

ANALYSIS OF “TARMAC DELAYS” AT NEW YORK AIRPORTS

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Abstract— In response to media coverage of so called Tarmac Delays, new Department of Transportation (DOT) regulations come into effect on April 2010. These regulations outline airline responsibilities with regards to flights that remain on the ground in excess of two hours. Included in the regulations are requirements that airlines provide food, water and lavatory service for passengers delayed more than two hours on the tarmac, and for gate resources to be made available for flights to return to the gate and de-plane passengers for flights grounded for more than three hours.

This paper describes the results of an analysis of “tarmac delays” at New York Airports from 2005 to 2009 using Bureau of Transportation Statistics (BTS) data: (i) John F. Kennedy (JFK), Newark Liberty International Airport (EWR) and La Guardia Airport (LGA) have been ranked as the top three airports with longest tarmac delays during the last five years, (ii) the probability of a flight experiencing a tarmac delay at a New York airport of greater than 2 hours is 0.54%, (iii) the average tarmac delay was 158 minutes per flight, (iv) June, July and August are the worst month for tarmac delays, (v) flights bound for Chicago O’Hare are the most likely to experience “tarmac delays,” (vi) an estimate of the annual cost to the airlines as a result of tarmac delay regulations at JFK, EWR, AND LGA is \$43,859 per year.

Tarmac delays, apron delays, lengthy aboard aircraft waiting times, ground delay, departure delays, on-board flight delays.

I. INTRODUCTION

After several widely publicized incidents of passengers remaining on airplanes on the tarmac for long hours [1][2], the Department of Transportation (DOT) has issued a new rule designed to protect airline passengers. These new regulations enforce the voluntary actions taken by airlines in 1999 which reduce passenger discomforts and the number of complaints, but had no impact on the frequency or magnitude of tarmac delays [3]. The new rule imposed by the DOT provides a regulatory mechanism to ensure airlines will meet the minimum standards for passengers’ service.

The Tarmac Delay regulations require the airlines adopt and publish contingency plans for lengthy tarmac delays including food and water for Tarmac Delays greater than 2 hours, and provides the passengers the rights to de-plane after 3 hours (with some limitations). The airlines must also respond to consumer problems, and publish tarmac delay data, designate an employee to monitor the effects of flight delays and cancellations. The strongest clause in the regulation declares “the operation of flights that remain chronically

delayed to be an unfair and deceptive practice and an unfair method of competition.”

This paper describes the results of an analysis Bureau of Transportation Statistics (BTS) [4] statistics to assess the frequency and severity of tarmac delays, and to estimate the cost of the regulations to the airlines. This study focuses on tarmac delays at New York Airports. Using data from 2005 to 2009, the following main results were identified:

- a) Flights departing from New York airports experienced the highest number of tarmac delays
- b) the probability of a flight experiencing a tarmac delay greater than 2 hours is 0.54%
- c) the average flight delay experienced by the passengers was 158 minutes with a maximum time of 435 minutes (more than 6 hours),
- d) the number of tarmac delays flights has showed a decreased trend,
- e) June, July and August are the worst month for tarmac delays, with 64% of the delayed flights occurring in these months.
- f) flights bound for Chicago O’Hare (8%) are the most likely to experience “tarmac delays,”
- g) Twenty-two airlines have had flights with tarmac delays.
- h) An estimate of the total cost to the airlines as a result of tarmac delay regulations at New York area is \$43,859 per year or \$476 per flight.

These results indicate that tarmac delays are a rare but “painful” phenomenon. The likelihood of tarmac delays is exogenous to the departure airport as illuminated by the most congested schedule periods (June, July and August) and flights departing to the most congested airports (Chicago O’Hare – 8%, ATL - 5%, LAX – 4%). Further, the costs to the airlines are approximately only \$43,859 per year.

This paper is organized as follows: Section 2 provides a background of tarmac delays regulations. Section 3 describes the method for analysis. Section 4 provides the analysis of the tarmac delays at New York Airports and the implications of the rule on this airport. Section 5 summarizes the results and conclusions.

