FACTORS OF INFLUENCE AND SUPPORT FOR INCREASING EFFICIENCY OF AIR TRANSPORT LOGISTICS BEFORE AND AFTER COVID-19

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Abstract. Spreading of the COVID-19 pandemic caused a profound and long-lasting negative impact on the dynamics of air transportation of passengers and cargo, despite the priority role of aviation companies in the global economy. The pandemic also negatively affected the efficiency of air transport logistics, which necessitated a more in-depth analysis of the factors of influence on changes in its level. The study reveals a methodological approach that allows to make a sound assessment of internal and external factors of influence and, based on its results, to develop a system of organizational and economic solutions for improving the efficiency of air transport logistics. In the context of the above, the advantages of using the integral indicators method for analysing the efficiency of aviation companies logistics are clarified. Based on the methods of selective observation and calculation of the system of relative and average values of changes in basic indicators, global trends in the development of aviation commerce are summarized and aviation companies that occupy leading positions in the provision of air transportation of passengers and cargo are identified. By synthesizing the methods of integral and point evaluation, the influence of sub-factors of external and internal logistics efficiency of the world's leading aviation companies for passenger transportation in the periods before and after COVID-19 was analysed. It was found that the aviation industry has fully recovered after spreading of the COVID-19 pandemic in terms of dynamics and efficiency of air transport logistics. As proposals based on the research results, a system of goals, influencing factors and resource provision for increasing the efficiency of air transport logistics in the post-COVID period was specified.

Keywords: logistics, air transportation, efficiency, global economy.

Introduction

Air transport has become one of the sectors affected by spreading of the COVID-19 pandemic. Research data on the use of air transport shows a significant negative impact of the pandemic on its passenger and cargo traffic globally, as well as on the reduced demand for new aircraft production during this period. For example, in 2020-2021, passenger traffic was 57-74% and cargo traffic 84-97% lower than in 2019 [1]. Only in 2024 that airlines reached the level of technical and economic indicators that corresponded to the pre-pandemic period. This indicates the lingering impact of the COVID-19 pandemic, which has posed a challenge to the air transport industry.

Studies have shown that the impact of the COVID-19 pandemic has significantly contributed to the growth of interest in transport logistics [2-4], the key tasks of which are a more accurate assessment of the revenues generated by supply chains and the efficiency of logistics management [5] and meeting strategic development objectives [6]. This is especially true for air transport companies, whose managers often resort to strategies that reduce the cost of logistics services and increase profitability in order to improve logistics efficiency. However, it is difficult to do this without a proper analysis of the trends in the air transport companies' market and analysis of the factors influencing the efficiency of their logistics. In addition, the implementation of strategies can have a short-term effect and lead to the development of organisational, economic and technical solutions to improve the efficiency of air transport logistics.

The analysis of factors affecting the success of air transport companies during the COVID-19 pandemic has been carried out in a number of modern studies [7-8], where a special place is given to the analysis of logistics factors. They are considered in the context of the impact of customer satisfaction with airline services, the impact of operational factors, information exchange factors, and effective cargo logistics management. However, the authors pay insufficient attention to solving the problem of comparative assessment of the efficiency of air transport logistics before and after COVID-19. This is important because, firstly, it allows determining the decisive factors influencing the efficiency of air cargo logistics in the pre-COVID period and, secondly, to clarify the system of goals, factors of influence and ensuring the improvement of the efficiency of air cargo logistics in the post-COVID period. Logistics efficiency can create additional effects, in particular, affect the value of the airline and ensure more sustainable financial results [9]. Along with the above, the use of the methodology of interpretive structural modelling in the analysis of logistics processes [10] allows clarifying the sub-

factors that form the internal efficiency of logistics, and the architecture used to build a process approach to its evaluation [11] allows clarifying the target orientation of the research results. Explanation of the effectiveness of results-based logistics, which interprets the factors of goal alignment, was discussed in [12].

