of this research is to conduct an in-depth structural analysis of the intensity and dynamics of passenger air traffic at the global, European, and national (i.e. Croatian) level, considering the specific crisis of the COVID-19 pandemic as a relevant factor in the development of passenger flow. To achieve the defined objective of this research, a structural analysis of the relevant indicators for the development of passenger flow at the airports of the Republic of Croatia was conducted. In addition, a comparative analysis of the intensity, structure and dynamics of passenger flow was carried out within the framework of a comparison of the relevant criteria and statistical data on the indicators of passenger flow at the international, regional, and national levels. The COVID-19 pandemic has significantly affected the state of passenger flow in air transport in terms of organisation and logistics, and especially in terms of the intensity and dynamics of passenger flows. Accordingly, uniform criteria for monitoring passenger flow, systematisation and structural analysis of relevant formation indicators are the basic requirements for continuous monitoring and planning of passenger flow in air transport.

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## 1 Introduction

Nowadays, more and more changes are caused by globalization; the world is developing rapidly, and with the rapid development of all sectors, the transport sector, including air transport, is also developing [1]. In the era of globalisation, it is very important to connect remote places with urban centres and make them accessible to the general population, and this is exactly what air transport offers to its users. The air transport sector has contributed enormously to the global expansion of business, communications, trade, and tourism. Despite this significant development, the air transport sector faces significant problems, such as excessive fuel consumption, higher fuel prices, increase in air traffic, competition, economic crisis, aviation emissions, safety, design, and operational chal-

lenges [2]. Air transport also makes an important contribution to economic growth by creating opportunities for employment and increasing gross domestic product (GDP) [3], [4]. However, it should be noted that air transport is an extremely sensitive mode of transport, as confirmed by various crisis situations that have led to a decline in passenger traffic [5].

The objective of this research is to analyse air passenger flow at the global, regional (European) and local (Croatian) level. It is important to note that humans are the main variable in the formation of passenger air flow and that their sensitivity to various unfavourable situations leads to changes in the flows themselves.

The COVID-19 crisis has led to a new round of loans, loan guarantees, capital injections, and wage subsidies,

raising questions about competition and resource efficiency [6]. It has significantly affected the state of air passenger flow in air transport in the Republic of Croatia and can be considered a crisis with the greatest impact on air transport.

## 2 Basic regulations and indicators of the passenger air flow formation

In this part of the research, terms and laws related to air transport are defined. It also defines the basic characteristics, indicators and factors that affect the formation of passenger flow in air transport. Within the framework of technology and organization of passenger flow, the technological characteristics of air transport and the characteristics of each type of passenger flow in air transport are defined.

### 2.1. The concept and meaning of passenger flow in air transport

To understand the basic characteristics and peculiarities of passenger flow in air transport, the basic concepts and terminology in air transport can be defined as follows [7], [8]:

- The transportation of people and goods by vehicles capable of controlled sustained flight is known as **air transport**.
- A **commercial air transport** service is an operation in which an aircraft transports passengers, cargo, or mail for a fee or other useful consideration.
- The **passenger terminal** is the area of the airport primarily used for passenger and baggage reception, short-term layover and check-in.
- An **airline** is an entity whose principal activity is to provide passenger, cargo, and mail transport services using owned or leased aircraft.
- **Passenger registration** is the process of recording passenger data and confirming the passenger's presence at the airport and assigning the passenger a seat on the aircraft.
- A **passenger** is any person on an aircraft for whom a ticket is issued.

In addition to the defined relevant basic terms in air traffic, there is a whole series of other terms that are not listed here because they are not central to the topic under consideration here.

#### 2.1.1 Basic features of air traffic and air passenger flow

Air transport is historically the youngest mode of transport, but it has nevertheless reached a high level of development and is very competitive in the market. Therefore, it is considered a phenomenon compared to the development rate of other modes of transport such as road,

rail and sea. Passenger air transport has experienced a steady increase over the years.

Air transport is a capital-intensive industry where a large amount of capital is invested in the construction of airports and aircraft. Passenger terminals and aircraft have to comply with a variety of regulations set by regulatory authorities. In addition, service users, i.e., passengers, who particularly value and pay attention to safety and comfort, must be satisfied.

The basic elements of traffic flow, and therefore air passenger flow, are [7]:

- traffic nodes,
- traffic demand,
- transport networks.

In the case of air transport, airports are considered transport hubs. With their passenger terminals, airports represent points of origin, destination, and intermediate, i.e., transit points. Transport demand arises when the population wishes to change their place of residence. This may be for tourism, business or other reasons. The transport network consists of air transport networks that are established to meet the demand. A potential demand for air passenger transport must be identified and satisfied by a specific offer. Demand for air passenger transport must be constantly monitored to ensure the most complete offer possible.

