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The Impact of Covid-19 on the Aviation Industry in Air Transportation

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Abstract:
The COVID-19 pandemic has unleashed an unprecedented upheaval in the aviation industry, marking one of the most significant disruptions in recent history. From March 2020 to May 2020, the industry experienced an unimaginable reduction in flight numbers, setting off a tumultuous journey of adaptation and recovery. Throughout this crisis, a plethora of scientific studies have emerged, examining both the direct and indirect impacts of the pandemic on aviation and vice versa. This paper presents a comprehensive review of these impacts within the context of recent literature. Drawing from nearly 200 meticulously curated papers published in 2021/2022, we have categorized them into eight distinct themes: airlines, airports, passengers, workforce, markets, contagion, sustainability, and economics. Through a systematic analysis, we distill the essence of the findings, shedding light on the multifaceted challenges and opportunities faced by the aviation industry in the wake of the pandemic. Furthermore, we outline a set of future research directions and policy considerations essential for fostering a pandemic-resilient aviation ecosystem. As the industry navigates through these unprecedented times, this research serves as a valuable compass, guiding stakeholders towards informed decision-making and sustainable recovery strategies.

1. INTRODUCTION

1.1 Background of the aviation in air transportation

The COVID-19 pandemic has inflicted unparalleled devastation upon the aviation industry, precipitating seismic disruptions and reshaping the contours of air transportation on a global scale. The impact of this crisis on aviation has been profound, with significant repercussions spanning passenger volumes, financial metrics, and systemic vulnerabilities. In 2020, the aviation sector bore witness to a staggering 60.2% reduction in air passengers compared to the preceding year, alongside net losses totaling $126.4 billion USD and a system-wide load factor of 65.1% (IATA, 2020). Furthermore, the pandemic precipitated a notable decline in direct aviation jobs by approximately 43%, with a concomitant decrease of an estimated 52% in aviation-supported employment (IATA, 2020). Despite tentative
signs of recovery, particularly in domestic markets during 2021, the industry remains ensnared in the throes of uncertainty and fragility (Dube et al., 2021; Tsvetkova et al., 2022; Calderón Peralvo and Cazorla Vanegas, 2022; Gao et al., 2022).

While the aviation sector has weathered previous crises, the COVID-19 pandemic stands out as an unparalleled disruptor, eclipsing even earlier adversities in its breadth and longevity. Past crises, such as the oil embargo of 1973, the September 11th terrorist attacks in 2001, and the global financial crisis of 2008, left enduring imprints on aviation operations and safety protocols (Issawi, 1978; Blunk et al., 2006;

Franke and John, 2011). However, the enduring and pervasive impact of COVID-19, coupled with its global magnitude, renders it a distinct and formidable challenge in the annals of aviation history.

Fig. 1 The unique impact of COVID-19 on aviation in context of earlier crises in terms of the number of transported passengers worldwide (data source: International Air Transport Association, IATA).

Amidst this backdrop of unprecedented turbulence, scholarly inquiry into the ramifications of the pandemic on aviation has burgeoned, reflecting the critical importance of understanding and addressing the multifaceted challenges confronting the industry. Building upon earlier investigations that explored the initial impacts of COVID-19 on aviation (Sun et al., 2021d), the present study endeavors to provide a rigorous review and analysis of the aviation-related literature pertaining to the years 2021 and 2022. The proliferation of academic research on this subject underscores its salience and the pressing need to comprehensively elucidate the complex interplay between the pandemic and aviation dynamics.

This paper unfolds as follows: Section 2 presents a systematic categorization of the research conducted in this review, furnishing a structured framework for comprehending the breadth and depth of scholarly inquiry. In Section 3, we delineate future research trajectories aimed at fortifying the resilience of aviation in the face of pandemics. Finally, Section 4 furnishes a conclusion, synthesizing key insights and offering reflections on the implications for the aviation industry in the post-pandemic era. Through this scholarly endeavor, we aspire to contribute to the collective understanding of COVID-19's impact on aviation and chart a course towards informed decision-making and policy formulation amidst uncertain times.

