Collegiate Aviation Review International

Volume 41 | Issue 1 Peer Reviewed Article #2

3-27-2023

A Bibliographical Analysis of Pragmatic Strategies Responding to the Pandemic Crisis in Aviation

Chien-tsung Lu
Purdue University

Taoran Yin
Purdue University

Ming Cheng
Civil Aviation University of China

Fecri Karanki
Purdue University

Haoruo Fu
Purdue University

The aviation industry has suffered from the COVID-19 pandemic since early 2020. Airlines, airports, and manufacturers reacted to fight against the disease to protect passengers as well as remain sustainable. The purpose of this study is to analyze existing archives and discover strategic plans implemented by essential actors of the commercial aviation system. Using inductive qualitative analysis in conjunction with VOSviewer bibliographical data visualization, this study unveils the practical strategies of resilience enacted by the airline industry, manufacturers, and commercial airports during the pandemic time. Based on the Crisis Response Matrix from Suk and Kim, airlines' survival strategies during COVID-19 include passenger protection, operational retrenchment, innovation, and long-term managerial plans. Manufacturers' main approaches are expanding business with maintenance, repair, and overhaul (MRO) on top of alternative fuel innovations for emission reduction. Remarkably, airports adopt policies and protocols to screen and protect passengers, share information about infected passengers, and create a contactless airport environment for the prevention and control of pandemic infectious diseases. Synthesis tables containing discoveries are provided for practitioners' future reference.

Recommended Citation:
Lu, C, Yin, T., Cheng, M., Karanki, F. & Fu., H. (2023). A Bibliographical Analysis of Pragmatic Strategies Responding to the Pandemic Crisis in Aviation. *Collegiate Aviation Review International*, 41(1), 29-55. Retrieved from http://ojs.library.okstate.edu/osu/index.php/CARI/article/view/9402/8468

Introduction

The aviation industry is one of the most popular modes of international transportation. The United States Federal Aviation Administration (FAA) stated that aerospace and other related industries made up 5.2% of the U.S. gross domestic product (GDP) in 2016 (Federal Aviation Administration [FAA], 2020). Based on Bureau of Transportation Statistics (BTS) data, after the COVID-19 pandemic hit at the beginning of 2020, passenger volume dropped to below 400 million passengers, a 62.2% decrease in passenger count and a 68.6% decrease in revenue-passenger-miles (RPM) leading to a net loss of USD$42 billion among US carriers, as of quarter two of the 2021 fiscal year (BTS, 2021). Despite the exponential increase in air cargo shipping in 2019 during the COVID-19 pandemic outbreak (International Air Transportation Association [IATA], 2019, 2021), only 4.5 billion passengers traveled on 38.3 million flights traveling around the world (International Civil Aviation Organization [ICAO], 2019).

The global pandemic is not new to the aviation industry. China took aggressive emergency management measures to successfully restore the business scale during the severe acute respiratory syndrome (SARS) outbreak between 2002 and 2003. During the Middle East Respiratory Syndrome (MERS) outbreak between 2012 and 2017, South Korea reported a 12% decline in revenue-passenger-kilometers (RPKs) right after the confirmation of MERS transmission via aircraft (IATA, 2020). The outbreak of Ebola between 2013 and 2016 infected 28,602 people causing Sierra Leone alone a 13% decline in seat capacity in 2014 (Amankwah-Amoah, 2016). However, these numbers would pale in comparison to the worldwide COVID-19 pandemic (World Health Organization [WHO], 2022). While the aviation industry is gradually recovering from the impact of coronavirus, strategies being successfully developed and deployed shall be known so the aviation industry can learn and prepare for the future public health crisis.

Literature Review

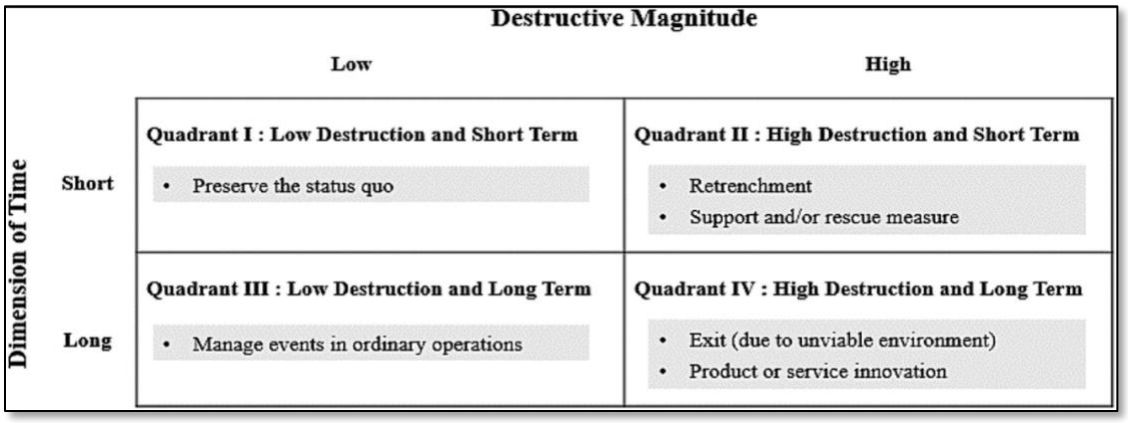
The aviation industry is very fragile, as examined by the SARS, MERS, and H1N1 pandemics that struck in the last two decades, which sheds light on the criticality of infectious disease prevention programs (Centers for Disease Control and Prevention [CDC], 2019). In tandem, IATA (2022), in response to the COVID-19 global health crisis, has created an effective Health Safety Checklist for Air Providers (IHSC) that encapsulates the essential aspects of disease spread prevention. The IHSC suggests systemic approaches for airline operations by providing a new standard of safety protocols and sanitation. The IHSC advocates a communication avenue between passengers and airlines from pre-departure to post-arrival, staff training, cleaning, and sanitation process, installation of onboard high-efficiency particulate air (HEPA) filters, embarking and disembarking procedures as well as employee self-awareness working processes (IATA, 2022). IATA also expresses the adoption of the epic Safety Management System (SMS) to identify health concerns and pandemic hazards prior to an etiological incident. Following the health SMS (HSMS), IATA suggests a health safety risk

management (HSRM) to assess the risk (likelihood and severity) of each hazard imposed by the pandemic (IATA, 2022). These systems are crucial to identifying failure points in the system for the airline to take advanced action. The robust ideas that HSMS and HSRM bring to the aviation industry yield an effective ability to offer proactive solutions.

Challenges and Response of Airlines

Amankwah-Amoah (2016) stated how the airlines followed three influential stages in mitigating the evolution of an epidemic into a pandemic, including 1) the recognition stage - disease analysis and policy development; 2) the retrenchment stage – reduction of air service to and from high-risk regions, and 3) recovery stage - return to new and normal operations with improved tactics of disease prevention (Amankwah-Amoah, 2016). Moreover, Suk and Kim (2021) give the 2 x 2 matrix describing the varying responses that a health crisis might invoke based upon the dimension of time and the destructive magnitude of the crisis (see Figure 1).

Figure 1
Quadrants of Response Strategy Matrix



In the case of COVID-19, many airlines initially moved quadrants from Quadrants I to Quadrants II once the severity of the pandemic started hitting the industry. Quadrants II is where the industry seeks governmental help when the liquidity of assets is an immense struggle for airlines. Airlines receive aid in the form of grants and loans such as the Coronavirus Aid, Relief, and Economic Security (CARES) Act. Furthermore, airlines begin hunkering down in Quadrant II, cutting back on revenue loss such as reducing flights, laying off employees, and other methods. For a longer impact, airlines would move from Quadrant II into Quadrant IV, where airlines consider initiatives to change the business model and continue surviving (Suk and Kim, 2021). Airlines would move from Quadrant IV to Quadrant III, maintaining realistic operations while hoping to grow into the new normal (Suk & Kim, 2021).