The choice of the mode of transport depends on the characteristics of the passengers. In recent years, the average age of passengers has dropped dramatically as the emergence of low-cost airlines has made air travel more accessible to the general population. Moreover, the most common reasons for air travel are almost exclusively business and tourism related. Air transport corresponds to the above motives, as the transport time is relatively short compared to the distance travelled. The safety aspect of passenger transport by air is almost the highest compared to other forms of passenger transport, as both airports and airlines, as the main transport service providers, must comply with a long series of strict regulations.

#### 2.1.2 Indicators and factors of the formation of passenger air flow

For any analysis of traffic flow, it is necessary to know the basic indicators and factors for the formation of traffic flows. The basic indicators of the formation of traffic flow are [9]:

- direction,
- intensity,
- type of structure of the flow.

The direction or line of passenger flow is determined by the origin or destination of a particular passenger flow. The intensity or volume of passenger flow is usually expressed as the total number of passengers per unit of time in a given area or on a given route. Finally, the type of pas-

senger flow depends on various criteria, such as: passenger flow during departure, transit and arrival. [10].

The factors of the formation of traffic flow are divided into [9]:

- geo-traffic factors,
- socio-economic factors
- other factors.

The most important transport geographic factors are terrain, climate, the arrangement of sea and land, and the development and structure of transport networks and lines [11]. The possibility of building airports and thus providing air transport services is largely determined by the geographical area, hence mountain ranges are an obstacle, whereas lowland areas facilitate the formation of air transport lines. The degree and dynamics of economic growth and development, as well as the characteristics, needs, and structure of the population, are the most important socioeconomic factors. The increase in passenger flow at airports as a result of globalization has increased the importance, but also the burden of the global airport system. Other factors include passenger demand and expectations, as well as the state of the economic market.

Defining the indicators and factors for the emergence of passenger flow enabled a clearer analysis of the specificity of passenger flows, which was applied in the next stage of the research.

## 2.2 Technology and organization of passenger flow in airports

The technology of transporting passengers by air is a complex process that begins with the arrival of passengers at the departure airport and ends with the departure from the destination airport.

The essence of the process of passenger transport by air is in overcoming relatively large spatial differences. Another feature of the passenger transport process is the impossibility of booking a seat on an aircraft of a particular airline, so it is necessary to efficiently connect certain points of origin and destination.

Seven principles must be applied in the organization of passenger transport: safety, regularity, punctuality, frequency, comfort, speed and economy [12]. Users of air transport services, i.e., passengers, are guided by these principles when choosing an airline. Each of the principles has a different value for each passenger. Therefore, it is important that airlines have a profile and that users know what a particular airline offers when they purchase an airline ticket.

## 3 Structural analysis of passenger air flow at the global, regional and national level

Air transport has transformed society from the local level to the global level, as remote parts of the world can be more easily connected to urban centres. Air transport

has made what was once difficult to access much more accessible and has made economic and social activity in the world faster, more connected, more diverse, and richer. However, throughout history, the air passenger transport industry has faced challenges such as world crises, terrorist attacks, and epidemics that have led to a decline in traffic [13]–[15].

In this part of the research, passenger air traffic is analysed at the global, regional (European) and local (in the Republic of Croatia) level. In the analysis of passenger flow, the limiting factor was the lack of data consistency at all levels, which led to corresponding discrepancies in the data presented.

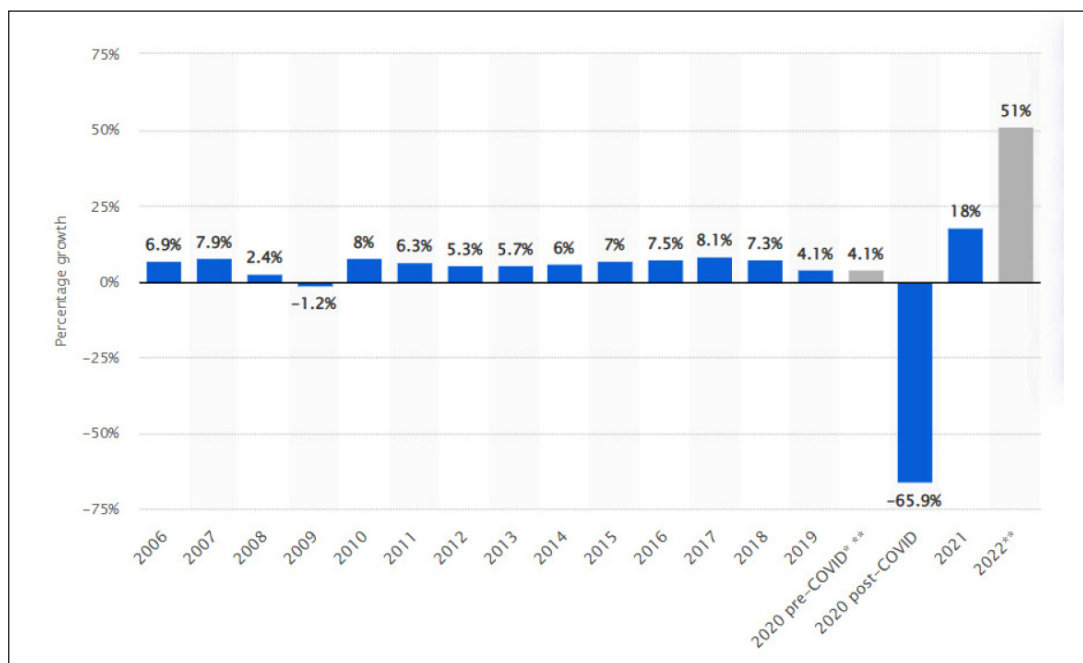
### 3.1 Analysis of air passenger flow at the global level

