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FORECASTING OF THE NUMBER OF AIR PASSENGERS IN THE UNITED STATES IN TERMS OF THE MAINTENANCE OF ECONOMIC SECURITY DURING THE IMPACT OF COVID-19

Abstract

The purpose of the study is to forecast the number of passengers transported by air in the United States for 2021-2022. The forecast is preceded by a multidimensional comparative analysis of the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021. To achieve this goal, the research data were grouped as dependent variables: years, months-years. The observed similarities, the analysis and evaluation of the literature as well as our own experience made it possible to forecast primary data for the future. The obtained results show a growing trend in the number of passengers transported by air in the United States. The forecast for 3 November 2021 to 31 December 2022 is 837,459, 877 prospective air passengers in the United States. The standard deviation of the obtained forecast was 255,680,3, the arithmetic mean was 1,975,141 passengers, and the median was 1,998,478 passengers. The observed similar trends in the identical months of July-October in 2019 and 2021 as well as the analysis of the literature and the own experience allowed for the selection of a method for the forecasting of the number of passengers transported by air in the United States for the future. The detected regularities as recurring trends in the number of air passengers transported in the United States on a dynamic basis may be used to forecast them for the future.

Keywords: economic security, air transport, forecasting, data analysis, COVID-19 pandemic

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Introduction – analysis of the literature on the subject of research

The study deals with issues related to air transport of passengers in the United States. The increasing phenomenon of globalization affects the increase in the demand for travel. In the available (and relevant) scientific literature, transport is interpreted as a set of activities associated with the movement of material resources of enterprises in the supply chain[1]. Transport includes the transit of cargo and people (passengers) in domestic and international traffic with the use of means of transport[2]. The article focuses on one type of transport considered to be the safest and fastest – air transport. It has become a convenient and mass way of relocating people. It is one of the most significant branches of the economy of great importance to economic development and its ultimate goal is to meet transport needs[3]. From the economic point of view, the increase in demand for air transport is one of the factors contributing to economic growth and its proper functioning affects the maintenance of an appropriate level of economic security.

Eugeniusz Zwierzchowski considers ensuring the safety of citizens as one of the basic tasks of the state. Ensuring the safety of citizens consists, inter alia, in various actions taken by state authorities to protect citizens against the consequences of hostilities and terrorist attacks, but also against the threat of domestic crime, the transmission of epidemic diseases, natural disasters, various types of catastrophes as well as other life-, health- and property- threating phenomena[4].

Security can be divided according to several criteria[5]. One of them is the subject criterion, thanks to which it is possible to distinguish between political security, military security, economic security, environmental security, social security, etc.[6].

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Economic security is associated with the provision of economic conditions necessary for the survival, prosperity and sustainable development of society as well as the efficient operation of the state and its institutions[7].

Economic security, therefore, refers to free access to markets, funds and natural resources which ensure the development of various entities and, thus, affect the appropriate level of the conditions that give confidence, its maintenance, and the possibility of improvement[8].

Continuous analysis, evaluation and forecasting of the number of transported passengers for the future are extremely important in terms of the correct planning and maintenance of an appropriate level of economic security. Many different standards and indices are used during our analysis. The median was calculated in the present study and dynamics indices were applied on a constant basis throughout our research. The methods of index calculation, such as the median or dynamics indices, are duly presented in numerous scholarly books on the subject in question[9]. Comparison of indices over time enables detection of regularities as a trend or seasonality. This type of regularity is detected by means of time series analysis[10]. The evaluation of the time series analysis conducted allows for the optimal selection of the method for the forecasting of the data under consideration. Forecasting methodology in literature remains scarce and is very scattered[11]. The selection of the forecasting method depends on the evaluation of historical data observations, the history of the process, the

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knowledge of the model builder, and information on the impact of external factors on the primary data under consideration.

In the present study, the external factor affecting the primary data is the COVID-19 infectious disease pandemic. The first case of COVID-19 was reported in Wuhan, China[12]. The disease tended to spread rapidly. Before long, it has become a threat to people all over the world. After the announcement of the COVID-19 pandemic by the World Health Organization on 11 March 2020[13], there was a strong weakening, especially in the air passenger transport sector[14]. A considerable decrease in the number of people transported by passenger air transport was recorded in every country of the world. The United States was one of the leaders in passenger air transport until 2019. Since March 2020, huge, previously unprecedented drops in the number of people transported by air transport have been visible[15]. The enormous declines also led to the fastest increase in the unemployment rate in the history of the United States in April 2020 to the level of 14.7%[16]. There was also a global decline in oil demand which, in turn, resulted in long-term strong drops in the price of a barrel of crude oil until the end of 2020[17].

