

ANALYSIS OF “TARMAC DELAYS” AT PHILADELPHIA AIRPORT

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Abstract— In response to media coverage of so called “lost flights,” new Department of Transportation (DOT) regulations come into effect on April 2010 with regards to Tarmac Delays. 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 Philadelphia airport from 2005 to 2009: (i) the probability of a flight experiencing a tarmac delay of greater than 2 hours is 0.44%, (ii) the average tarmac delay was 157 minutes per flight, (iii) the number of tarmac delays has remained the same over the 5 year period, (iv) June and July 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 PHL is \$17,000 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 being stranded on airplanes 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 Philadelphia (PHL) International Airport. Using data from 2005 to 2009, the following main results were identified:

- a) the probability of a flight experiencing a tarmac delay greater than 2 hours at PHL is 0.44%, and greater than 3 hours 0.01%
- b) the average delay experienced by the passengers was 157 minutes with a maximum time of 393 minutes (more than 6 hours),
- c) the number of tarmac delays has remained the same over the 5 year period with an average of 463 flights per year,
- d) June and July are the worst month for tarmac delays, with 49% of tarmac delays
- e) flights bound for Chicago O’Hare (14%) are the most likely to experience “tarmac delays,”
- f) an estimate of the total cost to the airlines as a result of tarmac delay regulations at PHL is \$34,000 per year or \$37 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 and July) and flights departing to the most congested airports (Chicago O’Hare - 14%, ATL – 5%, BOS – 5%). Further, the costs to the airlines are approximately only \$17,000 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 PHL 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 PHL. 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.

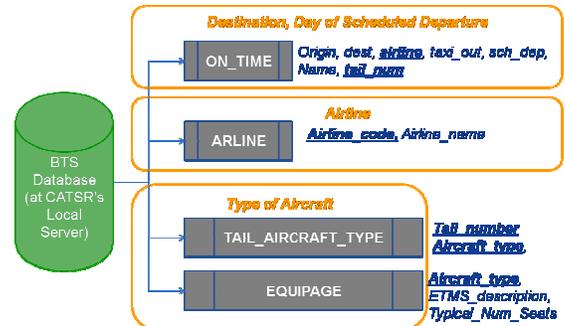


Figure 1 Data Source Model

IV. RESULTS

This section summarizes the results of the analysis.

A. Frequency of Occurrence

Table 1 shows the total departure flights grouped by the number of minutes delayed using taxi-out. A total of 517,887 flights departed from PHL during January 2005 and October 2009 were queried from the database. Only 0.44% of these flights, 2313, have taxi-out time greater than two hours.

The average annual percentage of delayed flights is 0.09%. The average of flights that spent more than two hours on the tarmac was 0.53% 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, 0.70% of flights have been delayed for more than two hours on the tarmac.

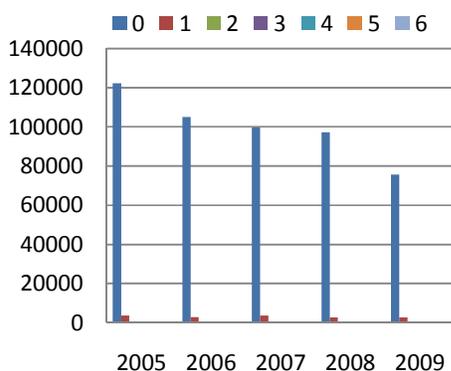
Table 1: PHL Departure Flights (Jan 2005 - October 2009)

Years	Tarmac Delay Grouped by Minutes							TOTAL
	0-59m	60-119m	120-179m	180-239m	240-299m	300-359m	360-419m	
2005	122,278	3,620	456	69	6			126,429
2006	105,045	2,833	339	85	10			108,312
2007	99,729	3,729	445	122	31	4		104,060
2008	97,372	2,770	248	81	27		1	100,499
2009	75,554	2,644	329	54	6			78,587
TOTAL	499,978	15,596	1,817	411	80	4	1	517,887
	96.54%	3.01%	0.35%	0.08%	0.02%	0.00%	0.00%	100%
Total Flights with Tarmac Delay >= 2 hours								2,313
Percentage of Flights with Tarmac Delay >= 2 hours								0.44%

NOTE: Percent subtotals may not add due to rounding

Only five flights of the total delayed flights (0.17%) have spent more than four hours on the tarmac during five years of analysis. This represents only 0.0007% of total flights (Figure 2). During the analyzed years, 96.54% of the flights stayed less than one hour on the tarmac, only 3.01% stayed between one and two hours, 0.35% between two and three hours and only 0.10% three hours or more (Figure 2 **Error! Reference source not found.**).

