
MULTIDIMENSIONAL ANALYSIS OF THE NUMBER OF PASSENGERS TRANSPORTED
BY AIR IN EUROPE BETWEEN 2019-2022 IN TERMS OF ECONOMIC SECURITY

Bartosz Kozicki¹, Paweł Jaśkiewicz², Dariusz Latosiewicz³,
Michał Więckiewicz⁴, Grzegorz Surowiecki⁵

^{1,2}Military University of Technology, Poland

³Human Resources Department Ministry of National Defence, Poland

⁴Stare Babice Commune, Poland

⁵Management Academy of Applied Sciences, Poland

E-mails: ¹bartosz.kozicki@wat.edu.pl; ²kacper.kumor@student.wat.edu.pl;
³dlatosiewicz@mon.gov.pl; ⁴legal@mwieckiewicz.pl; ⁵gsurowiecki@wp.pl

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Abstract. The article presents a multidimensional comparative analysis of the number of passengers transported by air in Europe between 2019-2022 in terms of economic security. Data for the study was taken from Eurostat and categorized line and bar graphs were used. The conducted research shows that in 2021, in each of the considered European countries, an average of 138% of the number of passengers of 2020 were transported by air. In 2022, an increase to 230% of the number of passengers of 2021 was observed. The forecasting of the number of passengers conducted by air transport for 2023 in 29 European countries under consideration was made. A naive method was used for the forecasting. In 2023, the largest number of passengers will be transported in Spain, followed by Germany in the second place and France as third. The sum of the forecast of the number of passengers transported for 2023 in 29 European countries under consideration will equal 1 401 839 218 people and will be higher than in 2022 by 296 222 604 people.

Keywords: management; passenger air transport; COVID-19; expenses; economic security

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JEL Classifications: R4

1. Introduction

The article outlines the following research problem: to what extent has the COVID-19 pandemic affected the number of passengers transported by air in 29 European countries under consideration? This made it possible to indicate the aim of the study: to conduct a multidimensional comparative analysis of the number of passengers transported by air in 29 European countries under consideration.

For the research problem and the purpose of the work, the following research thesis was outlined: the COVID-19 pandemic led to fluctuations in the number of passengers in 29 European countries under consideration, the values from 2019 in none of the countries under consideration were reached in 2022.

Multidimensional data analyzes were used in the study such as categorized line and bar graphs dynamically (Kot, Jakubowski, Sokołowski, 2011). This made it possible to observe trends, similarities and differences in fluctuations of the considered dependent variables in the identical time intervals adopted for the study.

2. Literature analysis of the research subject

The planning process is the first basic management function that must be conducted in organizations (Griffin, 1998, p. 227). Management is a tool that is to ensure the institution and the state the possibility to achieve the intended results in the external environment in which it operates (Drucker, 2000, p. 39). Actions taken as a result of management should allow for the principle that the optimization of one process involves changes in others, and the balance of these actions should be positive (Kowalczyk, 2011, p. 62). The fundamental management function, called planning, is greatly influenced by the future dynamically distributed financial resources for the implementation of tasks adopted in the plans (Mizura, Mitkow, Kozicki, 2023, p. 91, Przybylski et al., 2022). These funds, expended from the cash register or bank account, are called expenses (Nowak, 1999, p. 226). Until 2019, planning future expenses related to passenger air transport were made by observing historical phenomena regarding the number of passengers transported dynamically. On such a basis, the forecasting of the considered variables was conducted - by selecting the appropriate method. This made it possible to specify the future necessary funding in the budgets of the air passenger transport sector. Their correct planning had an impact on the financial result (Sadowska, 2017, p. 7, Jurgilewicz et al., 2021, p. 538).

In December 2019, an infectious disease was observed in Wuhan, China (Zhu et al., 2020), which tended to spread rapidly and pose a threat to human life (Kozicki, 2022, pp. 125-133). On March 11, 2020, the World Health Organization declared the COVID-19 pandemic (Satomi et al., 2020). The research related to the number of deaths in the initial phase of the pandemic indicated (March 2020) that in all European countries at that time it fluctuated around a statistical error of about 0,005 percentage point (Kozicki, Mitkow, 2020, pp. 213-227). Many long-term restrictions related to the ban on movement have been introduced, including air passenger transport. This resulted in decreases and large fluctuations of dependent variables in other sectors of the economy, and yet their effect meant often irreversible and unobserved changes in the history of the process. The study focuses on a multidimensional comparative analysis of fluctuations in dependent variables in passenger air transport in 29 European countries under consideration.