In the article, in order to build a model of the forecasting of retrospective data for the future, multidimensional comparative analyzes were used which are identified with the ordering of a relatively homogeneous set of objects to make decisions[18]. These are groups of statistical methods that simultaneously analyze at least two variables describing each examined object[19].

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Multidimensional analysis of the number
of passengers transported by air in the United States

The research began with the drawing of a line chart of the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021, on a daily basis (Fig. 1).
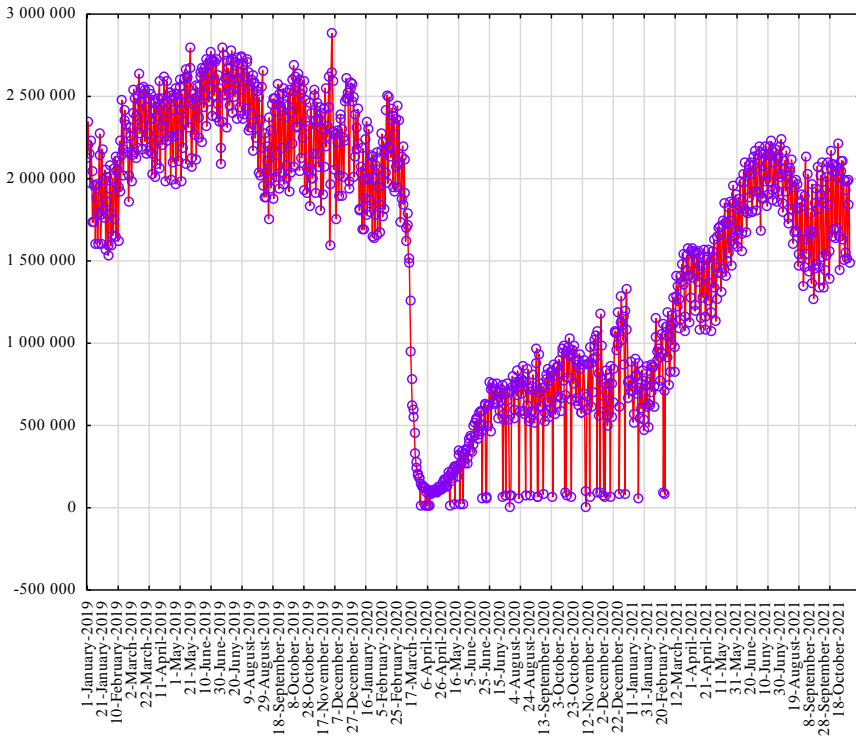

Figure 1. Line chart of the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021, daily data

Source: https://www.tsa.gov/coronavirus/passenger-throughput (04.11.2021).

Figure 1 shows that the largest number of passengers (842,301,625) in the United States was transported by air in 2019. In 2020, due to the COVID-19 pandemic, the number of passengers transported by air decreased to 302,955,637 and in 2021 (from 1 January to 2 November - 306 days) it increased to 464,103,837 passengers. In 2019, approximately 52.34% of the total number of air passengers was transported in the US in the period from 1 January 2019 to 2 November 2021. However, in 2020 only 18.83% and in 2021 (from 1 January to 2 November) about

28.84% of the total amount under consideration. The median of the number of transported passengers annually in the United States in the three analyzed years was as follows: 2019 – 2,356,802 passengers, 2020 – 689,895 passengers and 2021 (306 days – from 1 January to 2 November) – 1,787,234 passengers. The highest standard deviation from the arithmetic mean of the considered primary data in the analyzed period was in 2019 and amounted to 676,557 passengers. The second place in the ranking was 2021 (1 January to 2 November) with a standard deviation of 484,723,9 passengers. The third place is 2019 with a standard deviation result of 284,894,6.

