

Review Article

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COVID-19 and Aviation

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ABSTRACT

The crisis of the COVID-19 pandemic has undeniably affected many aspects of life from conveniences of everyday living to global economic repercussions. Due to the widespread mandated lockdowns early in the pandemic, the economy inevitably suffered greatly as evidenced by the stock market's unpredictability (6) and the 1.8 trillion USD in bailouts to private sectors from the US government. (18) The pandemic imposes a significant strain on several aspects of life as we know it, but the substantial effects on the travel industry, with particular focus on the aviation industry, will be the focus of this paper. This paper discusses various challenges such as the overall effect on the airlines due to the considerable decrease in the revenue of airlines, effect on global cargo transportation, the airworthiness of the aircraft, the profound impact the pilots face concerning the maintenance of their medical certificate and flying currencies, the effects on the pilot's mental health, public health challenges and various considerations for airlines moving forward. Despite these repercussions on the aviation industry due to the mandated shutdowns, the aviation industry had its challenges even before the COVID-19 pandemic. This literature review was conducted via search engines such as Google, Google Scholar, and PubMed with search keywords including "coronavirus, pandemic, aviation industry, lockdown, and airlines".

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Introduction

Outbreak and Epidemiology of the Coronavirus

Initial reports documenting the astoundingly breaking news of the novel coronavirus outbreak in Wuhan, China occurred in mid-December 2019 [1]. Shortly after, the coronavirus spread to the United States by January 20, 2020 [2]. The virus quickly spread, thereby reaching many other countries including Australia, Cambodia, Canada, Finland, France, Germany, India, Japan, Malaysia, Nepal, The Philippines, Republic of Korea, Singapore, Sri Lanka, Taiwan, Thailand, United Arab Emirates, United States, and Vietnam by Jan 30, 2020 [3]. Furthermore, on January 30, data confirming the human to human transmission in the United States was confirmed and documented [3]. Only a few short months later, there are now 51,857 reported cases in 25 countries globally by February 16, 2020 [3]. Due to the global extent of the virus now, the World Health Organization (WHO) declares the coronavirus outbreak a pandemic on March 27, 2020. The asymptomatic spread of the virus is confirmed and documented in April 2020 [4]. Because diagnostic tests are not available early during the virus and the coronavirus has been documented as having the potential of being an asymptomatic disease spread easily from human to human, it is agreed upon that a proper count of persons initially affected cannot be properly estimated or established at this time [5]. An interesting example to highlight the swift spread of the virus is detailed in the Japanese cruise ship, the Diamond Princess. On Feb 3, 2020, the ship arrived in Japan with 2,666 passengers and 1,045 crew members. Only 2 days prior, a symptomatic passenger,

who tested positive for COVID, departed the ship in Hong Kong. A mandatory 14-day quarantine was put in place by February 5th when several other passengers tested positive. By the 18th of the month, 14% of the passengers and crew members were positive. Ultimately, the Diamond Princess had an infection rate of 19.2%. Interestingly, during this time, the United States had only 15 confirmed COVID cases. The CDC had to act fast to implement public health travel restrictions [6].

Pre-COVID Aviation Industry Concerns Pilot Shortages

Prior to the pandemic, airlines and other companies relying on pilots were concerned due to facing an upcoming pilot shortage [7,8]. The hiring boom in the late 1990's is resulting in thousands of pilots at the major carriers approaching the mandatory retirement age [9]. Boeing releases their statement about this concern regarding the upcoming pilot shortage due to many current pilots quickly reaching the required retirement age of 65 back in June 2019 [7,10]. In addition to the upcoming shortage of pilots, Boeing forecasts a predicted 800,000 new pilots will need to be hired over the next 20 years due to the projected rapid growth of the aviation industry [7]. Additionally, the lower paying entry-level positions for commercial pilots and the high retention of Air Force military pilots has reduced the pipeline for pilots with the specific qualifications needed to work for an airline [9]. Despite the history of Air Force retention of pilots, there have also been periods of time where the Air Force has decreased its number of pilots. This

is an additional reason there was concern of pilot shortage as the military is a large contributor of pilots to the airlines [11].