Figure 2: Total Flights with a Tarmac delay (no cumulative)



B. Severity of Delays

The average delay is 157 minutes (2.37 hours), the minimum delay is 120 minutes, the maximum is 393, and the mode is 120 minutes. Figure 5 shows the distribution of flights and the average taxi-out time for each tarmac delay.

C. Tarmac Delays by Airline

Figure 3 shows the relation between airlines and tarmac delays. 1123 out of 2313 flights (49%) were operated by US Airways, followed by Southwest Airlines with 15%. This may

be happening because PHL is the primary hub for international flights of US Airways. Also, the only flight that stayed for more than 6 hours on the tarmac in 2008 corresponds to the US Airways flight US598, an A320 aircraft with destination to LAS. Its taxi-out time was 393 minutes reported as reported on the BTS, and was scheduled to departure on Monday, July 23rd at 4:05:00 PM.

Figure 3: Tarmac Delays by Airlines

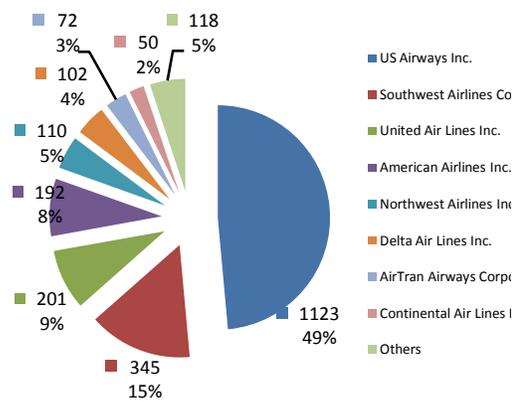
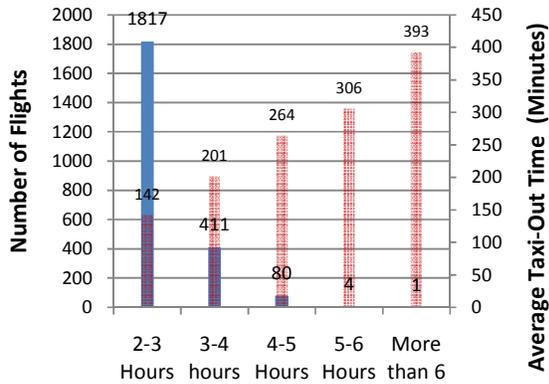


Figure 4: Distribution of Tarmac Delays and Average Taxi-Out Time



Only four flights, two from US Airways and two from Southwestern Airlines, had taxi-out times greater than five hours (Table 2). Three out of these flights occurred the same day, on Saturday February 14th, 2007 during the morning. That day a severe snow storm was affecting the operations at the airport.

Table 2: Taxi-out times greater than 5 hours (January 2005, October 2009)

Flight #	Destination	Schedule Departure	Aircraft Seats
US1071	SJU – San Juan, Puerto Rico	02/14/2007 9:30:00 AM	A333 - 295
US1991	ORD - O'Hare Int'l Airport	02/14/2007 9:50:00 AM	B733 - 128
WN993	MCO – Orlando Int'l Airport, FL	02/14/2007 7:10:00 AM	B737 – 126
WN2276	MDW - Chicago	6/19/2007 5:15:00 PM	B737 – 126

D. Tarmac Delays by Destination

The analysis shows that flights with ORD as a destination have had the greater taxi-out times (Figure 6).

Table 3 shows the four airlines that flew to ORD and its taxi-out time has been greater than two hours. This represents only a 13.57% of the delayed flights and 0.06% of total flights during the analyzed period. In this case, American Airlines' flights have been stayed more on the ground than US airways flights.