A critical analysis of the scientific publications of scientists on the subject allows us to identify the following reasons that necessitate an in-depth study of the factors of influence and ensuring the efficiency of air transport logistics before and after COVID-19:

- possible recurrence of pandemics and the emergence of similar conditions and consequences of their spread;
- the growing role of air transport logistics in the global economy and in the development of strategic development plans for companies;
- priority use of air transport for the carriage of passengers and cargo;
- obtaining additional effects of logistics efficiency.

Given the lack of research on the factors of influence and ensuring the efficiency of air transport logistics before and after COVID-19, the paper develops a methodological approach that allows for a reasonable assessment of internal and external factors of influence. Basing on the results, it develops a system of organisational, economic and technical solutions to improve the efficiency of air transport logistics.

Materials and methods

The study uses a wide range of data and scientific methods, which together provide data for decision-making to reduce the negative impact of pandemics on the efficiency of air transport logistics in the world. The sources of data for analysing the logistics efficiency of global air transport companies are the indicators of the World Bank, the International Civil Aviation Organisation (ICAO), as well as the financial statements of global airlines for the period 2018-2023.

The process of studying the factors of the influence and ensuring the efficiency of air transport logistics is shown in Figure 1.

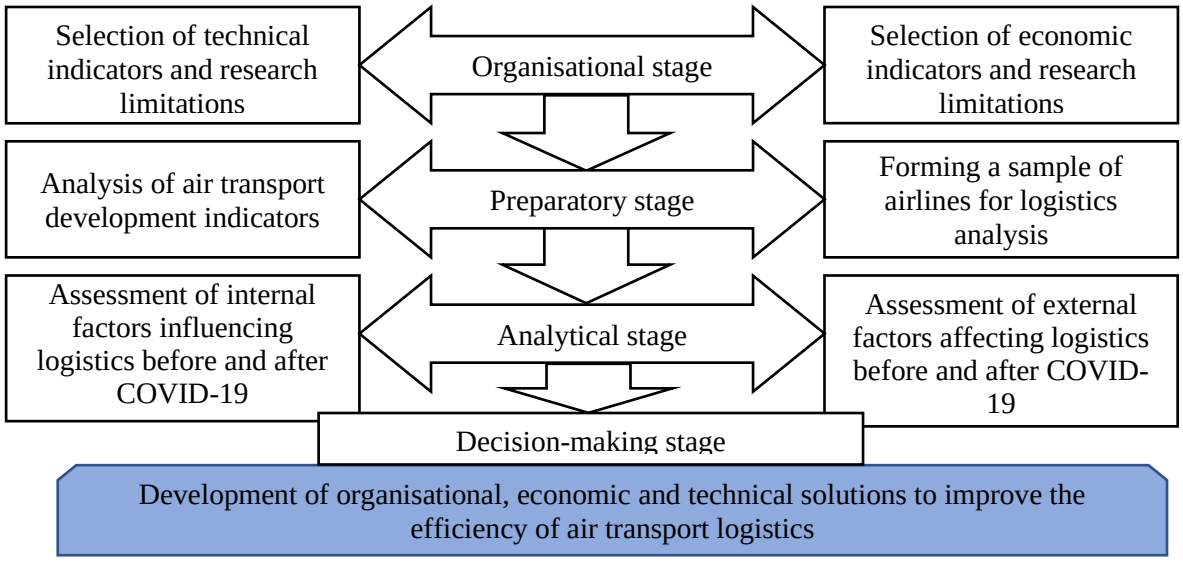

Fig. 1. **Process of implementing a methodological approach to assessing the factors of influence and decision-making to improve the efficiency of air transport logistics in the world**

For further research, based on the method of selective observation, a part of the general population of airline companies is determined, which is characterised by the maximum indicators in terms of passenger and cargo transportation. At the stage of generalisation of the world trends in the development of air transportation of passengers and cargo, the system of relative and average values of changes in the basic indicators - the volume of passenger and cargo transportation, taking into account the distance of their transportation - is used.

