Analysis of airline delay distribution differences

Transportation, Airlines

The open skies used to be a vast open space where a pilot could take an aircraft and not worry about bumping into anyone else because it was a unique and exclusive luxury. Today, it is the fastest form of transportation via a private or commercial aircraft that is affordable to all. Every day, there are hundreds of airplanes flying at any given moment taking people to their destination. At certain locations get more popular, it increases the traffic flow of aircraft flying in and out of these airports. Eventually, like a car traffic jam, there will be too many airplanes wanting to fly then the airspace can support. Add in maintenance problems from highly complex systems as well as increasing security and complex business organizations where certain issues can throw a wrench into the turning cog and low or stop the constantly moving machine. All of these different issues can bring about a delay that slows a passengers travel plans and may lower an airlines profit margins. This is why it is important to know and understand if passed actions to correct these problems are being effective and how the delay causes are distributed to know which cause of delay needs the most attention. That is why this study investigated if the distribution of delays from 2016 is different from 10 years before. This would show if any specific delay causes have changed for the better or worst, and if delays overall have decreased.

Multiple studies have examined the cost of these delays from loss of business by the airlines to the emotion effectives it bring on to the airlines' customers. At first, there will be a brief review of some of these reports are covered to further show that delays are a pertinent issue and how it specifically affects the airlines and their customers to illustration that it would be an opportune investment into finding ways of reducing delays.

Next, a review of the methods used will be discussed in detail providing where the data was collected and why the type of statistical analysis was used. After, the results will be revealed and reviewed to show if there was any significance discovered. Finally, this research will conclude with a discussion on how these finding related back to previous research and how it can improve the aviation community’s understanding on this subject.

Brief Literature Review

Based on the topic question if the distribution of airline delay causes are different more recently than in the past, it is ideal to address why this is an important issue to pursue. For airlines, delays can become a costly problem in already expensive venue. Ryerson, et al. (2014) studies the effects of delay caused by the National Airspace System (NAS) on the cost of fuel and time against the air carriers. This relates to the current topic by addressing the second biggest reason for delay in 2016, as shown in Table 1 at approximately 29. 5%, which is really the number one initial delay cause since late arrivals is the after effect delays created by an initial delay. Due to the mass amounts of aircraft that are traveling at a given time, there are congestion problems that occur at some of the most heavily trafficked airports. The NAS manages the flow of traffic, and depending on the way they operate, it can help reduce en route and gate delays, and terminal inefficiencies, which in turn can diminish airline fuel and time costs, and environmental effects. Ryerson, et al. (2014) examined these effects by recording actual flight data along major routes of flight and compared it to an ideal or originally requested route of flight. It was discovered that by

eliminating delays caused by NAS operations, it could reduce fuel consumption by 11 – 12%,.

About 75% of that value came from reducing terminal area inefficiencies, and the other 25% came from en route delays from airborne and departure delays, and excess flight time. Ryerson, et al. (2014) have concluded differences in terminal efficiency have a much larger impact on fuel consumption then delay does and that their benefit pool associated with improving terminal efficiency are much greater than other studies. By reviewing this study’s data, the overall number of NAS delays has decreased by 40% in 10 years that shows improvements have been made. However, it is still the biggest initial cause and thus can be reduced even more through the NAS and air carrier’s efforts. The next largest cause of delays comes from the air carrier’s control of its own operations.

Fageda and Flores-Fillol (2016) study the ways that airlines change their frequencies of flights according to delays and their type of network at the airport. This relates to this study but review that actions performed by air carriers in response to airport congestion and if there are any improvements attempted to counteract the negative results. There are two different network types of operation for airlines, either hub-and-spoke or fully-connected. A Hub-and-Spoke (HS) method, used by most major air carriers, involves a major airport center to bring people to a centralized location to maximize airplane capacity and exploit economies of traffic density. A Fully-Connected (FC) method, used mostly by low-cost carriers, is a point-to-point service that goes from origin to destination directly.