Challenges and Response of Airports

Airports, serving as the node of daily aviation operations, process passengers and cargo from different countries. As the major country's point of entry for international visitors, airports are undoubtedly the focal point of epidemic prevention. WHO’s Article 20 of the International

Health Regulation (IHR) (2005) indicates airports possess unique characteristics, which require the highest level of sanitation, control, and reporting procedures during pandemics (WHO, 2005). For instance, Singapore Changi International Airport, Dubai International Airport, and Doha Hamad International Airport, where only international flights process a large volume of transit traffic, would carry significant responsibility for executing epidemic prevention plans. These responsive plans include four intertwined levels: policy, process, technology, and individual levels (Arora, Tuchen, Nazemi, & Blessing, 2021). For policy and process levels, Changi airport developed the Transit Holding Areas (THA) concept, which requires transit passengers to deboard after arrival and are immediately directed to the transit holding area to avoid cross-contamination. Technological innovations such as no-touch security screening, online check-in systems, e-boarding passes, and facial recognition are enacted to interfere with communicable paths (Berry, Danaher, Aksoy, & Keiningham, 2020). Like the IATA's HSRM, a pandemic threat matrix provides the danger levels of a public health problem as well as corresponding recommendations, while the terminal design should have the characteristic of geometrical simplicity and modularity, which allows converting the function of terminal layout for a dynamic emergency demand (Shuchi, Drogemuller, & Buys, 2017; Štimac, Pivac, Bračić, & Drljača, 2021).

Airports in the Post-Public Health Crisis Era

The Airports Council International (ACI) provides a series of experience-based guidelines: operational and managerial recommendations offering new concepts and standards based on the latest technology trend (Airport Council International, 2020). Abeyratne (2020) promulgates systematic general training for airport managers, as most do not realize what artificial intelligence (AI) and statistical algorithms can be useful for disease forecast and prevention during a public health crisis. However, the collaborative synergy among airports worldwide regarding information sharing would be imperative, while ACI, IATA, and ICAO can be the platform to coordinate the existing data for analysis. During the COVID-19 pandemic, airports are deemed dangerous places due to populated passengers and employees. Establishing safety protocols to ease passengers' fear of aviation is necessary. Some researchers have suggested and enacted safety procedures to create a comfort zone or onboard social distancing against possible infections (Abeyratne, 2020; Tuchen, Arora, & Blessing, 2020). The learning curve of rebuilding passengers' confidence in airport safety will take a relatively long time, but archived lessons and experiences would be useful for risk analysis and proactive controls.

Aviation Manufacturers Survivability

During the downturn in the aviation industry in the aftermath of the 2001 terrorist attacks, the purchasing and leasing of aircraft decreased, but the aviation parts industry was able to be profitable due to an exponential increase of both C and D checks or overhauls (Schneider, Spieth, & Clauss, 2013). This can be seen in Boeing's financials which showed a backlog of $377 billion and 535 added net commercial orders, and $16 billion in revenue. In 2021, the delay of Air Force One, the failure of the Starliner Launch, and the continued difficulties in getting China to approve the airworthiness of the 737-MAX (Boeing, 2022) while Airbus experienced a €62 billion increase in order intake, nearly doubling their 2020 order intake despite 264 orders being canceled resulting in record net income of €4.2 billion for the year (Airbus, 2022). While

there will not be a noticeable immediate effect regarding new orders of large aircraft, Boeing earned significant profits from the global market of Maintenance, Repair, and Overhaul (MRO). Besides, a recent trend shows flexibility in layout configuration rather than compactness and efficiency in response to the international passenger reduction due to travel restrictions, flight cancellations, or lockdowns (Bouwer, Saxon, & Wittkamp, 2021; Collings, Corbet, Hou, Hu, Larkin, & Oxley, 2021). On the other hand, Airbus has strongly gained the upper hand in the battle between the American and European juggernauts. What Airbus did was an abandonment of practices that led to "Eurosclerosis"[1] (Archibugi, 2020, p.2). That said, to recover from COVID-19, European companies came together across national lines, avoided over-regulation, and embraced emergent technologies that Airbus has already been successful.

Supply Chain During the Pandemic

Another less visible hit by the pandemic is the jet fuel industry. With severe reductions in the use of AvGas and Jet A, major fuel stocks stood at 95% fuel storage capacity resulting in a drop in fuel prices (Tisdall, Zhang, & Zhang, 2021). Economists are worried that COVID-19 might result in unique long-term consumer behavioral changes that could shape the benefit of reducing global CO_2 emissions (Youssef, Zeqiri, & Dedaj, 2020). The fuel price has been in a promptly changing marketplace. The gruesome fluctuations, currency inflation, and ill workers have impeded the smooth fuel supply chain to be functional, from delayed loading and unloading process to ground transportation congestion. Moreover, the aviation industry typically does not use maritime cargo shipping parts or components due to the nature of time sensitivity as well as the corrosive sea salt. As a result, difficulties in securing space in air cargo have generated an additional financial burden for shippers. Another challenge is the recruitment, retention, and payment of a highly skilled workforce. Businesses must invest heavily in the workforce as competition is fierce (Paul, Chowdhury, Moktadir & Lau, 2021) while considering cost efficiency, agility, flexibility, and carefully leveraging environmental footprint (Farooq, Hussain, Masood, & Habib, 2021). The aviation supply chain has been affected substantially related to aviation fuel production, aircraft parts shipment, currency exchange rate, and lack of skilled professionals.

Global Governance of Pandemics

The aviation industry inevitably inherits the nature of uncertainty and complexity of global governance responding to COVID-19. Both ICAO and WHO establish regulations and recommended practices for fighting against global health crises, such as ICAO's Article 14 of the Convention on International Civil Aviation (ICAO, 2004) and WHO's International Health Regulations (IHRs) (WHO, 2016). However, Cuinn and Switzerr (2019) point out that the global governance of the public health crisis in the aviation industry is highly complex and hard to predict in the past due to the lack of interactions between countries and corresponding laws. Fortunately, the Severe Acute Respiratory Syndrome (SARS) in 2003 demonstrated an opportunity to resolve the conflicts and regulatory gaps between ICAO and WHO in coping with the pandemic. ICAO reviewed and modified existing Standards and Recommended Practices

[1] "Overly rigid labor markets and overregulation of the economy in favor of established special interests in Europe in the `70s and the `80s"

(SARPs) in the Chicago Convention related to passenger and crew health, considering global public health issues (ICAO, 2004). Two huge modifications to SARPs include creating a Passenger Locator Form, which helps track passengers who are potentially exposed to infectious diseases during a flight. A Universal Precaution Kit has been introduced on board to help crew members manage possible in-flight infectious disease incidents.

ICAO took a further step to create a "coordinating group" in 2016 under the Collaborative Arrangement program for the Prevention and Management of Public Health Events in Civil Aviation (CAPSCA). Currently, the CAPSCA acts as a linkage between countries of the IHR and the Chicago Convention (Cuinn & Switzerr, 2019). Non-governmental organizations, such as International Air Transport Association (IATA) and Airports Council International (ACI), as well as experts and private foundations within the aviation and public health fields, have been actively involved in such programs helping design detailed guidelines and suggestions under the laws and regulations published by ICAO and WHO. The ICAO SARPs have limited effects on stopping the transmission of the contagious virus via air transportation, while a state/country could add uncertainty and barriers interrupting the harmonic collaboration. Lockdowns and strict border controls posted by various countries during the COVID-19 pandemic directly resulted in the massive cancellation and suspension of international flights (Arora, Tuchen, Nazemi, & Blessing, 2021). Karns et al. (2015) pointed out that the vital actors in global governance are generally identified as states, intergovernmental organizations, non-governmental organizations, experts and epistemic communities, networks and partnerships, multinational corporations, and private foundations. By the time of this study, global governance of the public health crisis in the aviation industry remains challenging such as protocols and policies between China and U.S.A.

Lu & Sun (2021, December) completed a reference list including studies and guidelines concerning aviation operations when facing communicable diseases. A comprehensive reference list was provided, but it only focused on gathering information with no detailed summary of the specific practices. Lu and Sun's study presented a macroscopic view but did not deliver pragmatic solutions, which shapes an opportunity for an in-depth study.

