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# Assessing the resilience of the Baltic air transport sector in the context of economic crises

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ABSTRACT

The significance of this study lies in assessing the resilience of the air transport sector to economic crises, which is crucial in today's context where sustainable environmental development has become a new reality, and the development of aviation services is insufficient for achieving stable and resilient economic growth in the sector. The air transport sector significantly contributes to regional economic growth and the development of various other business sectors. This article evaluates the resilience of the air transport sector in the Baltic countries in the context of economic crises. The novelty of the research stems from the air transport sector undergoing entirely new and unexplored processes, significantly influenced by the COVID-19 pandemic and previous crises, such as the September 11 attacks and the Great Financial Crisis. There is a lack of a comprehensive evaluation model to assess the resilience of the air transport sector under economic instability. The article aims to assess the resilience of the air transport sector in the Baltic countries in the context of economic crises. The article describes external factors influencing the economic growth of the air transport sector. It examines the perspectives of different authors and institutions on the development of the air transport sector. The study analyses national and international documents, development plans, and investments related to enhancing the resilience of the air transport sector to economic crises. To assess the resilience of the air transport sector in the Baltic countries in the context of economic crises, an empirical study was conducted using the following methods: Pearson correlation coefficient method to evaluate the relationship between Revenue Passenger Kilometers (RPK) and Available Seat Kilometers (ASK) indicators of the sole national airline in the Baltic States, "Air Baltic", which belongs to Latvia, crucial for ensuring comprehensive stability; a multi-criteria evaluation using Simple Additive Weighting (SAW) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods to assess the current state and recovery level of the Baltic air transport sector after the COVID-19 pandemic; and an exponential smoothing method to forecast the growth of the Baltic air transport sector from 2024 to 2027, providing a realistic scenario.

KEY WORDS

**air transport sector, resilience, Baltic airports, flights, economy, sustainability COVID-19, economic crisis**

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## Introduction

The air transportation system is paramount to our societies, reflecting the technological advancements driven by societal needs and global interconnectedness (Wandelt et al., 2025). Assessment of the resilience of the air transport sector is crucial to ensure the sector can continue sustainable economic growth even in the context of economic crises. The sector's ability to efficiently respond to changing consumer needs is essential, given its economic sensitivity and potential to adapt quickly to dynamic circumstances. In the current operating environment,

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a broader range of services is required to attract diverse consumer groups and reduce the sector's vulnerability.

The air transport sector in the Baltic countries is implementing significant development projects focused not only on expanding flight networks and infrastructure but also on comprehensive sustainability. Strategies that enable the sector to operate efficiently even under economic uncertainty have become a primary source of resilience and flexibility. The Baltic air transport sector has a crucial impact on regional economic growth, social and economic integration, tourism, and international cooperation. It is important to ensure that during economic crises, the sector remains as resilient as possible, continuing its operations or, when challenged, quickly recovering and adapting to changing market conditions.

Expanding the air transport sector to include non-aviation services increases its resilience and strengthens national economies, providing a solid foundation to overcome future challenges.

The Baltic air transport sector lacks comprehensive tools for accurately assessing its resilience to economic crises. The COVID-19 pandemic has exposed the sector's vulnerabilities and highlighted the need for new strategies to adapt to changing conditions. Existing studies fail to provide an integrated framework that combines qualitative and quantitative indicators. Therefore, developing a methodology that enables a holistic assessment of the sector's resilience and supports informed decision-making is essential.

Despite ongoing global and political uncertainties, political conflicts or economic recessions, the air transport industry is steadily growing. The long-term growth rate of air passenger transport since 1970 is around 5.5 % (Çelik et al., 2025). Implementing certain key policies has significantly enhanced the sector's resilience during major economic crises; however, the network remains vulnerable to disruptions for some time, particularly in its most critical hubs (Deng et al., 2025).

To objectively assess the efficiency of air transport sector development in the Baltic countries, the following structural elements were chosen: airports, air carriers, and air traffic.

The first section, the Literature Review, examines the theoretical foundations and definitions of resilience, focusing on its relevance to the air transport sector. It reviews key scholarly works, identifies gaps in existing research, and discusses the interrelationship between resilience, sustainability, and economic adaptability, particularly in the context of crises.

The second section, Research Methods, details the methodology used to assess the resilience of the Baltic air transport sector. It includes using quantitative methods such as the Pearson correlation coefficient, multi-criteria evaluation (SAW and TOPSIS), and exponential smoothing. These methods evaluate the sector's performance and predict future growth. Key performance indicators, including Revenue Passenger Kilometers (RPK), Available Seat Kilometers (ASK), Employment (EMP), and Instrument Flight Rules (IFR), are introduced and explained.

The third section, Research Results, presents the findings from the empirical study. It highlights the recovery trajectory of the sector following the COVID-19 pandemic, evaluates resilience using the SAW and TOPSIS methods, and forecasts growth using the exponential smoothing method. This section provides insights into the sector's recovery and identifies the key drivers of its resilience.