Fageda and Flores-Fillol (2016) found that there is an average price reduction for every minute of delay of $1. 42 for direct passengers and $0. 77 for connecting passengers. This increase in delays raises prices and reduces demand for air travel, which hurts airline growth and prosperity because even a 10% decrease in delays can benefit the airlines about $7 per passengers. Fageda and Flores-Fillol (2016) ascertain that airlines using FC reduce their frequencies as delays increase at airports, whereas air carriers using HS escalation their frequencies. The reason for this escalation is a preemptive strategy used to avoid losing market power and provides passengers flying from a HS airport the benefit of higher frequencies and a greater number of non-stop destinations, even at the expanse of greater congestion. Again, air carrier and aircraft late arrival delays have gone down in 10 years but airports with a HS system presents a possible causes for these two delays maintaining high numbers. Another major topic about flight delays is how it affects ticket prices and the air travel market. This topic can help drive the reasoning behind why certain changes need to be made sooner than later and improve the way air travel is performed. F

orbes (2008) tests how the price response varies at different level of market competition and comes to a similar conclusion as Fageda and Flores-Fillol (2016) that prices fall by $1. 42 on average for each minute of flight delay. Forbes (2008) conducted his study at LaGuardia airport after the Reform Act for the 21st Century occurred to exploit the exogenous shock to the length of flight delays created by allowing new flight route to be addition into and out of the busy New York airport. Flight that flew into competitive markets, it was

discovered that there was a significantly larger price response, approximately $2. 44 per minute of delay, than on non-competitive routes.

Another result observed from the after effects of flight delays is the drop in service quality, which has a strong negative effect on the market price in competitive markets. Forbes (2008) concluded that passengers tended to have a lower willingness to pay for high prices at competition airports but at airports that are less competitive, the price elasticity is much smaller. Finally, an extra look at the way flight delays effect people’s emotions and customer behavior is necessary to get down to the core of why these delays are negatively effects the airline business.

Kim and Park (2016) identify the influence of airline service delays on emotional responses and customer behavior through a survey with 396 respondents after they experienced such a delay. Kim and Park (2016) investigate not only the negative reaction but also the positive and how it affects negative word-of-mouth and future flight purchases. These service delays produced a level of uncertainty in the passengers after their internal acceptable waiting time had been exceeded, which changed their emotions from positive to a negative reaction. Passing the acceptable threshold, it significantly influenced anger that negatively influenced the passenger’s repurchase intention and negative word-of-mouth about the airline. However, if the service delay was maintained at a reasonable length or a reasonable purpose for the delay was provided, passengers maintained a positive behavior and had a good response to the airlines. This relates back to the current study by showing the importance of knowing if the number of

delays have changed from the past, either for the better or worse, and which causes are the biggest contributors. Depending on the outcome, a new course of action can be produced to try and reduce the number of delays and improve the airline business.

Review Methods

To answer this study's question, valid data was required to be obtained by a reliable source. The Bureau of Transportation Statistics (BTS) requires that airlines that have 1% of total domestic scheduled-service passenger revenue report on-time data and causes of delay, which has been recorded since 2003 with 12 major airlines involved today. The total delay data from 2006 and 2016 was collected from the BTS website and split according to their categories. The data collected from 2016 can be viewed in Table 1 and the data from 2006 in Table 2. To conduct an accurate analysis of finding if the distribution of delay causes in 2016 is different from 10 years in the past, 2006, a Chi-Square Goodness-of-Fit test was performed. The type of outcome measure for this data is nominal because the measurement differentiates between delay causes, which are qualitative classifications. There are no cross-classified observations and it is to perform a hypothesis test about the distribution of a qualitative variable, a Chi-Square Goodness-of-Fit test is appropriate. To ensure that a Chi-Square Goodness-of-Fit is appropriate for these numbers, three assumptions need to be satisfied, and Table 3 shows the goodness of fit calculation numbers. The first assumption is that all expected frequencies are 1 or greater. This is good because all the expected frequencies are greater than 1. To find the expected frequency, the observed frequency of the 2006 data was converted into relative frequency and then

this was multiplied by the total observed frequency of the 2016 data. Next, the second assumption states that at most 20% of the expected frequencies are less than 5. This is valid because none of the expected frequencies are less than 5. Finally, the third assumption states that this is a simple random sample. This can be considered satisfied because this is a sample number and not the entire population number of all United States flights. Also, it is required that " air carriers report on operations to and from 29 United States airports that account for at least 1% of the nation's total domestic scheduled-service passenger enplanements". This means it is a sample that is randomly provided by the air carrier put together for statistical purposes.

