IMPACT OF WEATHER FACTORS
ON GO-AROUND OCCURRENCE

by

BHARATH DONAVALLI

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Civil Engineering at
The University of Texas at Arlington
May, 2016

Arlington, Texas

Supervising Committee:
Stephen P Mattingly, Supervising Professor
Siamak A Ardekani
James C Williams

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to professor Dr. Stephen P Mattingly for lending his support and steering me in the right direction, both in research and course work. His guidance, mentoring and knowledge helped in the successful accomplishment of this study.

I thank the National Aeronautical and Space Administration/ Federal Aviation Administration facility, North Texas Research Station for providing the Airport Surface Detection Equipment, Model X (ASDE-X) data.

ABSTRACT

IMPACT OF WEATHER FACTORS
ON GO-AROUND OCCURENCE

Bharath Donavalli, MS
The University of Texas at Arlington, 2016

Supervising Professor: Stephen P Mattingly

A “go-around” occurs when an aircraft, which is on final approach, aborts it landing due to unsatisfactory conditions. Go-arounds have a significant impact on the capacity of the airports and pose a serious concern at large airports, especially for airports with diagonal runways.

Go-arounds occur due to manual errors, mechanical faults and weather factors. This study focuses on the impact of weather factors on go-around occurrence. The study includes wind gust, storm events (thunderstorm, rain and snow) and visibility as the weather factors under investigation. The author uses a factorial sampling strategy where these factors are segmented into additional categories to create a sampling matrix. After classifying all days into one of the matrix cells, the study randomly selects a single day from each cell for a total of eighteen 18 days.

The author uses Airport Surface Detection Equipment, Model X (ASDE-X) data for this study. After cleaning the raw data and extracting the arrival aircraft data, the researcher identifies the total number of go-arounds using mapping software.

The study compares the categories for each factor of interest to determine if their go-around rates appear significantly different from each other using the two proportion Z test. The statistical analysis indicates that wind gust (>29 mph) and thunderstorm significantly increase the probability of a go-around. However, visibility does not show a significant impact.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

CHAPTER 1

INTRODUCTION

The United States had more fatal aviation crashes than any other nation. According to the Aviation Safety Network, a total number of 10,625 fatalities occurred since 1945 (Flight Safety Foundation, 2016). In 2014, 1287 civil aviation crashes occurred, resulting in 261 fatalities (National Transportation Safety Board).

According to the Boeing 2014 statistics shown in Figure 1, most of the fatal aviation accidents (48%) are observed within the final approach and landing stages (Boeing, 2015). This proves that the final approach and landing stages are the critical stages in airborne operation. Pilots may avoid an incident at the final approach stage by aborting landing and returning to the landing path when the conditions are satisfactory. This process of aborting the landing of an aircraft which is on final approach is called a go-around.

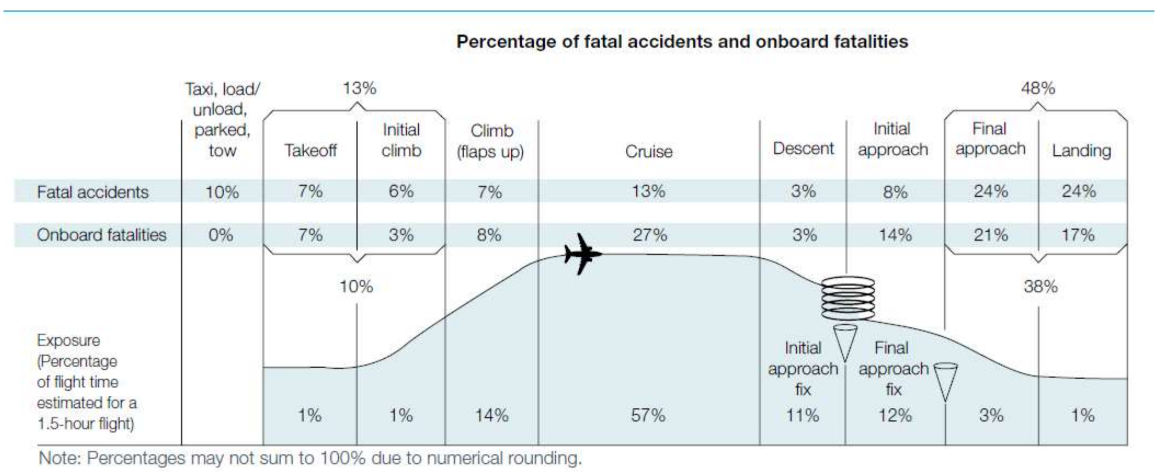

FIGURE 1 Percentage of fatal accidents and onboard fatalities *(Boeing, 2015)*.

A go-around has a significant effect on the capacity of airports with diagonal runways. When an arriving aircraft on the diagonal runway has to perform a go-around (Figure 2), it might collide with an aircraft taking off at the same time on a parallel runway, at the point of intersection of flight paths/ traffic patterns of two runways (circle marked portion in Figure 2). In order to avoid this conflict, air traffic operators halt the takeoff operation on parallel runways until the arriving aircraft takes a taxi way or performs a go-around. This shows the interdependency of the operations of the two runways. This scenario has a significant effect on the capacity of the airport during peak hours.