Research Questions

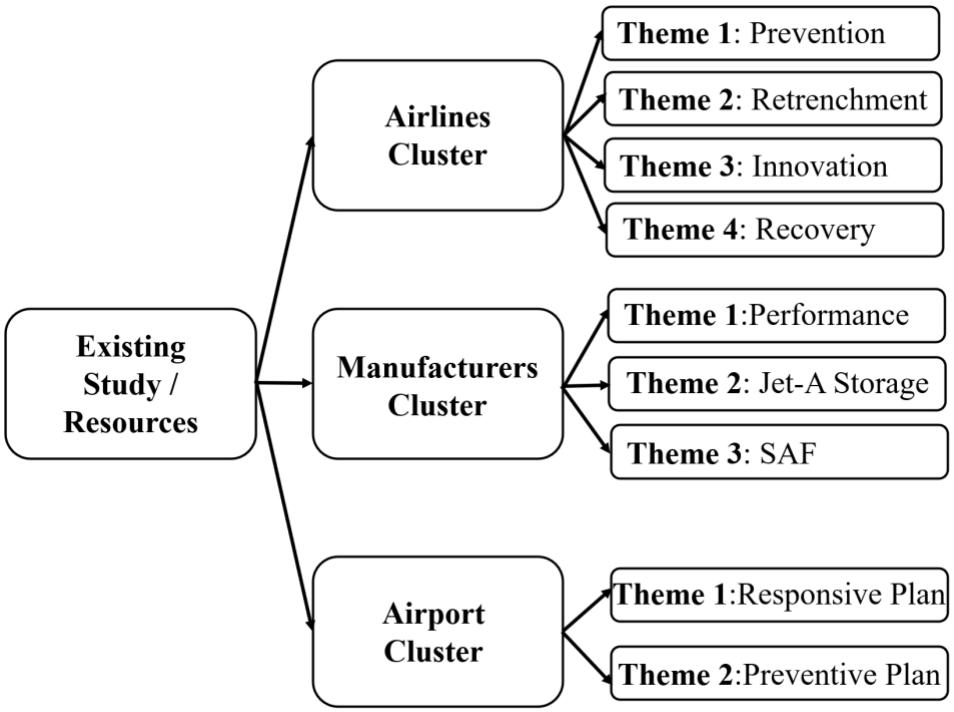
For aviation emergency response education, this study intends to understand three essential segments of the aviation industry – airlines, manufacturers, and airports, regarding what active defenses have been implemented to fight against the COVID-19 pandemic. The research questions are then defined as follows:

1. What were the strategies of resilience enacted by the airline industry during the public health crisis?
2. How did manufacturers remain sustainable during the global pandemic?
3. What innovations did commercial airports implement to cope with the global pandemic?

Research Methodology

The authors use a qualitative approach with inductive Meta-Analysis as the methodology to collect and analyze archives in conjunction with the application of VOSviewer for bibliographical visualization (Martínez-López, Merigó, Valenzuela-Fernández, & Nicolás, 2017). As defined by Timulatk (2009), Meta-Analysis is based on existing finished research that provides a more comprehensive analysis and findings regarding the given topic. The trustworthy documentation is reviewed concerning pandemic outbreaks, including 2003 SARS, 2012 MERS, 2013 Ebola, and COVID-19. Figure 2 briefly shows the data collection approach of this study.

Figure 2
Data Collection Illustration



To avoid trait error, this study purely focuses on existing finished research and cases and has no interference with people. The inter-rater tactic is used to secure the reliability of the result (Schwarz-Shea & Yanow, 2013). This study uses criterion validity to measure how the result reflects on present implementation (Salkind, 2018).

Findings

Strategies of Resilience Enacted by the Airline Industry

Looking into the myriad of studies, many common thematic areas displayed themselves. This study inductively categorizes four main stages that the airlines go through, those being the

P.R.I.M., namely Prevention (P), Retrenchment (R), Innovation (I), and Long-term Management (M), representing the primary strategies of resilience.

Prevention

During the Prevention stage, airlines focused on monitoring and assessing the situation and crisis at hand while closely looking upon governmental guidance and instruction on how to proceed. Especially after governmental instruction, many studies found that airlines began to alter their networks in response to passenger volume change and simultaneously mitigate the possibility of the virus spreading (Abate, Christidis & Purwanto, 2020; Amankwah-Amoah, 2020; Bielecki et al., 2021; Suk & Kim, 2021; Tuite, Watts, Khan, & Bogoch, 2019). Additionally, airlines implemented new standard operating procedures in the hope of eliminating the spread of active health threats to crew members and other passengers, including altering boarding and exiting patterns, enhancing cabin cleaning procedures, crew protective equipment, and elevating cabin hygienic and air-circulation standards (Amankwah-Amoah, 2016; Amankwah-Amoah, 2020; Bielecki et al., 2021; Chikodzi, Dube, & Nhamo, 2021; Cohen et al., 2016; IATA, 2022; Mangili & Gendreau, 2005; Suk & Kim, 2021; Thaichon, 2021).

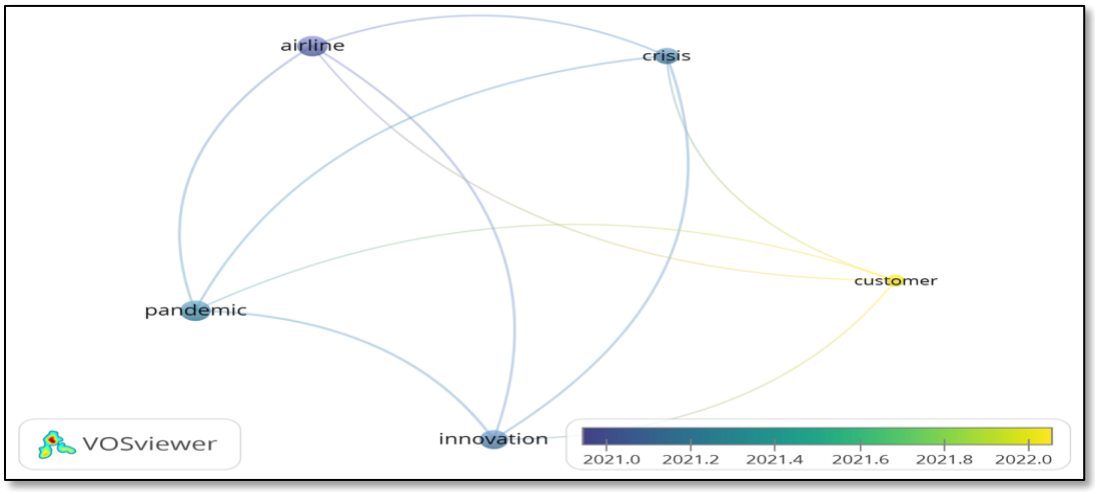
Retrenchment

Retrenchment is seeking to restructure the financial portfolios of its fleet through a variety of means such as leasing, bank loan refinancing, initial public offers, etc. The Retrenchment stage can take many forms with the goal of maintaining operations and staying out of financial trouble while preserving a good public image. Through the Retrenchment strategy, many airlines acted to survive due to reduced air travel and took reactive actions by removing less profitable flight routes (Abate, Christidis & Purwanto, 2020; Albers & Rundshagen, 2020; Amankwah-Amoah, 2020; Cohen et al., 2016; Czerny, Fu, Lei, & Oum., 2021; Suk & Kim, 2021; Tuite, Watts, Khan, & Bogoch, 2019), furloughing workers or offering early retirement packages (Amankwah-Amoah, 2020; IATA, 2022; Thaichon, 2021), canceling procurement contracts or postponing aircraft deliveries, retiring costly or aged aircraft, grounding less efficient aircraft (Albers & Rundshagen, 2020; Amankwah-Amoah, 2020; Bjelicic, 2012), and liquidating assets via aircraft sales among other methods (Albers & Rundshagen, 2020; Bjelicic, 2012; Chikodzi, Dube, & Nhamo, 2021; Suk & Kim, 2021). Airlines would be patient and attempt to wait out the worst timeframe of the global health crisis and see the resurgence of air travel.