The air transport industry is not only the main driver of global socio-economic growth, but also of great importance to economic development, directly and indirectly creating opportunities for employment, promoting tourism and local economies, and boosting foreign investment and international trade [16]. Global air passenger traffic has grown relatively steadily from the beginning, but there are certain challenges, which are discussed below.

Crises affecting the decline in passenger traffic can be local, regional, and global in nature. Local crises include strikes, earthquakes, and other local weather disasters. They do not necessarily have a large impact on global air passenger traffic, but the accumulation of several local crises can lead to a decline in global air passenger traffic. In addition, crises with a regional character refer to larger areas such as Europe, North America, Asia, etc. Crises with a regional character include strikes, volcanic eruptions such as the eruption of the Icelandic volcano Eyjafjallajökull in 2010, which led to the closure of almost all European air-space [17].

Finally, global crises also have a significant impact on air passenger traffic worldwide. Some of the major global crises that have impacted global air passenger traffic include: financial crises, geopolitical uncertainties, epidemics, and pandemics. The COVID-19 pandemic has certainly caused the largest decline in air passenger traffic in history, as shown in Figure 1.

As shown in Figure 1, there was a significant decline in air passenger demand of nearly 66% in 2020. Not even a close decline has been recorded since 2006, albeit 2009 is noteworthy, when a 1.2% year-on-year decline was recorded due to the global financial crisis. In addition, global air passenger traffic recorded constant growth averaging 5 to 8% per year. After the crisis year 2020, which was caused by the COVID-19 pandemic, a more significant growth in passenger traffic demand was recorded, i.e. in 2021, an increase of 18% was recorded compared to the previous year. Furthermore, it should be noted that, according to the data presented in Figure 1, a significant increase in air passenger demand is expected in 2022, with



**Figure 1** Annual change in the global air passenger traffic demand, from 2006 to 2022

Source: [18]

an increase of about 51% compared to the previous year. The COVID-19 pandemic is considered to be the most severe civil aviation crisis since World War II [19].

Changes in habits, such as the way people work e.g., by telecommuting, online education, and online conferencing, are likely to lead to permanent changes in business travel. In addition to business travel, changes in the behaviour of leisure travellers are inevitable. For example, some tourists will prefer shorter direct flights to long-haul flights via major hub airports, where they would be more exposed to potential infectious diseases. Clearly, further economic growth, technological changes, market liberalisation, the rise of low-cost airlines, airport congestion, petroleum product prices and other trends will affect commercial aviation worldwide.

Based on total passenger traffic in 2021, the largest airports in the world are Atlanta (about 75.7 million passengers), Dallas/Fort Worth (about 62.4 million passengers) and Denver (about 58.8 million passengers). They are followed by Chicago, Los Angeles, Charlotte, Orlando, Guangzhou, Chengdu and Las Vegas [20]. Eight of the ten airports mentioned are located in the United States of America and the remaining two in China. It can be concluded that these airports have a significant share of domestic passenger traffic in the total passenger traffic and that domestic flights mitigated the impact of COVID-19 measures on passenger traffic.