2. LITERATURE REVIEW:

2.1 The Impact of COVID-19 on Global Air Travel Demand and Passenger Mobility: A Comprehensive Review of Aviation Literature

The aviation industry has found itself at the epicenter of the COVID-19 pandemic, prompting a surge of scholarly inquiry aimed at comprehensively understanding its multifaceted impact. In the wake of seminal work such as the study by Sun et al. (2021d), which meticulously examined the initial repercussions of COVID-19 on aviation in 2020, this literature review seeks to offer a thorough synthesis of the aviation-related literature published during 2021 and 2022.

The burgeoning interest in the intersection of aviation and COVID-19 is attributable to several factors. Primarily, aviation has emerged as one of the industries most severely affected by the pandemic (Mumbower, 2022), necessitating a rigorous examination of its ramifications across various dimensions. Furthermore, the pivotal role of aviation in facilitating the global spread of infectious diseases, exemplified by the rapid transmission of COVID-19 across continents, underscores the urgency of analyzing its dynamics within the context of pandemics. Modern air transportation systems, characterized by their unparalleled speed and capacity to traverse vast distances, have significantly diminished the effective geographical barriers between communities (Brockmann and Helbing, 2013). Consequently, the efficiency of these systems has served to amplify the propagation of COVID-19, necessitating a nuanced exploration of aviation's role in shaping pandemic dynamics.

The proliferation of academic outlets conducive to the publication of studies on aviation and COVID-19 reflects the profound and wide-ranging impact of this crisis (Sun et al., 2021a). From specialized aviation journals and conferences to interdisciplinary platforms spanning transportation, public health, economics, and law, the scholarly discourse on this subject is diverse and expansive.

2.2 Methodology for Literature Review: A Systematic Approach to Compiling and Analyzing Aviation-Related Studies on COVID-19

In order to provide a structured framework for navigating this burgeoning literature, a meticulous review was undertaken to compile a comprehensive list of nearly 200 papers published between 2021 and 2022. Leveraging platforms such as Google Scholar and Web of Science, relevant keywords were employed to ensure the exhaustive coverage of pertinent studies, with due consideration given to citations of earlier works on COVID-19 and aviation. Several studies in the literature discuss specific airline examples, e.g., Allegiant Air (Zizka et al., 2021), American Airlines (Yu, 2021, Zuss, 2021), British Airways (Hamawandy et al., 2021), Garuda Indonesia (Haunan, 2021, Sabastian and Prijadi, 2021), LOT (Wasowska et al., 2021), Lufthansa (Kuno, 2021), and Singapore Airlines (Cheong et al., 2021).

The subsequent sections of this literature review are organized as follows: Section 2 presents a systematic categorization of research, delineating the thematic areas explored within the literature. Section 3 delineates prospective avenues for future research, aimed at advancing our understanding of the intricate interplay between aviation and pandemics. Finally, Section 4 offers a concluding synthesis of key insights gleaned from the analyzed literature and underscores their implications for theory, practice, and policy. Through this rigorous analysis, we endeavor to contribute to a nuanced understanding of COVID-19's impact on aviation and inform evidence-based decision-making in navigating the complex challenges posed by this unprecedented crisis (Brockmann and Helbing, 2013).

3. FRAMEWORK FOR INTERACTION BETWEEN AVIATION AND COVID-19

This section of our study undertakes a comprehensive survey of the literature concerning the repercussions of the COVID-19 pandemic on the aviation sector, focusing on publications from 2021 to 2022. Building upon the foundational work of Sun et al. (2021d), which delineated the impact of the initial year of the pandemic on aviation, this review aims to provide a structured analysis of subsequent research developments.The existing body of literature addressing aviation and COVID-19 is characterized by its disorganization, stemming from the convergence of diverse causes and the proliferation of publications across various platforms. This confluence of factors has resulted in a lack of uniform terminology and contributions from research groups with disparate backgrounds, making it challenging to discern the novelty and significance of individual studies within the broader literature landscape. Furthermore, many publications have reported on the impact of COVID-19 on aviation without clearly articulating key messages or thematic frameworks.

In response to these challenges, this study seeks to bring clarity and structure to the existing literature by establishing a systematic framework for analyzing the interactions between aviation and COVID-19. By synthesizing and categorizing the diverse array of research findings(Mumbower, 2022)., we aim to elucidate overarching themes and identify key insights that can inform our understanding of the pandemic's impact on the aviation industry.