In the literature, passenger air transport is identified with the purposeful transport of people and cargo in the airspace from the starting point to the destination (Ficoń, 2004, p. 51). It covers all economic, technical and organizational activities aimed at the implementation of transport processes constituting a link in the global transport market (Adeniran & Obembe, 2020; Adeniran et al., 2021; Periokaité & Dobrovolskienė, 2021; Holmen, 2022; Vennemo, 2023).

This type of transport is also considered to be the foundation of globalization because it is the only one that guarantees reaching any place on Earth (Nurzyńska, 2016, p. 63-64) within approximately one day. It is the youngest field and the fastest growing branch of transport (Czech, 2016, p. 12; Adeniran et al., 2023).

The air infrastructure of air transport is extremely important. It includes airways, i.e. networks in the airspace and airport control areas. Air traffic management is conducted using technologically advanced IT systems. Airports are divided depending on capacity and area. Managing the passenger air transport sector requires constant spending of financial resources on the maintenance and modernization of aviation infrastructure. Financial resources must be incurred even in the absence or decrease in the number of passengers and goods transported which was observed during the COVID-19 pandemic in respective European countries considered in the study. Undoubtedly, the passenger air transport sector has an impact on the economic security of the state which is identified with the condition of the economy. It refers to the condition of public finances and trends in the national economy related to public debt (Marszałek-Kawa, Kinelski, 2020, p. 5). Economic security is understood as the certainty of survival and development of the economic system of the state “guaranteeing that these entities will maintain an appropriate position in international economic relations and an adequate standard of living of the population” (Nurzyńska, 2016, p. 22). This term refers to the economically efficient functioning of the state, the maintenance of prosperity and the development of society, as well as the evaluation and counteracting related threats such as stockpiling, financial resources crucial for the operation of the economy and its organization (Kitler, 2018, p. 101).

3. Multidimensional analysis of the number of transported passengers in selected European countries

Figure 1 presents data on the number of passengers transported by air in respective European countries under consideration between 2019-2022.