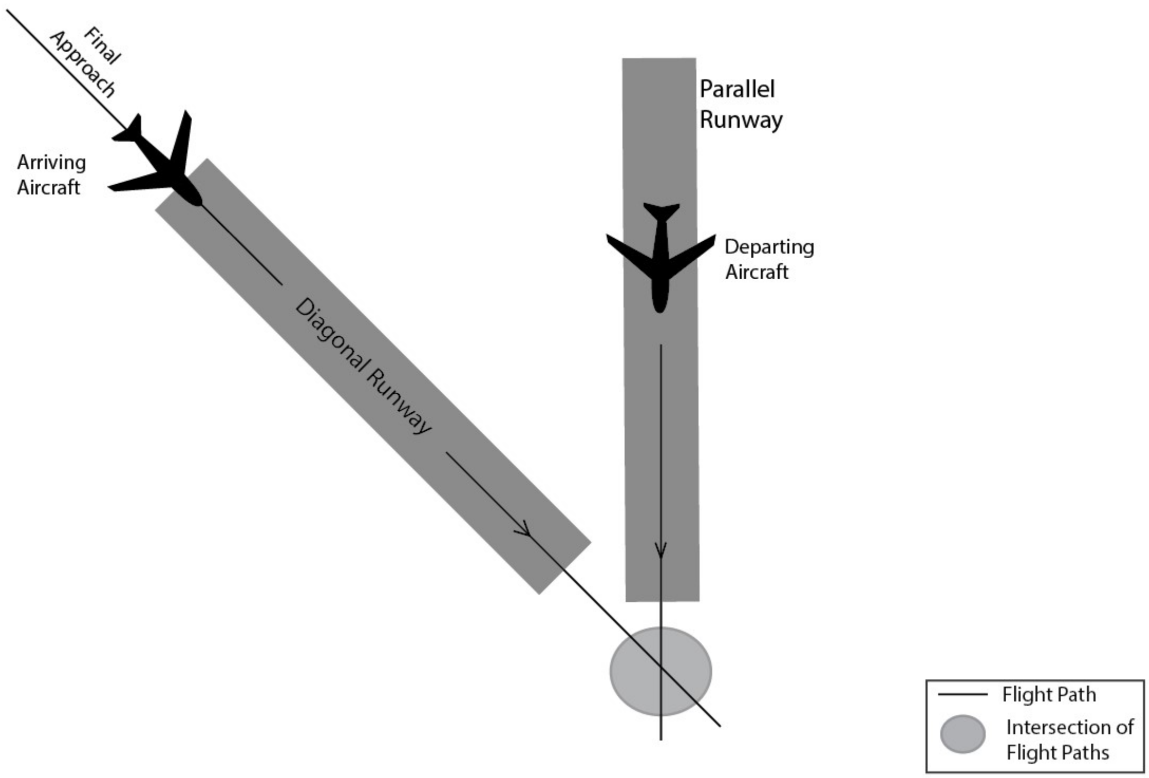

FIGURE 2 Intersection of flight paths of diagonal runways.

Understanding the possible causes for go-arounds may allow air traffic control to increase the operational efficiency of an airport during the peak hours. Realizing this need, the study tries to identify the weather factors that influence or impact the need for a go-around operation. In addition, the study analyzes the impact of the identified weather factors at different levels, on the go-around occurrence rate by performing statistical tests. The study also aims to develop a model that defines the proportions of daily go-arounds with these identified factors. The study provides a detailed description of identified key weather factors and assess their impact on go-around occurrence. Airport agencies can use the proposed framework to understand the risk and causes of go-arounds, and plan airport operations accordingly.

CHAPTER 2

CIRCUMSTANCES LEADING TO A GO-AROUND

The following circumstances may lead an aircraft to perform a go-around:

- Obstacles on the runway: Landing has to be aborted when obstacles are present on the runway safety area, which is an imaginary surface surrounding the runway (Federal Aviation Administration, 2004).
- Separation: Separation is the minimum vertical, lateral and longitudinal distance that an aircraft has to maintain from another aircraft to avoid a collision. If proper separation is not maintained by an arriving aircraft from the preceding arriving aircraft or departing aircraft on the same or diagonal runway, a go-around has to be performed to avoid a conflict (Namowitz).
- Inclement weather conditions (events): Thunderstorm, fog, snow, and rain are the weather conditions that may lead to go-around (Federal Aviation Administration, 2004).
- Wind: During heavy wind conditions, wind gust in particular, an aircraft may tend to lean in the direction of the wind, and thus, the aircraft will miss the center-line alignment with the runway and has to go-around (Federal Aviation Administration, 2004).
- Visibility: Lack of visibility may also lead an aircraft to abort landing. Sometimes birds are also a reason for poor visibility.
- Glide path: If an aircraft does not maintain the exact line and rate of descent to land, might miss the exact touchdown point and has to abort landing. (Federal Aviation Administration, 2004).
- Aircraft mechanical problems: Most aircraft crashes occur due to mechanical problems caused by turbulence, landing gear, engine, etc. (Federal Aviation Administration, 2004).