Innovation

The Innovation stage brings to light that airlines attempt to produce revenue in regularly unconventional ways, such as reconfiguring aircraft to accommodate greater cargo storage and shipping needs. Many airlines reconfigured their passenger aircraft fully into cargo aircraft or efficiently divided useful aircraft spaces while transporting fewer passengers (Abate, Christidis & Purwanto, 2020; Albers & Rundshagen, 2020; Cain & Pascual, 2021; Chikodzi, Dube, & Nhamo, 2021; Cohen et al., 2016; Czerny, Fu, Lei, & Oum., 2021; Islam, Lahijani, Srinivasan, Namilae, Mubayi, & Scotch 2021; Leder & Newman, 2005; Mangili & Gendreau, 2005; Suk & Kim, 2021; Thaichon, 2021). Additionally, airlines continued searching for means to refinance and leverage aircraft and other assets. Some airlines restricted frequent flyer programs allowing for more cashflow (Abate, Christidis & Purwanto, 2020; Albers & Rundshagen, 2020; Bjelicic, 2012; Cain & Pascual, 2021; Chikodzi, Dube, & Nhamo, 2021; Czerny, Fu, Lei, & Oum., 2021; Suk & Kim, 2021). Using VOSviewer, the bibliographical clusters are provided below (see Figure 3), showing Innovation, Crisis Management, Pandemic Control, and Customer are intertwined and closely correlated.

Figure 3
Airline Resilience Strategies Facing Public Health Crisis



Long-term Management

Lastly, when airlines are facing a lengthened global health crisis, airlines would adopt new procedures, such as requiring face masks, prescreening passengers, distancing passengers, and frequently cleaning cabins, just to name a few, in order to stay operational until the full return of normal air travel (Amankwah-Amoah, 2016; Amankwah-Amoah, 2020; Bielecki et al., 2021; Chikodzi, Dube, & Nhamo, 2021; Cohen et al., 2016; IATA, 2022; Islam, Lahijani, Srinivasan, Namilae, Mubayi, & Scotch 2021; Mangili & Gendreau, 2005; Read, Diggle, Chirombo, Solomon, & Baylis., 2014; Suk & Kim, 2021; Thaichon, 2021; Tuite, Watts, Khan, & Bogoch, 2019). Table 1 below shows the *Bibliographical Overview of Airline Actions Facing Public Health Crisis*.

Table 1
Bibliographical Overview of Airline Actions Facing Public Health Crisis

	Prevention			**Retrench**				**Innovate**		**Recovery**
Sources	Assessment and Monitoring	Network Alteration	Implement New SOPs	Flight Removal	Lay Off Workers	Retire Aircraft	Liquidate Assets	Refinance	Restructure Aircraft	Manage
Abate et al. (2020)		X		X				X	X	
Albers & Rundshagen (2020)				X		X	X	X	X	
Amankwah-Amoah (2016)		X	X							X
Amankwah-Amoah (2020)	X	X	X	X	X	X				X
Bielecki et al. (2020)	X	X	X							X
Bjelicic (2012)						X	X	X		
Cain & Pascual (2021)								X	X	
Chikodzi at al. (2021)			X				X	X	X	X
Cohen et al. (2016)	X		X	X					X	X
Czerny et al. (2021)				X				X	X	

Sources	**Prevention**			**Retrench**				**Innovate**		**Recovery**
	Assessment and Monitoring	Network Alteration	Implement New SOPs	Flight Removal	Lay Off Workers	Retire Aircraft	Liquidate Assets	Refinance	Restructure Aircraft	Manage
IATA (2022)			X		X					X
Islam et al. (2021)	X								X	X
Leder & Newman (2005)	X								X	
Mangili & Gendreau (2005)	X		X						X	X
Read et al. (2014)			X							X
Suk & Kim (2021)		X	X	X			X	X	X	X
Thaichon (2021)			X		X				X	X
Tuite et al. (2019)		X		X						X

Manufacturers' Strategies to Remain Sustainable During the Global Pandemic

In contrast to many other parts of the aviation industry discussed above, the aviation parts manufacturing industry did not experience a major recession during the public health emergency. Yet, the aviation supply chain has been impacted greatly. This study analyzes nineteen (19) articles and summarizes them into three thematic categories: Aviation Parts Manufacturing, Jet-A Storage, and Sustainable Fuels. The focus of each article and the corresponding theme are provided in Table 2.

Table 2
Overview of Article Bibliographies

Source	Aviation Manufacturing Performance	Jet-A Fuel Storage	Alternative Sustainable Fuels
Archibugi, 2020	x		
Airbus, 2022	x		
Boeing, 2022	x		
Bombardier, 2022	x		
Bouwer et al., 2021	x		
Collings et al., 2021	x		
COMAC, 2020	x		
Faber et al., 2022			x
Farooq et al., 2021	x		
GE, 2022	x		
Hosseini, 2022		x	
Nie et al., 2022			x
Paul et al., 2021			x
Santos & Delina, 2021			x
Schneider et al., 2013	x		
Tisdal et al., 2021		x	
Youssef et al., 2020		x	
Yusaf et al., 2022			x

Aviation Parts Manufacturing Industry

All the big players: Airbus (2022), Boeing (2022), GE Aviation (2022), Bombardier (2022), and COMAC (2020), experienced growth and profits due to heavy demands in Maintenance, Repair, Overhaul (MRO) services during the pandemic (Farooq, Hussain, Masood, & Habib, 2021). Both reduction of demand for new aircraft and the sheer size of the backlog of producing aircraft eclipse the number of active aircraft in the market. However, the fact is that many factories did not shut down due to the aviation manufacturing industry being considered essential maintenance work (Collings, Corbet, Hou, Hu, Larkin, & Oxley, 2021). This has been consistent compared to the case of SARS and Ebola pandemics (Archibugi, 2020). One informative aspect during the COVID-19 was that the demand for large aircraft like Boeing B777 and Airbus A380 in the early 2000s shifted to the need for smaller, more efficient aircraft due to the lack of passengers and flight cancellations (Schneider, Spieth, & Clauss, 2013). The

impetus on aviation manufacturers is leaning toward fuel efficiency from smaller jets rather than relying on large capacity sizes (Bouwer Saxon & Wittkamp, 2021).

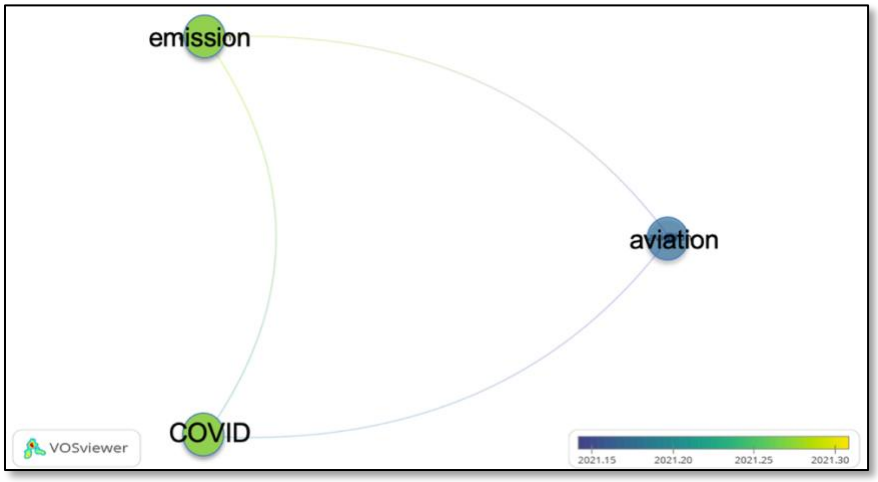
Jet-A Fuel Storage

A major problem many people may not be aware of in the aviation industry caused by the pandemic revolves around the usage and storage of aviation fuel (Youssef, Zeqiri, & Dedaj, 2020). Crude oil is the source of gasoline, kerosene (Jet-A), diesel, asphalt, petroleum, lubricants, and various plastics, which are all produced consistently during the refining process. Whenever gasoline is refined from crude oil, all other products are also created regardless of whether they are in demand or not. With the airline industry experiencing a major downturn between May 2020 and December 2021, the reserves of Jet-A fuel have been almost at capacity causing Jet-A to be sold at a loss to keep up with gasoline production (Tisdall, Zhang, & Zhang, 2021). Yet, through sanctions against Russian oil, imports of crude oil have gone down, which has had two effects on the Jet-A industry: 1) less Jet-A is being produced, and 2) using more fuel around restricted Russian airspace. While most countries have lifted travel restrictions, however, at the time of this study, China, the second largest airline market, continues reinforcing the "Dynamic COVID Zero" strategy and airline "Circuit Breaker" policy. The usage as well as storage of Jet-A in the long-term stays unpredictable (Hosseini, 2022).