The further stage of the research was the analysis of the distributions of the primary data under consideration in the group "years". In the first stage of the research, categorized histograms were used. The results of the research are outlined in Figure 2.
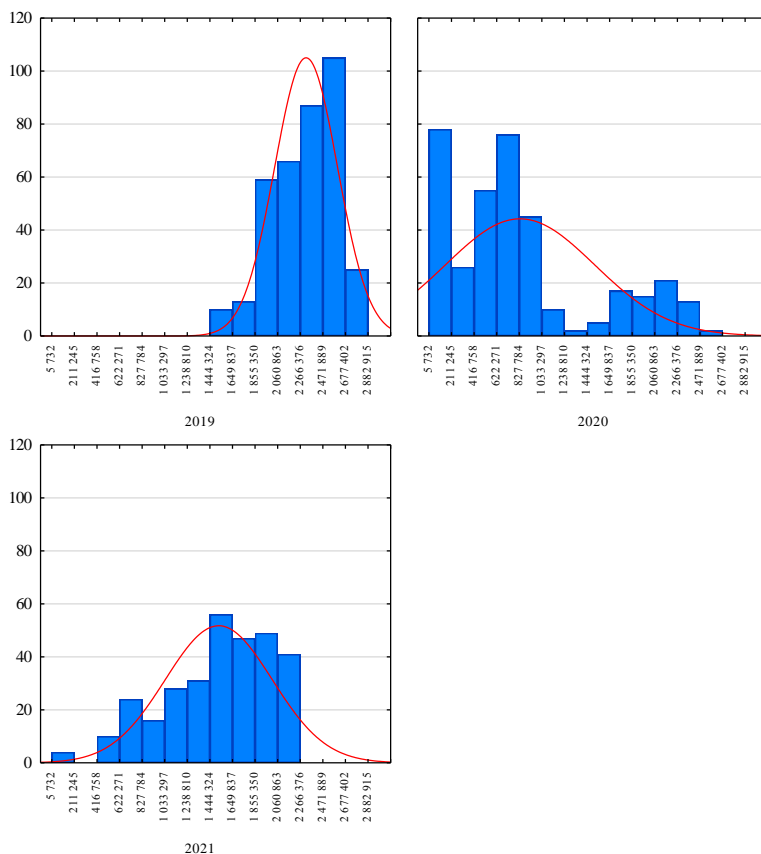

Figure 2. Categorized histograms of the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021

Source: https://www.tsa.gov/coronavirus/passenger-throughput (04.11.2021)

The information outlined in Figure 2 shows that the data distribution for 2019 and 2021 may be close to normal distribution. However, the distribution of historical data on the number of passengers transported by air in the United States in 2020 is by no means an example of normal distribution. In 2020, a bimodal distribution can be observed.

To determine the existence of a normal distribution in the considered primary data, a categorized normality graph with the Shapiro-Wilk test was used.
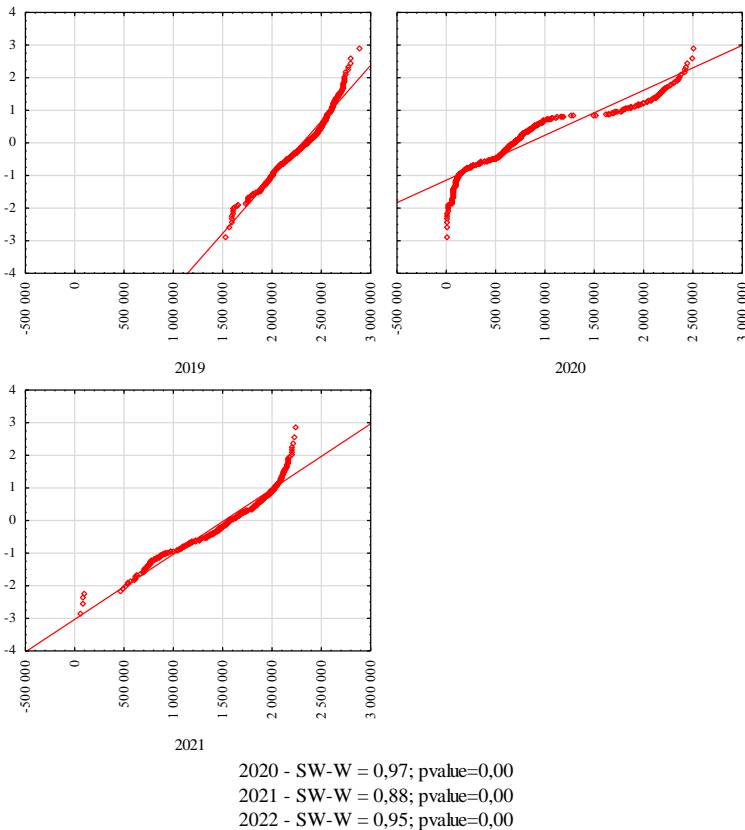

2020 - SW-W = 0,97; pvalue=0,00
2021 - SW-W = 0,88; pvalue=0,00
2022 - SW-W = 0,95; pvalue=0,00

Figure 3. Categorized normality graph with the Shapiro-Wolf test of the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021

Source: https://www.tsa.gov/coronavirus/passenger-throughput (04.11.2021).