Due to the air carriers providing all this information, a very large sample size of 1, 043, 738 is used, which provides reliable results and should accurately detect if there is a difference. This test was performed at the 5% significance level, α = 0. 05. Using the G*Power application, it computed that using a post test in the Chi-Square family, that the power from this sample would be essentially 1, meaning that the sample is so big that the probability that this test will reject a false null hypothesis guaranteed.

Results

The null hypothesis used was that the 2016 airline delay causes distribution is the same as the 2006 distribution, with the alternate being the opposite. The Chi-Square Goodness-of-Fit test was performed via StatCrunch online website, which produced the results shown in Table 4. The Chi-Square statistical value is extremely large, which was to be expected with a large sample and if there was a difference between the data. The P-value was

calculated to be smaller than 0. 0001, which is less than the specified significance level of 0. 05. The test results indicate that the 2016 airline delay causes distribution is different from the 2006 distribution, χ 2 (6, N = 1, 043, 753) = 12, 420. 43, p < 0. 0001. This can be interpreted that at the 5% level, the data does provide very strong evidence against the null hypothesis and it can be concluded that the 2016 airline delay causes distribution is different from the 2006 distribution. The results show that there is differences in distribution, which can be seen in Table 3 when comparing the observed and expected frequencies.

The critical Chi-Square statistic was 12. 59, which is the value that this study's Chi-Square test statistics need to be bigger than to reject the null hypothesis. The calculated test statistic was 12, 420, which much higher than needed that came about because of the large sample size. To examine the actual effect size of this statistically significant results, a post test using G*Power was performed. Again due to the sample size, the effect size was computed to be very small, w = 0. 004. Conclusion Since it can be concluded that there is a difference in the distribution of airline delays now than in the past, corrective actions can be validated. Looking at the data in Table 1 and 2, it can be deduced that the number of delays have gone by approximately 40%, which means that the NAS and air carriers' improvements have been working. The number cause of delays has changed from the NAS to aircraft late arrivals, and the NAS almost being as low as the air carriers. To lower late arrivals would require all the other reason to be lowered since it represents the after effects of an initial delay as it continues on with the remaining flights that day. This relates back to the previous research by

showing that the airlines and government do consider the effects of delays serious.

All the issues that were discussed from the other reports had an economic effect on the airlines and to continue making profits and maintaining a good business, this data shows that they have made necessary changes to operations to improve their efficiency by 38%. The government controls the NAS through the Federal Aviation Administration (FAA) and the data shows that an effort was put into improving airspace congestion and air traffic controller usage to better streamline the system by about 46%. Also, security delays had become so low that it only pertains to 0. 2% of the delays. This all means that this research’s results point to vast improvements within the last decade.

These findings help anyone better understand that flight delays are a cause for concern and that they are being reduced. This provides the implications that as time progresses, delays should continue to decrease and reduce the cost of operations for the government, airlines, or anyone flying an aircraft for travel. To successfully continue reducing these numbers, another study should be performed to find what has changed in the NAS or airlines specifically. This would provide feedback to validate any changes that were made to improve airline performance. Viewing the data, the number of delays due to weather and the national aviation system has gone down in frequencies possibly due to the improvement in technology. Getting the necessary feedback may help to discover what may need to be changed as new technology and new issues arise in the world. By knowing how the

aviation community has changed itself over the years, it allows everyone to better understand how aviation must continue to progress to become safer and most efficient.