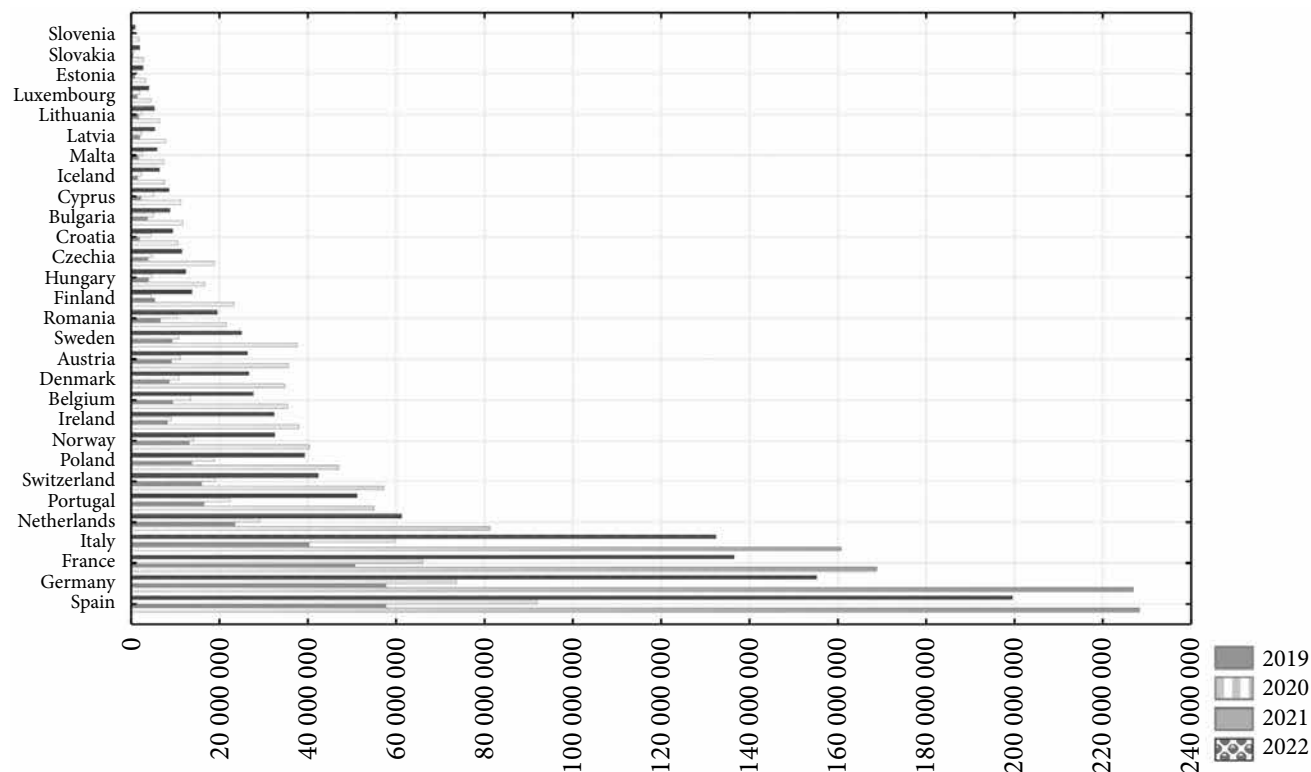


Figure 1. Categorized bar graph of the number of passengers transported by air in respective European countries under consideration between 2019-2022

Source: own study based on data obtained from the website: <https://ec.europa.eu/>, as of July 27, 2023

The largest number of people in 29 European countries under consideration was transported in Spain in 2019: 228 262 372. Germany was in the second place: 226 764 086 passengers. The third place in the ranking was taken by France where 168 726 788 people were transported by air in 2019. The last place in the ranking was taken by Slovenia with the number of passengers transported amounting to 1 719 039. Poland was in eighth place with the result of 46 942 771 passengers.

In 2020, due to the impact of the COVID-19 pandemic, huge decreases were observed. In Spain, compared to 2019, the decrease was 170 465 067 passengers. In Germany it amounted to 168 968 108 passengers and in Italy 120 262 584 passengers. The lowest decreases in 29 European countries under consideration in terms of the number of passengers transported in 2020 were in Slovenia: 1 431 252 passengers. Poland was ranked eighth: 33 117 311 passengers.

In 2021, compared to 2020, the largest increases in the number of passengers transported by air in 29 European countries under consideration were recorded in Spain: the increase of 34 100 936 passengers. The second place in the ranking was for Italy with the increase of 19 303 788 passengers. The third place was taken by Germany with the increase of 15 801 392 passengers. There was no increase between 2020 and 2021 only in Finland.

In the period under consideration, a decrease of 874 125 passengers was observed. Comparing 2019 and 2021, it can be observed that in 2021 none of the European countries under consideration reached the level of passenger numbers from 2019. The biggest differences were in Germany and amounted to 153 166 716 passengers.

The second place was for Spain with a difference of 136 364 131 passengers. France took the third place with a difference of 102 692 979 passengers. The last 29th place in the ranking was taken by Slovenia with a difference of 1 299 693 passengers. Poland was in the ninth place, here the difference in the number of passengers between 2019 and 2021 amounted to 28 048 959 passengers.

Considering 2022 compared to 2021, an increase in the number of people transported by air was observed in each of the 29 European countries. The largest increase was recorded in Spain and amounted to 107 672 962 people. The second place was Germany with an increase of 81 681 183 passengers and Italy was third with an increase of 72 716 576 passengers. Poland was ranked ninth with an increase of 20 453 730 people. The last place was taken by Slovenia with an increase of 549 465 people.

Comparing 2019 to 2022 in terms of air passenger transport, it can be clearly stated that in each of the 29 analyzed European countries in 2022 the level of the number of people transported in 2019 was not reached. The largest differences were observed in Germany: 71 485 533 passengers. The second place was taken by France with a difference in the number of passengers of 32 165 431 people. The third place in the ranking was for Spain with a difference of 28 691 169 passengers. In this classification, Poland took the thirteenth place with a difference of 7 595 229 passengers. Luxembourg was the lowest in the ranking with 308 322 passengers.