Sustainable Fuels

Regardless of COVID-19, the aviation industry is tackling the aviation fuel economy and "emissions reduction" challenge by researching alternative, enviro-friendly, or renewable fuels (Paul, Chowdhury, Moktadir, & Lau, 2021). One way this is being handled is by reducing the aromatics (n-alkanes, iso-alkanes, cyclo-alkanes, and methyl/ethyl components) found in Jet-A fuel specifically consumed by large aircraft. Another way being researched is the development of high-energy-density liquid aerospace fluids which are being compiled with new technologies to mimic the hydrocarbon properties of traditional fuels without many of the problematic carcinogens (Nie, Jia, Pan, Zhang, & Zou, 2022). One exciting potential fuel alternative is hydrogen which is abundant, clean, and produces no carbon emissions, which has the potential to help ease Global Warming. The main argument against hydrogen includes its high price and the fact that mixing hydrogen and fossil fuels creates a slighter thrust (Santos & Delina, 2021). But as seen in the reports from Boeing, Airbus, COMAC, and Bombardier, helping researchers to achieve environmentally friendly fuels has been at the forefront. While the air transportation industry started to recover from the major pandemic impact, the environment briefly absorbed less quantity of pollutants due to the lack of air travel (Santos & Delina, 2021). Figure 4 below demonstrates three critical bibliographical themes including fuel technology embracing emission reduction during the pandemic time between 2020 and 2021.

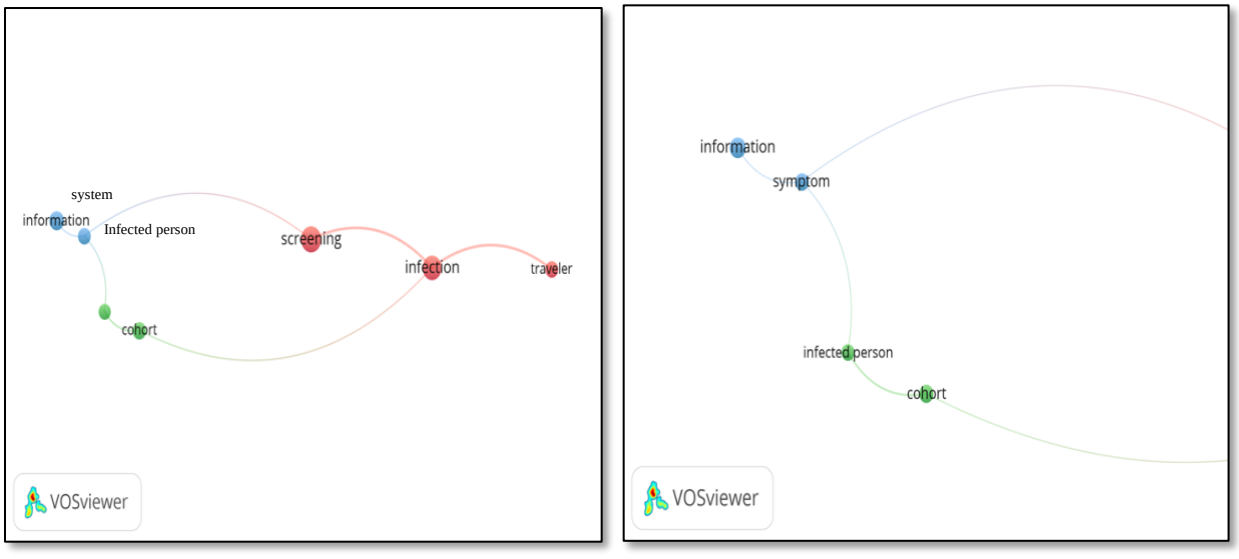
Figure 4
Fuel Technology Innovation - Emission Reduction



Commercial Airports Innovations When Coping With Public Health Crisis

A request for proposal of Transportation Research Board (TRB) Airport Cooperative Research Program (ACRP) 04-25 demanded the development of a web-based reference for airports' response to communicable diseases (TRB, 2021). To understand, this study reviews the responsive plans, preparedness, and sustainability plan of twelve (12) airports. Seven (7) airports are identified as reactive-oriented, as the actions were taken after the existence of a new communicable disease. Using VOSviewer, the authors demonstrate essential bibliographical clusters showing intercorrelated connections among three thematic areas, namely Passenger Screening (red color cluster), Cohort Groups (green color cluster), and Information Sharing (blue color cluster) as the primary emergency response approaches at airports (See Figure 5).

Figure 5
Airport Thematic Areas – Responses to Pandemics



Regardless, the holistic preventive plans as precautions that airports have taken when encountering an outbreak of public health crisis are presented below and in Table 3.

Temperature Screening & Identification

Six (6) out of twelve (12) airports in this study included temperature screening of passengers and staff at airports as one of the procedures against contagious disease spread. It is worth noticing that those six airports are all large in passenger volumes, which means they could be riskier for virus transmission in frequently populated areas. Other airports in this study also mentioned the temperature monitoring policy, but they relied more on the passengers/employees to report voluntarily.

Physical Distancing

All twelve airports in this study included physical distancing as a standard procedure to prevent or slow down the transmission of the communicable virus. Some airports have detailed quarantine/isolation plans, including treating passengers and crews according to the public health emergency policy. Some airports require aircraft doors to remain closed, and passengers and crew must remain on board until permission from the national/local public health agencies if a contagious disease is discovered in flight (Kapiti Coast Airport, 2019; Wichita Airport Authority, 2015). Airports also establish temporary isolation and quarantine locations/facilities at the airport to take care of infected personnel (Fairbanks International Airport, 2019; Kapiti Coast Airport, 2019; Philadelphia International Airport, 2020; Seattle-Tacoma International Airport - Port of Seattle, 2020; Wichita Airport Authority, 2015). Other physical distancing methods such as closing a portion of the terminal, removing seats at airport restricted areas, and 6 feet/1-meter social distancing requirements published by U.S. C.D.C. or equivalent foreign agencies. In conjunction with the required face masks, physical distancing has proven to be the most widely used and the most effective action for an airport to prevent transmission during the pandemic.

Sanitizing & Cleaning

Frequent sanitizing and cleaning the airport facilities, using human beings or robots, is another widely adopted action by airports worldwide. It is believed that frequent sanitizations can significantly reduce the chances of disease transmission happening at the airport, and it is recognized as an essential procedure during the pandemic (ACI, 2020).

Contact Tracing

Only two (2) airports in this study adopted contact tracing as one of their preventive programs facing a public health crisis. One of them is Tulsa International Airport but enforcing it on employees only (Tulsa Airports Improvement Trust, 2020). Another airport, Kapiti Coast Airport, included it under physical distancing as a response to identifying potentially infected staff after a contagious disease has been discovered post disembarkation (Kapiti Coast Airport, 2019). Other airports would provide a passenger's data only if the national/local public health agencies required it.

Information Seeking

Twelve airports would notify corresponding local or national public health agencies to seek professional guidance and instructions when dealing with a communicable disease (Fairbanks International Airport, 2019; Kapiti Coast Airport, 2019; Melbourne International Airport – Australia, 2020; Minneapolis-St. Paul International Airport, 2021; Narita International Airport, 2020; Pensacola International Airport, 2020; Philadelphia International Airport, 2020; Phoenix-Mesa Gateway Airport, 2009; Seattle-Tacoma International Airport - Port of Seattle, 2020; St. Pete-Clearwater International Airport, 2020; Tulsa Airports Improvement Trust, 2020; Wichita Airport Authority, 2015). Some airports have limited information dealing with new contagious diseases. As a result, more detailed guidelines and instructions published by professional agencies and international organizations are much needed for the airport to eliminate the transmission of diseases at the begging. Several international agreements and protocols require airports to notify public health agencies when discovering the existence or tendency of transmission of disease during operations. The World Health Act 1956 is the most common reference listing most infectious diseases and corresponding procedures an airport should take to reduce the possibility of disease spread (Kapiti Coast Airport, 2019).

