



Long-Term Impact of COVID-19 on Global Air Transport: Analyzing Recovery Patterns and Strategic Responses

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Abstract. *The outbreak of COVID-19 has tremendously affected the world's aviation business by causing significant losses and organizational difficulties. Specifically, in this paper, the analysis of the changes in the conditions of the pandemic's effect on the financial and traffic indicators of the companies in the aviation field and patterns of their operational strategies is considered. Based on the data, which covers January 2019- December 2021, it is established that there are revenue and passenger indicators that decrease with only partial restoration by the end of 2021. Various financial records obtained from the airline reports reveal massive reductions in revenue and increased expenses on cancellations and the grounding of aircraft. Using the passenger traffic data from IATA and ACI, it is possible to study the passenger volumes and analyze the time series to determine main recovery tendencies. Primary data from the surveys conducted in 2020 and 2021 to understand the passengers' confidence and travel inclination revealed a gradual recovery. This paper also focuses on other adaptive actions by airlines, like route changes and operation strategies to minimize losses. The results imply a focus on effective crisis management and policy measures to promote the improvement of resilience in businesses and industries. The issues and guidelines for future preparation are the creation of financial buffers, the implementation of contingent organizational structures, and the development of additional funding sources. Based on the current study, the following recommendations are proposed to policymakers, airline operators, and other related stakeholders.*

Keywords: COVID-19 Impact, global air transportation, aviation recovery strategies, passenger traffic analysis, air transport crisis management

1. Introduction

COVID-19 pandemic has affected many industries worldwide and stopped most of them without exception (Chen & Yeh, 2021; Szczygielski et al., 2022). Of all business ventures, the air transport business was the most affected and experienced the disaster's first and most acute impacts (Gonne & Hubert, 2020). The cancellation of flights, the shutdown of borders, and strict measures of social distancing reduced the numbers of passengers and revenues significantly. The free movement of people, the backbone of the aviation industry, was severely affected by the pandemic, and this sector was forced to deal with the consequences of the pandemic (Bielecki et al., 2020; Kešlová et al., 2020). The immediate effects were stark: Airline companies experiencing a financial crisis, airports recording reduced passenger traffic, and the overall aviation industry being challenged (Abdelati, 2024).

This paper aims to understand the long-term effects of COVID-19 long-term impact on the air transport industry. A lot has been said about the immediate impact, but a more

profound question relates to the future of the industry: how can the industry bounce back? This research aims to investigate recovery processes and assess the performance of the tactical actions taken by airline and airport organizations globally (Butler & Barrientos, 2020; Sanchez-Ramirez et al., 2021). This paper aims to identify measures to strengthen the air transport industry's preparedness for subsequent shocks by analyzing these facets. The information gathered will be helpful to industry players such as policymakers, airlines, and airport managers when facing similar situations in the future.

Therefore, per the formulated research objectives, the study employs a broad data collection approach that involves financial ratios, passenger traffic statistics, and opinion/perception data from industry reports and databases. The analytical framework comprises quantitative and qualitative data analysis techniques such as descriptive statistics, comparative analysis, and qualitative assessment. Such an analysis makes it possible to study the effects of the pandemic and the specific reactions of the industry more effectively and gain a better understanding of the required actions for future-proofing the sector.

This study's importance is in raising awareness of the importance of effective crisis management frameworks for the air transport industry. The current pandemic has revealed the degree of susceptibility of the aviation industry to global risks. Thus, it is necessary to create integrated approaches that would not only allow the overcoming of the existing problems and the prevention of their escalation but also the creation of adequate safeguards for the future. Some BPMS aspects include financial readiness in emergencies, business process adaptability, and communication channels. In achieving these aspects, the study will be of significant contribution towards the enhancement of the future air transport system to be able to withstand future shocks and continue to support globalization.

2. Literature Review

Studies in the literature concerning COVID-19 have described in detail the first and second-order impacts of the pandemic that affected aviation. Swastanto and his colleagues (Swastanto et al., 2022) focused on the disruptions of aviation maintenance training in Indonesia while describing how the online mode during the pandemic impacted the training outcomes. This paper highlights the general effects of the COVID-19 pandemic on the training and human capital development in the aviation industry. The same Get in study by He et al. (2020) (He, Niu, Sun, & Li, 2021) used extensive data portrait analysis to develop an accounting index that captures the effects of COVID-19 on numerous industries in China, including aviation. Their studies found that there are huge repercussions relating to financial setbacks, an increase in expenses, and various problems related to the airways or sectors connected with it.