The next stage of the research was the analysis of dynamic indices based on the constant number of passengers transported by air in respective European countries under consideration between 2020-2022 (constant: the number of passengers transported by air in the respective analyzed European countries in 2019). The test results are presented in Figure 2.

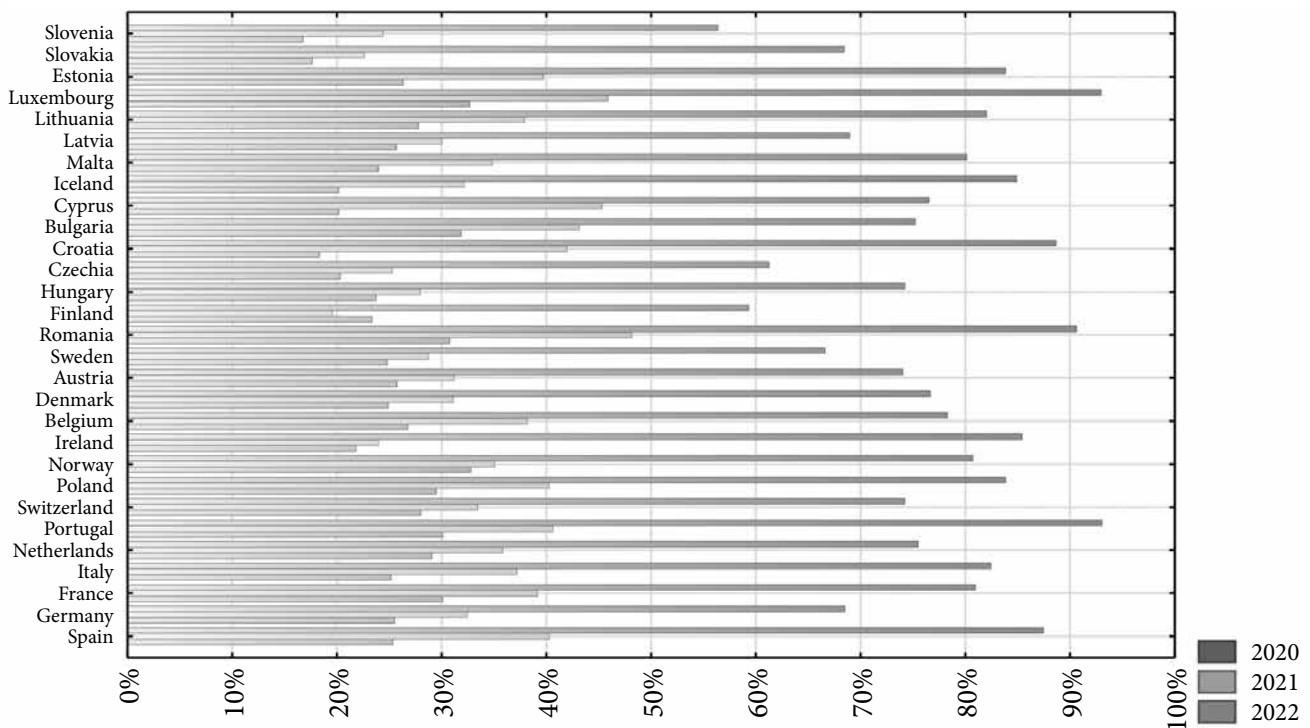


Figure 2. Categorized bar graph of dynamic indices based on the constant number of passengers transported by air in respective European countries under consideration between 2020-2022 (constant: the number of passengers transported by air in respective analyzed European countries in 2019)

Source: own study based on data obtained from the website: <https://ec.europa.eu/>, as of July 27, 2023

The data in Figure 2 show that the largest percentage decreases in the number of passengers transported by air in 29 European countries under consideration were in Slovenia. In 2020, 17% of the number of passengers from 2019 were transported there. The second place in the ranking was Slovakia where in 2020 18% of the number of passengers from 2019 were transported.

The third place was taken by Croatia which also transported 18% of the number of passengers. However, in Poland in 2020, 29% of the number of passengers from 2019 were transported. The smallest percentage decreases were recorded in Norway. In this country, in 2020, 33% of the number of people transported in 2019 were transported by air.