The fourth section, Discussion, interprets the research results within the context of broader economic and operational challenges faced by the air transport sector. It explores the implications of the findings, emphasising the critical role of sustainability, non-aviation services, and adaptability in enhancing resilience. Additionally, it analyses key lessons learned from the COVID-19 crisis and other disruptions, providing a comprehensive understanding of the sector's capacity to withstand and recover from economic shocks.

Finally, the fifth section, Conclusions, summarises the study's main findings and their implications for the Baltic air transport sector. It offers practical recommendations for policymakers and industry stakeholders, highlighting strategies to enhance sector resilience and sustainability. The conclusions also provide directions for future research, emphasising the need for further exploration of resilience-building approaches to ensure long-term stability and growth in the sector. This structure ensures a logical progression of ideas, guiding readers seamlessly from theoretical concepts to practical applications and policy insights.

## 1. Literature review

Resilience is defined differently in scientific literature and is most often associated with economic recovery following shocks (Martin et al., 2015). Economic resilience refers to the self-restoration and adaptability of an economy following external shocks.

Greater economic resilience can help an economy quickly return to previous growth trajectories or reallocate resources to new growth directions (Martin et al., 2015; Okuneviciute Neverauskiene et al., 2021; Okuneviciute Neverauskiene et al., 2025).

Researchers are increasingly expanding the concept of resilience in their studies, recognising that resilience should encompass the ability to restore a system to its original state and promote system recovery (Zhong et al., 2024). An economy must be able to absorb shocks and adapt to them quickly and have the capacity to change its structure and transition to a new growth path following external shocks. Thus, economic resilience is defined by its adaptability and transformation capabilities (Pan et al., 2023).

Other perspectives in the literature argue that it is not enough to have resources to reallocate; clear analytical alternatives are also needed to guide resource distribution, given that even entities within the same sector operate under different conditions. Effective economic resilience to crises requires tangible resource allocation models to analyse trade-offs between resilience dimensions (Dormady et al., 2019).

As research on resilience and its understanding progresses, particularly regarding future perspectives, resilience becomes inseparable from sustainability. Modern challenges include environmental issues such as species extinction, climate change, ecosystem degradation, and resource depletion. The juxtaposition of sustainability and resilience concepts emerged to address these critical issues and prepare for the future. These efforts depend on the effective management of natural resource markets, which are crucial for economic growth, ecological sustainability, and social well-being.

Exploring the complex interaction between resilience, sustainability, and efficiency aims to understand how this dynamic can drive recovery initiatives and create a more resilient future. Given the current instability and insecurity, there is a heightened need to enhance sustainability and resilience. Systems' ability to absorb shocks, adapt to changes, and recover quickly has become key in facing significant disruptions such as climate-related disasters and global pandemics. In contrast, sustainability advocates for a world where current and future generations can live harmoniously, meeting their material and environmental needs without sacrificing social or environmental justice or economic progress. The United Nations' Sustainable Development Goals (SDGs) emphasise the interdependence of these elements (Yu & Ye, 2024).

Understanding the complexity of resilience is crucial; the pursuit of economic resilience should not hinder the goal of becoming an environmentally neutral sector (Wang et al., 2024). Currently, as environmental sustainability and economic stability are pressing issues, much attention is given to the relationship between financial practices, ecological well-being, and economic resilience (Okuneviciute Neverauskiene et al., 2021; Cao & Tao, 2023). The relationship between sustainability and resilience is increasingly interlinked.

The air transport sector is transitioning to a new phase where the development of non-aviation services is becoming as important as aviation services. The sector has evolved from a "people-moving machine" to a "people business". Non-aviation revenue sources are diverse: retail, food and beverages, parking, advertising, car rentals, customer service, and real estate (International Air Transport Association, 2023).

A review of the scientific literature identified several factors that significantly influenced the resilience of the air transport sector during the COVID-19 pandemic: travel restrictions and perceived safety risks of air travel (Su et al., 2023). As the recovery process continues, cooperation among various air transport sector companies is likely to expand (Gabriel Bae et al., 2021). In a recent study, researchers identify historical improvements in social conditions as an important factor in explaining the decline in air passenger numbers during COVID-19. The need for long-haul travel is being replaced by virtual meetings, a factor that air carriers should consider to be prepared for future risks (Bergantino et al., 2024).

Resilience assessments in the sector have only recently begun and have increased significantly during and after the COVID-19 pandemic. Maintaining resilience during difficult times is crucial, so interest in the sector's resilience is rapidly growing (Cook et al., 2023). Increasing research on the resilience and recovery of the air transport sector shows that lessons learned from the COVID-19 crisis have significantly strengthened the sector both technologically and strategically.

Gradual changes and more extreme climate-related events will impact the air transport sector's operations, infrastructure, and economy. Given aviation's importance to global connectivity and mobility, it is essential for the sector to understand and adapt to these risks (Burbidge et al., 2023). With a resilient management approach, companies must be prepared to respond to changes and anticipate them, overcom-

ing challenges and maximising opportunities. This readiness allows companies to remain resilient and competitive, gaining a competitive advantage by being prepared to face challenges and adapt to changes (Bakreen et al., 2022).