Information Dissemination

Airports, except Tulsa International Airport and Phoenix-Mesa Gateway Airport, suggest that information communication with the general public is vital and indispensable to minimize the impact on public health. Communication in the early phase of virus transmission is critical to increasing public awareness, so the general public can take protective measures such as Personal Protective Equipment (PPE) accordingly. Transparent information communication during the pandemic can help rebuild public confidence to travel, which is vital for the industry's recovery from a public health crisis (Melbourne International Airport – Australia, 2020). Airports can also restate information gathered from international or national health agencies to help disseminate essential information.

New Technology

Two airports responded that the implementation of new technology would help contain disease transmission listed in their emergency response programs (ERPs). Understandably, an ERP can only reactionarily adopt the latest technology at the airport. But both airports mentioned that the new touchless technology such as biometrics and advanced kiosks could largely eliminate personal contact and thus reduce the risk of virus transmission (Melbourne International Airport – Australia, 2020; Seattle-Tacoma International Airport - Port of Seattle, 2020).

Target Procedure

Target procedure means the specific procedure that will only apply to a certain type of virus outbreak based on the virus’s unique characteristics. In this study, eight airports have target procedures or similar equivalent actions in response to the contagious disease. The most common target procedure is the checklist. Airport authorities tailor-make checklists for a particular type of

virus with support from international/national organizations to help quickly identify the spreading tendency and reduce the risk of transmission (Melbourne International Airport – Australia, 2020; Minneapolis-St. Paul International Airport, 2021; Narita International Airport, 2020; Philadelphia International Airport, 2020; Phoenix-Mesa Gateway Airport, 2009; Seattle-Tacoma International Airport - Port of Seattle, 2020; Tulsa Airports Improvement Trust, 2020; Wichita Airport Authority, 2015). A bibliographical overview of the airports' responsive as well as preventive plans to cope with public health crises is provided below in Table 3.

Table 3
Bibliographical Overview of Airports' Plans When Facing Public Health Crisis

	Responsive Plans							
Airport Name	Information Seeking	Information Dissemination	Screening & Identification	Physical Distancing	Sanitizing & Cleaning	Contact Tracing	New Technology	Target Procedures
Melbourne International Airport	x	x	x	x	x		x	x
Minneapolis-Saint Paul International Airport	x	x	x	x	x			x
Pensacola International Airport	x	x	x	x	x			
Philadelphia International Airport	x	x	x	x	x			x
Seattle-Tacoma International Airport	x	x		x	x		x	x
St. Pete-Clearwater International Airport	x	x		x	x			

Tulsa International Airport, NZ	x				x	x	x	x
Preventive Plans								
Kapiti Coast Airport, NZ	x	x			x	x	x	
Fairbanks International Airport	x	x			x			
Tokyo Narita International Airport, Japan	x	x	x		x	x		x
Phoenix-Mesa Gateway Airport	x		x		x	x		x
Wichita Dwight D. Eisenhower National Airport	x	x			x	x		x

Conclusion

The aviation industry is extremely vulnerable to a global health crisis. This study delivers a holistic review for airlines, airports, and manufacturing/MRO industries to sustain from ongoing and future communicable diseases outbreak. The previous studies on a similar topic either only focus on one of the three specific segments of the aviation industry or only provide a macroscopic view of the reference lists. This study provides a list of best practices for each segment of the aviation industry. The operator can use the result of this study as a checklist to identify the most effective approaches to preparing for or recovering from an outbreak of communicable diseases with the consideration of the unique local situation.

This study finds that airlines conduct four main stages, prevention, retrenching, innovation, and recovery, of operations during the public health crisis while expecting a full recovery. For the aviation manufacturing industry, the pandemic did not have a significant impact compared to that of both airline or airport industries due to the increased opportunities to perform MRO and optimized reconfigurations of airplanes for cargo services. Airlines are focusing on the efficiency of smaller aircraft with more environmentally friendly and sustainable operational features. Moreover, the balance point between aviation fuel usage and storage remains unpredictable; in particular when the Russia-Ukraine war continues to develop while China's airline market stays largely intangible.

This study also unveils that airports follow suggested guidelines published by WHO, IATA, and U.S. C.D.C. to construct their preventative and emergency response plans. Information sharing and transparent communication with the flying public can primarily help create public awareness and significantly reduce the risk of communicable diseases at the beginning stage. Other practices such as screening and identification, face masks and physical distancing, and sanitizing and cleaning programs are the top-used practices by airports and are proven relatively effective by the practitioners.

Future Study

There is no air cargo service provider included in this study. A future study on air cargo may be performed to fill the gaps. By the time of the study, China has imposed more strict pandemic policies against public health crises such as "Dynamic COVID Zero," "Stay-at-Home," and "Circuit Breaker" protocols. A future Case Study of the post-COVID pandemic achievement in China compared to other leading aviation countries like the U.S.A and Europe Union countries would be researchable. This study did not measure the effectiveness of the actions taken by the industry. A follow-up benefit-cost study assessing the result of all the efforts shall be performed.

References

Abeyratne, R. (2020). Training the airport manager in a post-COVID-19 world. *Journal of Airport Management, 14*(4), 1–9. Retrieved from https://content.ebscohost.com/ContentServer.asp?T=P&P=AN&K=146323385&S=R&D=a9h&EbscoContent=dGJyMNXb4kSeqLY40dvuOLCmsEqep7dSsqy4S66WxWXS&ContentCustomer=dGJyMO7r8Hzz27mF39%2FsU%2BPe7Yvy

Abate, M., Christidis, P. & Purwanto, A. J. (2020). Government support to airlines in the aftermath of the COVID-19 pandemic. *Journal of Air Transport Management, 89.* https://doi.org/10.1016/j.jairtraman.2020.101931

Airbus. (2022). *Airbus reports strong Full-Year (FY) 2021 results*, EN Press Release Airbus FY 2021 Q4. https://www.airbus.com/en/newsroom/press-releases/2022-02-airbus-reports-strong-full-year-fy-2021-results

Airports Council International (ACI). (2020*). Airport Operational Practice: Examples for Managing COVID-19.* ACI World. https://store.aci.aero/wp-content/uploads/2020/04/Airport-Operational-Practice-Examples-for-Managing-COVID19.pdf

Albers, S. & Rundshagen, V. (2020). European airlines′ strategic responses to the COVID-19 pandemic. *Journal of Air Transport Management, 87.* https://doi.org/10.1016/j.jairtraman.2020.101863

Amankwah-Amoah, J. (2016). Ebola and global airline business: An integrated framework of companies' responses to adverse environmental shock. *Thunderbird International Business Review, 58*(5), 385-397. https://doi.org/10.1002/tie.21789

Amankwah-Amoah, J. (2020). Note: Mayday, Mayday, Mayday! Responding to environmental shocks: Insights on global airlines' responses to COVID-19. *Transportation Research Part E: Logistics and Transportation Review*, 143. https://doi.org/10.1016/j.tre.2020.102098

Archibugi, D. (2020). Post-pandemic reconstruction: Airbus can serve as an investment model for Europe. *LSE Business Review.* Retrieved from http://eprints.lse.ac.uk/104769/1/businessreview_2020_05_16_post_pandemic_reconstruction_airbus_can.pdf

Arora, M., Tuchen, S., Nazemi, M., & Blessing, L. (2021). Airport pandemic response: An assessment of impacts and strategies after one year with COVID-19. *Transportation Research Interdisciplinary Perspectives, 11,* 100449–100449. https://doi.org/10.1016/j.trip.2021.100449

Berry, L. L., Danaher, T. S., Aksoy, L., & Keiningham, T. L. (2020). Service safety in the

pandemic age. *Journal of Service Research: JSR, 23*(4), 391–395. https://doi.org/10.1177/1094670520944608