As shown in Table 1, the largest airport by international passenger volume is Dubai, with more than 29 million passengers in 2021, followed by Istanbul with approxi-

**Table 1** "Top 10" airports according to international air passenger traffic

|     | Airport                         | Number of passengers 2021 | % of change 2020 / 2021 | % of change 2019 / 2021 |
|-----|---------------------------------|---------------------------|-------------------------|-------------------------|
| 1.  | Dubai, UAE                      | 29.110.609                | 12,7                    | -66,3                   |
| 2.  | Istanbul, Turkey                | 26.466.169                | 66,0                    | -33,1                   |
| 3.  | Amsterdam, Netherlands          | 25.488.783                | 22,1                    | -64,4                   |
| 4.  | Frankfurt, Germany              | 22.697.490                | 34,8                    | -64,0                   |
| 5.  | Paris Charles de Gaulle, France | 22.616.995                | 18,7                    | -67,6                   |
| 6.  | Doha, Qatar                     | 17.701.978                | 41,4                    | -54,4                   |
| 7.  | London Heathrow, UK             | 17.624.931                | -14,7                   | -76,8                   |
| 8.  | Antalya, Turkey                 | 17.148.111                | 160,4                   | -40,3                   |
| 9.  | Madrid, Spain                   | 15.337.775                | 38,8                    | -65,9                   |
| 10. | Cancun, Mexico                  | 13.261.951                | 94,5                    | -19,7                   |

Source: [20]

mately 26.5 million passengers, Amsterdam with approximately 25.5 million passengers and Frankfurt with approximately 22.7 million passengers. All of the above airports are characterised by the fact that they are often transit airports connecting various smaller airports, i.e., they are hub airports. In addition, they can be described as tourist centres, which in turn suggests many passengers. London's Heathrow Airport is the only one that recorded a 14.7% decrease in passenger traffic in 2021 compared to 2020. At the same time, Antalya International Airport recorded the largest increase in passenger traffic of 160.4% in 2021 compared to 2020. In 2021, all major airports recorded a significant decrease in passenger traffic compared to 2019 with the London Heathrow Airport recording the largest decrease (-76.8%), which may also be related to the United Kingdom's exit from the European Union (i.e. Brexit) [21].

### 3.2 Analysis of air passenger flow in Europe

Long distances and various geographical obstacles (mountain ranges, islands, etc.) make it difficult to connect European urban centres by road and rail. Moreover, a major disadvantage of rail and road transport is the long duration of transport over long distances. Therefore, connecting Europe by air is extremely important for its transport, economic and social integrity. Shorter travel times and greater comfort are of great importance to passengers, especially when it comes to tourist and business travel between tourist and/or economic centres. Therefore, the demand for passenger air transport in Europe is continuously increasing. Passenger air transport is the second most used mode of transport in Europe after the

car. From 1995 to 2019, the number of passenger kilometres travelled by aircraft more than doubled [22].

European air passenger traffic experienced a decline in 2020 due to the financial crisis and did not return to pre-crisis levels until 2011. The real upturn came after 2014, when the curve moved upwards until 2019, when the highest number of passengers was recorded at European Union airports (approximately 1.035 million). At that time, it was predicted that the volume of passengers would continue to increase. On the contrary, passenger traffic dropped sharply in 2020, and the recovery will take longer than expected. However, in 2021, the situation improved, and more precisely, the actual recovery started in the summer of 2021. Europe was one of the earliest affected regions in the world during the COVID-19 pandemic. The decline in passenger traffic and airline activity in 2020 resulted in large losses for airlines in the region. Airlines in Europe still experienced an overall decline of nearly 68% in 2021 compared to 2019 [24].

According to the Eurocontrol report, Ryanair was the busiest airline operator from June 2, 2022, to June 8, 2022, Ryanair is the busiest airline operator, with an average of 2962 flights per day, followed by EasyJet (1586), Turkish Airlines (1973), Lufthansa (1240), Air France (1071), KLM (784) and Wizz Air (749) [25]. The largest increase in the number of daily flights compared to the number of flights in 2019 was recorded by Wizz Air (20%). In addition, Ryanair saw an increase in the average number of flights per day (14%), while all other airlines saw a decrease in the average number of flights per day. Ryanair, EasyJet, WizzAir, Vueling, Eurowings and Pegasus are the main low-cost carriers in Europe. In the long-haul category, Turkish Airlines, Lufthansa, Air France, KLM, British Airways and SAS are in the lead.