In the scientific literature, many resilience-like concepts are compared, including robustness, redundancy, ingenuity, rapidity, diversity, efficiency, autonomous components, strength, collaboration, adaptability, mobility, accessibility, safety, recovery, absorption, reliability, vulnerability, risk, and sustainability. Several recent reviews also indicate that resilience is a multidimensional concept with no unified definition (Wang et al., 2023). To fully utilise the concept of resilience, it is essential to consider the critical factors of resilience, robustness, recoverability, and adaptability (Janeckova, 2023). Recent literature calls on researchers to develop indicators to measure the current level of resilience so that users can anticipate problems from early signals of potential vulnerabilities (Feo-Valero et al., 2024). Reviewing the scientific literature and evaluating different yet interrelated perspectives made it clear that the concept of resilience is evolving in response to the changes brought by globalisation (Table 1).

The study will further examine the resilience of the air transport sector in the context of economic crises, where integrated sustainability is the normal operating environment.

The development of non-aviation services/products is becoming increasingly important for the Baltic air transport sector, particularly in achieving resilience under economic instability. The COVID-19 pandemic demonstrated the high vulnerability of aviation, as any safety-related disruptions result in grounded planes, causing substantial losses.

Different definitions of resilience can lead to varying dimensions for its quantitative assessment based on one or multiple criteria. Several researchers have explained related concepts from different perspectives to better compare the differences and similarities between resilience dimensions. Based on performance indicators used for measurements, scientists have identified three related concepts in their studies: reliability, vulnerability, and resilience. They summarised four types of performance indicators: travel time, connectivity, accessibility, and capacity. Other researchers compared several related concepts (e.g., risk, reliability, robustness, vulnerability, sustainability, and safety) facing disruption threats, linguistic characteristics, and system responses. While they provided valuable insights into resilience definitions and quantitative metrics, there are two limitations. First, resilience definitions and connotations overlap with other concepts. Second, resilience definitions are general and not specific to the air transport sector (Wang et al., 2023).

Resilience is most commonly measured using standard economic indicators such as GDP growth and employment. However, specific indicators such as business formation and patenting are also used (Martin et al., 2015; Papaioannou, 2023; Okuneviciute Neverauskiene et al., 2024). Generally, resilience assessment studies employ various methods, such as historical data analysis, to evaluate the air transport sector's resilience during crises and simulate hypothetical scenarios to provide recommendations to air transport companies facing such crises. Some studies use only quantitative or qualitative methods, while others combine them.

The global air transport demand recovery is assessed by RPK (International Air Transport Association, 2022). RPK is an airline industry metric showing the distance paying passenger travel. It is calculated as the number of revenue-paying passengers multiplied by the total distance travelled. As this

Tab. 1. Definitions of resilience in scientific literature

| Author | Year | Definition |
|---|---|---|
| Martin R; Sunley P; Tyler P; | 2015 | Self-restoration and adaptability of an economy following external shocks. |
| Zhong F; Chen R; Luo X; Song X; Ullah A; | 2024 | Ability to restore a system to its original state and promote system recovery. |
| Pan S; Hu T; You J; Chang S; | 2023 | Economic resilience defined by adaptability and transformation capabilities. |
| Dormady N; Roa-Henriquez A; Rose A; | 2019 | Choice of analytical alternatives. Tangible resource allocation models are needed to analyse trade-offs between resilience dimensions. |
| Wang J; Liao F; Wu J; Sun H; Wang W; Gao Z; | 2024 | Resilience is a multidimensional concept with no unified definition. |

Source: author's elaboration on the basis of (Martin et al., 2015; Zhong et al., 2024; Pan et al., 2023; Dormady et al., 2019; Wang et al., 2024).

metric indicates actual air transport demand, it is often referred to as airline traffic. RPK forms the basis of many transport indicators. ASK is another similarly important metric for assessing the air transport sector's recovery. Airlines must align their supply (ASK) with market demand (RPK). A shortage of seats often leads to higher airfares, while excess capacity can increase fixed costs. Thus, capacity growth is positive only if it matches increased air transport demand (Airline Geeks, 2016). Another significant metric for assessing the air transport sector's recovery is Air Transport Movement (IFR), which is the sum of take-offs and landings performed under instrument flight rules (Law Insider, 2024.).

European civil-military organisation dedicated to supporting European aviation (Eurocontrol) study on European traffic development and recovery after previous crises showed that it took the air transport sector 1.5 years to recover and return to previous levels after the September 11, 2001, attacks in the US (Statfor, 2020). The terrorist attacks on the World Trade Center and the Pentagon were not only attacks on the United States but also on the global air transport system (International Air Transport Association, 2021). In response to this crisis and aiming to adapt and remain resilient, the air transport sector implemented security measures, leading to today's high security standards in airports, aircraft etc. From an economic perspective, September 11 brought a wave of financial devastation to the air transport sector (International Air Transport Association, 2021).