II. TARMAC DELAYS REGULATION

Tarmac delays, also known as ground delays, refer to delays that occur on the ground of the airport with passengers already on board. Tarmac delays include taxi-in, for arrivals, or taxi-out, for departures, and apron-gate (both) delays.

Regardless the cause of the ground delay, passengers face a lot of problems when a flight is held for long hours on the tarmac. To protect passengers, the DOT issued an Advance Notice of Proposed Rulemaking (ANPRM) in 2007 announcing the needs to consider or amend rules to address primarily the problems passengers face during long tarmac delays. In December 2009 that the DOT issued the regulation entitled “Enhancing Airline Passenger Protections”. This regulation will take effect on April 2010 [5].

The new rule has five components to protect passengers and ensure that airlines provide a service that meet minimum standards:

1. Require carriers to adopt and publish contingency plans for lengthy tarmac delays
2. Require carriers to respond to consumer problems
3. Declare the operations of flights that remain chronically delayed to be an unfair and deceptive practice and an unfair method of competition
4. Require carriers to publish delay data on their websites.
5. Each carrier must adopt a customer service plan and self-audit adherence to it.

The first clause establishes the requirement for a contingency plans that includes:

- a) *Passengers on planes delayed on the tarmac for two hours will have access to food, water, clean lavatories, and the assistance of medical personal if needed, and*
- b) *Passengers on planes delayed on the tarmac for three hours will be permitted to deplane, unless there is a safety and/or security-related impediment to deplaning passengers or air traffic control advises the pilot that permitting passengers to return to the gate or disembark would significantly disrupt airport operations. [5]*

These rules apply to any carrier that operates domestic scheduled passenger service, including any charter service that uses any aircraft with 30 or more passenger seats. The contingency plan should be included for those aircrafts that presents long ground delays on the tarmac and have fewer than 30 seats.

III. METHOD OF ANALYSIS

A data mining analysis using BTS database has been done to compute tarmac delays at JFK, EWR, AND LGA. The analysis includes only the use of taxi out time to compute the tarmac delays. It has been demonstrated that much of the delays occurs during taxi out because aircrafts are delayed at their origin if the predicted demand at their destination is expected to exceed the predicted capacity [6].

Figure 1 shows the four tables and their fields used to extract the data for the analysis. All four tables were

downloaded from the BTS website and stored in a local server. The local database contains information from January 2005 to October 2009. ON_TIME table keeps information about the flights. This table is the main source to compute tarmac delays by destination and day of schedule departure. ARLINE table is needed to get the name of the airline’s code that exists in table ON_TIME. TAIL_AIRCRAFT_TYPE and EQUIPAGE are used to obtain information regarding the aircraft such as type, typical number of seats, and tail number.

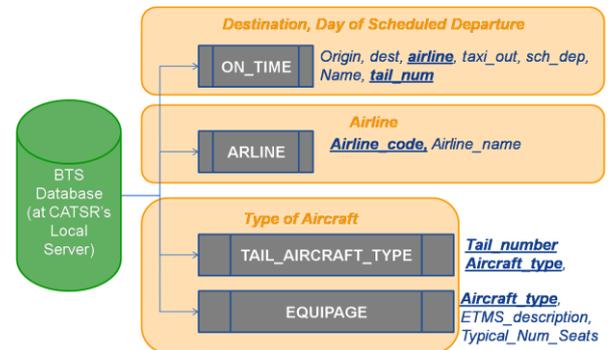
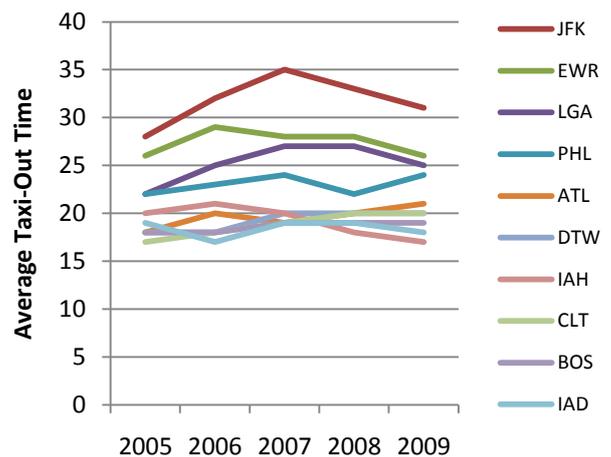


Figure 1 Data Source Model

A preliminary analysis of the data revealed the top 10 airports with more tarmac delays. Figure 2 shows that New York airports have experienced the most tarmac delays since 2005.

