
The Use of Virtual Reality in Air Transport During a Pandemic

Submitted 30/08/20, 1st revision 20/09/20, 2nd revision 25/10/20, accepted 17/11/20

Arkadiusz Józwiak¹, Tomasz R. Waśniewski², Mieczysław Pawlisiak³,
Ewa Brożyna⁴

Abstract:

Purpose: Considering the realities of the 21st century and the global COVID-19 pandemic, the article aims to present the pandemic's impact on transport processes in selected European countries and suggested using virtual reality in these processes.

Findings: The data provided by the International Air Transport Association (IATA) shows that every day about one hundred thousand aircraft fly, carrying over 140 thousand tons of cargo in total. As far as passenger transport is concerned within the European Union territory alone, more than a billion people use air transport annually, which gives the daily average of almost three million passengers. With an average cruising speed of about 800 kilometers per hour, we can assume that air transport meets the time requirements.

Practical Implications: Time is one of the key determinants in society's functioning and the economy on a European and global scale. This determinant of the implementation of specific tasks is, in many cases, the main determinant of decisions made. It is not without reason that the phrase "time is money" is in common use. Considering such perception of the reality of the first half of the 21st century, it is reasonable to consider what means of transport can meet the expectations related to saving time needed to transport people and goods. This is particularly important in times of disruptions caused by the COVID - 19 pandemic.

Keywords: Air transport, pandemic, virtual reality.

JEL Code: L21, L27, N67.

Paper Type: Research study.

¹Military University of Technology, Poland, arkadiusz.jozwiak@wat.edu.pl;

²Military University of Technology, Poland, tomasz.wasniewski@wat.edu.pl;

³Military University of Technology, Poland, mieczyslaw.pawlisiak@wat.edu.pl;

⁴Military University of Technology, Poland, ewa.brozyna@student.wat.edu.pl;

1. Characteristics of Passenger Transport and Cargo Transport in Air Transport

Air transport has been growing since its inception, with few exceptions, especially due to the Second World War and the terrorist attacks of 11 September 2001. The rapid development took place, especially after the end of the Second World War. Favorable conditions for the development of this type of transport were created due to the possibility of using military aircraft to transport passengers and cargo. Moreover, the United States offered aid to some European countries, Japan, and Latin America, under the Marshall Plan (Steil, Plan, and Marshall, 2020) in the total amount of \$ 800 billion. It was a huge amount for those times. It was intended mainly for the reconstruction and development of the industry and the expansion and modernization of air transport.

This financial stimulus enabled civil air transport to recover after the war's turmoil and introduce measures enabling its dynamic development. When analyzing events in air transport, it is noted that in the years 1955-1970, the foundations for the construction and operation of today's modern airports were shaped practically all over the world. The fact that modern airplanes land a hundred and sometimes a thousand times at airports forced the need to have hardened and properly maintained runways. An additional requirement was the proper location of the runways, considering several conditions, including wind direction or densely populated areas. The expansion of runways, parking spaces, and maneuvering area was continued simultaneously with the extension of passenger and cargo terminals.

The introduction of the Boeing 747-100 wide-body aircraft in 1970 forced the implementation of some revolutionary changes. Passenger terminals and aircraft fuel supply system had to be rebuilt. It became necessary to shorten the refueling time while increasing the fuel demand for aircraft. This aircraft became a symbol of a new era in aviation. Many of the changes introduced at airports resulted from the development of technology and political and economic factors. In Europe, at the beginning of the 1970s, airports became literally, not only figuratively, a window to the world.

They also constituted a significant element of economic policy. It can be exemplified by attempting to privatize the British Airport Authority and several European airports, which have been successful. Since then, governments of many countries have made changes in their activity related to financing airports. Today, they are mainly economic entities operating by market laws, which, in turn, allows for their further development. It also boosts air transport's functioning, which shows an annual increase in the number of passengers transported and tons of cargo. However, it is necessary to take a broad view and pay attention to the conditions that impact air transport. They include:

- further privatisation and commercialisation of airports;

- progressive deregulation of prices in air transport;
- liberalisation of the transport services market;
- negative impact on the natural environment through e.g. high fossil fuels consumption (Qiu, Rui; Xu, Jiuping; Xie, Heping; Zeng, Ziqiang and Lv, Chengwei, 2020).
- threat of terrorism.