Another crisis studied by Eurocontrol was the Great Financial Crisis, after which it took the air transport sector eight years to return to its pre-crisis state (Statfor, 2020). The global downturn affected the finances of air transport companies in both passenger and cargo transport. While reduced demand was expected to be part of a cyclical downturn, the crisis started sooner and hit harder than most experts anticipated (Franke & John, 2011).

The crisis further examined by Eurocontrol is the COVID-19 pandemic. Many researchers are currently studying the pandemic's impact on the air transport sector's economy, and the final results and lessons learned are still unclear. However, according to Eurocontrol research, COVID-19 caused the most significant downturn compared to the aforementioned economic crises. Rational decision-making suggests that based on logic and data, managers will choose an alternative with the highest subjective expected value. However, the rapid onset of COVID-19 and the relentless news cycle brought tension and negative sentiments into the community, triggering emotional reactions. Both information overload and emotions compromise the rationality of managers and consumers, making it especially difficult to make appropriate decisions (Tisdall & Zhang, 2020).

Based on the International Air Transport Association 2021 data, the following table clearly shows the comparison of major economic crises in the air transport sector (Table 2).

Each major economic crisis has different impacts on the air transport sector, not only due to the varying nature of the crises themselves but also because of the different contexts in which they occur. The era and its characteristics during which a crisis manifests play a crucial role; thus, the effects can significantly vary in the present and future.

The air transport sector in the Baltic countries — Lithuania, Latvia, and Estonia — exhibits several key features that influence its operations and development. These countries, located in a geographically strategic position between East and West, leverage their location to become a significant European air transport hub. The Baltic countries are well-positioned to act as a bridge between Eastern Europe, Scandinavia, and other Western European countries, facilitating the development of both passenger and cargo air transport services.

The Baltic States have a single national carrier, A/S Air Baltic Corporation, which, according to the Lat-

Tab. 2. Impact of the September 11 attacks, the 2008 Great Economic Crisis, and the COVID-19 pandemic on the air transport sector

| | September 11 attacks (2000–2001) | 2008 Great Economic Crisis (2008–2009) | COVID-19 pandemic (2019–2020) |
|---|---|---|---|
| RPKs | - 2.9 proc. | -1.2 proc. | - 65.9 proc. |
| Yield | - 6.4 proc. | - 16.5 proc. | - 55.6 proc. |
| Flights | 1.1 proc. | -1.3 proc. | - 39.9 proc |
| Profit fluctuation | - USD 12.2 billion | - USD 40.8 billion | - USD152.8 billion |

Source: author's elaboration on the basis of (International Air Transport Association, 2021).

vian Ministry of Transport, substantially influences the region's air transport sector. Therefore, it is essential to assess this key player's RPK and ASK (Fig. 1).

The graph and accompanying data clearly illustrate the performance of A/S Air Baltic Corporation during the period from 2019 to 2023, particularly in terms of ASK and RPK indicators. The example of A/S Air Baltic Corporation from 2019 to 2023 demonstrates the dramatic impact of the COVID-19 pandemic on the air transport industry, followed by a resilient recovery phase. The initial sharp decline in ASK and RPK in 2020 highlighted the immediate impact of the pandemic. In the subsequent years, a steady recovery was observed, with strategic increases in capacity ASK and a stronger rebound in demand (RPK).

IFR is another indicator that vividly reflects the situation of the Baltic air transport sector and can be used to assess the sector's resilience and recovery post-crisis (Fig. 2).

The chart reflects the impact of the pandemic on air transport in the Baltic region, followed by a recovery period from 2021 to 2023. The nearly parallel movement of departures and arrivals throughout the years also indicates that the volume of incoming and outgoing air traffic in the Baltic countries remains consistent over time.

The Baltic air transport sector is intrinsically linked with continuous digitisation and the integration of advanced technologies, which are essential for enhancing operational efficiency and providing high-