Combatting pre-COVID challenges

There are large implementation measures by major airlines due to these concerns. For example, in February 2020, United Airlines purchased a flight school to train aspiring pilots. This act made them the only major United States airline industry to own such a training facility [12]. In addition to United's measures to train upcoming pilots by purchasing their own training academy discussion of and technological advances regarding self-flying, pilotless planes to combat these concerns of upcoming pilot shortages [13]. Talks of change and technology advancement were being discussed well in advance to the COVID-19 pandemic [12,13]. Airbus and Boeing are creating and test flying their prototype self-driving air taxis in 2019. This is accomplishing a huge step in the direction toward the future of air travel by potentially changing the traditional 2-pilot cockpit to a single pilot cockpit or even a pilotless cockpit to compensate for the predicted pilot shortages [13]. Little did the airlines know, the novel coronavirus would quickly provide them with an ironic solution regarding their pilot shortages. Now, due to the shutdowns, the airlines have too many pilots as flights are being drastically cancelled. For this reason, many employees are subsequently, temporarily, or indefinitely, furloughed [7,8,14].

Impact of Shutdown on the Economy September 11, 2001

We know from history how devastating airline shutdowns can be to the global economy and the airline industries. After the September 11, 2001, terrorist attacks, all flights were temporarily grounded. Despite shutdowns and mass cancellations of flights, a full grounding of all flights did not happen because of the pandemic. After 9/11, there was a significant decrease in the number of airline passengers for a year straight [15].

Aviation Industry

In contrast to a potentially beneficial environmental outcome of the pandemic being a decrease in levels in carbon emission and air pollution due to the lessening of air and car travel there are numerous negative economic consequences from the shutdown of the aviation industry [16]. Initially, concerns rose regarding the extent of transmission of the virus due to the uncertainty about the risk of transmission in an enclosed aircraft cabin full of passengers during air transportation (7) since the virus has known human to human transmission [17,18].

When lockdowns are mandated, travel restrictions put in place, and global quarantines issued, traveling becomes virtually impractical during this time due to flight cancellations [19,20,22]. And, therefore, a significant decrease in the number of international passengers [20,22]. According to the Transportation Security Administration's (TSA) website, on April 14, 2020, 87,534 passengers (about the seating capacity of the Los Angeles Memorial Coliseum) crossed security checkpoints, a startling 96% decrease in contrast to the 2,208,688 passengers a year earlier on April 14, 2019. While the current number of daily passengers has risen to 586,718 as of August 19, 2020, this is still a significant 74.5% decrease from the 2,306,838 travelers (about twice the population of New Hampshire) reported on the same day a year prior. (17) As of October 19, 2020, TSA states there is a 60% reduction in volume of airport passengers from this time last year [23,24].

ICAO (International Civil Aviation Organization) presumes a worldwide loss of up to a \$253 billion (about \$780 per person in the US) USD in gross revenue of airlines, in the worst-case

scenario [25].

Airlines

The lockdown affects globalization, technology, and, subsequently, the sustainability of major airlines including but not limited to Austrian Airlines, Virgin Australia, and many other airlines expressing their concerns as they are considering potentially declaring bankruptcy [19,20]. Virgin Atlantic declared bankruptcy in August 2020 as most of their destinations are international [21]. Delta Airlines reports a loss of \$60 million a day due to aircraft groundings, while British Airways cut tens of thousands of jobs [22]. European airlines predict a loss of 90% in capacity due to current restrictions [22]. In August 2020, the combined loss of revenue for the biggest 4 United States airlines over the preceding few months is 10.3 billion USD. The Crash-burn analysis from the International Air Transport Association (IATA) predicts a potential 244–420-billion-dollar gross revenue loss for the year of 2020 [19]. As flights are cancelled, larger aircraft are put away since they will not be in use and current flights are being rerouted [24].