The conditions presented above, though important, will not hinder the development of the construction and operation of airports as well as passenger and cargo transport. This thesis is confirmed by the growth of passenger traffic at the world's biggest airports.

Table 1. Number of passengers handled/ departing and arriving / at Europe's biggest airports

No.	Airport	Number of passengers handled in 2017 / persons / (ACI, 2020)	Number of passengers handled in 2018 / persons / (Tvn24, 2020)	Changes compared to the previous year
1.	LONDON, GB /LHR/	78 014 598	approx. 80 100 000	+3.0
2.	PARIS, FR /CDG/	69 471 442	ok. 72 000000	+3.4
3.	AMSTERDAM, NL /AMS/	68 515 425	ok. 71 000000	+3.7
4.	FRANKFURT, DE /FRA/	64 500 386	ok. 69 500000	+6.1
5.	ISTANBUL, TR /IST/	64 119 374	ok. 68 000 000	+6.1

Source: Own creation.

The figures presented in Table 1 concerning the five biggest airports in Europe clearly show an upward trend in the number of passengers handled at airports. Airports in Frankfurt and Istanbul are leaders of this growth. When assessing the volume of cargo transport using air transport, it can be noted that among leading European airports are those that were involved in the transport of the highest number of passengers. Table 2 presents these values in absolute numbers.

Table 2. The volume of cargo transported by the largest European airports

No.	Airport	Loading and unloading of goods / cargo / in 2017 / tons / (ACI, 2020)	Loading and unloading of goods / cargo / in 2019 / tons /*	Changing trends /% /
1.	PARIS, FR /CDG/	2 195 229	2 318161	+5.6
2.	FRANKFURT, DE /FRA/	2 194 056	2 360804	+7.6
3.	LONDON, GB /LHR/	1 794 276	2 131599	+18.8
4.	AMSTERDAM, NL /AMS/	1 778 382	1 952663	+9.8
5.	ISTAMBUL, TR /IST/	1 720 000	1 79224 0	+ 4.2

Note: *Estimated data calculated on the basis of changes in the volume of the air cargo transport in relations from 2016 to 2017

Source: Own creation.

The figures representing the number of tons of cargo handled at the biggest European airports show an upward trend. This means that the needs related to air transport to transport cargo will grow shortly. This creates organizational challenges regarding the operation of cargo bases at airports. Also, in the coming years, it can be expected that new means of air transport will be used for cargo transport, such as the biggest transport aircraft in the world - ANTONOV 125 and 225 / RUSŁAN, MIRIJA / and transport drones.

When assessing air transport involved in the implementation of transport tasks, the number of airport operations should be taken into account. These are the activities related to the acceptance of the aircraft at the airport, its handling and securing, and taking off for the next flight. These figures show the effort of the entire airport staff, which should be made in order, on the one hand, to ensure the possibility of transporting passengers and cargo and ensuring the safe performance of all operations. It is also important to complete the tasks in the prescribed time while considering the quality of their execution. Table 3 presents figures concerning airport operations/take-off, landing / concerning the biggest airports in Europe.

Table 3. *Airport operations at the biggest European airports*

No.	Airport	Number of take-offs and landings in 2017 (ACI, 2020)	Number of take-offs and landings in 2019*	Trends
1.	AMSTERDAM, NL /AMS/	514625	551678	7.2
2.	PARIS, FR /CDG/	482676	489433	1.4
3.	LONDON, GB /LHR/	475915	479729	0.4
4.	FRANKFURT, DE /FRA/	475537	501216	5.4
5.	ISTAMBUL, TR /IST/	460785	449726	-2.4

Note: *Estimated data obtained from calculations of the state in 2017 with a changing trend in 2016 and 2017

Source: Own creation.