Астахов & Бойко (2023) appeared to analyze the measures taken by governments and state support programs after the aviation Emergency of the pandemic. They gave plenty of examples of how the airports and airlines managed to sustain themselves, emphasizing the strategic changes undertaken, especially by those airports and airlines specifically in the European region, Heathrow London, and Paris Charles de Gaulle, among others. Grewe et al. (2021) considered the climate consequences of the aviation emission scenario, including COVID-19. They showed how COVID-19 affects aviation emission consequences as well as how the industry can work towards a more sustainable future post-COVID. Thompson and Kannan (Arena & Aprea, 2021; Rimmer, 2020) investigated about Asian region regarding the

anticipated post-COVID-19 air traffic, vaccination percentages, and social measures affecting the aviation business, revealing that the sector is capable of performing well even under pandemic circumstances.

Besides these studies, Löffert & Diehl (2023) focused on psychological contact during the pandemic and the empirical findings of employees' perceptions of the contracts of aviation industry employees, which exposed rewarding new observations on contractual sources to manage employment relationships in the crises. While analyzing the Malaysian government's measures taken regarding the aviation industry in moving from the pandemic regeneration period to the endemic one, Zakaria et al. (2023) compared the governmental measures and their efficiency.

Although there has been a mass of literature focused on the immediate COVID-19 impacts on the aviation industry, extreme gaps still exist concerning long-term recovery and strategic management post-pandemic. Much of the research evidence can be put into the short-term disruption in the airline industry and the initial response. A void exists in the literature about how aviation can recover sustainably and enhance resilience in the wake of emergencies. It is our collective responsibility to fill this void and develop sustainable recovery strategies. Little comprehensive literature on the long-term recovery trajectories of the aviation industry is available to support these kinds of perspectives. There is, therefore, a need to understand these patterns, hence coming up with the right ways of ensuring that the industry is sustainable and resilient enough. Finally, although there is abundant evidence on short-term crisis management strategies, there is limited research on post-pandemic, or crisis, strategic management practices including financial planning, operational adjustments, and reforms of policies for long-term resilience.

While the study by Grewe et al. (2021) indicates the environmental effects of lowered air traffic, further in-depth research is critical on the way forward for the industry to include measures for sustainability. The psychological and embodied social costs to workers do not appear in much detail in the research. It is crucial that we, as researchers and industry professionals, pay more attention to these costs and consider measures that can be taken to help employee well-being and productivity be sustained in the long term. Few comparative studies exist so far that discuss how different regions reacted and how recovery has proceeded. Such studies can provide an understanding of best practices and customize strategies concerning regional variations in the aviation industry.

The paper elaborates on ways in which future research may address these gaps, ensuring a more holistic understanding of the aviation sector's recovery process. This time around, the sector is much better placed to ward off any future rampant disruptions.

3. Data and methodology

For this research, a comprehensive dataset shall be used to assess the long-term effects of the COVID-19 pandemic on the global air transport industry. The primary data sources will include financial metrics, passenger, and survey results data, which will be retrieved from studies based on the industry and different databases, respectively. This information will cover January 2019 to December 2021, enabling a clear comparison among the pre-pandemic, pandemic, and post-pandemic periods (IATA, 2022).

The financial data had been collected from financial statements of airlines and reports in the industry, all sources pointing out numerous details on revenue loss, costs of

cancellations and grounding, and the overall financial health of airlines due to the pandemic (Teker & Güner, 2016). Salient financial metrics that have been analyzed include quarterly and annual revenues, operating costs, net profits or losses, and liquidity ratios. The descriptive statistic, expressing means, medians, and standard deviations, was utilized along with percent changes to quantify the economic impact on the airlines. This approach will clarify the immediate and long-term financial impacts of the pandemic on the aviation industry (Feng & Wang, 2000).

Table 1. Impact on Global Air Transport Market (2020)

Category	Value
Expected Revenue (2020)	\$581 billion
Actual Revenue (2020)	\$314 billion
Number of Cancelled Flights	4.5 million
Financial Losses Due to Cancellations	\$35 billion
Number of Grounded Aircraft	> 5,000
Total Estimated Financial Losses	\$113-\$314 billion

Extracted passenger traffic data was obtained from global aviation databases and associations such as International Air Transport Association and Airports Council International (IATA and ACI). The data illustrated a profile of the drop and eventual recovery of passenger traffic in total numbers of passengers, passenger load factors, and flight frequencies. This involved comparing passenger traffic experienced by the industry in the pre-pandemic year 2019 and the highly pandemic-hit 2020, alongside the immediate recovery year of 2021/month of interest. The year-over-year change in passengers and revenue passenger kilometers was calculated to feature the magnitude of the impact and recovery.