In 2021, compared to 2019, the largest decreases in the number of passengers were visible in Finland. 20% of the number of passengers in 2019 were transported there by air. The second place in the ranking was taken by Slovakia where 23% of the number of passengers from 2019 were transported in 2021. The third place was taken by Ireland where in 2021 24% of the number of passengers from 2019 were transported. Poland was ranked 21st. In 2021, 40% of the number of passengers from 2019 were transported here. The smallest decreases that year were visible in Romania where 48% of the number of passengers from 2019 were transported.

Considering 2022, it can be observed that the largest decreases in the number of passengers in the 29 analyzed European countries were in Slovenia. In 2022, 56% of the number of passengers from 2019 were transported there. The second place was Finland where in 2022 59% of the number of passengers from 2019 were transported. The third place was taken by the Czech Republic with the number of passengers in 2022 representing 61% of those transported in 2019. In Poland in 2022, 84% of passengers from 2019 were transported. The smallest percentage decreases in 2022 were recorded in Portugal: 93% of the number of passengers from 2019.

To sum up, the arithmetic mean of the percentage of people transported by air in the 29 European countries under consideration in 2020 showed a huge decrease: to 26% of the number of passengers transported in 2019. Increases were observed in subsequent years. In 2021, an average of 35% of passengers from 2019 were transported and in 2022 there was an increase to 78% of the number of passengers from 2019.

The next stage of the research was a multidimensional comparative analysis of dynamic indices based on an inconstant number of passengers transported by air in respective European countries under consideration between 2020-2022.

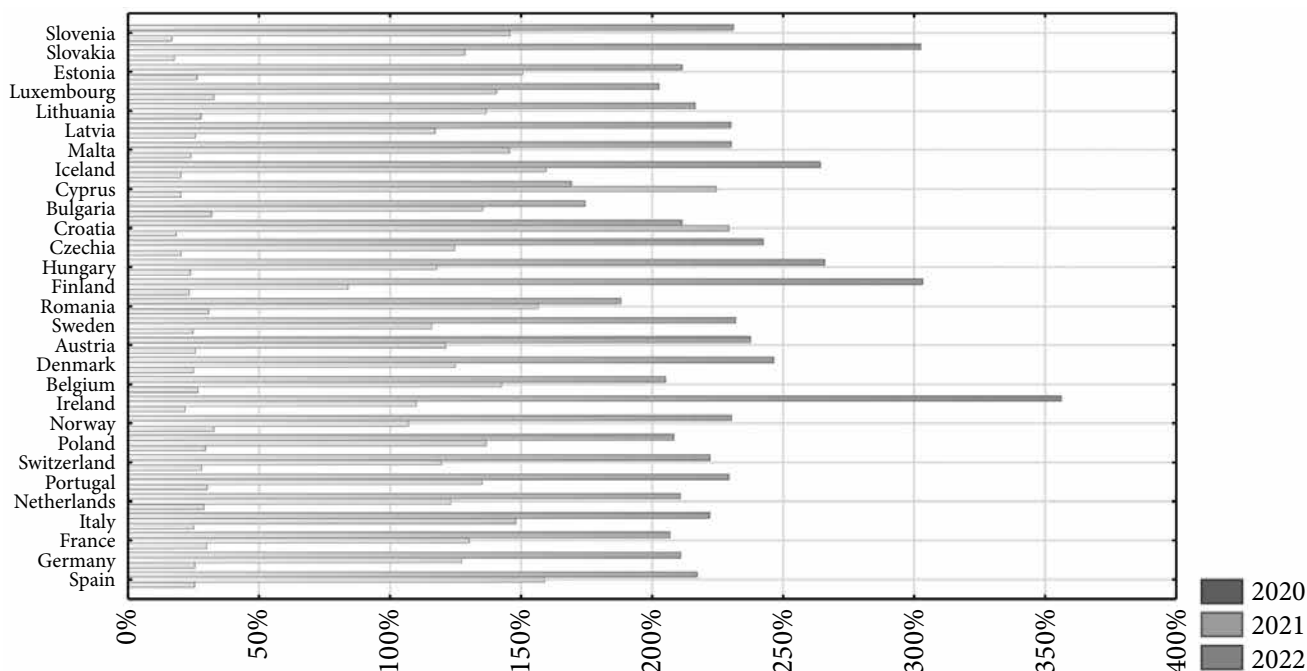


Figure 3. Categorized bar graph of dynamic indices based on an inconsistent number of passengers transported by air in respective European countries under consideration between 2020-2022