This study focuses on the impact of wind gust, storm events (thunderstorm, rain and snow) and visibility factors on the go-around occurrence rate and developing a model with these factors that defines the proportion of daily go-arounds.

CHAPTER 3

METHODOLOGY

This study uses observed and recorded flight data to assess when a go-around occurs. The go-around rate may vary depending on the weather conditions; the study determines the aggregate go-around rate on a daily basis. By combining the daily go-around data with the observed weather conditions, the author may establish comparative scenarios for different conditions and explore the aggregate go-around rates for statistically significant differences. The Case Study section provides a detailed presentation of the comparative scenarios and sample structure considered in this particular study. The rest of this section provides a description of the data used in the study and the procedure necessary to clean and use it.

Data Type

Airport Surface Detection Equipment, Model X, or ASDE-X is a safety tool that detects potential conflicts on the runways and taxiways by tracking the location of aircraft and airport vehicles at each second. The location data of aircraft and vehicles are obtained from surveillance radar located on the top of the aircraft and remote tower, and other surveillance equipment present at the airport. ASDE-X tracks the aircraft flying within a 5-mile radius of the airport (Federal Aviation Administration, 2010).

ASDE-X stores the track data in an XML format. At each second, the location (longitude and latitude), altitude, track number (specific number given to an aircraft when the tracking starts for the first time), name and other relevant information of the aircraft are stored.

Data Cleaning

ASDE-X may not record complete information for every aircraft at each second, which creates missing fields. These missing field values may be obtained from other data points in the same flight track. The analysis of go-arounds only requires a subset of all of the ASDE-X data fields (i.e. altitude, longitude, latitude, track, and time). The cleaning of the raw data to obtain the required data is performed using a spreadsheet.

First, the data for every aircraft is grouped by sorting the raw data using the track number followed by time. Then, the relevant information (latitude, longitude, altitude, track, and time) required to distinguish the departing and arriving aircrafts is retained and rest is excluded. The relevant information is further filtered by altitude and time to obtain all arrival aircraft data. A track number may be assigned to more than one aircraft on the same day, but, they can be differentiated by the time.

Having the required track information of all the arrival aircraft, a go-around aircraft can be identified by applying latitude/longitude thresholds to the runway. When an arriving aircraft cross the thresholds, which are opposite to the arriving side of the runway, it is identified as a go-around.

CHAPTER 4

CASE STUDY

The study investigates go-around rates at Dallas/Fort-Worth (DFW) International airport, which ranks as the fourth busiest airport in operations (landing and takeoffs) and ninth busiest among passengers served, in the world (Dallas/Fort Worth International Airport, n.d.). In 2015, a total number of 681,261 operations were recorded with an average daily capacity of 2,814 operations (reportable hours: 7.00 AM to 9:59 PM) (Federal Aviation Administration, 2016). DFW has ASDE-X data available, and a large number of flights daily, which makes it a strong candidate for this study. DFW has a runway configuration that fits the potential problem of intersecting flight paths during go-arounds.

As shown in Figure 3 DFW has seven runways; five are parallel runways and the other two are diagonal. DFW operates in south flow about seventy percent of the time due to prevailing winds; during the remaining thirty percent of the time, it operates in north flow. In the case of crosswinds, especially from the west or north-west, the diagonal runways are brought into operation (Dallas/For Worth International Airport, n.d.). Despite DFW sharing its airspace with other airports west and south-east of its location, the study distinguishes the aircraft arriving to or departing from DFW from other aircraft by their flight paths.