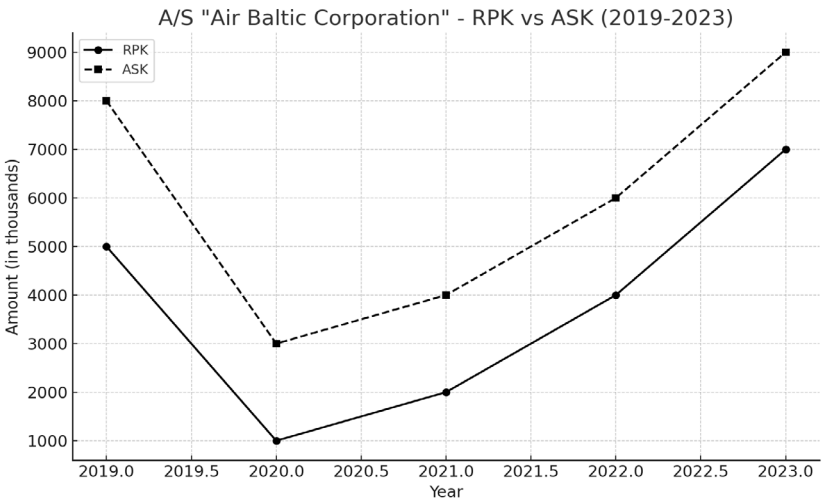
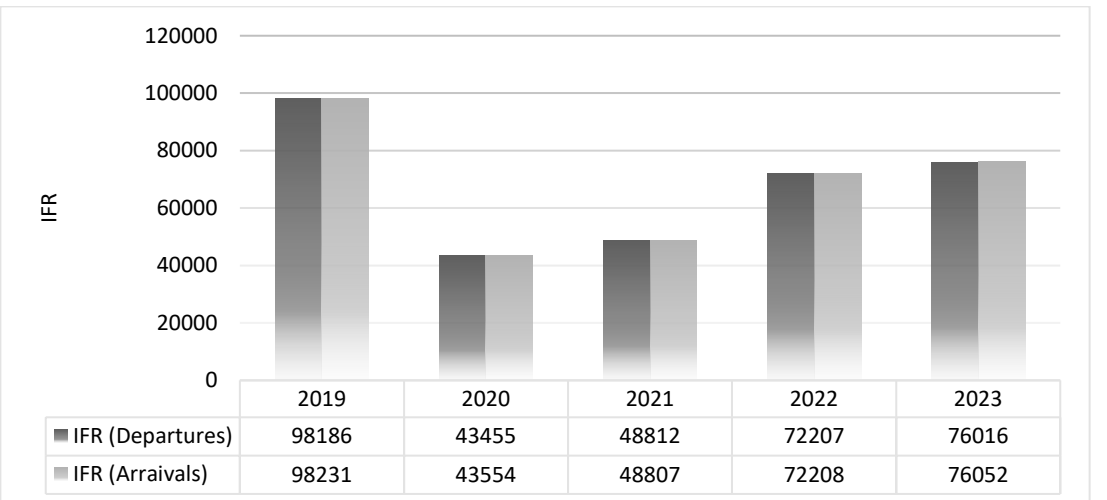



Fig. 1. Dynamics of RPKs and ASKs of Air Baltic airlines

Source: author's elaboration on the basis of Air Baltic, 2020; Air Baltic, 2021; Air Baltic, 2022; Air Baltic, 2023).




| | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|
| IFR (Departures) | 98186 | 43455 | 48812 | 72207 | 76016 |
| IFR (Arraivals) | 98231 | 43554 | 48807 | 72208 | 76052 |

Fig. 2. Baltic air traffic movements by instrument

Source: author's elaboration on the basis of (Aviation Intelligence Unit Portal, 2024).

quality services. Investments in smart technologies such as artificial intelligence, big data analytics, and blockchain are crucial for fostering innovation and ensuring competitiveness.

Riivo Tuvike, the CEO of Tallinn Airport, stated that the unique challenges faced by the aviation industry in recent years have underscored the need to focus more on increasing non-aviation revenues. Over-reliance on aviation income poses a vulnerability risk. As a small airport on the periphery of Europe with a small population and significant pressure from airlines, the scope for increasing aviation revenues is limited. Boosting non-aviation revenues is essential (Tuvike, 2023) to safeguard the aviation business. According to Riga Airport's financial report for the first half of 2023, revenues from non-aviation services increased by 60 per cent compared to the first half of 2022, indicating a high demand for non-aviation services.

The Baltic air transport sector currently prioritises infrastructure development and non-aviation services to achieve greater resilience to economic fluctuations. However, more investments in digitisation and advanced technologies are necessary to make the sector more competitive and efficient in the future.

## 2. Research methods

Based on the analysis of scientific literature, the following key evaluation indicators have been identified to assess the resilience of the air transport sector: RPK, which indicates actual air transport demand, ASK, IFR movements, and employment (EMP).

To evaluate the resilience of the Baltic air transport sector to economic crises, an empirical study was conducted using the Pearson correlation coefficient, multi-criteria evaluation (SAW and TOPSIS), and exponential smoothing methods. The following structural units were chosen for the assessment: airports, air carriers, and air traffic.

### 2.1. Pearson correlation coefficient

The Pearson correlation coefficient measures the linear relationship between two variables.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y)^2 - (\sum y)^2]}} \quad (1)$$

Here: r is the correlation coefficient; n is the number of data pairs; ∑xy is the sum of the product of the two variables; ∑x is the sum of the values of the first variable; ∑y is the sum of the values of the second variable; $\sum x^2$ is the sum of the squares of the values of the first variable; $\sum y^2$ is the sum of the squares of the values of the second variable.

The purpose of the Pearson correlation coefficient is to determine the relationship between the RPK and ASK data of "Air Baltic", the sole national airline in the Baltic countries, which is particularly important for assessing the recovery of the air transport sector after the COVID-19 pandemic.