Table 2. Passenger air transport sector (2019 vs. 2020)

Year	Number of Passengers	Revenue (Billion USD)
2019	4.5 billion	\$830 billion
2020	2.7 billion	\$372 billion

The analysis carried out on this time-series data was for establishing the trends of passenger traffic and revenues over the study period (Barczak, et al., 2022). The mathematical techniques used, including moving averages, exponential smoothing, and autoregressive moving average, are known for their rigor and reliability. Such analysis allowed the full comprehension of long-term recovery patterns, besides the prediction of future trends in the aviation industry. Such trends will advise in the graphical depiction and proper spelt out magnitude of the pandemic effects, as well as the recovery trajectory for the industry.

Also, the analysis was carried out on passenger confidence surveys of 2020 and 2021 by understanding travel intentions and changing consumer behavior during the pandemic. They gave quantitative information about travel frequency, safety concerns, and future traveling plans. The statistical techniques in summarizing the survey results and extracting meaningful patterns contributed to an overall understanding of the pandemic's impact on

passenger behavior. The survey data helped to judge the confidence levels and readiness of travelers to return to air travel, from which relevant industries would pick up valuable lessons.

The study, therefore, seeks to apply such quantitative approaches that go in-depth into the impact the pandemic brings to the aviation industry and the effectiveness of the various strategic responses. In this way, it captures both the immediate and long-term critical impacts of the pandemic on financial performance, passenger traffic, and consumer confidence. The findings of this study will provide invaluable knowledge to stakeholders in the aviation industry, potentially shaping the future of the industry.

4. Results and Discussion

4.1 Financial Impact

The COVID-19 pandemic hit the financial state of airlines severely. The analysis revealed that the decline in revenues was radical between 2019 and 2020. Hence, the most affected regions were those that used international routes frequently. In this sense, the projected global revenues were to be 581 billion in 2020; however, what was actually recorded was 314 billion, as presented in the Table 1. This deficit mainly occurred due to the large scale of cancellations of flights, with around 4.5 million flights canceled, worth \$35 billion on refunds only. More than 5,000 aircraft were grounded, further adding to airlines' cost pressures. The total estimated financial losses by different estimates ranged from \$113 billion to \$314 billion, thereby showing how deep the economic erosion of the industry is. Jobs in the aviation industry were also heavily hit as a surge in layoffs and airline bankruptcies was recorded. For example, Virgin America laid off 3,000 workers, 600 of whom were pilots, as did others, such as South African Airways. A financial reserve of \$61 billion is said to have been eroded in the second quarter of 2020.

Table 3. Impact on airlines

Metric	Value
Reduction in International Passenger Traffic (2020)	60%
Increase in Unemployment in the Aviation Sector	Significant
Total Financial Reserves Lost by Airlines (Q2 2020)	\$61 billion

4.2 Passenger Traffic and Confidence

Meager passenger traffic was noted to have experienced a sharp fall, from 4.5 billion passengers in 2019 to 2.7 billion passengers in 2020 (Table 2). The 2021 figures recovered, showing a passenger traffic level compared to 2019 at half the level. Survey analysis further allowed the elicitation of passenger confidence and travel intentions. In June 2020, 45% intended to travel within two months after the end of containment of the virus, while 55% only planned to make trips after six months or more. By June 2021, the percentage planning to substitute trips within 1-2 months has decreased to only 30%, substituting such trips after six months or more, taking six months or longer. These data are shown in Table 4.