Figure 6: Destinations with taxi-out times greater than 2 hours (January 2005 - October 2009)

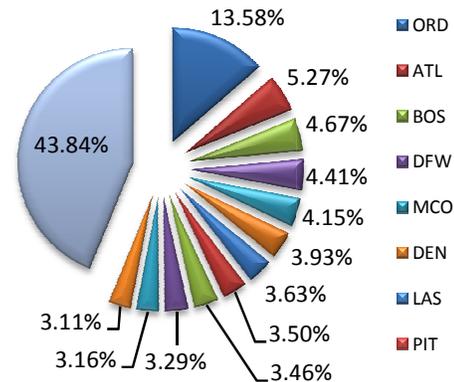


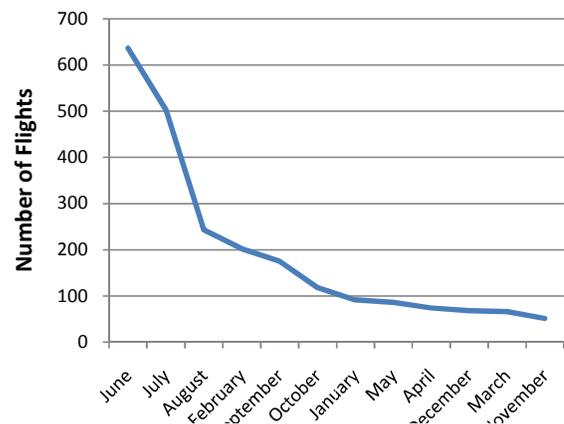
Table 3: Airlines with Tarmac greater than two hours and ORD as destination (January 2005- October 2009)

Year	AA- American Airlines	MQ - American Eagle	UA - United Airlines	US- US Airways	Grand Total
2005	23		28	17	68
2006	26	1	29	19	75
2007	32		28	19	79
2008	10		18	22	50
2009	6	5	16	15	42
Total	97	6	119	92	314
%	30.89%	1.91%	37.90%	20.30%	100%

E. Tarmac Delays by Month

The analysis shows that most of the tarmac delays flights happen during June and July. 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



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 4).

Table 4: 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 PHL	\$220

Table 5 shows the number of passengers per tarmac delay. To compute the costs to airlines on each category, the following formula is used:

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

Table 5: Estimated number of Passengers and Total Passengers on Tarmac Delays

Tarmac Delay Criteria	Number of Passengers (January 2005-October 2009)*	Total Passengers using Load Factor 80%
2 Hours	252,077	172,795
3 Hours	71,315	57,052
4 Hours	11,970	9,576
5 Hours	675	540
6 Hours	150	120
Total passengers		268,950
Average passengers per flight		116

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 6 summarizes the costs per category based on the number of passengers and tarmac delay. The total annual average cost per airline is \$17,711.

Table 6: Cost per Category to Meet Component One

	Food	Deplane	Re-Board	Cancellation
Passengers	268,949.60	67,288.00	65,403.94	1,884.06
Cost per passenger	\$3.71	\$1.37	\$1.37	\$220.00
Total Cost (Jan 2005-October 2009)	\$997,803	\$92,184	\$89,603	\$414,493
Annual Cost	\$199,560	\$18,437	\$17,920	\$82,898
Average per airline (18 airlines)	\$11,087	\$1,024	\$995	\$4,605
Total Average Annual Cost	\$17,711			

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 \$11,087.
- 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 67,288, representing an average cost of \$1,024 per airline.
- Re-Board Costs: This cost is computed based on the probability of re-boarding an airplane which is 97.2% [7]. The total number of re-boarding passenger is 65,403 with an average cost of \$995 per airline.
- Cancellation: This cost is computed based on the probability of cancelling a flight after deplaning which is 2.8% [7]. The total number of passengers in flights cancelled after deplaning is 1,884. The average airfare cost at PHL is \$220 [4]. The average annual cost for an airline to cancel flights when taxi-out time is greater than three hours is \$4,605.

V. CONCLUSIONS

These results indicate that tarmac delays are a rare but “painful” phenomenon. Tarmac delays in excess of 2 hours occur 0.44% of the time. Tarmac delays in excess of 3 hours occur 0.01%. The average delay was 157 minutes.

The tarmac delays are strongly correlated with exogenous effects. The departure airport as illuminated by the most congested schedule periods (June) and flights departing to the most congested airports (Chicago O’Hare -14%, ATL – 5%, BOS – 5%).

Further, the cost to the airlines is approximately \$17,711 annually. Future work includes analysis of other airports, and costs to passengers.

ACKNOWLEDGMENT

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