Figure 2 Top-Ten Airports with higher Average Taxi-Out Time (January, 2005 to October, 2009)



IV. RESULTS

This section summarizes the results of the analysis when tarmac delay is greater than two hours.

A. Frequency of Occurrence

Table 1 shows the total departure flights in the three airports grouped by the number of minutes delayed using taxi-out. A total of 1,873,219.00 flights departed from New York Airports during January 2005 and October 2009 were queried from the database. Only 0.54% of these flights (10,117) have taxi-out time greater than two hours.

The average annual percentage of delayed flights is 0.11%. The average of flights that spent more than two hours on the tarmac was 0.56% annually during 2005 and 2008. The worst year was 2007 when 0.72% of the flights spent more than two hours. Based on ten months of data for 2009, 0.46% of flights have been delayed for more than two hours on the tarmac.

Table 1: New York Departure Flights (Jan 2005 - October 2009)

Year	0-59min	60-119m	120-179m	180-239	240-299	300-359m	360-419m	420-479m	Total
2005	371,406	12,114	1,291	251	46	8	1		385,117
2006	372,690	21,411	1,549	353	91	22	1		396,117
2007	374,410	26,078	2,219	549	94	22	5	1	403,378
2008	351,921	22,336	1,669	391	105	20	3	1	376,446
2009	296,620	14,116	1,198	195	30	2			312,161
Total	1,767,047	96,055	7,926	1,739	366	74	10	2	1,873,219
Percentage	94.33%	5.13%	0.42%	0.09%	0.02%	0.00%	0.00%	0.00%	100.00%
Total flights with Tarmac Delay >= 2 Hours									10,117.00
Percentage of Flights with Tarmac Delay >= 2 Hours									0.54%

NOTE: Percent subtotals may not add due to rounding

Only 452 flights of the total delayed flights (0.02%) have spent more than four hours on the tarmac during five years of analysis. During the analyzed years, 94.33% of the flights stayed less than one hour on the tarmac, only 5.13% stayed between one and two hours, 0.42% between two and three hours and only 0.12% three hours or more. Table 2 shows the distribution of total flights per tarmac delay and airport. JFK has the majority of tarmac delay flights, followed by EWR and LGA.

Table 3: Statistics of Taxi-Out Time per Airport on Taxi-Out greater than Two Hours.

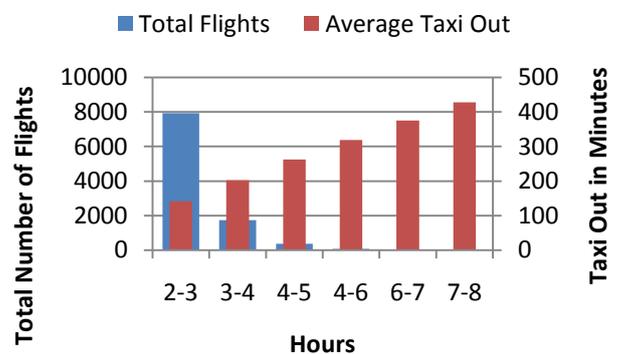
Airport	AVG	MIN	MAX	STAN DEV
EWR	156	120	394	36
JFK	161	120	435	43
LGA	155	120	342	32
Average	158	120	435	38

Table 2: Total Flights and Average Taxi-Out Time per Airport

Tarmac Delay	Total Flights			Average Taxi Out		
	EWR	JFK	LGA	EWR	JFK	LGA
2-3	2742	3090	2094	142	141	143
3-4	569	755	415	201	204	200
4-5	95	224	47	263	263	263
4-6	19	44	11	317	318	323
6-7	3	7		380	374	
7-8		2			429	
Total	3428	4122	2567	156	161	155
%	34%	41%	25%	158 Minutes		

Figure 3 shows the distribution of flights and the average taxi-out time for each tarmac delay.

