British Journal of Economics, Management & Trade
8(3): 230-236, 2015, Article no.BJEMT.2015.113
ISSN: 2278-098X

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Causative Factors of Air Traffic Delay in Muritala Muhammed International Airport Lagos, Nigeria

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/BJEMT/2015/18708
Editor(s):
(1) John M. Polimeni, Associate Professor of Economics, Albany College of Pharmacy & Health Sciences, New York, USA.
Reviewers:
(1) Ayse Kucuk Yilmaz, Department of Management and Strategy, Anadolu University, Turkey.
(2) Anonymous, University of Aeronautics and Astronautics, China.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1063&id=20&aid=9707

Original Research Article

Received 6th May 2015
Accepted 29th May 2015
Published 11th June 2015

ABSTRACT

The study examined the factors which contribute to the occurrence of flight delay in Muritala Muhammed International Airport, Lagos Nigeria. Three airlines were purposely selected from thirty two (32) airlines operators. Data was collected from 50 sampled respondents based on simple random sampling technique from the three (3) purposely selected airlines. These data were subsequently analysed through regression analysis. The result showed that air traffic delay can be accounted for by bad weather, ACFT maintenance, ACFT fuelling, air traffic congestion, operations flight doc., Pax late boarding, baggage handling, VIP movement and ACF damage. The result further reveals that the most potent contributor is bad weather. Therefore, the study recommended that service provider and the regulating agency should ensure that flight schedules are spread out as much as possible to avoid congestion of traffic and its associated problem.

Keywords: Causative; air traffic delay; transportation; meteorological; weather; airport.

1. INTRODUCTION

Transportation is a vital activity in moving both freight and passengers around the world. It is one of the tools that civilized societies need so as to bring order out of chaos, because it cuts across every phase and facet of our existence. Air transport is relatively expensive when

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compared with other modes of transport like water, road and rail system respectively. However, air transport is the fastest of these modes. Aviation industry plays important role in providing for the world economies. One of the main challenges facing the aviation industry is to develop capacity to meet demand; delay is one of the performance indicators. Traffic delay is experienced whether in the departure or arrival of aircrafts. If an aircraft arrives late at its destination, the delayed inbound flight may not only be delayed on its next flight leg but it may also affect other flights within the airline network. Delay as defined by the oxford leaner's dictionary is a period of time when somebody or something has to wait because of a problem that makes something slow or late. Air traffic delay refers to an arrival or departure flight in excess of the estimated time on the flight plan.

The root cause of delay can be either manmade or natural. The former is caused by airmen (personnel involved in flight movement) which could range from slow facilitation process, technical or maintenance problems, airspace cognition, movement breakdown while the later is caused by natural occurrence such as bad weather, natural disaster like volcano eruption, tornados. The causal effect of these factors is that goods and passenger will not get to their destination has scheduled. Apart from increasing the operational cost on the airline, it also increases fatigue on airman, passengers etc. hence, in all ramification air traffic delay boils down to loss of resources.

Prompt performance of airlines schedule is key factor in maintaining satisfaction of both current and new customers in airline industry. Also, maintaining economical operations during irregular conditions is essential to achieve expected revenues. These require clever management of the different operation resources (aircraft, pilots and flight attendants) to ensure their on-time readiness for each flight in the planned schedule. However, flight schedules' are often subjected to numerous sources of irregularity. According to (Rosenberger, Schaefer, Goldsman, Johnson, Kleywegt and Nemhauser [1]) weather accounts for nearly 75% of system delays. In an air traffic flow management (ATFM) initiative for each controlled flight, a controlled time of arrival or arrival *slot* is as-signed at the regulated area or arrival airport. Based on filed flight plans and weather forecasts, trip times can be estimated with reasonable accuracy and consequently, the CTA is translated to a controlled time of departure (CTD) at the origin airport. Thus, the CTD is the CTA minus the trip time and the total delay assigned (D) is the CTD minus the estimated (scheduled) time of departure (ETD).

Ground holding program is one of the basic methods of lowering the cost problem that usually occur during delay and congestion incur due to uncertainty of future landing capacity over a several hour interval in air traffic flow management (ATFM). It means to have a flight wait on the ground at its point of origin than to have it circle the airport at its destination, unable to land. Secondly, cruise speed management provides aircraft operators with an additional option to tackle delays and their associated costs. Studies such as (Mohleji [2], Schaefer and Miller [3], Hansen [4], Mueller and Chatterji [5] and Rosen [6]) on airport congestion have identified several factors which generate flight delays: saturation of airport capacity (including air transportation control activities), airline problems, reactionary delays, passengers and cargo, weather and other unpredictable disruptions (e.g. strikes). Among all these factors, delay time experienced by flights and passengers can be mostly attributed to the first two groups: problems caused by air transportation control and airports, and by airlines.

In addition stormy weather causes delays not only at airports experiencing the inclement weather, but also at airports with flights connecting from the airports experiencing inclement weather. During stormy weather, airport capacity is reduced due to increased aircraft separations. Because instrument landing systems are required for aircraft navigation in these conditions, this situation is called Instrument Meteorological Conditions (IMC). Clear weather is known as Visual Meteorological Conditions (VMC).