### 2.2. SAW Method

SAW method calculates the sum Sj of the weighted normalised values of all indicators for each j-th object (alternative).

$$S_j = \sum_{i=1}^{m} w_i \bar{r}_{ij} \quad (2)$$

here: $w_i$ is the weight of the of the i– th indicator; $\bar{r}_{ij}$ — the normalised value of the i-th indicator for the j-th object. The initial data, if the criterion is minimising, is normalised according to the formula:

$$\bar{r}_{ij} = \frac{\min\limits_j r_{ij}}{r_{ij}} \quad (3)$$

here: $\bar{r}_{ij}$ — the value of the i-th criterion for the j-th alternative.

If the criterion is maximising, it is normalised according to the formula:

$$\bar{r}_{ij} = \frac{r_{ij}}{\max\limits_j r_{ij}} \quad (4)$$

### 2.3. TOPSIS Method

TOPSIS method calculates the distance from the ideal negative and ideal positive solutions. Since equal weights are assigned to all criteria, the first step involves normalising the matrix according to the formula:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (5)$$

Next, we calculate the weighted matrix using the formula:

$$v_{ij} = w_j n_{ij} \ for\ i = 1, \dots, m; j = 1, \dots, n, \quad (6)$$

here: $w_j$ — is the weight of criterion j.

The next step is to calculate the ideal positive and ideal negative solutions using the formula:

$$V^{+} = (v_1^{+}, v_2^{+}, \dots, v_n^{+}) = \left( \left( \max_i v_{ij} \middle| j \in I \right), \left( \min_i v_{ij} \middle| j \in J \right) \right); \quad (7)$$

$$V^{-} = (v_1^{-}, v_2^{-}, \dots, v_n^{-}) = \left( \left( \min_i v_{ij} \middle| j \in I \right), \left( \max_i v_{ij} \middle| j \in J \right) \right), \quad (8)$$

Where I is identified with the maximising criterion and J with the minimising criterion, i = 1, ... m; j = 1, ... , n.

The distances between the ideal positive and ideal negative solution are then calculated using the formula:

$$S_i^{+} = \sqrt{\sum_{j=1}^{n} \left( v_{ij} - v_i^{+} \right)^2}, \ i = 1, 2, \dots, m; \quad (9)$$

$$S_i^{-} = \sqrt{\sum_{j=1}^{n} \left( v_{ij} - v_i^{-} \right)^2}, \ i = 1, 2, \dots, m. \quad (10)$$

The relative closeness to the ideal positive solution is then calculated using the formula:

$$P_i = \frac{S_i^{-}}{S_i^{-} + S_i^{+}}. \quad (11)$$

The final step involves ranking the objects under investigation.

The objective of the multi-criteria assessment is to develop a coherent framework of indicators and apply it practically to evaluate the resilience of the Baltic air transport sector to economic crises.

Exponential Smoothing Method

The exponential smoothing method is employed for time series forecasting.

$$S_t = \alpha x_t + (1 - \alpha) S_{t-1} \quad (12)$$

Here: St is the smoothed data point at time t; α is the smoothing factor between 0 and 1; Yt is the true data point at time t; $1S_{t-1}$ is the previous smoothed data point.

The percentage change for each year is then determined in order to objectively assess and represent the rate of change.

The exponential smoothing method aims to identify future projections for the Baltic air transport sector, the analysis of which would allow the sector to be assessed for its resilience to economic crises.

## 3. Research results

Based on the literature analysis, the following key indicators have been identified to assess the resilience of the Baltic air transport sector to economic crises: RPK, ASK, IFR, and EMP.

The Pearson correlation coefficient is used to determine the relationship between RPK and ASK. Since the Baltic countries have only one national airline, "Air Baltic", which is based in Latvia, only the data from this airline are evaluated. The correlation coefficient between RPK and ASK is close to 1, indicating a very strong relationship between the analysed data. This means that as one variable increases or decreases, the other variable tends to increase or decrease at a very similar rate. This result demonstrates that "Air Baltic" effectively converts available seat capacity into revenue, indicating profitable operations. It also reflects a good pricing strategy and efficient route management, with destinations that meet consumer expectations. It is evident that the company is successfully handling the external factors induced by the COVID-19 pandemic.

The chosen multi-criteria SAW method calculates the assessment score by adding the normalised values of the criteria multiplied by their weights. It is assumed that all indicators are equally important and equal weights are assigned. All values are maximising. The results obtained using the SAW method are as follows (Table 3).

The results indicate that the year 2019 had the highest overall score. However, 2023 shows the highest results in almost all areas, with the RPK indicator being particularly high, suggesting that the demand for flights has returned to pre-pandemic levels. 2023 is identified as a year of recovery for the air transport sector. The TOPSIS method was also applied to ensure objectivity and a more accurate evaluation (Table 4).

The TOPSIS method calculates the distance to the ideal point, and according to this method, the year 2023 is closest to the ideal point. This indicates that the air transport sector performed successfully this year.