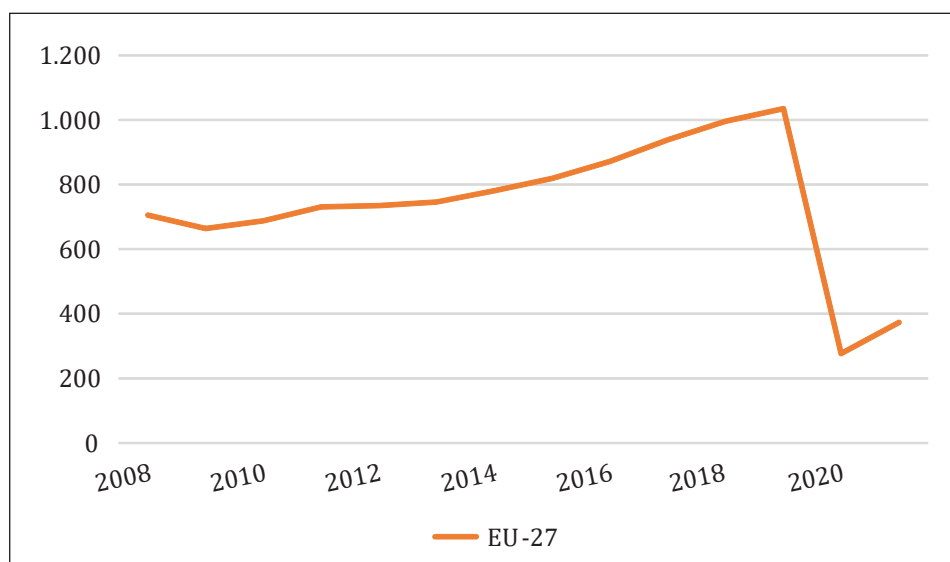


Figure 2 Air passenger traffic in the EU-27, from 2008 to 2021 (in millions)

**Table 2** “Top 10” European airports according to the total number of air passengers (national and international passengers) in 2021

|     | <b>Airport</b>                | <b>Number of passengers</b> | <b>% of change 2019/ 2021</b> |
|-----|-------------------------------|-----------------------------|-------------------------------|
| 1.  | Istanbul Havalimani           | 37.270.486                  | -28%                          |
| 2.  | Paris CDG                     | 26.202.655                  | -66%                          |
| 3.  | Amsterdam Schiphol            | 25.493.176                  | -64%                          |
| 4.  | Istanbul Sabiha Gökçen        | 24.917.855                  | -30%                          |
| 5.  | Frankfurt Main                | 24.837.681                  | -65%                          |
| 6.  | Adolfo Suarez Madrid- Barajas | 23.198.861                  | -61%                          |
| 7.  | Antalya                       | 22.061.193                  | -39%                          |
| 8.  | Barcelona El Prat             | 18.499.394                  | -64%                          |
| 9.  | Paris Orly                    | 15.722.501                  | -51%                          |
| 10. | Palma de Mallorca             | 14.480.133                  | -48%                          |

Source: [23]

As shown in Table 2, Istanbul Havalimani Airport ranks first in Europe with more than 37 million passengers in 2021, followed by Paris Charles de Gaulle with approximately 26 million passengers and Amsterdam Schiphol with approximately 25 million passengers. All major European airports saw a significant decrease in passenger numbers compared to 2019. By far the largest change compared to 2019 was recorded by the Paris Charles de Gaulle Airport (-66%), followed by Frankfurt Main Airport (65%) and Amsterdam Schiphol and Barcelona El Prat Airports (-64%). In contrast, the aforementioned Istanbul Havalimani Airport recorded the smallest decrease (-28%).

According to the Eurocontrol report, three possible scenarios are presented: a high, a base and a low scenario. The high scenario assumes that passenger traffic will return to 2019 levels in 2023. The base scenario, which is considered the most likely, assumes that the 2019 traffic levels will be regained in 2024. Finally, the low scenario assumes a worst-case scenario in which passenger air traffic would recover until after 2027. Passenger air traffic data for the first half of 2022 support the positive projection that the impact of COVID-19 will diminish in the near future and that passenger air traffic will recover as quickly as possible. The baseline scenario assumes travel with few restrictions and focuses on avoiding infection. Increasing numbers of passengers are assumed to choose air travel, especially business travellers, and traffic levels will return to pre-pandemic levels as early as 2023. The return of passengers will lead to an increase in demand for air travel, while airports and airlines are already facing staff shortages. However, the shortage of ground staff is causing major delays and numerous flight cancellations, slowing a possible rapid return to pre-pandemic traffic levels.

The biggest risks to air travel, especially passenger travel, are the high rate of inflation, disruptions in energy markets, and a decline in the purchasing power of potential passengers which could cause them to forgo travel and use their money for basic living needs.

### 3.3 Analysis of air passenger flow in the Republic of Croatia

Due to the geographical division, shape and terrain of the Republic of Croatia must be connected with domestic airlines. Travelling by bus requires changing several bus lines, which takes a lot of time, and travelling by car over such long distances requires a high level of concentration from the driver, which could demotivate passengers. In this case, despite the well-developed highway network, air transport has priority, mainly because of the speed and comfort that air transport offers its users. Moreover, rail transport in the Republic of Croatia is not very competitive compared to road and air transport [26], [27]. Therefore, very few passengers choose rail transport due to its low frequency and long travel time. The expansion of the rail network and the increase in speed would certainly increase the competitiveness of this mode of transport.