The observations of the normality graphs (Fig. 3) show that the figures from 2019 are closest to normal distribution, then the data from

2021. The data from 2020 do not constitute normal distribution. The arrangement of the quantiles for 2019 and 2021 is similar. On the other hand, the conducted three Shapiro – Wilk tests indicate the lack of a normal distribution in all three considered cases because pvalu is lower than the accepted level of significance

The forecasting of the number of passengers transported by air in the United States for 2021-2022

The observation of the similar arrangement of quantiles in 2019 and 2021 has become a premise for further research in this area. For this purpose, the primary data was grouped according to dependent variables "months/years" and presented in Figure 4.
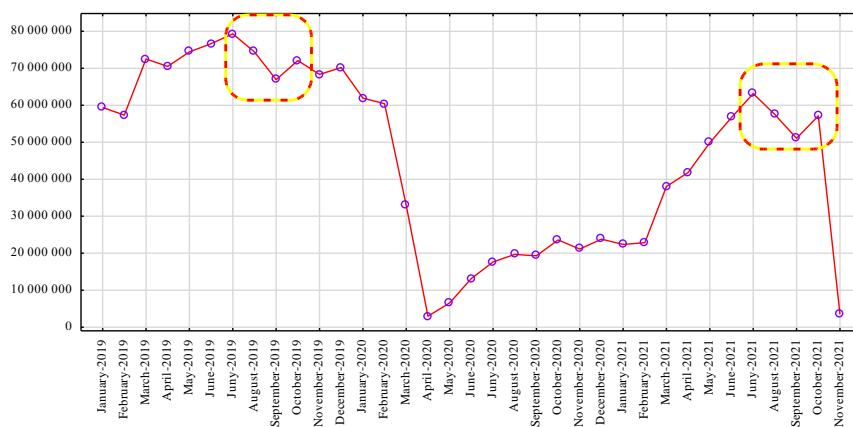

Figure 4. Line chart of the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021 in the group of dependent variables "months"

Source: https://www.tsa.gov/coronavirus/passenger-throughput (04.11.2021).

The results of the research presented in Figure 4 show similar trends in the number of passengers transported by air in the United States in the identical months from July to October in 2019 and 2021. The trend was presented by a decrease in the number of passengers transported by air in the identical months from July to September, followed by an increase in identical months – in October. The primary data of the above-mentioned phenomenon, along with the calculated indices of dynamics on a constant basis and the median, are presented in Table 1.

Table 1. Descriptive statistics of the number of passengers transported by air transport in the United States in the identical months of July – October in 2019 and 2021, with the calculated indices of dynamics on a constant basis

	2019	**2021**	Index of dynamics on a constant basis (**constant-2019**)
July	79,332,046	63,188,017	0,796501
August	74,445,793	57,484,123	0,772161
September	66,941,195	51,089,715	0,763203
October	72,108,333	57,162,404	0,79273
Median			**0,782445**

Source: https://www.tsa.gov/coronavirus/passenger-throughput (04.11.2021).

The observed similarity of the trends in the number of passengers transported by air in the United States in the identical months of July – October in 2019 and 2021 became the premise for the calculation of the median of the obtained dynamics indices (0,782445) which became the foundation for the forecasting of following months in 2021 based on the time series of retrospective data from the identical months of 2019. The evaluation of the literature analysis shows that, according to experts, the number of passengers transported by air in the United States will reach the level of 2019 around 2025. This, in turn, has become the reason to claim that in 2022 there will be an increase in the number of passengers transported, compared to 2021, which, according to the author, will constitute approximately 0.87% of the number of passengers transported by air in the United States in 2019. The forecasting results are outlined in Figure 5.