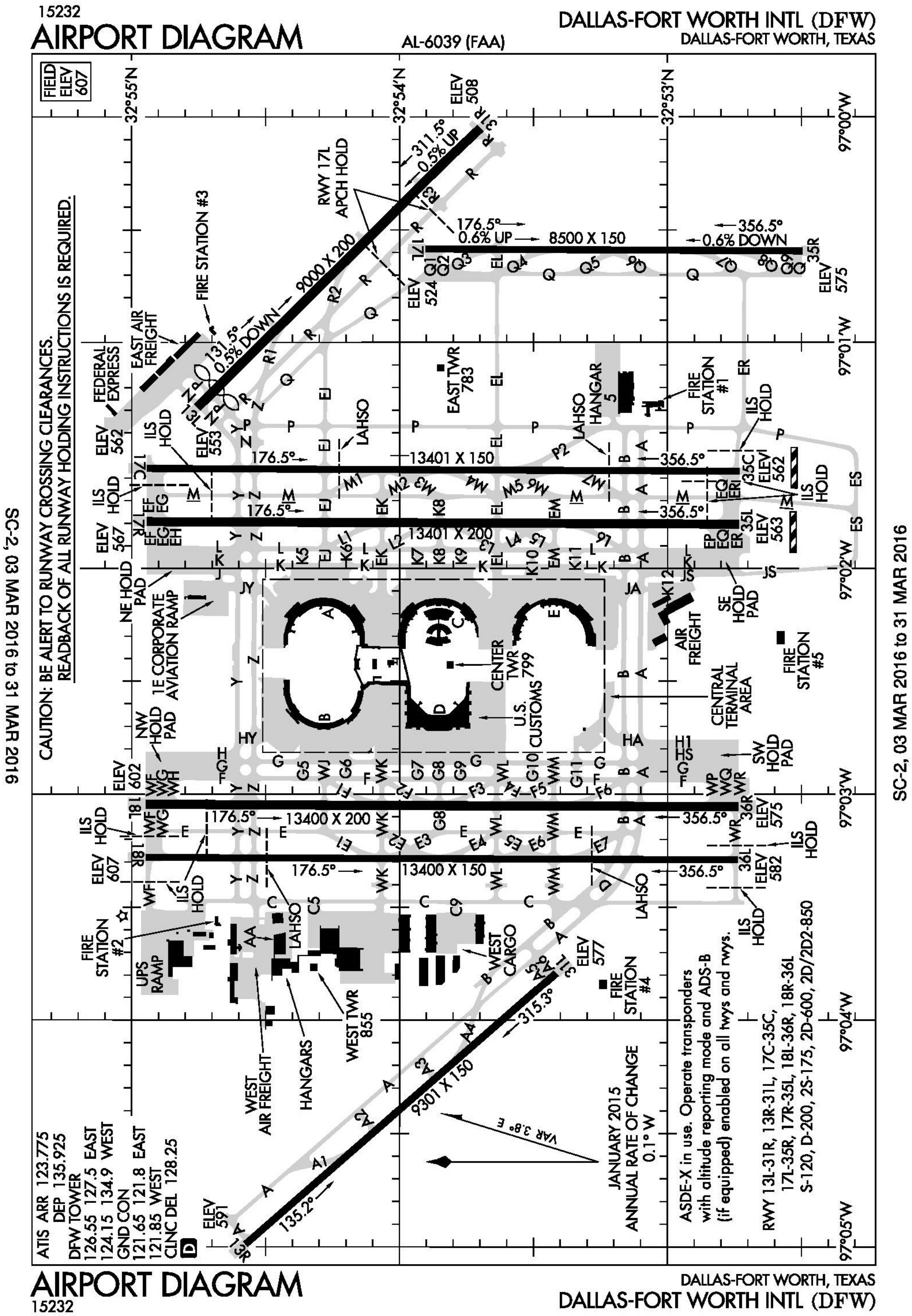

FIGURE 3 DFW Airport Diagram *(Federal Aviation Administration, n.d.)*.

Selection of Variables and Their Ranges

Based on the literature review, weather conditions (e.g. thunderstorm, rain, and snow), wind gust and visibility, which may range from zero to ten miles, represent the key weather factors impacting the need for an aircraft to perform a go-around. From weather underground website, the author obtains the event, wind gust and visibility data at DFW airport for every day in the years 2014 and 2015. Weather underground website provides a combined and accurate data of the various weather parameters observed from its personal weather stations and other sources used by National Weather Service (NWS) (Weather Underground, n.d.). The study defines wind gust as the highest gust speed observed throughout a day; this is a single value for each day. Visibility is the average value of each hour visibility in miles. The wind gust varies between two and sixty miler per hour during the years 2014 and 2015.

In order to develop data clusters for analysis and sampling, the author creates a distribution of the daily wind gust and visibility; these distributions may be divided into three roughly equal groups or thirds. Wind gust has significant variability and Figure 4 describes the values used to define the low, medium and high thirds. Visibility does not separate as easily into equal thirds or even halves because a majority of the days have a visibility of 10 miles; therefore, the study just separates visibility into two groups with visibility equal to ten miles in one group and all other visibility in the other group (Figure 4).

Among the events, a thunderstorm creates a greater likelihood of go-around than rain and snow. Thus, weather conditions are categorized into three groups;

- Occurrence of thunderstorm
- Occurrence of Rain and/or snow

  Note: (If two events occur on any given day, the event with higher intensity takes prominence)

- No event

Considering the three classes of wind gust and events and two classes of visibility, the study develops a cluster matrix (3*3*2) (Figure 4) for sampling and analysis. The author classifies each of the 730 days into one of these cells and randomly samples a day from each cell for a total of eighteen days. If the DFW airport was partially or fully closed during any of the selected days, the author excludes that day and picks a fully operated day from the same cell. The author obtains the total number of go-arounds and arrivals for these eighteen days using the above mentioned data cleaning process.