Through this structured approach, we endeavor to provide researchers, policymakers, and industry stakeholders with a comprehensive overview of the current state of knowledge regarding the intersection of aviation and COVID-19. By elucidating the key findings and implications of recent research, we aim to contribute to evidence-based decision-making and facilitate the development of strategies to address the challenges posed by this unprecedented crisis in the aviation sector.

4. IMPACT OF COVID-19 ON AIRLINES: FINANCIAL CHALLENGES, BUSINESS MODEL ADAPTATIONS, AND STRATEGIC RESPONSES:

The COVID-19 pandemic has posed unprecedented challenges to the aviation industry, with airlines facing significant operational and financial hurdles. It synthesizes recent scholarly literature to provide insights into the impact of COVID-19 on airlines, focusing on the period between 2021 and 2022. Drawing on a diverse range of sources, this study examines the indirect effects and long-term implications of the pandemic on airline operations, as well as financial-oriented analyses that have emerged as relevant data becomes increasingly available.Amidst the pandemic, airlines have encountered formidable difficulties, including reduced passenger demand, operational constraints, and financial instability. Many airlines have been compelled to seek government aid or secure investments from investors to sustain their operations. However, some airlines, such as Air Italy and Norwegian Air Shuttle, have faced insurmountable challenges and ceased operations altogether [Mumbower, 2022].

Early studies predominantly explored the immediate network effects and operational challenges experienced by airlines during the peak of flight reductions in March/April 2020. However, recent literature has shifted towards analyzing the long-term impacts of COVID-19 on airlines and advocating for strategic responses to mitigate future risksOne critical issue highlighted in the literature is the over-reliance of airlines on historical patterns and models, which has hindered their ability to make informed short-term modifications to their networks. Scholars emphasize the importance of investing in novel technologies, particularly in data science and artificial intelligence, to enhance airlines' agility and responsiveness to changing market dynamics [Sun et al., 2021a; Garrow and Lurkin, 2021].

Furthermore, the financial impact of COVID-19 has necessitated a reevaluation of airline business models and workforce restructuring efforts. Scholars propose strategic frameworks and response matrices to guide airlines in navigating the crisis under different threat levels and
durations [Kim and Sohn, 2022]. The literature also offers numerous case studies examining the responses of specific airlines, such as Allegiant Air, American Airlines, and British Airways, to the pandemic. Comparative analyses have been conducted to assess the resilience and adaptability of airlines across different regions, providing valuable insights for industry stakeholders.

5. GOVERNMENT SUPPORT FOR THE AVIATION INDUSTRY AMIDST COVID-19:

In response to the unprecedented challenges faced by the aviation industry due to the COVID-19 pandemic, governments worldwide initiated state-aid relief and support packages. Notably, the European Union (EU) implemented legislative additions and measures to amend its common state aid legal regime, aimed at providing support to member countries' flagship carriers (Trimarchi, 2021). Similarly, the United States introduced the Coronavirus Aid, Relief, and Economic Security Act (CARES) stimulus package to bolster the aviation sector (Mountain et al., 2020), while Australia allocated substantial funds to support its aviation industry (Zhang and Zhang, 2021). Scholarly discourse on state aid packages for the aviation industry reflects a critical stance, largely due to perceived shortcomings and criticisms. The public criticism stems from concerns regarding the distribution of aid without adequate obligations towards the aviation industry and the discrepancy between the packages and the industry's actual needs (Bezemer, 2021). Furthermore, waivers on airways fees and charges are deemed ineffective when airline fleets remain largely grounded (Tisdall and Zhang, 2020).

Studies examining state aid packages, particularly within the European context, highlight significant regional disparities and discriminatory practices. The heterogeneous nature of support across regions,

coupled with variations in magnitude and type of aid, contradicts efforts to foster fair competition among aviation stakeholders (Hobe, 2021). Agnolucci (2021) offers a detailed analysis of state aid distribution among individual EU member countries, emphasizing differences in policy and sectoral distribution.
The arbitrary distribution of state aid has led to legal challenges and societal implications. Ryanair, for instance, has filed numerous lawsuits challenging the legality of state aid to national carriers within the EU (DeutscheWelle, 2021). Similar concerns have been raised in the Indian context (Jha et al., 2021). Moreover, scholars advocate for tying state aid to the achievement of societal goals and reducing investors' fears (Scheelhaase et al., 2021; Corbet et al., 2022).