Source: own study based on data obtained from the website: <https://ec.europa.eu/>, as of July 27, 2023

When evaluating the inconsistent dynamic indices of data on the number of passengers transported by air in respective European countries under consideration between 2020-2022, it can be observed that from 2021 to 2022 their strong increase is visible. In 2020, a decrease was observed compared to 2019. During this time, on average, 26% of 2019 passengers were transported by air in each of the 29 European countries under consideration. However, in 2021, 138% of passengers from 2020 were transported. In 2022, then, there was an increase to 230% compared to 2021.

In 2022, the largest increases were observed in Ireland and amounted to 356% of the number of passengers from 2021. The second place was taken by Finland which recorded an increase to 303% compared to 2021. The third place was taken by Slovakia where the increase was 303% compared to 2021. Poland was ranked 23rd with an increase of 208% compared to 2021. The lowest ranked country was Cyprus with an increase of 169% compared to 2021.

Then, for research purposes, a linear graph of the number of passengers transported by air in respective European countries between 2013-2022 was outlined in Figure 4.

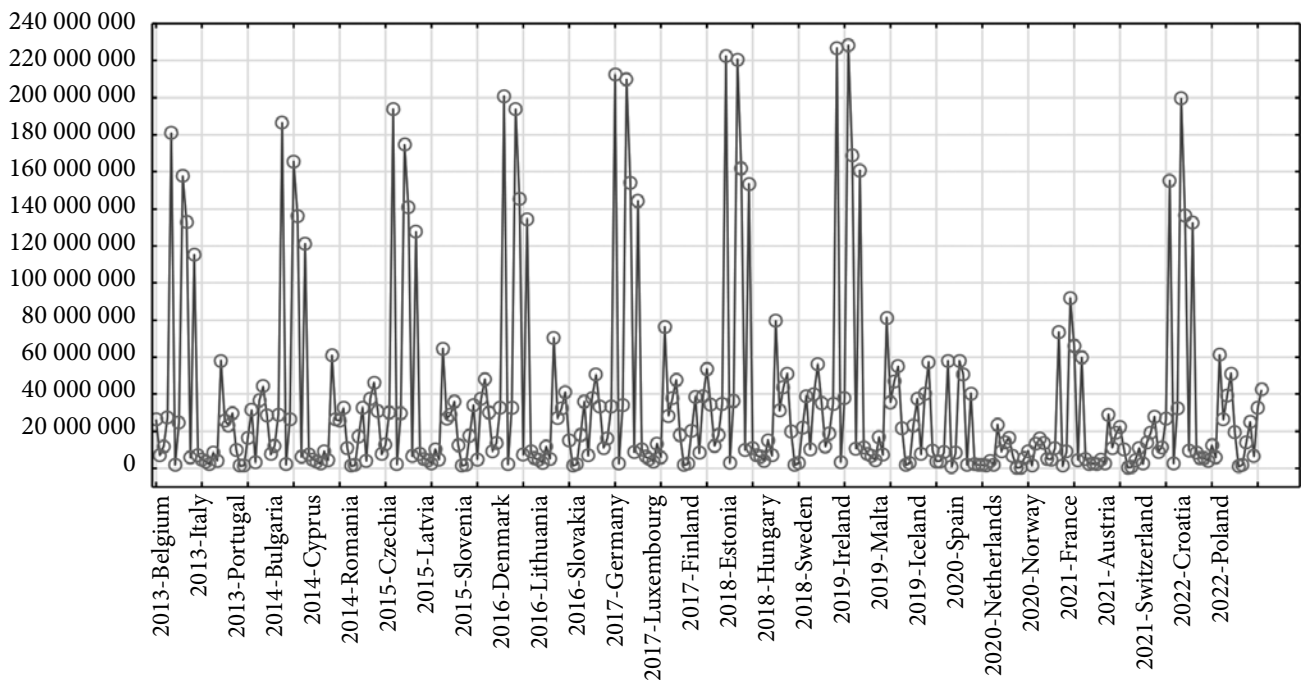


Figure 4. Categorized line graph of the number of passengers transported by air in respective European countries under consideration between 2013-2022

Source: own study based on data obtained from the website: <https://ec.europa.eu/>, as of July 27, 2023

The observation of the data in Figure 4 shows that from 2013 to 2019 there was an increasing trend in the number of passengers in 29 European countries under consideration. In 2020, due to the COVID-19 infectious disease pandemic, there were huge decreases in the number of passengers. They have been increasing since 2021 but, still, not at the same level as before 2019.