Bielecki, M., Patel, D., Hinkelbein, J., Komoroski, M., Kester, J., Ebrahim, S., Rodriguez-Morales, A. J., Memish, Z. A. & Schlagenhauf, P. (2020). Air travel and COVID-19 prevention in the pandemic and peri-pandemic period: A narrative review. *Travel Medicine and Infectious Disease, 38.* https://doi.org/10.1016/j.tmaid.2020.101939

Bjelicic, B. (2012). Financing Airlines in the Wake of the Financial Markets Crisis. *Journal of Air Transport Management, 21*, 10-16. https://doi.org/10.1016/j.jairtraman.2011.12.012

Boeing. (2022). Boeing Reports Fourth-Quarter Results, *Quarterly Reports Q4* https://investors.boeing.com/investors/investor-news/press-release-details/2022/Boeing-Reports-Fourth-Quarter-Results/default.aspx

Bombardier (2022) Annual Information Form 2021, *Bombardier Financial Reports* https://bombardier.com/system/files/financial-reports/2022-02/Bombardier-2021-Financial-Report-en.pdf

Bouwer J., Saxon S., & Wittkamp N. (2021). Back to the future? Airline sector poised for change post-COVID-19. *McKinsey & Company.* https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/back-to-the-future-airline-sector-poised-for-change-post-COVID-19

Bureau of Transportation Statistics (BTS). (2021, September 15). *U.S. Airlines Show First Profit Since COVID-19 in 2nd Quarter 2021.* https://www.bts.gov/newsroom/us-airlines-show-first-profit-COVID-19-2nd-quarter-2021

BTS. (2021, November). *Passengers: All Airlines - All Airports.* https://www.transtats.bts.gov/Data_Elements.aspx?Qn6n=G

Cain, L. N. & Pascual, M. E. (2021). Loyalty programs: the vital safety feature for airlines to survive COVID-19. *International Hospitality Review.* https://doi.org/10.1108/IHR-03-2021-0017

Centers for Disease Control and Prevention (CDC). (2019). *2014-2016 Ebola outbreak in West Africa*. Centers for Disease Control and Prevention. Retrieved August 15, 2022, from https://www.cdc.gov/vhf/ebola/history/2014-2016-outbreak/index.html

Chikodzi, D., Dube, K. & Nhamo, G. (2021). COVID-19 pandemic and prospects for recovery of the global aviation industry. *Journal of Air Transport Management, 92.* https://doi.org/10.1016/j.jairtraman.2021.102022

Cohen, N. J., Brown, C. M., Alvarado-Ramy, F., Bair-Brake, H., Benenson, G. A., Chen, T., Demma, A. J., Holton, N. K., Kohl, K. S., Lee, A. W., McAdam, D., Pesik, N., Roohi, S., Smith, C. L., Waterman, S. H. & Cetron, M. S. (2016). Travel and Border Health

Measures to Prevent International Spread of Ebola. *Supplements, 65(3),* 57-63. https://www.cdc.gov/mmwr/volumes/65/su/su6503a9.htm

Collings, D., Corbet, S., Hou, Y. G., Hu, Y., Larkin, C., & Oxley, L. (2022). The effects of negative reputational contagion on international airlines: The case of the Boeing 737-MAX disasters. *International Review of Financial Analysis, 80*. https://doi.org/10.1016/j.irfa.2022.102048

Convention on International Civil Aviation, December 7, 1944, https://www.icao.int/publications/documents/7300_orig.pdf

COMAC (2020) *COMAC Market Forecast 2020-2039.* http://www.comac.cc/fujian/2020-2039nianbao_en.pdf

Cuinn, G.O., & Switzerr, S. (2019). Ebola and the airplane – securing mobility through regime interactions and legal adaptation. *Leiden Journal of International Law, 32*(1), 71-89. https://doi.org/10.1017/S0922156518000547

Czerny, A. I., Fu, X., Lei, Z. & Oum, T. H. (2021). Post pandemic aviation market recovery: Experience and lessons from China. *Journal of Air Transport Management. 90.* https://doi.org/10.1016/j.jairtraman.2020.101971

Faber, J., Király, J., Lee, D., Owen, B., & O'Leary, A. (2022). *Potential for reducing aviation non-CO2 emissions through cleaner jet fuel*. CE Delft. https://cedelft.eu/wp-content/uploads/sites/2/2022/03/CE_Delft_210410_Potential_reducing_aviation_non-CO2_emissions_cleaner_jet_fuel_FINAL.pdf

Fairbanks International Airport. (2019). Fairbanks Airport Emergency Plan. http://dot.alaska.gov/faiiap/pdfs/FAI_airportemergencyplan.pdf

Farooq, M. U., Hussain, A., Masood, T., & Habib, M. S. (2021). Supply chain operations management in pandemics: a state-of-the-art review inspired by COVID-19. *Sustainability (Basel, Switzerland), 13*(5), 2504. https://doi.org/10.3390/su13052504

Federal Aviation Administration [FAA]. (2020, January). *The Economic Impact of Civil Aviation on the US Economy.* https://www.faa.gov/sites/faa.gov/files/about/plans_reports/2020_jan_economic_impact_report.pdf

General Electric (GE). (2022*). GE Announces Fourth Quarter and Full Year 20201 Results*. https://www.ge.com/news/press-releases/ge-announces-fourth-quarter-and-full-year-2021-results

Hosseini, S. E. (2022). Transition away from fossil fuels toward renewables: lessons from Russia-Ukraine crisis. *Future Energy, 1*(1). https://orcid.org/0000-0002-0907-9427

International Air Transportation Association [IATA]. (2019). *Air passenger market analysis.* https://www.iata.org/en/iata-repository/publications/economic-reports/air-passenger-monthly---dec-2019/

International Air Transportation Association. (24, January 2020). *IATA Economics' Chart of the Week: What can we learn from past pandemic episodes?* https://www.iata.org/en/iata-repository/publications/economic-reports/what-can-we-learn-from-past-pandemic-episodes/

International Air Transportation Association. (2021, December 2). *What Types of Cargo are Transported by Air?* https://www.iata.org/en/publications/newsletters/iata-knowledge-hub/what-types-of-cargo-are-transported-by-air/#:~:text=Where%20to%20find%20more%20information,jobs%20are%20always%20in%20demand.

International Air Transport Association. (2022). IATA Health Safety Checklist for Air Operators. (4th ed).

International Civil Aviation Organization. (2004). *Protection of Health of Passengers and Crews and Prevention of the Spread of Communicable Disease Through International Travel,* Res A35-12. https://www.icao.int/Security/COVID-19/ReferenceMaterial/Assembly%20Resolution%20A35-12.pdf

International Civil Aviation Organization [ICAO]. (2019). *Annual report 2019.* https://www.icao.int/annual-report-2019/Pages/default.aspx

Islam, T., Lahijani, M. S., Srinivasan, A., Namilae, S., Mubayi, A. & Scotch, M. (2021). From bad to worse: airline boarding changes in response to COVID-19. *Royal Society Open Science, 8(4).* https://doi.org/10.1098/rsos.201019

Kapiti Coast Airport. (2019). Airport Emergency Plan (AEP). https://www.kapiticoastairport.co.nz/media/pdfs/Kapiti-Coast-Airport-Holdings-Ltd_Exposition_Airport-Emergency-Plan.pdf

Karns, M. P., Mingst, K. A., & Stiles, K. W. (2015). *International organizations: the politics and processes of global governance* (Third edition.). Lynne Rienner Publishers, Inc.