Croatian airports are connected to many European cities. In particular, the largest Croatian airport, Zagreb, offers direct flights to many popular destinations. This makes the Republic of Croatia an easily accessible destination and suitable for many potential tourists. The connectivity and high frequency of flights to and from the Republic of Croatia, especially during the summer months, favour tourism as the leading industry in Croatia. In 2021, tourism will account for 15.8% of Croatia's gross domestic product (GDP) [28]. In addition, air transport, with its basic activities, also stimulates many supporting activities that can potentially provide employment for residents near airports in various sectors. It can be concluded that air transport is extremely important for the social and economic development of Croatia.

As can be seen in Figure 3, the volume of air passengers in the Republic of Croatia has grown over the last thirty years with several periods of crises leading to decrease in the total number of passengers at airports. Since 1991, the number of passengers at Croatian airports grew almost exponentially until 2008, when the highest number of passengers in the history of Croatian aviation was re-

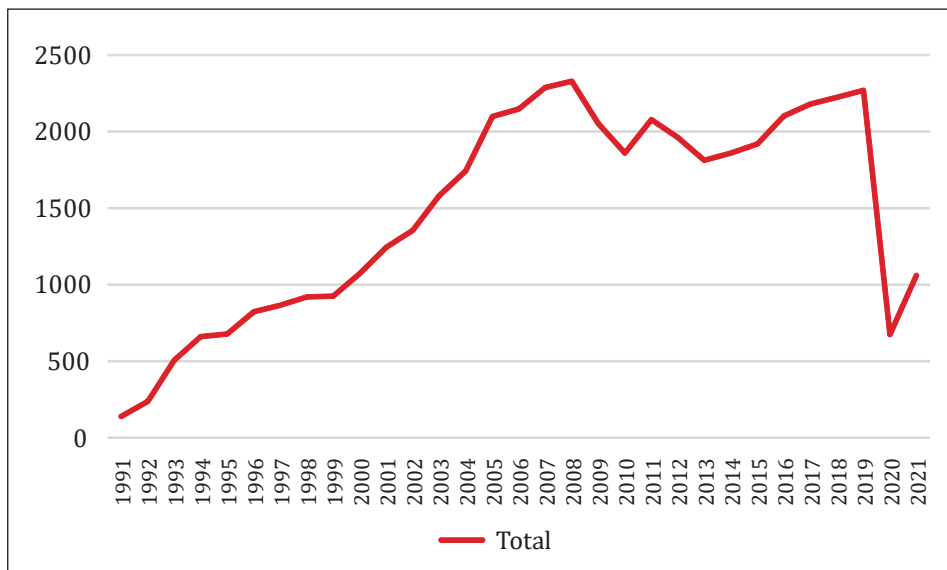


Figure 3 Air passenger traffic in the airports of the Republic of Croatia, from 1991 to 2021

Source: [29]

corded (2,329,000 passengers). In 2009, there was a significant decrease in the number of passengers, which was caused by the financial crisis. This decline was also seen in 2010, but in 2011 the number of passengers increased again. This was short-lived, however, as a slight decline was already recorded in 2012. The decline in 2012 was followed by a slow increase in passenger numbers until 2019, when 2,270,000 passengers were recorded, the highest number since 2009. It can be concluded that it took ten years for numbers to return to anywhere near pre-financial crisis levels. Unfortunately, this did not last long either, as in 2020 there was a sharp decline in passen-

ger traffic at Croatian airports caused by the outbreak of the COVID-19 pandemic. The number of passengers in 2020 was only 30% of the traffic in 2019, and the decrease in traffic demand also led to a decrease in the number of connections between Croatia and other countries. Thus, in 2019 there were still 120 lines, while in 2020 this number dropped to only 68 lines, i.e., almost 50% fewer lines.

Figure 4 shows a comparison of the number of air passengers in Croatian airports. All Croatian airports recorded relatively constant growth and the largest number of passengers in 2019. The largest Croatian airport in terms of the number of passengers is Zagreb Airport, followed by