To evaluate the impact of factors on the efficiency of airline logistics, the article uses the method of integral indicators, which makes it possible to eliminate ambiguity in assessing the impact of sub-factors that form its components, to provide an integrated assessment and the possibility of comparing related research objects, high accuracy of the results obtained, and the possibility of forecasting the state of logistics in the future. This method involves assessing two components of logistics efficiency: external and internal. For a comparative assessment of the impact of external sub-factors on the logistics efficiency of airline companies, we will use the External Logistics Performance Index (ExtLPI), which includes the following sub-factors: customs clearance efficiency (ExtLPI1); infrastructure efficiency (ExtLPI2); level of transportation at optimal prices (ExtLPI3); logistics competence (ExtLPI4); flight tracking capability (ExtLPI5); and the degree of timeliness of passenger delivery (ExtLPI6). The methodology for calculating this index is based on the Logistics Performance Index Methodology [13-14]. For a comparative assessment of the impact of internal factors on the logistics efficiency of airline companies, we will use the Internal Logistics Performance Index (IntLPI), whose sub-factors are supply subsystem efficiency (IntLPI1); passenger support subsystem efficiency (IntLPI2); distribution subsystem efficiency (IntLPI3); inventory management subsystem efficiency (IntLPI4); transportation subsystem efficiency (IntLPI5); warehousing subsystem efficiency (IntLPI6), where, along with economic indicators, a system of technical indicators is also assessed [15]. For each of the sub-factors, a scoring assessment is applied according to the methods [13-15], which allows to evaluate indicators in the range from 1 to 5 points, based on the obtained values and the evaluation scale, which is applied taking into account the trends in the values of indicators.

The influence of logistics efficiency on the prospects for the development of the world's largest aviation companies is determined by the methods of information-logical analysis based on the results of assessing the impact of external and internal sub-factors on the efficiency of their logistics.

The application of a problem-target approach based on the principles of target orientation, complexity, efficiency, targeting and priority is the basis for further clarification of goals and ensuring improvement of logistics efficiency of aviation companies. The use of a systematic approach aimed at integrating innovation and logistics flows, ensuring synchronisation of logistics processes of production and implementation of innovations on an ongoing basis, determining possible changes in the positioning of aviation services is the basis for improving the system of organisation of logistics support for the development of aviation companies in the world.

The existing limitations of the proposed methodological approach include significant labour intensity of collecting statistical information; constant change of the sample of airlines for logistics analysis, which is due to the dynamics of their technical and economic indicators; ambiguity in assessing the impact of sub-factors that form the components of the method of integral indicators.

Results and discussion

The presented data on the dynamics of selected technical and economic indicators of air transport development in the global economy indicate a significant impact of the COVID-19 pandemic on the studied processes (Table 1).

Table 1

Technical and economic indicators of air transport development in the world [1]

Indicators	2018	2019	2020	2021	2022	2023
Commercial flights, millions	38.1	37.5	19.7	24.2	29.0	35.7
Aircraft deliveries	1832	1432	820	1054	1246	1390
Segment passengers, millions	4338	4487	1781	2285	3262	4439
Global air passenger traffic, billion passengers-kilometers	8276	8659	2961	3628	5889	8168
Segment cargo, freight millions tonne	59.9	58.8	49.5	57.0	56.5	61.4
Global air freight traffic, billion tonne kilometers	239.6	234.0	193.8	233.1	220.2	216.1

In particular, in 2020-2021, the lag compared to 2019 is 35-48% for commercial flights, 26-43% for aircraft deliveries, 49-60% for passengers, and 3-16% for cargo. Using the method of relative and average values of changes in the studied basic indicators, it was found that in 2018-2023, the average annual growth in passenger traffic by air in the world was 10.5%, while the average annual growth in cargo traffic was only 1.06%.