4. Forecasting

This became the premise for the forecasting of the number of passengers transported in 29 European countries under consideration for 2023. The forecasts are presented in Figure 5.

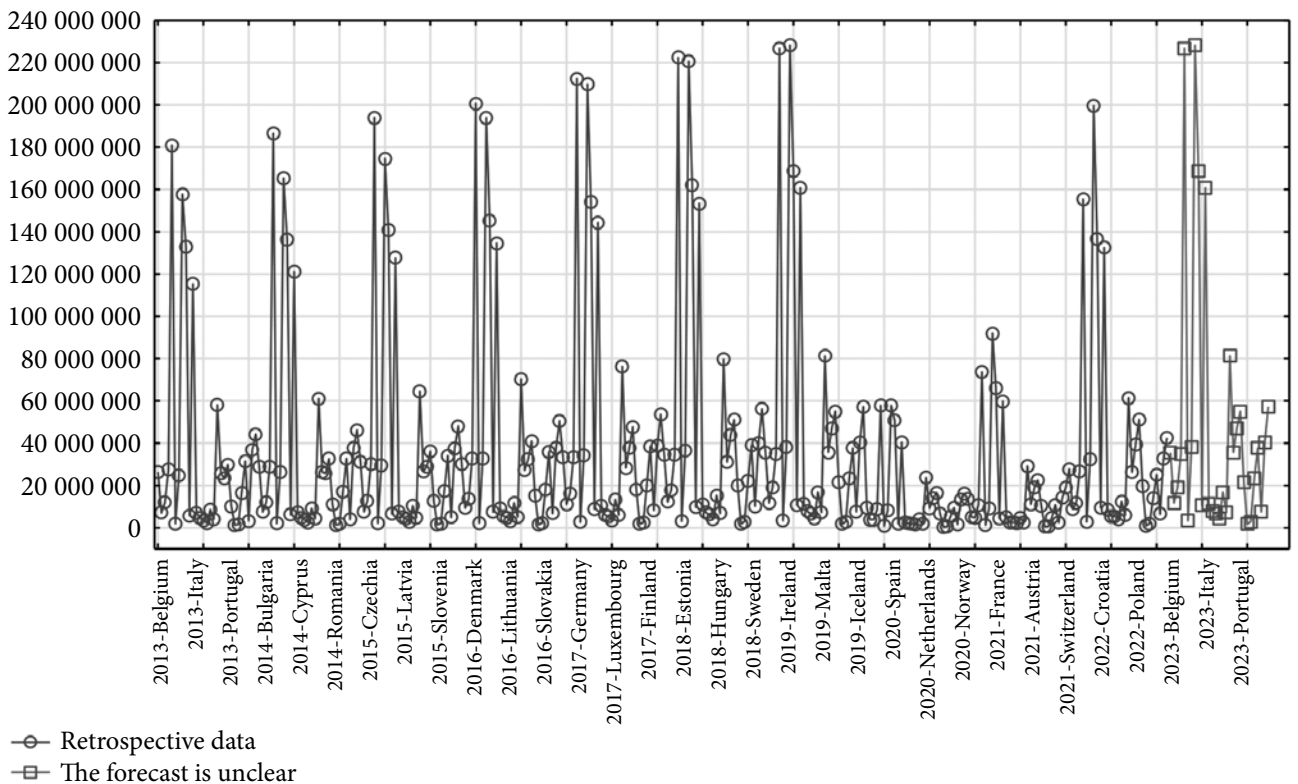


Figure 5. Categorized line graph of the forecast of the number of passengers transported by air in respective European countries under consideration for 2023 together with retrospective data

Source: own study based on data obtained from the website: <https://ec.europa.eu/>, as of July 27, 2023

The forecasting of the number of passengers transported by air made in Figure 5 assumes that in 2023, in each of 29 European countries under consideration, it will be equal to that of 2019. In 2023, the largest number of passengers will be transported in Spain: 228 262 372 people. Germany is in the second place with a passenger forecast of 226 764 978. France is in the third place. There, the forecast amounts to 168 726 788 people. Poland is ranked eighth with the forecast number of passengers transported by air equal to 46 942 771. The last place in the ranking was taken by Slovenia with the forecast number of passengers equal to 1 719 039 people.