The forecast of the number of passengers transported in November – December 2021 was 104,657,463. The total number of future passengers transported by air in the United States for 2021 is 568,761,300. In 2022 the number of passengers should increase to 732,802, 414. Having analyzed three incomplete years of retrospective data from January 2019 to 2 November 2021 and the obtained forecasts for the period from 3 November 2021 to 31 December 2022, it was observed that in 2019 approximately 34.42% of the total number of passengers was transported. In 2020, due to the COVID-19 pandemic, there was a decrease to around 12.38% of the total number of air passengers in the United States. In 2021, it will increase to 23.24%, and in 2022 to 29.95% of the total number of passengers transported.

According to the obtained forecasts, the largest number of air passengers in the United States will be transported in July 2022 – at the level of approximately 69,015,880 people. The sum of the forecast for the number of transported passengers in the United States from 3 November 2021 to 31 December 2022 will amount to 837,459,877. The standard deviation of the obtained forecast was 255 680,3, the arithmetic mean is 1,975,141 passengers and the median is 1,998,478 passengers.
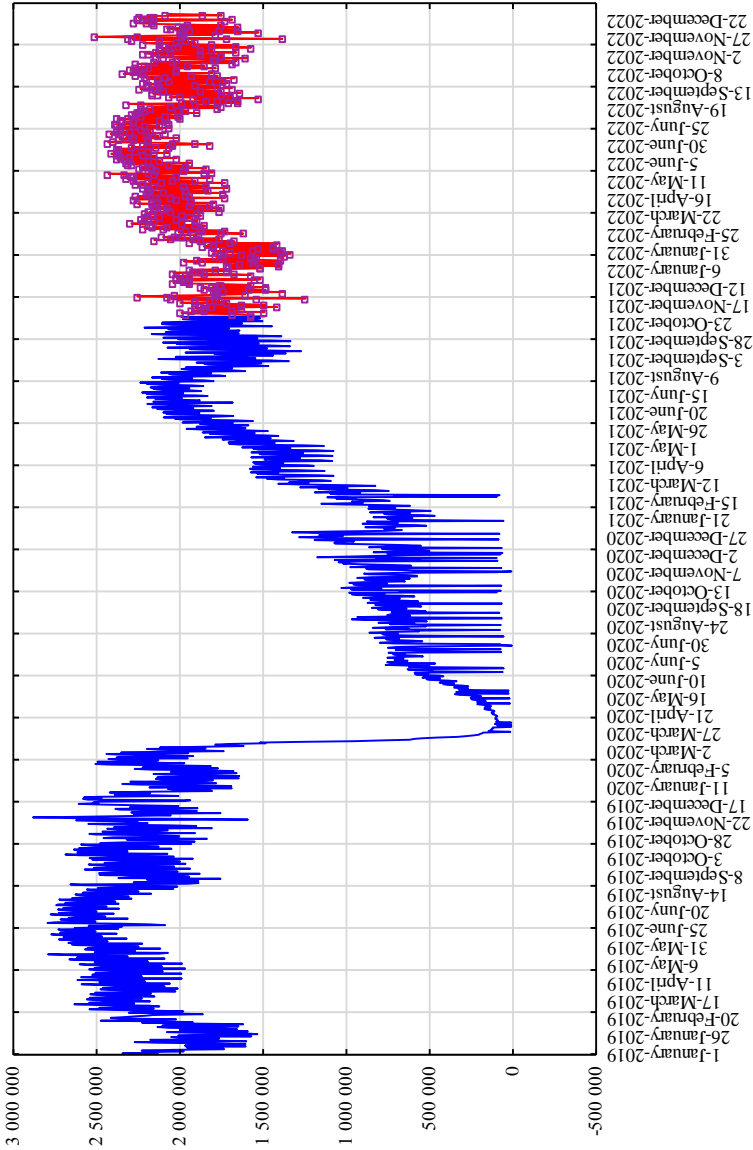
—— The real data - air passanger (from 1 january 2019 to 2 november 2021)

—■— Forecasting - air passanger (from 3 november 2021 to 31 december 2022)

Figure 5. Line chart of historical data on the number of passengers transported by air in the United States from 1 January 2019 to 2 November 2021 and their forecast for the period from 3 November 2021 to 31 December 2022

Source: https://www.tsa.gov/coronavirus/passenger-throughput (04.11.2021).

Conclusions

Until 2019, air transport had been one of the most dynamically developing modes of transport in the world, its goal was to transport human and material resources in space as quickly as possible.

The research shows that at the beginning of 2020 in the United States there were enormous drops in the number of passengers transported by air caused by the COVID-19 pandemic. From April to October 2020, there was a growing tendency in the number of passengers transported but it was a much lower level compared to 2019. No uptrend was observed from November 2020 to February 2021, while from March to July 2021 there was a strong upward trend followed by declines until September and an increase in October.