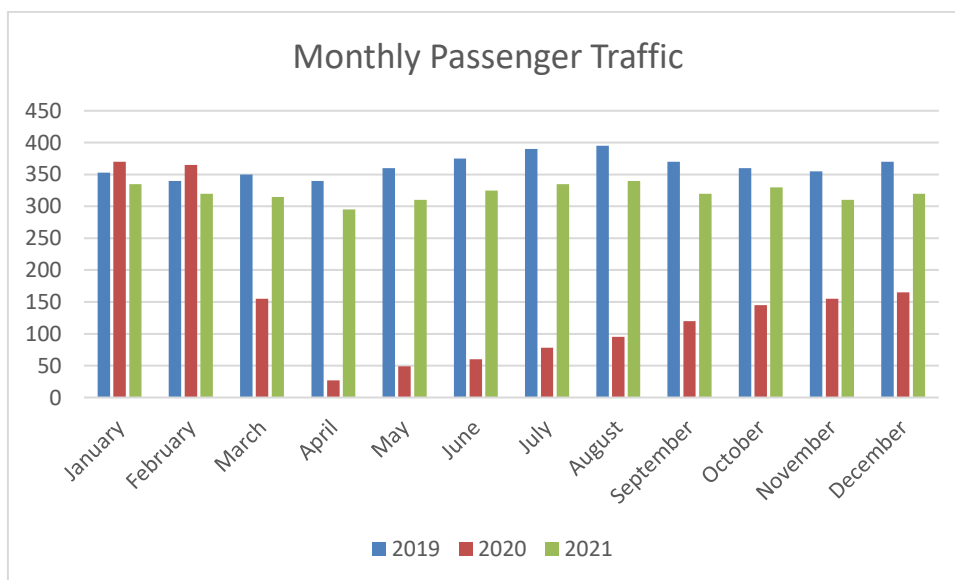
Table 4. Passenger Confidence (June 2021 Survey)

Metric	Percentage
Plan to Fly Within 1-2 Months	30%
Plan to Fly After 6 Months or More	60%
Plan to Fly After 1 Year or More	10%

Conclusions about the recovery of the aviation industry were drawn from a comprehensive time-series analysis of the passenger traffic data. The data set included a monthly passenger traffic series from January 2019 to December 2021. This analysis, which involved the application of advanced techniques over raw data, revealed underlying trends, smoothed short-term fluctuations, and highlighted the main trend.

Table 5. Monthly Passenger Traffic Data (January 2019 - December 2021) in millions

Mounth	2019	2020	2021
January	353	370	335
February	340	365	320
March	350	155	315
April	340	27	295
May	360	49	310
June	375	60	325
July	390	78	335
August	395	95	340
September	370	120	320
October	360	145	330
November	355	155	310
December	370	165	320

**Figure 1.** Summary of passenger traffic data

Effect of COVID-19 on passenger numbers, according to Figure 1. The impact of the COVID-19 pandemic on passenger numbers is very evident—plunging numbers since early

2020. The moving average is on course to drop dramatically from the base point in March 2020, with this unusual plunge extending up to the lowest points in April 2020 when the travel ban was at its peak and lockdowns at the pitch.

There has been a recovery in passenger traffic, although from mid-2020, the recovery is observed at painfully slow speeds, with levels remaining well below pre-pandemic figures. From mid-2021, the rolling average shows a slow but continuous recovery in passenger travel volume. Despite the slow recovery, passenger traffic in December 2021 was still about 50% lower than that of December 2019, showing the prolonged effect of the pandemic on air transport.