5. Summary and conclusions

In 2020, due to the impact of the COVID-19 pandemic, huge decreases in the number of air transport passengers were observed in all analyzed European countries. In Spain in 2020, compared to 2019, the decrease was 170 465 067 passengers. In Germany it amounted to 168 968 108 passengers and in Italy 120 262 584 passengers. The lowest decreases in 29 European countries under consideration in 2020 were recorded in Slovenia: at the level of 1 431 252 passengers. Poland was ranked eighth with the result of 33 117 311 passengers.

In 2021, compared to 2020, the largest increases in the number of passengers transported by air in 29 European countries under consideration were recorded in Spain: by 34 100 936 passengers. The second place in the ranking was Italy with an increase of 19 303 788 passengers. The third place was taken by Germany with an increase of 15 801 392 passengers. An increase between 2020 and 2021 in the number of passengers transported by air was not recorded only in Finland. In the period under consideration, a decrease of 874 125 passengers was observed.

Considering 2022 compared to 2021, an increase in the number of people transported by air was observed in each of 29 European countries under consideration. The largest one was recorded in Spain: 107 672 962 people. In the second place there was Germany with an increase of 81 681 183 passengers and Italy was third with an

increase of 72 716 576 passengers. Poland was in the ninth place in the ranking with an increase of 20 453 730 people. The last place was taken by Slovenia with an increase of 549 465 people.

To sum up, the number of passengers transported in respective European countries in 2022 did not reach the level of 2019.

The answer to the research problem can be provided by analyzing dynamic indices on a constant basis where the number of passengers transported in each of 29 European countries considered in 2019 was a constant itself. It was observed that in 2020, on average, about 26% of the number of passengers from 2019 were transported in each European country. In 2021, an increase to 35% of the number of passengers from 2019 was observed and in 2022 to 78% of the number of passengers from 2019.

According to the authors, the aim of the research was achieved, a multidimensional data analysis was conducted using various indices that were compiled dynamically online and bar charts in terms of their evaluation.

The conducted research shows that in 2021, in each of the European countries under consideration, an average of 138% more passengers were transported by air compared to the data from 2020. In 2022, however, an increase to 230% of the number of passengers from 2021 was observed. The research thesis was confirmed. In 2022, none of 29 European countries under consideration reached the number of passengers transported in 2019.

The analysis of the built time series of the number of passengers transported in 29 European countries under consideration between 2013-2022 indicates two regularities: an increasing trend and seasonality every 29 periods. Another evaluation is the identification of huge, unprecedented decreases in the number of passengers transported in each of the European countries in 2020 due to the impact of the infectious disease COVID-19. Then, between 2021-2022, systematic increases are visible.

This made it possible to use a naive method to forecast the number of passengers transported by air in 2023. In 2023, the largest number of passengers will be transported in Spain: 228 262 372 people. Germany is in the second place with a passenger forecast of 226 764 978. The sum of the forecast of transported passengers for 2023 in 29 European countries under consideration will total 1 401 839 218 and will be higher than in 2022 by 296 222 604 people.

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Bartosz KOZICKI - Military University of Technology, PL. Research interests: national security, internal security.
ORCID ID: 0000-0001-6089-952x

Paweł JAŚKIEWICZ - Military University of Technology, PL. Research interests: national security, internal security.
ORCID ID: 0000-0002-8863-6948

Dariusz LATOSIEWICZ - Human Resources Department Ministry of National Defence, PL. Research interests: national security, people management.
ORCID ID: 0000-0002-7108-2491

Michał WIĘCKIEWICZ - Stare Babice Commune, PL. Research interests: national security, internal security.
ORCID ID: 0009-0000-3626-9034

Grzegorz SUROWIECKI - Management Academy of Applied Sciences, PL. Research interests: national security, internal security.
ORCID ID: 0009-0002-8270-0416