The unstable dynamics of air transportation indicators in the world, losses in the pre-covid period and a decrease in the revenues of airline companies in the post-covid period [1] require optimisation of logistics costs, which is an additional source of growth in their profitability, and analysis of the factors that will ensure an increase in the efficiency of logistics of airline companies.

When forming the sample of global airlines for further research, those with the highest passenger (in billion passenger-kilometres) and cargo (in billion tonne kilometres) volumes as of 2023 were selected. In the passenger segment, the leading companies include American Airlines (USA), United Airlines (USA), Delta Air Lines (USA), Air France-KLM (France), Emirates (UAE), International Airlines Group (UK/Spain), Lufthansa Group (Germany), Southwest Airlines (USA), Turkish Airlines (Turkey), and Qatar Airways (Qatar); in the segment of cargo transportation - Federal Express (USA), Qatar Airways (Qatar), United Parcel Service (USA), Emirates (UAE), Atlas Air (USA), Korean Air (South Korea), Turkish Airlines (Turkey), Cathay Pacific Airways (Hong Kong), China Southern Airlines (China), Cargolux (Luxembourg). It is determined that the share of airline companies in the total population in terms of passenger traffic is 40.62%, while in terms of cargo traffic - 45.01%. Let us assess the impact of external and internal factors on the logistics efficiency of airline companies engaged in passenger transportation.

The results of the assessment of the impact of external sub-factors on the efficiency of logistics of airline companies engaged in passenger transportation are summarised in Table 2.

Table 2

Comparative assessment of the impact of external sub-factors on the efficiency of logistics of airline companies for transportation of passengers in 2023 to 2018

Companies	ExtLPI1 (2023/ 2018)	ExtLPI2 (2023/ 2018)	ExtLPI3 (2023/ 2018)	ExtLPI4 (2023/ 2018)	ExtLPI5 (2023/ 2018)	ExtLPI6 (2023/ 2018)	ExtLPI (2023/ 2018)
American Airlines, United Airlines, Delta Air Lines, Southwest Airlines	3.70/3.76	3.90/4.10	3.40/3.54	3.90/3.93	3.80/4.14	4.20/4.13	3.80/3.92
Air France–KLM	3.70/3.63	3.80/4.00	3.70/3.60	3.80/3.82	4.10/4.17	4.00/3.99	3.90/3.86
Emirates	3.70/3.66	4.10/3.98	3.80/3.76	4.00/3.83	4.20/4.23	4.10/3.89	4.00/3.89
International Airlines Group	3.50/3.85	3.70/4.09	3.50/3.69	3.70/4.04	3.70/4.32	4.00/4.10	3.70/4.01
Lufthansa	3.90/4.09	4.30/4.38	3.70/3.83	4.20/4.26	4.10/4.40	4.20/4.22	4.10/4.19
Turkish Airlines	3.00/2.94	3.40/3.36	3.40/3.19	3.50/3.23	3.60/3.68	3.50/3.37	3.40/3.29
Qatar Airways	3.10/3.18	3.80/3.43	3.10/3.62	3.90/3.46	3.50/3.78	3.60/3.53	3.50/3.50

A comparative assessment of the impact of external sub-factors on the efficiency of airline passenger logistics shows that the best ExtLPI values are for Lufthansa (4.10 in the post-COVID period and 4.19 before the spread of COVID-19), whose high value is formed by high ExtLPI4, ExtLPI5, ExtLPI6. For other companies, it has worse values: Emirates (4.00/3.89), Air France-KLM (3.90/3.86), American Airlines, Delta Air Lines, United Airlines, Southwest Airlines (3.80/3.92), International Airlines Group (3.70/4.01), Qatar Airways (3.50/3.50), Turkish Airlines (3.40/3.29). For almost all of the companies studied, with the exception of Qatar Airways and Turkish Airlines, the most influential sub-factor on external logistics efficiency is a high ExtLPI6. Based on the results of the research, we can state that the simultaneous positive impact of many external sub-factors forms a significant increase in the companies' ExtLPI.