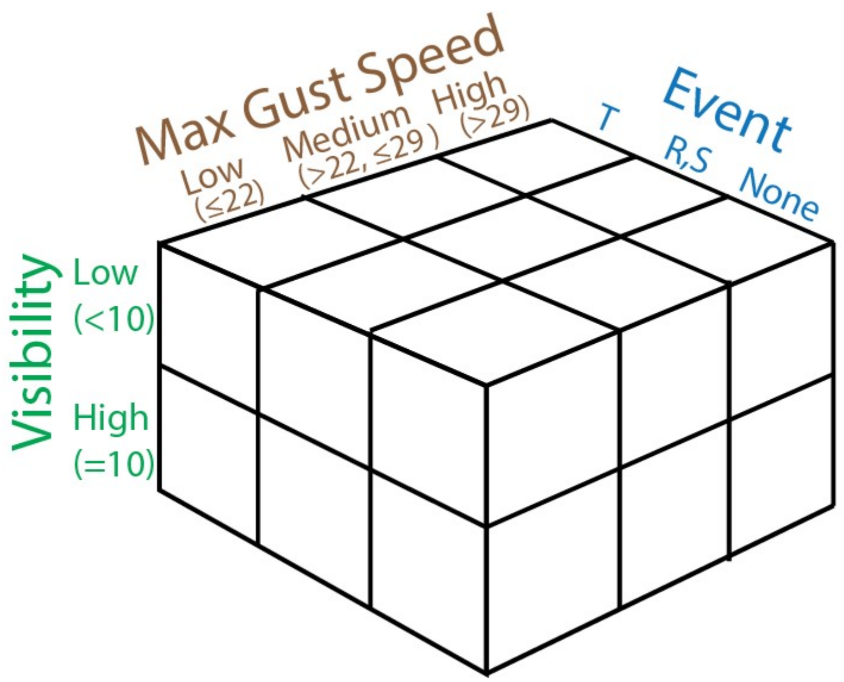

FIGURE 4 Sampling and analysis cluster matrix.

As DFW shares its airspace, the data includes aircraft flying above DFW airport at high altitudes. Hence, latitude/longitude thresholds could not be applied to the runways in identifying aircraft that performed go-arounds. Instead, the author visually inspected each flight using mapping software. As ASDE-X starts tracking (every second) all aircraft that enter the 5-mile radius of the airport, the path of the aircraft can be easily observed in mapping software.

Figure 5 is a screenshot of mapping software, which depicts an arriving aircraft (on runway 18R) performing a go-around, with 217 being its track number and dots representing its location at each second.

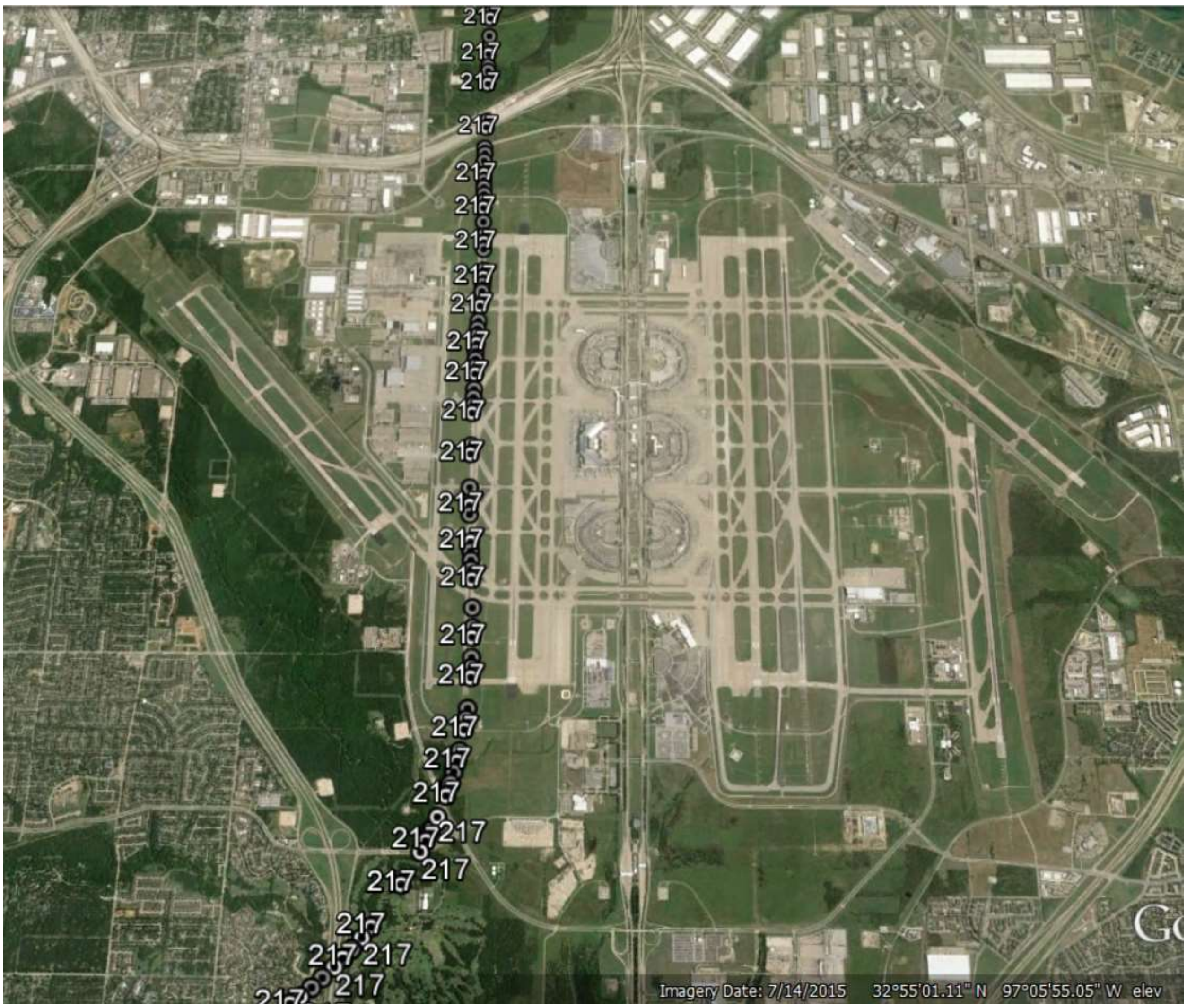

FIGURE 5 Tracking of go-around flights.