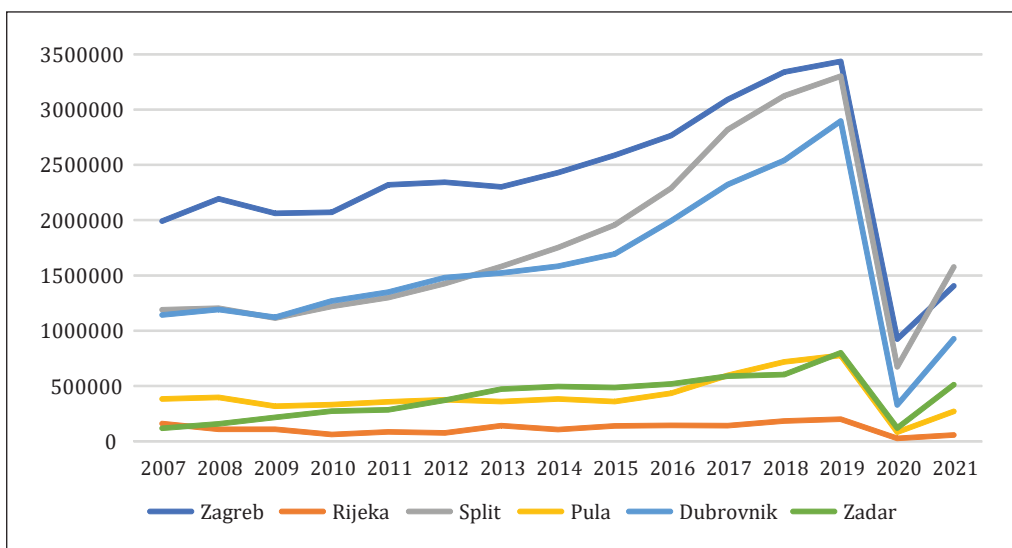


Figure 4 Air passenger traffic in Croatian airports, from 2007 to 2021

Source: [29]



Split and Dubrovnik. In 2020, all of airports recorded a decline in number of air passengers, ranging from 80% to 98%.

Croatian airports are extremely seasonal, as most of the annual passenger traffic is handled in the summer months. This is especially true for international passengers. The number of domestic passengers remains relatively constant throughout the year, but the largest number of domestic passengers is recorded in August. A dynamic growth and development is also recorded by low-cost carriers, which is mainly observed at the airports on the Croatian coast, which is related to the trend of increasing tourist movements in the summer months

In March 2022, the largest number of passengers arriving at Croatian airports came from Germany (61,819), followed by the United Kingdom (21,168), the Netherlands (18,236), France (15,898) and Italy (13,667) [29]. The majority of arrivals from German airports are accounted by a large number of Croatian emigrants who have settled in Germany and, of course, a large number of tourists from this region for whom Croatia is a desired destination. All countries mentioned above recorded a significant increase in passenger numbers compared to March 2021.

#### **4 Impact of the COVID-19 pandemic on the passenger air flow in the Republic of Croatia**

Until 2020, the volume of air passengers in the Republic of Croatia recorded a relatively constant increase. This was mainly due to the strong development of tourism, as most passengers arrived from international airports. In the first half of 2020, the aviation industry faced another crisis, in this case it was the COVID -19 pandemic that spread rapidly around the world. At the beginning, it was not expected that this crisis would have such an impact on the entire global economy and, consequently, on air passenger traffic. In the analysis of air passenger flow in the previous section, it was found that the decline in traffic at all levels ranged from 80% to almost 100%. The following section will highlight the changes in the functioning of airports as a result of the impact of the COVID-19 pandemic, followed by an overview of passenger traffic at Croatian airports from the previous section.

##### **4.1 Organizational and technological changes in Croatian airports during the COVID-19 pandemic**

Air transport is used daily by a large number of people who change their residence for various reasons. Therefore, air transport lends itself to the transmission of many infectious diseases, including the COVID-19 virus. Therefore, it was necessary to effectively manage airport operations to reduce the transmission of the virus as much as possible during ongoing operations [30]–[32]. Experts faced this challenge in the early 2020s, when the disease began to spread worldwide. At the outset, very little was

known about the contagiousness of the virus itself. Under these circumstances, the only option was to suspend all air traffic. For a short time, air travel was one of the industries most affected by COVID -19, with numerous flight cancellations and airport closures. After realising that the whole world had to adapt to the new situation, measures began to be taken to allow further development of passenger air transport [33].

Health protection measures taken by airlines to prevent the spread of the disease are:

- disinfection and cleaning of aircraft,
- checking passengers' medical documents (COVID-19 passports, tests, etc.) during boarding and disembarking,
- ensuring the necessary distance between passengers and staff,
- establishing a protocol in the event that an infected person is on board the aircraft,
- informing passengers about the required health documents before and during the flight.

The following health protection measures had to be implemented by airports:

- temperature measuring devices, e.g, infrared cameras,
- ensuring the necessary distance between the passengers themselves and the staff,
- testing points in the airport area or in the vicinity of an airport.

These measures served to eliminate or at least reduce the risk of infection at the point of departure. The most effective means of reducing the likelihood of infection was a negative test for the virus COVID -19. Passengers were required to present the negative test at the check-in counter or attach an electronic version of the negative test during online check-in. To better accommodate passengers, testing centres were established at some airports. However, this posed a challenge for the airport organisation, as the areas designated for the test centre had to be separated. It should be noted that the capacity of almost all airports was significantly reduced due to the need to maintain a safe distance between passengers. Therefore, a further reduction in the overall capacity of the airport limits the number of passengers that can be at the airport at any given time. Consequently, in the future, when planning a passenger terminal, it will be necessary to consider the test site as another point in the flight registration process in case another crisis like this occurs. It would also make sense to recalculate airport capacity now that more space per passenger is needed. Since airports are capital-intensive investments and it is not easy to increase capacity in a short period of time, airports need to better plan for a gradual increase in capacity. In addition, it will be beneficial for airports to shift their focus to reorganising and optimising processes within the limits of available capacity.