Figures concerning take-off and landing operations at Europe's biggest airports show an overall upward trend. Istanbul airport breaks this trend, but it does not change the overall growth trends. This situation took place in the first months of 2020, but the situation has changed dramatically from the beginning of March. Based on the research results on COVID-19 cases conducted by experts from John Hopkins University, it can be concluded that traffic at airports decreased dramatically almost overnight. Detailed research shows that compared to the previous year, a decrease in passenger traffic by 84% was reported during the first half of this year. This is the average figure concerning Europe as a whole (ACI Europe, 2020). The collapse of air traffic took place practically all over the world (Pere Suau-Sanchez; Augusto Voltes-Dortac and Natàlia Cugueró-Escofetad, 2020). The transport of cargo and the number of take-off and landing operations decreased to a comparable extent. Detailed figures concerning the decrease in the number of passengers from March to June 2020 are presented in Table 4.

Table 4. Decrease in the number of passengers at European airports in the period from March to June 2020 (ACI Europe, 2020)

No.	Specification	Decrease in the number of passengers compared to 2019 /%				
		01.03.20	29.03.20	03.05.20	24.05.20	07.06.20
1.	Airports in Europe /on average/	10	96	99	98	96
2.	Airports in Italy	12	97	99	99	97
3.	Airport in France	9	97	99	98	96
4.	Airports in Germany	12	97	99	97	96
5.	Airports in Great Britain	5	95	98	98	97
6.	Airports in the Benelux Countries	7	97	99	98	96
7.	Airports in the Nordic Countries	5	96	97	94	94
8.	Airports in Southern Europe	16	98	100	99	96
9.	Airports in Central and Eastern Europe	10	97	99	99	96

Source: Own creation.

The presented figures show not only a crisis but even a collapse in passenger air transport. It was a consequence of closing the borders, and the small transport tasks that were carried out resulted from the obligations of governments responsible for bringing their citizens, who were staying abroad, back to the country. Several restrictions have been introduced in air transport, potentially leading to serious long-term consequences for the global aviation industry (Sandro Nižetić, 2020). Another challenge was the air transport of people infected with the virus and special requirements (Roland Albrecht, Jürgen Knapp, Lorenz Theiler, Marcus Eder and Urs Pietsch, 2020).

An equally unfavorable situation was observed in the case of the air transport of cargo. Air transport of cargo became significantly limited, not only within the European Union but, most of all, it resulted in the elimination of intercontinental transport between Europe and Asia / China /. From the very beginning of the COVID-19 pandemic, there was no cargo transport between those countries. The difference between passenger and cargo transport was earlier, with the decline in the pandemic in China, that air transport of cargo was restarted. The details are presented in the table below.

The data presented in the table and the graph concerning the decrease in the transported cargo using air transport is not uniform or similar in all airports in Europe. It depends on two main factors. The first includes the quantitative and qualitative relations between a given country's national economy and the economy of entities located outside its borders - for example, in China. The second factor is the result of actions taken in a particular country, for example, opening borders and loosening restrictions. On the one hand, these two factors exacerbate the economic recession by tightening restrictions and closing borders, but, on the other hand,

loosening restrictions and pro-economic activity can stimulate a rapid return to the pre-pandemic situation.

Table 5. Decline in the volume of air transport of cargo in the first half of the 21st century as a result of the COVID-19 pandemic*

No.	Specification	The decrease in the weight of transported cargo /% / compared to the same time last year				
		01.03.2020	29.03.2020	03.05.2020	24.05.2020	05.06.2020
1.	Airports in Europe /on average/	40	97	73	63	44
2.	Airports in Italy	37	99	86	69	53
3.	Airports in France	39	98	80	68	50
4.	Airports in Germany	40	96	71	64	40
5.	Airports in Great Britain	39	99	74	63	39
6.	Airports in the Benelux Countries	42	97	72	65	41
7.	Airports in the Nordic Countries	40	98	66	60	39
8.	Airports in Southern Europe	38	97	74	64	42
9.	Airports in Central and Eastern Europe	40	96	75	62	40

Note:* The data contained in the table are a derivative and the effect of deduction, taking into account data on the state of passenger transport, the state of the economy of European countries and their relationship with the potential of China, where the fight against the pandemic ended earlier than in other countries

Source: Own creation.