CHAPTER 5

ANALYSIS

Using the previously established weather condition scenarios, the study seeks to determine significant differences in go-around rates between the scenarios. The paper describes two proportion Z tests within each weather condition and a linear regression model. The study uses Minitab and SAS software to complete the analysis.

Two Proportion Z Tests

Table 1 presents the total number of arrivals, go-arounds and proportion, which is the ratio of total number of go-arounds to the total number arrivals for each weather condition scenario. A ten percent level of significance (α) is considered throughout the analysis.

TABLE 1 Proportion of Go-Arounds of Each Individual Variable Range

Variable	Range	Total Arrivals	Go-arounds	Proportion of Go-around
Wind Gust	High	4810	25	0.005198
	Medium	5399	10	0.001852
	Low	5600	12	0.002143
Event	Thunderstorm	4974	21	0.004222
	Rain- Snow	5189	11	0.002120
	No event	5646	15	0.002657
Visibility	High visibility	8032	23	0.002864
	Low visibility	7777	24	0.003086

The sample size (total number of arrivals) of each scenario is greater than 30. Hence, the author considered two proportion Z test. Table 2 presents the two proportion Z tests of the variables. From these tests, high wind gust (> 29 mph) significantly increases the likelihood of go around events over the medium and low wind gust dates. Similarly, the thunderstorm event appears to have a significantly greater rate of go-arounds than rain, snow or clear days. However, visibility appears to have no significant impact on the rate of go-arounds.

TABLE 2 Two Proportion Z Tests.

Variable	Comparing (Range)	Hypothesis	Result P-Value	Remark
Wind Gust	High	Null: $p_1 - p_2 = 0$	0.0025	Go-around rate during high wind gust is significantly greater than medium range
	Medium	Alternative: $p_1 - p_2 > 0$		
Wind Gust	Medium	Null: $p_1 - p_2 = 0$	0.7327	No significant difference between medium and low range wind gust
	Low	Alternative: $p_1 - p_2 \neq 0$		
Wind Gust	High	Null: $p_1 - p_2 = 0$	0.0057	Go-around rate during high wind gust is significantly greater than low range
	Low	Alternative: $p_1 - p_2 > 0$		
Event	Thunderstorm	Null: $p_1 - p_2 = 0$	0.0302	Go-around rate during thunderstorm event is significantly greater than the rate during rain-snow events
	Rain-Snow	Alternative: $p_1 - p_2 > 0$		
Event	Rain-Snow	Null: $p_1 - p_2 = 0$	0.5664	No significant difference between rain-snow events and no events
	No event	Alternative: $p_1 - p_2 \neq 0$		
Event	Thunderstorm	Null: $p_1 - p_2 = 0$	0.0861	Go-around rate during thunderstorm event is significantly greater than the rate during no events
	No event	Alternative: $p_1 - p_2 > 0$		
Visibility	High	Null: $p_1 - p_2 = 0$	0.7974	No significant difference between high and low visibility
	Low	Alternative: $p_1 - p_2 \neq 0$		

Model

The aggregated daily data is used to develop a linear regression model that defines the proportion of daily go-arounds as the dependent variable. In this model data, wind gust and visibility are considered continuous variables, and the event is defined as a dummy variable. The author reduces the event variable to only two cases (thunderstorm or no), because the proportions of go-arounds with events rain-snow and without any events are not significantly different in the previous analysis.

Various models, with and without transformations of both the response and predictor variables were previewed (Appendix B). The best model among these is represented in equation1.

$$Proportion = 0.00644 + 0.00008834\ (max\ gust\ speed) + 0.00181(weather\ event) - 0.00070289(visibility) + \varepsilon$$

Equation 1

The model indicates that the proportion of go-arounds increases with

- increase in wind gust
- decrease of visibility
- occurrence of thunderstorm

All the variables in the model have a P-value greater than assumed level of significance (0.1), which indicates that none of the variables are significant (represented in Appendix B.1). The R-Square and Adjusted R-Square of the model are 0.3082 and 0.1600 respectively. This indicates that this model is not an ideal model for making any policy decisions, but it does provide limited insight into the relationship of a change in weather condition. The lack of definitive fit exhibited by this model indicates that many factors other than weather conditions significantly contribute to the liklihood of go-around occurrence and linking these factors into the model appears critical for estimating a stronger model.