Both the SAW and TOPSIS methods show that 2020 was the most challenging year for the air transport sector due to the pandemic. However, by 2023, the sector had recovered and, according to some indicators, even surpassed pre-pandemic levels.

Using the SAW and TOPSIS methods, the years have been ranked to demonstrate the pace of recovery after COVID-19 (Fig. 3).

The study conducted using the SAW and TOPSIS methods allows for a systematic evaluation of the impact of different indicators on the overall air transport sector. Although some individual indicators show that the results for 2023 exceed those of 2019, when the years are ranked according to both meth-

Tab. 3. Results obtained by the SAW method for each indicator separately

| Year | RPK | ASK | EMP | IFR Departures | IFR Arrivals |
|---|---|---|---|---|---|
| **2019** | 0.284 | 0.260 | 0.208 | 0.290 | 0.290 |
| **2020** | 0.072 | 0.098 | 0.160 | 0.128 | 0.129 |
| **2021** | 0.107 | 0.139 | 0.174 | 0.144 | 0.144 |
| **2022** | 0.223 | 0.218 | 0.218 | 0.213 | 0.213 |
| **2023** | 0.314 | 0.284 | 0.240 | 0.224 | 0.224 |

Tab. 4. Assessing the resilience of the Baltic air transport sector to economic crises using TOPSIS

| Year | RPK | ASK | EMP | IFR Departures | IFR Arrivals |
|---|---|---|---|---|---|
| **2019** | 0.876 | 0.871 | 0.594 | 1.000 | 1.000 |
| **2020** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2021** | 0.145 | 0.224 | 0.181 | 0.098 | 0.096 |
| **2022** | 0.625 | 0.645 | 0.722 | 0.525 | 0.524 |
| **2023** | 1.000 | 1.000 | 1.000 | 0.595 | 0.594 |

Tab. 5. Projected realistic scenario

| | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|
| **RPK** | 6025.22 | 6932.2 | 7513.13 | 8150.55 |
| **ASK** | 7986.53 | 8983.9 | 9632.18 | 10340.14 |
| **Employment** | 5759.40 | 6188.76 | 6523.27 | 6874.39 |
| **IFR (Departures)** | 69983.88 | 74186.61 | 74116.13 | 74746.16 |
| **IFR (Arrivals)** | 69992.5 | 74184.59 | 74104.29 | 74724.5 |

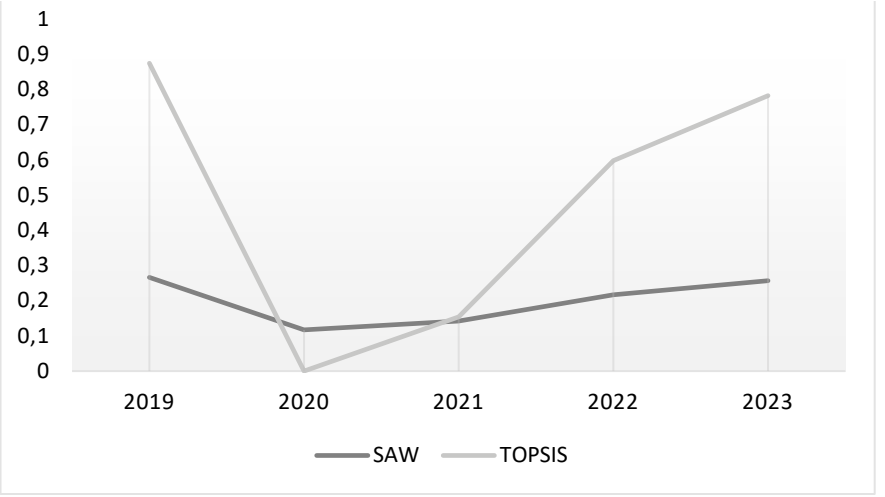



Fig. 3. Recovery rates after COVID-19

ods, 2019 still remains higher, indicating that the Baltic air transport sector has not yet returned to pre-pandemic levels in 2023.

The evaluation reveals a clear recovery following the economic crisis of 2020, indicating that the sector is moving in the right direction. Based on the obtained scores, the Baltic air transport sector should continue to monitor and analyse which operational areas contributed most to this success and adapt their strategies to remain resilient against future economic crises.

The following realistic scenario was obtained using the exponential smoothing method for forecast calculations (Table 5).

To further evaluate and objectively represent growth rates, the percentage change in the forecast was calculated (Fig. 4).


Fig. 4. Annual percentage change in the forecast

The Baltic air transport sector is implementing a growth strategy by increasing the number of passengers and available seat capacity. Such positive growth figures may indicate an optimistic market development scenario. Rising ASK and RPK values require careful management of operational capabilities to maintain optimal seat occupancy levels and avoid excess seat capacity.

The increasing number of employees indicates that the sector is investing in human resources. However, it is important to ensure that the growth in the workforce aligns with demand and does not exceed the necessary efficiency levels. Forecasts of IFR data suggest that the sector anticipates stability in its international flights. This could be a strategic decision that should be analysed considering market trends, competition, and geopolitical factors.