Figure 3: Total Flights and Average Taxi-Out Time per Tarmac Delay



B. Severity of Delays

The average delay is 158 minutes (2.38 hours), the minimum delay is 120 minutes, the maximum is 435, and the mode is 120 minutes (Table 3).

C. Tarmac Delays by Airline

Figure 4 shows the relation between airlines and tarmac delays. 1617 out of 10,117 flights (16%) were operated by Continental Airlines, followed by Delta Airlines with 15%. When we look at individual airports, the airlines vary. At EWR, most of the tarmac delay flights were operated by Continental Airlines, while at JFK and LGA were JetBlue Airways and American Airlines respectively. Figure 4 shows the distribution of airlines per airport.

D. Tarmac Delays by Destination

The analysis shows that flights with ORD as destination have had the greater taxi-out times (Figure 5). However, BOS is the destination with more number of flights leaving from those three airports (111,150 flights, 6.22%) and ORD is the second destination with more flights (98,364 flights, 5.51%). Flights departing from EWR and LGA to ORD have the higher probability of tarmac delays. Flights leaving from JFK to LAX have the higher probability of tarmac delays (Table 4).

Figure 4: Tarmac Delay by Airlines and Airports

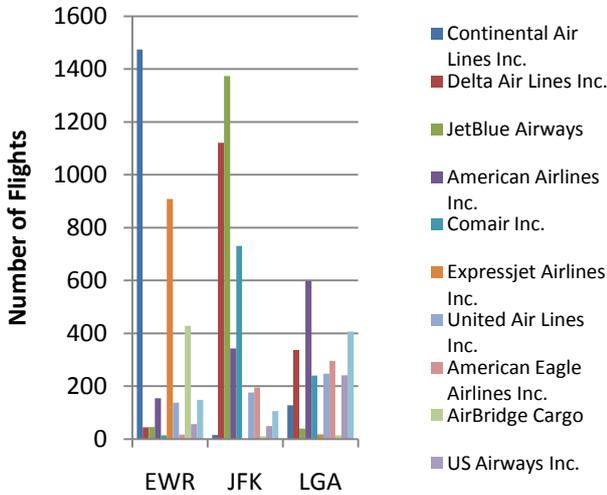
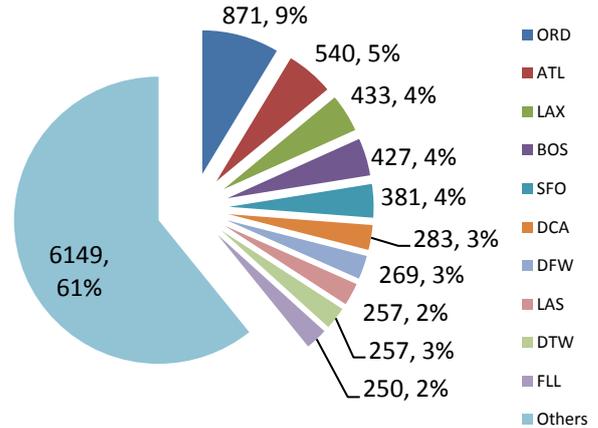


Figure 5: Destinations with taxi-out times greater than 2 hours (January 2005 - October 2009)



Only two flights have been delayed for more than seven hours on the tarmac. One was operated by JetBlue Airways on February 2nd, 2007 with Houston as destination. The other one, DL151, was operated by Delta Air Lines on July 23rd, 2008 flying to San Francisco. Both delayed occurred at JFK airport.