CHAPTER 6

CONCLUSION

While the modeling provides inconclusive results, certain weather conditions appear to increase the risk of go-around occurrence. A high wind gust (> 29 mph) increases the likelihood of go-around occurrence. Thunderstorm also presents a significantly greater probability of go-arounds compared to other events. Visibility appears to have no significant impact on the occurrence of go-arounds. This may be due to the limited variability in visibility at DFW airport; however, the role of visibility in go-around occurrence requires further investigation and quantification. While the factors discussed in this paper may not be the direct cause of go-arounds, they provide some indication of the conditions where go-arounds will occur more frequently. Furthermore, the observed go-around rates may vary at other airports; however, the factors indicating an increased risk appear likely to remain the same.

FUTURE RECOMMENDATIONS

- The analysis only considers a sample of 18 days. A larger sample size may be able to estimate a stronger model.
- This study only focused on Dallas/Fort Worth international airport. Expanding the study to multiple airports, would help us better understand the impact of the weather factors on occurrence of a go-around.
- Instead of aggregate modeling, disaggregate modeling with detailed weather conditions during each flight's approach may help in quantifying the significance of the weather factors.
- Maintaining a detailed record of go-arounds at each airport, would be of great help in future research work. These records should include aircraft name, date, time and

reason for performing a go-around, to properly characterizing the causes of go-arounds.

REFERENCES

1. Boeing. (2015, August). *Aviation Safety* . Retrieved from Boeing Website: http://www.boeing.com/resources/boeingdotcom/company/about_bca/pdf/statsum.pdf

2. Dallas/For Worth International Airport. (n.d.). *Aircraft Noise*. Retrieved from Dallas/For Worth International Airport: https://www.dfwairport.com/inthecommunity/aircraft_noise.php

3. Dallas/Fort Worth International Airport. (n.d.). *DFW Fast Facts*. Retrieved from DFW Airport: https://www.dfwairport.com/visitor/P1_009559.php

4. Donoghue, J. (n.d.). *Flight Safety Foundation* . Retrieved from Flight Safety : http://flightsafety.org/aerosafety-world-magazine/march-2012/the-rare-go-around

5. Federal Aviation Administration. (2004). Airport Traffic Patterns. *Airplane Flying Handbook*, 7-1 to 7-4.

6. Federal Aviation Administration. (2004). Approaches and Landings. *Airplane Flying Handbook*, 8-1 to 8-35.

7. Federal Aviation Administration. (2010, October 05). *Fact Sheets*. Retrieved from Federal Aviation Administration: http://www.faa.gov/news/fact_sheets/news_story.cfm?newsid=6296

8. Federal Aviation Administration. (2015). Order JO 7110.65W. *Air Traffic Organization Policy*.

9. Federal Aviation Administration. (2016, February 17). *NextGEN*. Retrieved from Federal Aviation Administration: http://www.faa.gov/nextgen/snapshots/airport/?locationid=27#tab-capacity

10. Federal Aviation Administration. (n.d.). *Airport Diagrams*. Retrieved from http://www.faa.gov/airports/runway_safety/diagrams/

11. Flight Safety Foundation. (2016, March 31). *Worst geographical regions*. Retrieved from Aviation Safety Network: http://aviation-safety.net/statistics/geographical/worst_geo_loc.php

12. Kanji, G. K. (2006). *100 Statistical Tests.* Sage Publications.

13. Kutner, M. H., Nachtsheim, C. J., Neter, J., & Li, W. (2005). *Applied Linear Statistical Models.* McGraw-Hill/Irwin.

14. Namowitz, D. (n.d.). 10 Reason to Go-Around. *The Best of Flight Training Magazine*. Aircraft Owners and Pilots Association.

15. National Transportation Safety Board. (n.d.). *Aviation Statistics.* Retrieved from National Transportation Safety Board: http://www.ntsb.gov/investigations/data/pages/aviation_stats.aspx

16. Sandberg, M. (2012). *Applications of ASDE-X Data to the Analysis of Airport.* Massachusetts Institute of Technology.
17. *Weather Underground*. (n.d.). Retrieved from The Weather Company, LLC: www.wunderground.com

CHAPTER 7

APPENDIX

Appendix A: Tables

TABLE A1 Total Number of Arrivals and Go-arounds from Each Cell

Date	Wind Gust range	Event	Visibility-Range	Total Go-arounds	Total Arrivals
26-Apr	High	Thunderstorm	High	8	896
19-Apr	High	Rain/Snow	High	3	822
16-May	High	No event	High	0	744
13-Apr	High	Thunderstorm	Low	8	632
13-Dec	High	Rain/Snow	Low	2	771
25-Apr	High	No event	Low	4	945
21-Apr	Medium	Thunderstorm	High	2	904
20-May	Medium	Rain/Snow	High	1	947
3-May	Medium	No event	High	1	898
24-May	Medium	Thunderstorm	Low	2	813
16-Jun	Medium	Rain/Snow	Low	1	802
14-May	Medium	No event	Low	3	1035
12-May	Low	Thunderstorm	High	1	936
6-Nov	Low	Rain/Snow	High	3	860
10-Jun	Low	No event	High	4	1025
15-Nov	Low	Thunderstorm	Low	0	793
20-Aug	Low	Rain/Snow	Low	1	987
30-Nov	Low	No event	Low	3	999
Total				**47**	**15809**