The results of the assessment of the impact of internal sub-factors on the logistics efficiency of airline companies for transportation of passengers are summarised in Table 3.

Table 3

Comparative assessment of the impact of internal sub-factors on the efficiency of airline companies' logistics for passenger transportation in 2023 to 2018

Companies	IntLPI1 (2023/ 2018)	IntLPI2 (2023/ 2018)	IntLPI3 (2023/ 2018)	IntLPI4 (2023/ 2018)	IntLPI5 (2023/ 2018)	IntLPI6 (2023/ 2018)	IntLPI (2023/ 2018)
American Airlines	4.00/4.10	3.99/4.09	2.77/2.63	2.00/1.58	1.97/1.59	3.24/3.33	3.01/2.72
United Airlines	4.03/4.18	3.95/3.92	2.45/2.50	3.01/2.76	2.30/2.17	3.55/3.46	3.31/3.17
Delta Air Lines	4.10/4.28	4.25/4.31	3.15/3.25	4.00/3.96	3.82/3.36	3.90/3.72	3.97/3.81
Air France–KLM	3.92/3.00	2.20/2.10	2.04/1.50	3.11/2.96	3.13/2.80	2.15/2.17	2.98/2.25
Emirates	3.85/3.82	2.26/2.03	3.87/4.00	2.66/2.42	1.56/0.70	3.92/4.11	3.00/2.85
International Airlines Group	4.01/4.12	2.50/2.05	2.43/2.13	3.80/3.82	2.11/1.57	3.20/2.82	3.12/2.55
Lufthansa	4.10/4.07	3.55/3.65	4.00/3.88	2.44/2.30	2.12/1.98	2.70/2.86	3.20/3.12
Southwest Airlines	4.05/4.17	4.00/3.93	1.20/0.50	2.50/2.90	4.03/4.27	3.20/3.15	3.28/3.15
Turkish Airlines	3.35/2.88	3.00/2.26	2.33/1.75	2.90/2.80	2.00/2.07	2.92/2.90	2.78/2.22
Qatar Airways	3.83/3.00	2.81/2.29	2.22/2.13	2.79/2.67	3.02/2.84	3.20/3.26	2.78/2.48

It was found that the impact of IntLPI sub-factors is more negative compared to ExtLPI, except for the efficiency of the supply subsystem. Delta Air Lines has the best values of the index, with all sub-factor impacts being relatively balanced, but more attention should be paid to increasing the share of countries covered by passenger traffic. Southwest Airlines should also pay attention to distribution issues. The relatively low values of the transport profitability indicators for United Airlines and Lufthansa result in a decrease in the efficiency of their logistics. Emirates' low performance is offset by its impeccable reputation in the airline market and its extensive coverage, which will help improve its low profitability in the future. It is worth noting that all airlines have improved their internal logistics efficiency, which has contributed to the successful overcoming of the negative impact of the COVID-19 pandemic on their operations.

The use of information and logic analysis allows comparing the ExtLPI and IntLPI values of the world's leading airlines and indicates a more favourable impact of external sub-factors of logistics efficiency, which form a favourable environment and good prospects for the development of aviation commerce. It should also be noted that the world's airlines engaged in passenger transportation have significant reserves for improving internal logistics efficiency.

The problems identified as a result of the study of the impact of logistics efficiency sub-factors indicate the expediency of adjusting the goals of logistics management, as the latter are often attributed to the logistics of cargo transportation, without paying due attention to the logistics of passenger transportation.