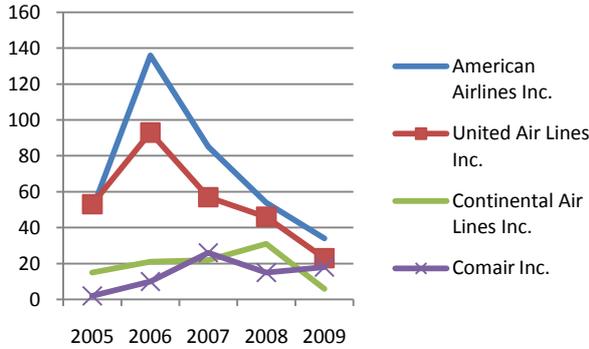
Table 4: Tarmac Delay by Origin and Destination (Jan 2005 – Oct 2009)

DEST	EWR		JFK		LGA			
	Total	Tarmac	DEST	Total	Tarmac	DEST	Total	Tarmac
	684696	3428		544737	4122		556654	2567
ORD	5.27%	7.67%	LAX	7.32%	8.08%	ORD	9.11%	17.53%
ATL	5.63%	4.17%	SFO	5.18%	6.87%	ATL	8.29%	11.41%
DFW	2.70%	2.98%	BOS	6.43%	5.29%	DCA	8.78%	5.96%
BOS	3.00%	2.92%	LAS	3.52%	4.15%	DFW	4.30%	4.75%
LAX	2.35%	2.89%	ORD	2.12%	3.81%	CLE	2.79%	4.40%

+

Figure 6 shows the four airlines that flew to ORD and its taxi-out time has been greater than two hours. This represents only a 8% (797) of the delayed flights (10,117) and 1% of total flights (105,562) flying to ORD during the analyzed period. In this case, American Airlines' flights have been stayed more on the ground when flying to ORD.

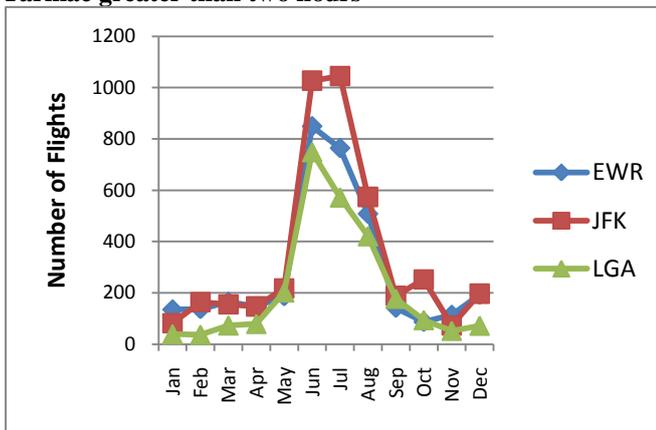
Figure 6: Top Four Airlines flying to ORD with Tarmac Delays



E. Tarmac Delays by Month and Day of the Week

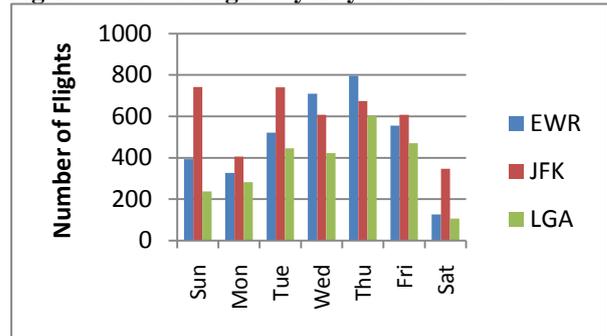
The analysis shows that most of the tarmac delays flights happen during June, July and August on all the airports and during the analyzed years. It seems to be a strong relationship between summer and taxi-out time (Figure 7).

Figure 7: Total Number of Flights By Month with Tarmac greater than two hours



In general, most of the tarmac delays have happened on Thursday (20%). At JFK, most of the delays have occurred on Sunday and Tuesday (16%). Figure 8 shows the distribution of tarmac delays among day of the week.

Figure 8: Total Flights by Day of the Week



F. Monetary Cost Analysis based on Component One

One of the rules requires the airlines to:

- provide food, water and medical assistance when the tarmac delay exceeds two hour, and
- allow passengers to deplane after three hours.

Four cost categories have been defined to estimate how much it would cost to the airlines to meet the above requirements (Table 5). The costs per passenger are just labor costs, therefore, additional costs, such fuel, are not included [7][8].