TABLE A2 Aggregate Data Used for the Analysis

Proportions of Go-around (of each day)	Wind Gust (mph)	Event (Thunderstorm or No)	Visibility (miles)
0.008928571	34	1	10
0.003649635	36	0	10
0.000000000	35	0	10
0.012658228	40	1	6
0.002594034	59	0	8
0.004232804	31	0	10
0.002212389	23	1	10
0.001055966	27	0	10
0.001113586	28	0	10
0.002460025	24	1	7
0.001246883	23	0	9
0.002898551	23	0	9
0.001068376	20	1	10
0.003488372	19	0	10
0.003902439	20	0	10
0.000000000	22	1	9
0.001013171	19	0	9
0.003003003	16	0	7

Appendix B: Models and their ANOVA tables

TABLE B1 Proportion of Go-arounds vs. Wind gust, Event and Visibility

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.00005192	0.00001731	2.08	0.1491
Error	14	0.00011655	0.00000832		
Corrected Total	17	0.00016847			

Root MSE	0.00289	R-Square	0.3082
Dependent Mean	0.00308	Adj R-Sq	0.1600
Coeff Var	93.53319		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	0.00644	0.00614	1.05	0.3121	0
Wind Gust	1	0.00008834	0.00006902	1.28	0.2214	1.04356
Event	1	0.00181	0.00150	1.21	0.2468	1.07711
Visibility	1	-0.00070289	0.00057760	-1.22	0.2438	1.11321

TABLE B.2 Proportion of Go-arounds vs. Inverse Wind Gust

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.00002136	0.00002136	2.32	0.1470
Error	16	0.00014711	0.00000919		
Corrected Total	17	0.00016847			

Root MSE	0.00303	R-Square	0.1268
Dependent Mean	0.00308	Adj R-Sq	0.0722
Coeff Var	98.29573		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00690	0.00261	2.65	0.0175
In Wind Gust	1	-0.09576	0.06282	-1.52	0.1470

TABLE B.3 Proportion of Go-arounds vs. Wind Gust and Event

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.00003959	0.00001980	2.30	0.1341
Error	15	0.00012888	0.00000859		
Corrected Total	17	0.00016847			

Root MSE	0.00293	R-Square	0.2350
Dependent Mean	0.00308	Adj R-Sq	0.1330
Coeff Var	95.02063		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	-0.00059574	0.00210	-0.28	0.7807	0
Wind Gust	1	0.00010520	0.00006869	1.53	0.1465	1.00153
Event	1	0.00229	0.00147	1.56	0.1389	1.00153

TABLE B.4 Exponential of Proportion of Go-arounds vs. Inverse-Square Root Wind Gust

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.00002119	0.00002119	2.27	0.1513
Error	16	0.00014932	0.00000933		
Corrected Total	17	0.00017051			

Root MSE	0.00305	R-Square	0.1243
Dependent Mean	1.00309	Adj R-Sq	0.0696
Coeff Var	0.30455		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.99668	0.00432	230.76	<.0001
InSqrt Wind Gust	1	0.00124	0.00082031	1.51	0.1513

TABLE B.5 Proportion of go-arounds vs. Inverse-Square Root Wind Gust

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.00002092	0.00002092	2.27	0.1515
Error	16	0.00014755	0.00000922		
Corrected Total	17	0.00016847			

Root MSE	0.00304	R-Square	0.1242
Dependent Mean	0.00308	Adj R-Sq	0.0694
Coeff Var	98.44450		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-0.00329	0.00429	-0.77	0.4545
InSqrt Wind Gust	1	0.00123	0.00081545	1.51	0.1515

TABLE B.6 Exponential (Proportion of Go-arounds) vs. Inverse-Square Root Wind Gust and Visibility

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.00004346	0.00002173	2.57	0.1101
Error	15	0.00012705	0.00000847		
Corrected Total	17	0.00017051			

Root MSE	0.00291	R-Square	0.2549
Dependent Mean	1.00309	Adj R-Sq	0.1555
Coeff Var	0.29014		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	1.00592	0.00703	143.06	<.0001	0
InSqrt Wind Gust	1	0.00104	0.00079038	1.32	0.2061	1.02286
Visibility	1	-0.00090552	0.00055847	-1.62	0.1258	1.02286

TABLE B.7 Exponential (Proportion of Go-arounds) vs. Wind Gust and Events

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.00004017	0.00002009	2.31	0.1333
Error	15	0.00013034	0.00000869		
Corrected Total	17	0.00017051			

R-Square	0.2356	Adj R-Sq	0.1337

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.99388	0.00211	472.94	<.0001
Wind Gust	1	0.00010590	0.00006908	1.53	0.1461
Event	1	0.002310	0.001475	1.57	0.1381

TABLE B.8 Exponenetial (Proportion of Go-arounds) vs. Wind Gust and Visibility

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.00004032	0.00002016	2.32	0.1322
Error	15	0.00013018	0.00000868		
Corrected Total	17	0.00017051			

R-Square	0.2365	Adj R-Sq	0.1347

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1.00899	0.005902	170.97	<.0001
Wind Gust	1	0.00008134	0.00007019	1.16	0.2646
Visibility	1	0.0008945	0.0005687	-1.57	0.1366