For global airlines, which are leaders in terms of passenger traffic, the development of solutions to improve logistics efficiency is a matter of debate. After all, constant changes in the internal and external environment inherent in the logistics activities of aviation companies make their logistics management techniques individual and limited in reuse. This requires managers to monitor the logistics environment of aviation commerce, pointing to the importance of constantly searching for new universal approaches to solving logistics problems. At the same time, the emergence of efficiency problems and logistics goals for aviation companies have the same plane, so it is possible to apply a problem-targeted approach based on the principles of target orientation, complexity, efficiency, targeting and priority. Such an approach will ensure the simultaneous development of goal subsystems, clarification of key factors of influence and improvement of resource provision through the adoption of organisational, economic and technical decisions to improve logistics efficiency.

The overall goal of logistics efficiency management is to ensure cost optimisation, which is especially relevant today, given the importance of taking into account the negative effects of the spread of COVID-19 and improving the development of air transport.

Therefore, the subsystem of goals to be achieved by aviation companies to improve logistics efficiency should include: exploring opportunities to increase the level of passenger load on aircraft, using the latest equipment and modern technologies for repair and renewal of aircraft and their navigation equipment, optimising transport routes, entering new markets in countries requiring aviation services, avoiding excessive stocks of aviation fuel and aircraft spare parts in order to rationalise the use of warehouse space. To avoid losses, information technologies for risk management of logistics systems should be used, which have proven their effectiveness [16].

The subsystem of influence factors should be aimed at ensuring timely response to the environment of direct influence (political and economic situation in the world, changes in fuel prices, response to spread of pandemics), improving management processes (increasing the competitiveness of airlines), continuous monitoring of the internal logistics environment and its subsystems (improving the logistics management mechanism).

The resource provision subsystem should include optimising the availability of all types of resources to the required extent and their efficient use, developing ways to increase the profitability of transportation, efficient use of funds that should be used to upgrade the aircraft fleet, timely provision of relevant and reliable information, advanced training of pilots and maintenance personnel, and engagement of specialists from various fields to develop and make optimal decisions.

Conclusions

1. The spread of COVID-19 has become an unprecedented challenge for many industries, including the global air transport sector, which has experienced the largest drop in its history. One of the key ways to restore its growth is to improve the efficiency of airline logistics.
2. The recovery of air transport is much faster in the passenger sector than in the cargo sector, despite its significant reduction (by 49-60%) compared to cargo transportation (3-16%). It has been determined that this is achieved due to the stimulating impact of internal and external factors of logistics efficiency of airline companies.
3. The impact of factors on the efficiency of air cargo logistics allows us to highlight the differences in performance before and after COVID-19. In particular, the analysis of external subfactors in the post-COVID period shows that they lagged behind the pre-COVID period in 80% of cases. In comparison, the lag for internal subfactors was recorded in 35% of cases. A comparative assessment of the impact of external sub-factors on the efficiency of logistics of the world's largest airline companies in the transportation of passengers is made, the most influential being infrastructure efficiency and flight tracking capacity (in the period before the spread of COVID-19), degree of timeliness of passenger delivery and flight tracking capacity (in the post-COVID period). As for internal sub-factors, supply subsystem efficiency and passenger support subsystem efficiency were identified as the most influential in the pre- and post-quarantine periods.
4. The aviation industry has almost recovered from the COVID-19 pandemic. Therefore, in order to improve the efficiency of air transport logistics, it is necessary to pursue goals that take into account the consequences of the negative impact on their volumes, develop incentives and improve resource provision, given the forecasts for further global economic growth, stabilisation of aviation fuel prices and gradual return to profitability.

Author contributions

Conceptualization, I.K.; methodology, S.S. and I.K.; software, B.V.; formal analysis, N.T. and I.K.; investigation, S.S., N.T. and B.V.; data curation, S.S., N.T. and B.V.; writing–original draft preparation, I.K.; writing–review and editing, N.T.; visualization, B.V., S.S.; project administration, I.K.; funding acquisition, N.B. All authors have read and agreed to the published version of the manuscript.

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