Leder, K. & Newman, D. (2005). Respiratory infections during air travel. *Internal Medicine Journal, 35(1),* 50-55. https://doi.org/10.1111/j.1445-5994.2004.00696.x

Lu, C-t. & Sun, H. (2021, December). COVID-19–A Reference List and Visualized Qualitative Aviation Research Themes. *2021 IEEE 3rd International Conference on Civil Aviation Safety and Information Technology (ICCASIT),* Changsha, China, 2021, pp. 301-308, DOI: 10.1109/ICCASIT53235.2021.9633515

Mangili, A. & Gendreau, M. A. (2005). Transmission of infectious diseases during commercial air travel. *The Lancet, 365(9463),* 989-996. https://doi.org/10.1016/S0140-6736(05)71089-8

Martínez-López, F.J., Merigó, J.M., Valenzuela-Fernández, L., & Nicolás, C. (2018). Fifty years of the European Journal of Marketing: A bibliometric analysis. European Journal of Marketing, 52(1/2), 439-468. https://doi.org/10.1016/j.jiph.2017.12.011

Melbourne International Airport - Australia. (2020). COVID-Safe Airport Operations. https://www.melbourneairport.com.au/getmedia/e0e25cc3-74e4-4c87-9375-5e0c04833aae/200901-Melbourne-Airport-COVID-Safe-Plan-Airport-Operating-Standard-(FINAL).pdf.aspx

Minneapolis-St. Paul International Airport. (2021). Travel Confidently Playbook: A comprehensive guide for COVID-19 pandemic response and recovery. https://www.mspairport.com/sites/default/files/2021-01/TravelConfidentlyMSP%20PLAYBOOKv3.pdf

Narita International Airport (2020). Measures to Prevent COVID-19 Infection at Narita Airport. Narita Airport News Release, 1-17. https://www.naa.jp/en/20200612-prevent_corona_en.pdf

Nie, J., Jia, T., Pan, L., Zhang, X., & Zou, J. J. (2022). Development of high-energy-density liquid aerospace fuel: a perspective. *Transactions of Tianjin University, 28*(1), 1-5. https://link.springer.com/article/10.1007/s12209-021-00302-x

Paul, S. K., Chowdhury, P., Moktadir, M. A., & Lau, K. H. (2021). Supply chain recovery challenges in the wake of COVID-19 pandemic. *Journal of business research, 136,* 316-329. https://doi.org/10.1016/j.jbusres.2021.07.056

Pensacola International Airport. (2020). COVID-19 Response Plan. http://flypensacola.com/wp-content/uploads/2020/12/ATR_Plan-102020.pdf

Philadelphia International Airport. (2020). PHL COVID-19 Recovery playbook. https://www.phl.org/drupalbin/media/PHL%20COVID19%20Recovery%20Playbook091120.pdf

Phoenix-Mesa Gateway Airport. (2009). Phoenix-Mesa Gateway Airport Pandemic Response Plan.https://airportscouncil.org/wp-content/uploads/2018/08/PMGA_Pandemic_Response_Plan_05.28.09.pdf

Priest, H. & Roberts, P. (2006, July 12). Reliability and Validity in Research. *Royal College of Nursing Publishing Company. 20*(44). https://link.gale.com/apps/doc/A149022548/AONE?u=purdue_main&sid=bookmark-AONE&xid=b71f3802

Read, J. M., Diggle, P. J., Chirombo, J., Solomon, T. & Baylis, M. (2015). Effectiveness for screening for Ebola at airports. *The Lancet, 385(9962),* 23-24. https://doi.org/10.1016/S0140-6736(14)61894-8

Salkind, N. (2018). *Exploring research* (9th edition). Pearson Education Limited.https://www.pearson.com/us/higher-education/program/Salkind-Exploring-Research-Books-a-la-Carte-9th-Edition/PGM2481416.html

Santos, K., & Delina, L. (2021). Soaring sustainably: Promoting the uptake of sustainable aviation fuels during and post-pandemic. *Energy Research & Social Science, 77*, 102074. https://doi.org/10.1016/j.erss.2021.102074

Schneider, S., Spieth, P., & Clauss, T. (2013). Business model innovation in the aviation industry. *International Journal of Product* Development 12, 18(3-4), 286-310. https://doi.org/10.1504/IJPD.2013.055010

Schwarz-Shea, P. & Yanow, D. (2013). *Interpretive Research Design*. Routledge. https://learning.oreilly.com/library/view/interpretive-researchdesign/9780415878081/

Seattle-Tacoma International Airport - Port of Seattle. (2020). FlyHealthy@SEA. A plan for protecting the health of SEA passengers and employees and restoring confidence in air travel. https://www.portseattle.org/sites/default/files/2020-09/FlyHealthy%40SEA_Sep3_SPREADS.pdf

Shuchi, S., Drogemuller, R., & Buys, L. (2017). Flexibility in airport terminals: identification of design factors. *Journal of Airport Management, 12*(1), 90-108.

St. Pete-Clearwater International Airport. (2020). PIE COVID-19 Action Plan. https://fly2pie.com/docs/default-source/news/press-releases/2020/pie-COVID-19-updated-action-plan-media-release-6-24-20-with-action-plan.pdf?sfvrsn=c64a53db_0

Štimac, I., Pivac, J., Bračić, M., & Drljača, M. (2021). The impact of COVID-19 pandemic on the future airport passenger terminals design. *International Journal for Traffic and Transport Engineering, 2021, 11*(1): 129-142. http://ijtte.com/uploads/2021-01-18/b2dd2cfa-f626-cc75ijtte.2021.11(1).08.pdf

Suk, M. & Kim, W. (2021). COVID-19 and the Airline Industry: Crisis Management and Resilience. *Tourism Review, 76*(4). 984–998. https://doi.org/10.1108/TR-07-2020-0348

Thaichon, P. (2021). COVID in the Aviation Industry: Crisis Management, Its Decisions and Outcomes. In: Ratten, V., Thaichon, P. (eds) COVID-19, Technology and Marketing. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-16-1442-2_2

Timulatk, L. (2009). Meta-analysis of qualitative studies: A tool for reviewing qualitative research findings in psychotherapy. *Psychotherapy Research*, 19(4-5), 591–600. https://doi.org/10.1080/10503300802477989

Tisdall, L., Zhang, Y., & Zhang, A. (2021). COVID-19 impacts on general aviation–comparative experiences, governmental responses and policy imperatives. *Transport Policy, 110*, 273–280. https://doi.org/10.1016/j.tranpol.2021.06.009

Tuchen, S., Arora, M., & Blessing, L. (2020). Airport user experience unpacked: Conceptualizing its potential in the face of COVID-19. *Journal of Air Transport Management, 89*, 101919. https://doi.org/10.1016/j.jairtraman.2020.101919

Transportation Research Board (TRB). (2021, April 16). ACRP 04-25: Airports and Communicable Diseases—Preparedness and Response. https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=5030

Tuite, A. R., Watts, A. G., Khan, K. & Bogoch, I. I. (2019). Ebola virus outbreak in North Kivu and Ituri provinces, Democratic Republic of Congo, and the potential for further transmission through commercial air travel. *Journal of Travel Medicine, 26(7).* https://doi.org/10.1093/jtm/taz063

Tulsa Airports Improvement Trust. (2020). COVID-19 Response Plan. https://www.tulsaairports.com/wp-content/uploads/2020/06/TAIT-COVID_19_Response-Plan-Updated-9-2-20.pdf

Wichita Airport Authority. (2015). *Wichita National Airport Procedures for responding to infectious disease situations and pandemic plan*. https://www.flywichita.com/wp-content/uploads/2018/02/No.15-PROCEDURES-FOR-RESPONDING-TO-INFECTIOUS-DISEASE-SITUATIONS.pdf

World Health Organization. (2016). *International health regulations (2005) Third Edition*. Geneva: World Health Organization. https://www.who.int/publications/i/item/9789241580496

WHO. (2022) *Weekly epidemiological update on COVID-19 - 1 February 2022.* Retrieved from: https://www.who.int/publications/m/item/weekly-epidemiological-update-on-COVID-19--1-february-2022

Youssef, A. B., Zeqiri, A., & Dedaj, B. (2020). Short and long run effects of COVID-19 on the hospitality industry and the potential effects on jet fuel markets. *IAEE Energy Forum* (pp. 121-124).

Yusaf, T., Fernandes, L., AbuTalib, A. R., Altarazi, Y. S., Alrefae, W., Kadirgama, K., & Laimon, M. (2022). Sustainable Aviation—Hydrogen Is the Future. *Sustainability, 14*(1), 548. https://www.mdpi.com/2071-1050/14/1/548/pdf