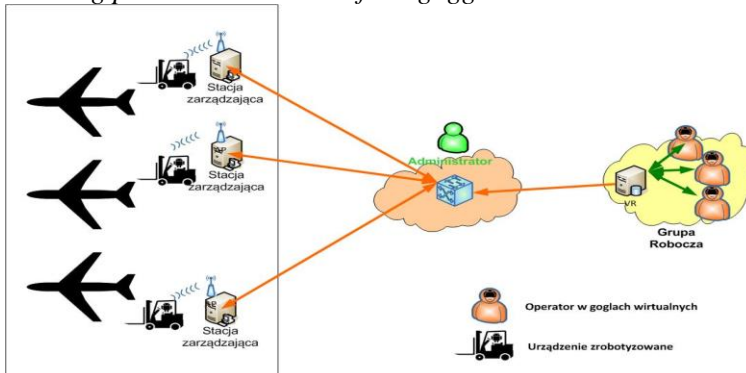
To sum up the above considerations, it should be noted that the world was not ready to face such events. It is necessary to draw conclusions and implement solutions for the future to be ready to deal with such threats.

2. Technological Solutions

The worldwide pandemic has caused difficulties in the transport of people and goods. Air transport has been paralyzed in terms of passenger transport and cargo transport. The cargo transport has been limited due to a shortage of personnel that loads the plane's goods. The threat of the spread of COVID19 resulted in a significant reduction of the loading staff. The coupling of VR goggles with loading machines is a possible solution. This type of solution would allow you to work from any place and use the loading staff from other airports in emergency mode. This mode of operation would allow for a year-round operation without interruption, without downtime.

Figure 6 shows an example of a solution for communicating with robotic transport devices to load or unload an aircraft.

Figure 1. Loading planes with the use of VR goggles



Source: Own creation.

Operators would be equipped with goggles through which they could see what is happening on the reloading device. This type of solution: the VR platform with goggles is presented in Figure 7. This solution will allow you to simulate the movement of the device by moving on the platform.

Figure 2. VR Platform



Source: Own creation.

On the other hand, static operators will be able to control devices with the use of manipulators, Figure 3.

Figure 8. VR Manipulator



Source: Own creation.

The integration of this type of technological solution with unloading and loading devices would reduce losses for the aviation industry, which amounted to approx. 60% in the first half of the year. A decrease in passenger air transport in Europe amounted to approx. 80%. The technical capacity to protect passengers traveling by air is insufficient, and research may take a long time. On the other hand, air transport could fill this gap with cargo transport.

Now, the technology of virtual reality is dynamically developing. The cost of virtual reality goggles is small, but the cost of computers with high computing power to operate the goggles' software is high. The universality of this type of solutions in the aviation industry and other branches of the economy would allow the use of employees from other regions of the world within one corporation. The global COVID19 pandemic has shown that the way we work can be changed. Employees work remotely from home, connecting to work via internet connections.

3. Conclusions

Air transport plays an increasingly important role in the entire transport system, as evidenced by the available figures. Due to its specificity (including special security measures), it should be prepared to face various threats/dangers. As the COVID-19 pandemic has shown, man has again turned out to be the weakest link. Therefore, the share of the human factor in the transport process should be minimized, e.g., through process automation or the use of modern technologies. The suggested use of virtual goggles presented in the paper would help manage the transport process, thus minimizing the human factor's risk.

Further research and analysis in the presented issues could focus on applying other modern technologies and tools (e.g., artificial intelligence) to organize air transport.