Cargo

In addition to the airlines being obviously negatively affected due to decreased numbers of passengers, the air cargo industry was also significantly affected by the coronavirus pandemic. During this time, there is an increase in the need for shipment of medical equipment including personal protective equipment to the United States from China, as healthcare workers cannot work virtually. Furthermore, there is also a generalized increase in the need for shipment of food and supplies due to the widespread decreased availability of items in the grocery stores secondary to customers buying products out of panic. Thus, the decreased number of flights out of Wuhan, China led to a significant air cargo capacity deficiency as China is the largest exporter to the United States in terms of medical devices [21,28]. Figure 1 shows a drastic decline in the number of thousands of flights from January through May 2020 regarding China's departure flights [28].

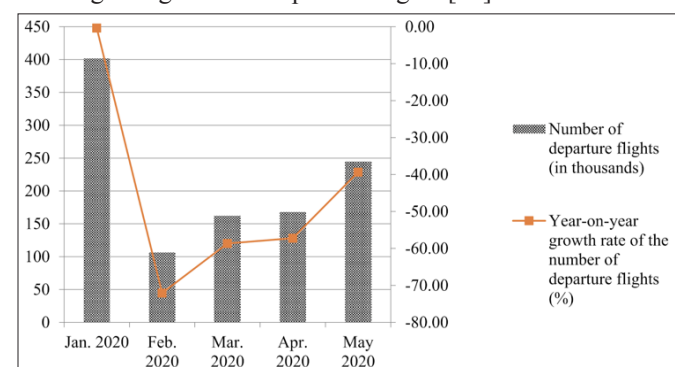


Figure 1: Graph showing a drastic decline in the number of thousands of flights from Jan -May 2020 regarding China's departure flights [28].

The Future of the Aviation Industry

The "New Normal" - Public Safety Measures

Despite limited research on the spread of COVID-19 during a flight, there is plenty of research that demonstrates other respiratory-spread diseases, such as tuberculosis and influenza, are easily spread in these conditions [29]. The near future of the airline industry will look different due to substantial changes required as the result of COVID-19 on the airlines and the paying customers. Social distancing in airports and on flights will be one of the new expectations for passengers [14]. A survey conducted revealed over 75% of the frequent flyers questioned were concerned regarding contracting a respiratory illness during a flight. Most of the survey

respondents also expressed those airlines should provide masks, hand sanitizer. For the future, careful consideration of public health safety measures and the financial responsibilities of the airlines will continue to be a delicate balance as airlines continue to adapt to COVID-19 precaution regulations. For example, a practical measure of social distancing on flights includes selling less tickets to keep the middle seat open and unoccupied on flights [30]. However, these measures to protect the health of the public significantly decrease revenue for airlines [31]. Costs of tickets will need to significantly raise (a 43-54% increase in cost) for airlines to merely break even if social distancing measures are enforced. (21) This makes travelling by air significantly less affordable, as described in Table 1. (Despite the need for an increase in ticket price for the sake of airline's income, Jeff Hoffman, the Global Entrepreneurship Network board chair, states the cost of airline tickets are down by 25% over the past month as of October 19, 2020[33]. This is good for the consumers, but obviously not ideal for the airlines [24].

	BREAKEVEN LOAD FACTOR	AVERAGE FARE 2019	AVERAGE FARE WITH SOCIAL DISTANCING	INCREASE
Africa & Middle East	75%	\$181	\$259	+43%
Asia Pacific	81%	\$141	\$217	+54%
Europe	79%	\$135	\$201	+49%
Latin America	79%	\$146	\$219	+50%
North America	75%	\$202	\$289	+43%
North Asia	76%	\$135	\$195	+45%

Table 1: Percent increase in the cost of an airline ticket in 2020 when compared to 2019 when social distancing measures are implemented per the IATA website [32].

Many airlines have changed their boarding process to accommodate social distancing and other preventative measures. Ironically, one study found the newly implemented "back-to-front boarding process" to be increasing COVID-19 exposure despite measures to do the opposite [33]. In addition, certain measures, such as temperature screening, have been shown to be unreliable or inadequate [29].