6. GUIDELINES FOR POLICY NEEDS AND FUTURE RESEARCH IN THE WAKE OF THE COVID-19 PANDEMIC:

The COVID-19 pandemic has precipitated significant upheaval in the aviation industry, prompting a critical need for research to elucidate the enduring impacts and inform future policy decisions. Drawing upon a comprehensive literature review, this paper presents several recommendations and directions for future research aimed at addressing the long-term challenges and opportunities induced by the pandemic.

Exploration of Long-Term Impacts:

A paramount area for future research involves delving into the enduring effects of the COVID-19 pandemic on aviation. Despite the gradual easing of travel restrictions and operational adjustments, it is imperative to discern the lasting changes in passenger behavior, industry practices, and regulatory frameworks. By conducting longitudinal studies, researchers can illuminate insights into the persistence of COVID-19-induced disruptions and their implications for the future of air travel (Kim and Sohn, 2022; Kim et al., 2021; Kim, 2022).

Endemic Considerations and Variant Management:

As the global community transitions toward coexisting with COVID-19 as an endemic disease, it is crucial to anticipate and address the challenges posed by emergent variants of concern. Future research should focus on developing strategies for effectively managing aviation restrictions and travel protocols in the face of evolving epidemiological threats (Karim and Karim, 2021). Recent
responses to the identification of the Omicron variant underscore the potential future impact of such variants on aviation restrictions and global travel patterns.

Collaboration and Preparedness:

Enhanced collaboration among governments, aviation stakeholders, and international
organizations is essential for improving pandemic preparedness and response capabilities. Research should explore mechanisms for enhancing coordination, information sharing, and decision-making processes to facilitate a unified approach to crisis management (World Health Organization [WHO] ; International Air Transport Association [IATA]).

Minimizing Societal and Economic Impacts:

The socioeconomic ramifications of the COVID-19 pandemic extend beyond the aviation industry, affecting communities, economies, and global supply chains. Future research should assess the broader societal and economic implications of prolonged travel restrictions and shifts in consumer behavior (Bezemer, 2021). By analyzing the differential impacts on vulnerable populations and industries, researchers can inform targeted policy interventions aimed at mitigating adverse effects and promoting inclusive recovery.

7. THE FUTURE ROLE OF NETWORK, FLEET, AND PRICING ECONOMICS IN AVIATION POST-COVID-19:

The COVID-19 pandemic has precipitated significant shifts in demand patterns and operational uncertainties within the aviation industry, necessitating a reevaluation of network, fleet, and pricing strategies. This paper explores the anticipated long-term changes in airline operations and their implications for economic decision-making.

Evolution of Pricing Strategies:

Traditionally, airlines have priced long-distance point-to-point flights at premium rates, catering to time-sensitive passengers, particularly business travelers. However, (Chan and Haines, 2021) with the potential decline in business travel post-pandemic, there is a growing proportion of price-sensitive passengers. This may lead to a narrowing of price differentials between non-stop and connecting flights. Airlines may need to adapt their pricing models to accommodate shifting passenger demographics and demand dynamics (Normile, 2021). The COVID-19 crisis has accelerated fleet restructuring efforts, with many airlines retiring older or fuel-inefficient aircraft. Future fleet decisions will likely be influenced by changes in flight frequencies and passenger preferences. The reduced demand for frequent connections, particularly in the absence of business travelers, may favor larger aircraft operating at lower frequencies. This marks a potential reversal
of previous trends favoring high-frequency narrow-body connections (Chan and Haines, 2021).