Table 5: Cost Category and Price per Passenger

Cost Category	Price Per Passenger
Food and Drinks	\$3.71
Deplaning	\$1.37
Re-boarding	\$1.37
Airfare average cost at JFK, EWR, and LGA	\$220

Table 6 shows the number of passengers per tarmac delay across airports. To compute the costs to airlines on each category, the following formula is used:

$$Cost\ Category = Total\ Passengers\ using\ load\ Factor\ 80\% \times cost's\ fee$$

Table 6: Estimated number of Passengers and Total Passengers on Tarmac Delays

Tarmac Delay Criteria (Hours)	Number of Flights	Estimated Number Passengers	Number of Passengers Load Factor 80%
2	7,926	954,632	763,706
3	1,739	218,843	175,074
4	366	50,512	40,410
5	74	9,913	7,930
6	10	1,246	997
7	2	358	286
Total	10,117	1,235,504	988,403
Average passengers per flight		122	98

NOTE: Total number of passengers is computed by multiplying number of lights by number of average seats of the aircraft. When BTS does not include the aircraft type, 145 is used as the average number of seats.

Table 7 summarizes the costs per category based on the number of passengers and tarmac delay. The total annual average cost per airline is \$43,859.

Table 7: Cost per Category to Meet Component One

	Food	Deplane	Re-Board (97.2%)	Cancellation (2.8%)
Passengers	763,706	224,698	218,406	6,291
Cost per passenger	\$3.71	\$1.37	\$1.37	\$220.00
Total Cost (Jan 2005-October 2009)	\$2,833,349	\$307,836	\$299,216	\$1,384,137
Annual Cost	\$566,670	\$61,567	\$59,843	\$276,827
Average per airline (22 airlines)	\$25,758	\$2,799	\$2,720	\$12,583
Total Average Annual Cost Airline	\$43,859			
Average per Flight	\$381.50			

NOTE: Subtotals may not add due to rounding

- Food Costs: Food costs were computed based on the total number of passengers with a tarmac delay greater than two hours. The estimated annual average cost per airline is \$25,758.
- De-plane Costs: De-plane costs only occur when flights have a taxi-out greater than three hours. The total number of deplaned passengers is 224,698, representing an average cost of \$2,799 per airline.
- Re-Board Costs: This cost is computed based on the probability of re-boarding an airplane which is 97.2% [8]. The total number of re-boarding

passenger is 218,406 with an average cost of \$2,720 per airline.

- Cancellation: This cost is computed based on the probability of cancelling a flight after deplaning which is 2.8% [8]. The total number of passengers in flights cancelled after deplaning is 6,291. The average airfare cost is \$220 [4]. The average annual cost for an airline to cancel flights when taxi-out time is greater than three hours is \$12,583
- The average number of flights per year during the analyzed period was 2,529. The average total cost of a tarmac delay flight is \$381.50.
- The annual cost of tarmac delay is \$964,908. The distribution of costs per airport according to the percentage of tarmac delay flights is \$393,945 for JFK (41%), \$326,945 for EWR (34%), and \$244,827 for LGA (25%).

V. CONCLUSIONS

These results indicate that tarmac delays are a rare but “painful” phenomenon. Tarmac delays in excess of 2 hours occur 0.54% of the time. Tarmac delays in excess of 3 hours occur 0.11%. The average delay was 158 minutes.

The tarmac delays are strongly correlated with exogenous effects. The departure airport as illuminated by the most congested schedule periods (June-August) and flights departing to the most congested airports (Chicago O’Hare -9%, ATL – 5%, LAX – 4%). Among the three airports, JFK presents the majority of delays (41%), followed by EWR (34%) and LGA (25%). Most of the delays have occurred on Thursdays at EWR and LGA, and on Sundays and Tuesdays at JFK.

Further, twenty-two airlines departed from these three airports with tarmac delays greater than two hours. The average cost to the airlines is approximately \$43,859 annually. Future work includes analysis of other airports, and costs to passengers.

ACKNOWLEDGMENT

Thank you for technical assistance and suggestions from John Ferguson, Guillermo Calderón (CATSR). This project was funded by internal George Mason University Foundation Funds.

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