A simulation study notes COVID-19 testing (Testing with rapid antigen same-day test or RT-PCR within 3 days of trip) for asymptomatic travelers seems to be a beneficial health and safety measure put in place by airlines. However, they also note post-travel COVID testing along with 5 days of quarantine is still needed to reduce transmission [34]. Antigen testing can be more readily available and exceptionally reliable, however; certain countries are only accepting PCR as means of proof of a negative test. There are even trials suggesting dogs can sniff out COVID positive patients at a higher sensitivity than antigen tests [29].

Air Canada, Qantas, Cathay Pacific, United Airlines, and many others have updated their websites to include information regarding current protocols they are implementing to reduce COVID-19 transmission. When a group of frequent flyers were surveyed, they stated these measures by the airlines helped them feel safer while traveling [30].

Interestingly, the airlines in six Arab countries (Saudi Arabia, the United Arab Emirates, Oman, Qatar, Bahrain, and Kuwait) show that less than half of the airlines had self-assessment measures in place. Additionally, not all the airlines in these countries required

the use of face mask during flight [36].

Will the Airlines Recover?

When discussing the potential post-COVID return to function regarding the airline industry, many considerations must be discussed. For example, many airlines are requesting financial funding from the government due to COVID-related economic losses. This is putting additional pressures on the government. Besides, the full reopening and recovery of airline industries is vital not only for the airlines, travel, and tourism but also for global cargo needs as discussed above [36]. Additionally, it takes airlines a surprisingly full 22 months to return to pre-9/11 levels [15]. The United CEO predicts a full airline recovery by 2024 while the Airbus CEO predicts the industry might need up to 5 years to reach pre-COVID-19 levels Jeff Hoffman, the Global Entrepreneurship Network board chair, states he does not believe airlines will return to pre-COVID levels due to technological advancements cutting the amount of future business traveling by allowing meeting to be conducted virtually instead of in person [22,24]. A current prediction from the Department of Biostatistics at Harvard states airline travel internationally could be up to 58% pre-pandemic level [24,37].

Impact on Pilots

Currency Requirements and Temporary Extensions

In addition to the evident impression that COVID-19 has made in the aviation industry comprising components such as the airlines, tourism, and cargo, pilots will have to explore the lockdown and what it means for their future careers concerning their medical certification and currency requirements to maintain a license[38]. According to Cahill et al., 2020, "COVID-19, the aviation industry will not be the same, and nor will those who remain working in the industry." As more flights are grounded and fewer passengers are traveling, fewer jobs are now available for pilots [38]. ICAO is potentially granting temporary extensions of upcoming expired medical certifications for a particular period during the COVID-19 pandemic via the Civil Aviation Authority (CAA) to increase flexibility and relieve some of the ongoing stressors that pilots are already facing from the pandemic [39]. Due to practical limitations in renewal during this public health crisis, the FAA is also temporarily amending their rules to grant leniency concerning their usual strict requirements regarding medical certifications and knowledge-based examinations. These amendments allow for the continual use of pilots who may have otherwise expired in terms of currency. For example, pilots must complete three takeoffs and three landings during the preceding 90-day period to stay current; however, an additional 60 days has been granted by the FAA to meet this requirement due to limitations in renewal. Moreover, before these temporary extensions were put into place, airline pilots are required to obtain a medical and physical exam every 6 months. These temporary amendments help grant leniency during the unprecedented times of reduction in the number of flights and, therefore, complications of fulfilling the currency and medical certificate requirements [16,40].