8. IMPACT OF REGIONAL DISPARITIES ON AVIATION FLOW AND ADDRESSING CHALLENGES AND FINDING SOLUTIONS:

Divergent approaches to pandemic intervention among countries have resulted in regional disparities that pose challenges for aviation flow. For instance, countries like China and New Zealand have adopted stringent containment measures, leading to asymmetries in international travel patterns. The persistence of travel restrictions, such as Australia's blockade on incoming travelers from New Zealand, exacerbates the "backhaul problem" faced by airlines, where flights operate with insufficient passenger loads. These regional disparities are likely to impact airline performance and route profitability (Chan and Haines, 2021). As the aviation industry navigates through these challenges, there is a pressing need for better modeling and understanding of the evolving demand landscape and operational constraints. Airlines must develop adaptive strategies to optimize network efficiency, fleet utilization, and pricing structures in response to changing market dynamics. Collaborative efforts among industry stakeholders, policymakers, and researchers are essential for devising effective solutions to mitigate the impact of regional disparities and ensure the resilience of the aviation sector in a post-pandemic world.

8.1 Sampling Methodology:

The sampling methodology applied in this study adhered to a systematic process aimed at identifying and selecting academic literature pertinent to the impact of the COVID-19 pandemic on the aviation industry. The selection process followed rigorous criteria to ensure the integrity and relevance of the included sources.Firstly, a comprehensive search was conducted across prominent academic databases, including Google Scholar and Web of Science, utilizing a combination of keywords such as "COVID-19," "aviation," and "air transportation." This initial phase aimed to retrieve scholarly articles, conference papers, and reports published within the timeframe of 2021 to 2022.Subsequently, retrieved sources underwent meticulous screening based on predefined inclusion criteria. These criteria encompassed relevance to the research topic, credibility of the publication source, and methodological rigor. Only peer-

reviewed articles, reputable conference papers, and authoritative reports focusing on the impact of COVID-19 on aviation were considered eligible for inclusion.

The selection process involved a detailed review of each identified source to ascertain its alignment with the research objectives. Duplicate or irrelevant publications were excluded, while eligible studies were retained for further analysis. The final sample size was determined based on the saturation of themes and the depth of coverage required to achieve a comprehensive understanding of the research topic, resulting in the inclusion of nearly 200 academic papers and reports.

8.2 Analysis Methodology:

The analysis methodology employed in this study adhered to a structured approach designed to synthesize and interpret the findings of the selected literature. The analysis process encompassed several key steps aimed at extracting insights, identifying patterns, and drawing informed conclusions.Initially, the literature was organized into thematic categories based on recurring topics, trends, and research focus areas. These categories included the impact of COVID-19 on airlines, government support measures, future research directions, and the role of network, fleet, and pricing economics in aviation post-COVID-19.Subsequently, relevant data, key findings, and insights from each selected publication were systematically extracted and synthesized. This process involved summarizing the main arguments, methodologies employed, and empirical evidence presented in the literature.The synthesized data were then analyzed to identify overarching patterns, trends, and discrepancies across the literature. Through comparative analysis and critical reflection, emergent themes within the research landscape were explored, and gaps in knowledge were identified.

Finally, the synthesized findings were critically reflected upon and interpreted to discern their implications for the aviation industry. This process entailed assessing the robustness of evidence, evaluating the significance of research findings, and drawing informed conclusions based on the analyzed literature.By adhering to this systematic approach, the study aimed to enhance the credibility, rigor, and validity of the findings, thereby contributing to a nuanced understanding of the impact of COVID-19 on the aviation industry.

9. CONCLUSION:

The COVID-19 pandemic was anything but a near miss (Velu and Iyer, 2021); it was a full blow to our entire society. Aviation, by design, is prone to take huge, yet ambiguous roles in the evolution of pandemics, being one of the major casualties, but also enabling the effective spread of a contagion through a highly-efficient, global transportation system. Without changes to the way we live and travel, the COVID-19 pandemic will not be the last pandemic to hit our society (Chansuk et al., 2022, Tsvetkova et al., 2022, Rahman Fatmi et al., 2022). Using a categorization framework, this paper discussed the impact of COVID-19 on air transportation systems concerning various aspects. Such a comprehensive review of existing work is indispensable for the research not only to avoid reinventing the wheel by re-publishing known findings in various venues, but much more to extract the essence of scientific findings and derive a coordinated call for policy intervention and providing a clear set of recommendations for future work.

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