In the present study, a similar trend was observed in the number of passengers transported by air in the United States from July to October in 2019 and in 2021. The trend was presented with a decrease in the number of passengers transported by air from July to September, followed by an increase in October. The months are identical for both 2019 and 2021.

The observed regularity and the analysis and evaluation of the literature, as well as our own experience allowed for the development of a model for the forecasting of primary data for the future.

The forecast of the number of passengers transported in November-December 2021 was 104,657,463. The total number of future air passengers in the United States for 2021 is estimated at 568,761,300. In 2022, the number of passengers traveling by air is expected to increase to 732,802,414.

Having analyzed three incomplete years of retrospective data from January 2019 to 2 November 2021 and the obtained forecasts for the period from 3 November 2021 to 31 December 2022, it was observed that in 2019 approximately 34.42% of the total number of passengers were transported. In 2020, due to the COVID-19 pandemic, there was a decline to approximately 12.38% of the total number of air passengers in the United States. In 2021, the number of passengers will increase to 23.24% and in 2022 to 29.95% of the total number of passengers.

In 2021, increases in passenger air transport in the United States were observed which may serve as a premise to conclude that, in a few years, the level recorded in 2019, in terms of the number of passengers transported by air, will be achieved. Undoubtedly, the growing tendency in the number of passengers transported by air in the United States in 2021 is influenced by the increasing number of vaccinated people.

The return to the pre-COVID-19 situation will require even more intensive attempts to contain the spread of the infectious disease by the continuous increasing of the vaccinated population and subsidizing of sectors that suffer losses from the persistent disease and as such require temporary financial support.

An element influencing the level of security of citizens is the obligation of the state to combat epidemic diseases[20]. Public authorities must focus on ensuring the safety of their citizens, both in the economic context and with regard to the protection of people's health and life. Therefore, in order to be able to talk about improving the condition of the economy and returning to the situation from before the Covid-19 pandemic, the state must cover not only matters related to the control of the pandemic, but also matters related to the economic security of the state and human safety. The conducted research has clearly shown the degree of the impact on the state of the economy, with a particular emphasis on the subject of research presented in the article, i.e. air transport, of a random event, such as a pandemic, and how difficult it is to return to the pre-Covid-19 state.

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Prognozowanie liczby pasażerów lotniczych w Stanach Zjednoczonych pod kątem utrzymania bezpieczeństwa ekonomicznego w okresie skutków COVID-19

Streszczenie

Celem badania jest prognoza liczby pasażerów przewiezionych drogą lotniczą w Stanach Zjednoczonych na lata 2021-2022. Prognozę poprzedza wielowymiarowa analiza porównawcza liczby pasażerów przewiezionych drogą lotniczą w Stanach Zjednoczonych od 1 stycznia 2019 r. do 2 listopada 2021 r. Aby osiągnąć ten cel, dane pogrupowano jako zmienne zależne: lata, miesiące-lata. Zaobserwowane podobieństwa, analiza i ocena literatury oraz własne doświadczenia pozwoliły na prognozowanie danych pierwotnych na przyszłość. Uzyskane wyniki wskazują na rosnący trend liczby pasażerów przewożonych drogą lotniczą w Stanach Zjednoczonych. Prognoza na okres od 3 listopada 2021 do 31 grudnia 2022 to 837 459 877 potencjalnych pasażerów lotniczych w Stanach Zjednoczonych. Odchylenie standardowe uzyskanej prognozy wyniosło 255 680,3, średnia arytmetyczna 1 975 141 pasażerów, a mediana 1 998 478 pasażerów. Obserwowane podobne trendy w identycznych miesiącach lipiec-październik w 2019 i 2021 roku oraz analiza literatury i własnych doświadczeń pozwoliły na wybór metody prognozowania liczby pasażerów przewiezionych drogą lotniczą w Stanach Zjednoczonych na przyszłość. Wykryte prawidłowości jako powtarzające się trendy w liczbie pasażerów lotniczych przewożonych w Stanach Zjednoczonych na zasadzie dynamicznej mogą posłużyć do ich prognozowania na przyszłość.

Słowa kluczowe: bezpieczeństwo ekonomiczne, transport lotniczy, prognozowanie, analiza danych, pandemia COVID-19