References:

- ACI. 2020. Airlines and airports decry uncoordinated. Retrieved from: <https://www.aci-europe.org/media-room/262-airlines-and-airports-decry-uncoordinated-eu-extrenal-border-reopenings.html>.
- ACI Europe. 2020. EUROPE: Airport Passenger Traffic (COVID-19). Retrieved from: <https://www.aci-europe.org/european-airports-passenger-traffic-1-march-28-june-2020> access 08. 07. 2020.
- ACI. 2020. Annual traffic data. Retrieved from: <http://https://aci.aero/data-centre/annual-traffic-data/passengers/2017-passenger-summary-annual-traffic-data/>.
- ACI. 2020. Aircraft Movements. Retrieved from <https://aci.aero/data-centre/annual-traffic-data/aircraft-movements/2017-aircraft-movements-annual-traffic-data/>.
- ACI. 2020. Annual traffic data. Retrieved from: <https://aci.aero/data-centre/annual-traffic-data/cargo2017-cargo-summary-annual-traffic-data/>.
- Albrecht, R., Knapp, J., Theiler, P., Eder, M., Pietsch, U. 2020. Transport of COVID-19 and other highly contagious patients by helicopter and fixed-wing air ambulance: a

- narrative review and experience of the Swiss air rescue Rega. *Scandinavian Journal of Trauma Resuscitation & Emergency Medicine*, 28(1).
- Coyle, J.J., Bardi, E.J., Langley, C.J. Jr. 2020. Zarządzanie Logistyczne, PWE, Warszawa.
- Infoair. 2020. Rozwoj transport lotniczego more, Retrieved from: <http://infoair.pl/rozwój-transportu-lotniczego-more-29595.html> access .
- Józwiak, A. Owczarek, P, Prochowski, L, Świdorski, A. 2020. Analysis of the impact of the use time of n1 motor vehicles on the economic efficiency of their maintenance. *Eksploatacja i Niezawodność – Maintenance and Reliability*, 22(1), 121-129.
- Józwiak, A., Świdorski, A. 2017. Algorytmy sztucznej inteligencji w logistyce, *Prace Naukowe Politechniki Warszawskiej*, 117, 97-108.
- Krzyżaniak, S., Niemczyk, A., Majewski, J., Andrzejczyk, P., Organizacja, I. 2013. *Monitorowanie Procesów Magazynowych*, ILiM, Poznań.
- Kwaśniewski, S., P., Zajac. 2010. *Nowoczesny magazyn. Logistyka. Teoria i praktyka*. Tom 1, ed. Krawczyk S., Difin, Warszawa.
- News Line. 2020. Influence of pandemic on European airports clear as March passenger numbers are launched, Retrieved from: <https://news.alizaaviv.com/european-airports/>.
- Suau-Sanchez, P., Voltes-Dortac, A., Cugueró-Escofetad, 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*, 86, 102749.
- Nižetić, S. 2020. Impact of coronavirus (COVID-19) pandemic on air transport mobility, energy, and environment: A case study. *International Journal of Energy Research*.
- Qiu, R., Jiuping, X., Heping, X., Ziqiang, Z., Chengwei, L. 2020. Carbon tax incentive policy towards air passenger transport carbon emissions reduction; *Transportation research part-D and environment*, 85.
- Steil, B. 2020. *Marshalla Plan. Postawić świat na nogi*, przekład: Katarzyna Bożyńska-Chojnacka, Piotr Chojnacki, Wydawnictwo Literackie Kraków.
- Świdorski, A., Józwiak, A, Jachimowski, R. 2018. Operational quality measures of vehicles applied for the transport services evaluation using artificial neural networks. *Eksploatacja i Niezawodność – Maintenance and Reliability*, 20 (2).
- Tvn24. 2020. Ze-swiata. Retrieved from: <https://tvn24.pl/biznes/ze-swiata/article4293630.ece> access 08. 07. 2020.