## 4. Discussion of the results

The assessment of the resilience of the Baltic air transport sector to economic crises aligns with findings from previous studies on the resilience of air transport systems. Resilience, as highlighted by Martin et al. (2015), encompasses the ability to recover and the capacity to adapt and thrive in new realities. Our study confirms this by showing that the Baltic air transport sector has implemented strategies focusing on both aviation and non-aviation services, echoing similar findings by Cook et al. (2023), who emphasised the role of diversification in strengthening sector resilience.

The recovery patterns identified in this study, particularly the strong correlation between RPK and ASK indicators, are consistent with observations by Gabriel Bae et al. (2021), highlighting the importance of effective supply-demand management in enhancing operational efficiency during crises. Moreover, this study's results regarding the increasing emphasis on infrastructure development and direct flights align with Su et al. (2023), who identified similar trends in global air transport recovery post-COVID-19.

The role of sustainability in resilience, as evidenced by the integration of non-aviation services in the Baltic air transport sector, supports the conclusions of Burbidge (2023), who argued that sustainability and resilience are closely interconnected. This study also confirms the findings of Zhong et al. (2024), who emphasised that sustainable practices mitigate economic shocks and enhance adaptability to future crises.

A comparison with Eurocontrol studies reveals parallels in recovery timelines across different crises. For instance, the recovery period observed for the Baltic sector post-COVID-19 mirrors the 1.5-year recovery after the September 11 attacks, as noted by Statfor (2020). However, the economic impact of COVID-19, as shown by the steep decline in RPK (-65.9 %), far exceeds that of previous crises, consistent with findings by the (IATA, 2021).

In terms of methodological contributions, the offered application of multi-criteria evaluation (SAW and TOPSIS) and exponential smoothing methods allows for a structured approach to resilience assessment, aligning with suggestions by Wang et al. (2023) to develop comprehensive quantitative metrics for resilience analysis. These methods, combined with the use of the Pearson correlation coefficients, provide a robust framework for assessing the interconnectedness of key indicators such as RPK, ASK, and EMP.

The importance of non-aviation services as a resilience factor is also consistent with recent trends observed in airport cities, as discussed by Bergantino (2024). This shift towards revenue diversification reflects a global pattern, where airports increasingly rely on retail, parking, and real estate to offset aviation revenue fluctuations.

While this study demonstrates the Baltic air transport sector's progress in recovering from the COVID-19 pandemic, it also underscores the need for further advancements in digitalisation and smart technologies. These findings align with findings by Bakreen et al. (2022), who emphasised the importance of technological innovation in maintaining competitiveness and resilience in air transport.

In summary, this study contributes to the broader understanding of resilience by confirming and expanding upon previous research. The integration of findings from other studies strengthens the argument that resilience is a multidimensional concept, requiring coordinated efforts in sustainability, diversification, and adaptability. Future research should explore the long-term effects of resilience strategies and the role of global interconnectedness in shaping recovery patterns.

## Conclusions

The assessment of the resilience of the Baltic air transport sector to economic crises has shown that the sector is transitioning to a new development phase, where the expansion of aviation services alone does not ensure resilience under economic uncertainty. The COVID-19 pandemic demonstrated that offering only aviation services is insufficient for this sector, necessitating a broader spectrum of services. This approach makes air transport businesses more consumer-oriented, attractive to investors and ensures greater stability in uncertain conditions.

A scientific analysis of the resilience of the Baltic air transport sector to economic crises identified key indicators RPK, ASK, EMP, and IFR, which were used to evaluate the sector's performance. The study results showed a strong correlation between RPK and ASK, indicating that Latvia's sole national airline, "Air Baltic", effectively converts available seats into revenue. This is an important indicator that confirms the company's operations are profitable and meet market needs.

The multi-criteria SAW analysis allowed for the examination and comparison of each year's performance based on the mentioned indicators, identifying that 2023 was particularly successful for the air transport sector, and the challenges faced during the pandemic were successfully overcome. This indicates that the sector not only withstood the impact of the COVID-19 crisis but also managed to recover efficiently, which is crucial for sustainable future development.

The TOPSIS method, which evaluates the ideal point, also confirmed that 2023 was the closest to the ideal scenario, demonstrating the best level of sector resilience and effectiveness during the analysed period. These results indicate that the sector can adapt to changing conditions and manage resources efficiently.

The Baltic air transport sector shows that sustainability and resilience to economic crises are closely linked. By integrating sustainability strategies into its operations, the sector successfully withstands economic shocks.

By developing non-aviation services, the sector diversifies its activities, reducing dependency on the cyclicality of aviation and increasing revenue stability.

This study demonstrates that the Baltic air transport sector is on the right track towards achieving sustainability and resilience to economic challenges. However, it is necessary to continue strengthening the technological base and expanding the range of services to ensure the sector's long-term success from a practical point of view.

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