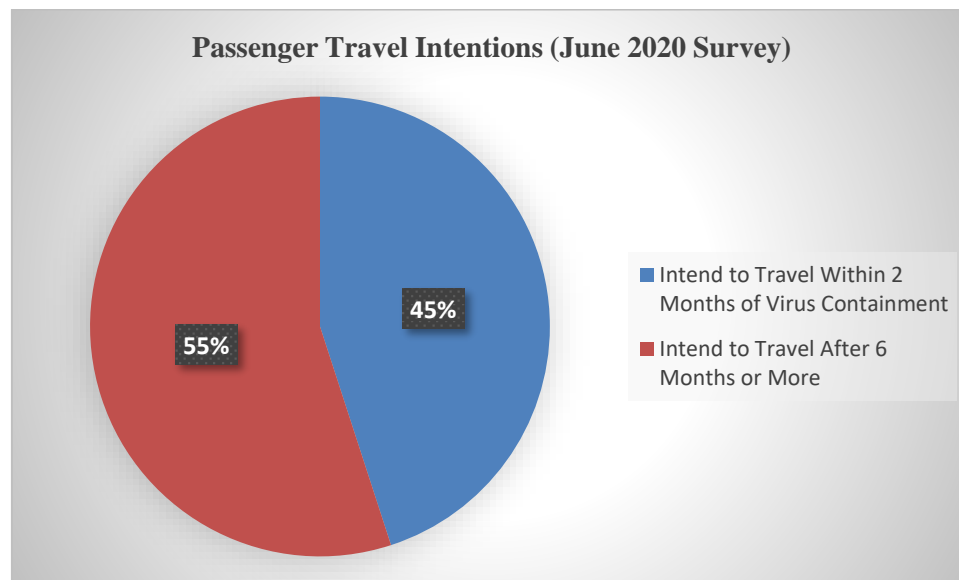


Figure 2. Passenger travel intentions

4.3. Operational Adjustments

Airlines made many operational changes to sustain themselves. These changes include mass layoffs, route cancellations, and fleet management plans to cut costs. For instance, Etihad Airways has canceled all new aircraft orders, which are seen as a precautionary measure toward expanding the fleet in light of uncertainties (see Table 6). Some of these were bound to impact manufacturers and the supply chain in the aviation industry in the long run.

Table 6. Airline layoffs and bankruptcy

Event	Value
Number of Employees Laid Off by Virgin America	3,000 employees
Number of Employees Laid Off by Virgin America (Including Pilots)	600 pilots
Airlines Declaring Bankruptcy (e.g., South African Airways)	Multiple airlines
Number of New Aircraft Orders Cancelled by Etihad Airways	All orders

4.4. Market Recovery Patterns

Therefore, the recovery tendencies were slightly dissociated between international and domestic traffic, where the latter showed some signs of a speedy recovery. Recovery in passenger traffic and revenues was predicted slowly post-2021 despite the fact that full

recovery is still a few years away. The predicted slow recovery indicated that strategic responses are very much required to increase industry resiliency.

Table 7. International air passenger market analysis (2020-2021)

Metric	Value
Reduction in International Passengers (2020)	60%
Revenue Lost by Global Airlines (2020)	\$372 billion
Projected Recovery in Passenger Numbers (2021)	Gradual increase
Decline in Global GDP Due to Pandemic (2020)	17% in Q1 2020

4.5 Strategic Responses and Future Resilience

Airlines have been successful in managing the crisis through their strategies in liquidity, government support, and flexible operational strategies. For future preparedness, there will be the need to increase the robustness of financial buffers, allow flexible operational models, and diversify revenue risks toward global disruptions. This will mean regulatory change, such as more agile regulatory frameworks, can be implemented quickly to enable rapid adjustment.

It would, therefore, lay a foundation for these areas of interest, thereby giving an idea of the far-reaching impacts of COVID-19 in the aviation industry and establishing a critical understanding of strategic planning and resilience, which are integral to sustainable recovery and preparedness for future crises.

Conclusion

The paper focused on the substantial financial, operational, and psychological effects of COVID-19 on the global aviation industry. The findings underscore the necessity of robust crisis management plans centered on resilience and ensuring green recovery. The study's key takeaways are liquidity management, government interventions, and flexible operational models. The research also underlines the critical role of passenger confidence in the recovery process and airlines' requirements to adopt changing consumer behavior patterns. Understanding these dynamics allows the aviation industry to chart its way out with strategies essential to face immediate problems and build long-term resilience. Future research must analyze the long-term recovery patterns, post-pandemic strategic management, and environmental consequences of aviation practices. This calls for improvement in each of these areas to ensure that the impacts of future disruptions are cushioned and the sector is well-placed to forge ahead into the future with confidence. All this speaks of the industry stakeholders, policymakers, airline operators, and airport authorities who require such integral approaches to survive and thrive in the post-pandemic.

The present study has analyzed the forces of COVID-19 on the aviation industry, but some aspects still need attention in the future. This will detail the long-term recovery landscape and assist in shaping effective strategies for future resilience. It must further try to uncover detailed strategic management practices that can be put into place after this pandemic, especially regarding financial and operational changes and policy reform. It remains one more significant area for future research: the understanding of the impacts on the environment and embedding sustainable considerations associated with reduced air

traffic recovery strategies. This is crucial for the long-term recovery and resilience of the aviation industry. However, one area that demands immediate attention is the psychological and social impacts of the pandemic on workforce welfare and productivity within the sector of aviation. These research areas will be important to address best practices and tailor-made strategies through comparative studies about how differently the regions have responded to this pandemic and recovered. Future studies on these topics can contribute significantly to the preparedness and resilience of the industry in the face of potential global disruptions.

Funding

This research received no external funding.

Acknowledgments

The authors would like to express their gratitude to the Department of Automotive and Tractors, Faculty of Engineering, Minia university, Egypt

Conflicts of Interest

The authors declare no conflict of interest.

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