#### 4.2 Analysis of air passenger traffic in Croatian airports during the pandemic

In the last two and a half years, Croatian passenger air transport has faced many challenges caused by the COVID-19 pandemic. Of course, this is not limited to Croatian airports, as the pandemic has affected airports all over the world. It should be noted that Croatian airports belong to the category of smaller airports, as none of them has a passenger volume of more than 5 million passengers per year [34].

The number of passengers at Croatian airports in 2020 corresponded to only 30% of the revenue generated in 2019. For the airports, this meant a great loss of financial resources. The sudden drop in traffic led to a complete collapse in revenue from air traffic and other areas, such as aircraft landing fees, parking fees, infrastructure fees, passenger fees, and ground handling fees [31]. As a result, revenues from restaurants, parking lots and various stores in airports also decreased. To mitigate the impact of the lack of passenger traffic and to generate at least some aviation revenue airports tried to accommodate as many cargo aircraft as possible.

Airports in the Republic of Croatia are highly seasonal, with passenger traffic significantly higher in the summer months than during the rest of the year. On the positive side, the number of infected people is lower in the summer months and measures can be relaxed, so that the drop in traffic is less than at airports with constant passenger traffic throughout the year.

The recovery of Croatian airports from the effects of the COVID-19 pandemic is moving in a positive direction, and passenger traffic is expected to continue to increase and return to 2019 levels in a relatively short time. However, in recent months, the problem of lack of ground staff at airports has arisen, so this will be another crisis to which airports in the Republic of Croatia will have to respond [35].

### 5 Conclusion

In order to qualitatively analyse passenger flow at airports, it is necessary to know the basic indicators and factors for the formation of passenger flow. Geo-traffic factors such as terrain, climate, sea and land access, as well as the structure and lines of the transport network have a great influence on the formation of certain airlines. In the Republic of Croatia, for example, it is extremely important to connect Dubrovnik and its hinterland with the rest of the country in order to create a complete transport connection. In addition, large mountain massifs, seas and oceans are an obstacle to passenger transport by land, i.e. the travel time increases significantly, which is unacceptable in the age of globalisation, as one usually needs to be at a certain destination in the shortest possible time. Added to this are socio-economic factors, which include a country's level of development and the habits and needs of its popu-

lation. For example, passenger air traffic is more typical for tourists vacationing in the Republic of Croatia than for the local population. This becomes clear when analysing the number of passengers during the year. International passenger flow at Croatian airports are more pronounced in the summer months, while domestic traffic is less noticeable and more or less constant throughout the year.

The analysis conducted in this research shows that global air passenger traffic records an almost constant increase in the number of passengers choosing air transport for their travels. Throughout history, there have been several crises that have caused disruption on a global scale. These include war crises, terrorist attacks, various financial crises that affect the purchasing power of the population and cause anxiety, so that the population does not prioritise travel and in most cases refrains from it, then weather disasters that can affect an entire region and cause a decrease in global passenger traffic. Finally, epidemics and pandemics should be highlighted, of which SARS and MERS have had the greatest impact, as well as COVID-19 in 2020, which has by far the greatest impact on the decline in air passenger traffic. This research found that this decline was nearly 66% year-over-year. European air passenger traffic largely follows global air passenger traffic trends. Recovery from such a decline is long and slow, so it will take years for the airline industry to recover from the damage caused by COVID-19 measures.

The aforementioned territorial disparity of the Republic of Croatia, the terrain and shape of the country are favourable factors for the development of air passenger traffic within the country. Nevertheless, the majority of passenger traffic at Croatian airports consists of international passengers. Therefore, air passenger traffic in Croatia can be described as highly seasonal, which is true for almost all Croatian airports studied. Only Zagreb Airport records a relatively constant number of passengers throughout the year. The reason for this could be that it is located in the country's capital and is the largest airport in the Republic of Croatia. It is followed by Split and Dubrovnik airports, which are located on the Adriatic coast and see most of their traffic during the summer months. For all airports, 2019 was the record year in terms of the number of passengers, but the very next year, 2020, the results were extremely low. All airports in Croatia were severely affected by the COVID-19 pandemic, and the best recovery was recorded by Zadar Airport, which in 2021 reached 64% of the traffic volume of 2019.

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