Mental Health

As a result of the decline in job availability and stress imposed on an already stressful career, significant strides in increasing the screening for mental health issues have already taken place in the form of mental health apps and websites, thanks to technological advances and app development. Certain airline safety agencies, such as the European Union Aviation Safety Agency, have implemented systems to manage and monitor pilot safety and risk [38]. The Federal Aviation Administration, who distributes medical certificates to pilots, should not ignore the profound impact of

the coronavirus on the pilot's mental health and should include additional screening questions in the required medical certificate renewal appointments [41]. One study of pilot's health during the pandemic reported a significant increase in mental and physical health including an improvement in self-reported sleep quality after a 17-week program that focused on sleep, diet, and exercise for pilots [42]. The control group of pilots who did not undergo the interventional program reported a significantly worsening of quality of sleep. An increase of sleep quality will improve pilot performance and safety during flight [42]. Physicians of pilots must stress the importance of a healthy diet, physical exercise, and good sleep quality to improve physical health, mental health, and flight safety, especially during the pandemic [1,43].

Conclusion

Initial reports of the breakout of the novel coronavirus in Wuhan, China occurred in mid-December 2019. Shortly after, it spread to the United States in January and was declared a pandemic in March. The coronavirus interrupts countless parts of our world today as evidenced by the global economic impact seen. There is a particularly evident impression on the aviation industry. The decrease in the number of travelers due to the lockdown has considerably and drastically negatively impacted the aviation industry. This is demonstrated by significant monetary loss which leads to airline bankruptcies. Furthermore, potentially increased ticket prices are put in place to combat these monetary losses. To compensate for monetary losses due to public health safety measures such as in-flight social distancing measures (selling less tickets and not putting passengers in the middle seats), airlines will need to raise ticket prices to cope with the losses.

Before the COVID pandemic, there were already concerns in place regarding the aviation industry. Such apprehensions included an upcoming pilot shortage due to many pilots quickly reaching the mandated retirement age. Ironically, when COVID-19 hit, airlines were now faced with challenges of having too many pilots due to the cancellation of numerous flights and having more employees than necessary. Flights have been significantly restricted during the coronavirus pandemic, but a full grounding of all flights did not occur as did after the September 11 attacks. It took about 22 months for the airlines to return to baseline after the complete grounding of all flights. It will be interesting to see how long it takes the airlines to recover after the coronavirus' shutdown of airline flights as Airbus' CEO predicts needing a full five years to return to pre-COVID levels. In addition, the furloughs and early retirements offered to pilots due to the excess of pilots and the shortage of flights will leave the airlines without enough pilots when they return to pre-COVID schedules, a stark contrast to the pre-COVID pilot shortage concerns.

In addition to the evident impression of COVID-19 in the aviation industry including the airlines, tourism, and cargo, pilots will also have to explore the lockdown and what it means for their future careers concerning their medical certification and currency requirements to maintain a license. The pilots have been severely impacted due to the decrease in job availability, furloughs, and the increase in job-related stressors. Due to the displacement of pilots to other equipment and forcing the newest pilots with the least seniority off their aircraft and on to other equipment. For these reasons, training increases dramatically despite a reduced number of flights due to pilots being reassigned to new aircraft. Now airlines are faced with more challenges such as paying pilots overtime to train in simulators for their newly assigned aircraft despite the reduction in number of flights.

Some of the profound challenges the pilots face due to the pandemic, such as the feasibility of maintaining their flight currencies and medical certificates, are counteracted by favorable amendments and temporary rules leniency grants by the FAA and ICAO to support the continuation of pilots working despite currency issues. In addition to these logistic challenges regarding licensing and certification maintenance despite decreased job availability due to cancelled flights, the pandemic has also taken a toll on the mental health of pilots. Some suggestions would be to implement advanced screening tools into the pilot's future medical screening appointments to monitor them for changes in their mental health status due to these ongoing stressors. In addition, implementing new mental health apps to check in on the pilots before flights and warn them of symptoms experienced by those with deteriorating mental health could be beneficial.

Going forward, future aspects of the airline industry must be altered after special considerations are implemented. The "new normal" moving forward in the aviation industry and, specifically, airline travel will include social distancing measures and other public health safety measures provided by the Centers for Disease Control and Prevention (CDC) and the WHO. Undoubtedly, the coronavirus has had a significant impact on the economy, travel, cargo, airlines, aircraft, pilots, and many other components of the aviation industry.

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No ethical approval required.

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The authors declare no conflict of interest.

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