Furthermore, studies have identified the stages of flight in which delays occur and the causal factors that result in delays. For example, DOT classifies delays as gate delay, taxi-out delay, airborne delay and taxi-in delay. In a research conducted by Mueller [5] the data shows that 84% of all delays occur on the ground (gate, taxi-out, taxi-in), out of which 76% are prior to takeoff (gate, taxi-out), suggesting that focusing on ground delay prediction will have the most impact on improving forecasting algorithms.

Air traffic delay has become a major problem for air traveler and airline operators. Occasional delays are part of air travel today, as much as we dislike delays; we cannot avoid them even in well run airlines. Murtala Muhammed international Airport encounters the highest amount of traffic movement. Recently, there have been series of reports related to delays in air traffic. Delay often results in the increase in fuel consumption of aircrafts, affects passengers getting to their destination on time. In most cases the connecting flight is missed and the airline operators have no other option order than to take their passengers back to their point of departure and the ticket fair refunded back to them. Air traffic delay cannot be averted but can be managed. Arising from the above scenario, this, study attempts to examine the factors which contribute to the occurrence of flight delay in Murtala Muhammed International Airport.

2. LITERATURE REVIEW

Various literature discussed the issue of delay, Whalen, Carlton, Henyer and Rechard [7] believe that delay occur because an airport facility (i.e. runways and gates) is a scare resource and at key airports, airlines and scheduling more flights than that capacity can support. As a result more and more flights are delayed, even under normal weather conditions and considerable costs are imposed on the travelling public. Grupta [8] observed that the continuous growth of air traffic is rapidly bringing the National airspace system (NAS) to congestion levels that are strongly affecting level of service, delays and safety. The use of Geographic Information System (GIS) by Yahaya [9] in assessing traffic delays and how they Affect incident in Lagos sector of Nigeria airspace between 2008 and 2009, clearly concluded that air traffic delay whether on ground or in the air are noting in any way related to aircraft incident.

Rosen [6] measures the change in flight times resulting from infrastructure-constant changes in passenger demand. Results indicate that delays rise with the ratio of demand to fixed airport infrastructure, decreasing average flight times by close to seven minutes after the sharp decrease in demand in the fall of 2001. Flight time differences between the airlines in the sample are small, though the larger United had shorter average flight times in the winter quarter than America West, the smaller airline in the data sample.

Allan, Gaddy and Evans [10]. examined delays at New York City Airports from September 1998 through August 2000 to determine the major causes of delay that occurred during the first year of an Integrated Terminal Weather System (ITWS) use and delays that occurred with ITWS in operation that were "avoidable" if enhanced weather detection. The methodology used in the study of Allan, Gaddy, Evans [10] has considered major causes of delays (convective weather inside and well outside the terminal area, and high winds) that have generally been ignored in previous studies of capacity constrained airports such as Newark International Airport (EWR). The research found that the usual paradigm of assessing delays only' in terms of Instrument Meteorological Conditions (IMC) and Visual Meteorological Conditions (VMC) and the associated airport capacities is far too simplistic as a tool for determining which air traffic management investments best reduces the "avoidable" delays. Janic [11] presents a model for assessment of the economic consequences of large-scale disruptions of an airline single hub-and-spoke network expressed by the costs of delayed and cancelled complexes of flights. The model uses the scheduled and affected service time of particular complexes to determine the delays caused by disruption.

Wu [12] explores the inherent delays of airline schedules resulting from limited buffer times and stochastic disruptions in airline operations. It is found that significant gaps exist between the real operating delays, the inherent delays (from simulation) and the zero-delay scenario. Results show that airline schedules must consider the stochasticity in daily operations. Schedules may become robust and reliable, only if buffer times are embedded and designed properly in airline schedules.

According to FAA statistics (TCWF [13]), weather is the cause of approximately 70 percent of the delays in the National Airspace System (NAS). In addition, weather continues to play a significant role in a number of aviation accidents and incidents. While Kulesa [14] reported that most commonly find human error to be the direct accident cause, weather is a primary contributing factor in 23 percent of all aviation accidents. Hazards associated with convective weather include thunderstorms with severe turbulence, intense up- and downdrafts, lightning, hail, heavy precipitation, icing, wind shear, microbursts,

strong low-level winds, and tornadoes (Kulesa [14].

Hansen [4] analyzes runway delay externalities at Los Angeles International Airport (LAX) using a deterministic queuing model. While Mehndiratta, Kiefer and Eads [15] propose a simulation framework to analyze the effects of stochastic flight delays on static gate assignments, Abdelghany, Abdelghany and Raina [16] present a flight delay projection model, which projects flight delays and alerts for down-line operation breaks for large-scale airlines schedules. Hansen and Hsiao [17] analyze the recent increase in flight delay in the US domestic system by estimating an econometric model of average daily delay that incorporates the effects of arrival queuing, convective weather, terminal weather conditions, seasonal effects, and secular effects (such as half year). Hansen and Zhang [18] investigated the interaction between LaGuardia Airport (LGA) and the rest of the aviation system by estimating simultaneous equations of average LGA and National Airspace System delay using two-stage least squares. Hansen and Peterman [19] use regression to analyze the delay impacts of the implementation of Traffic Management Advisor (TMA) metering at Los Angeles International Airport (LAX) in order to assess whether and how they have affected NAS performance.

Statistical models and simulation method are used to analyze flight delay, including deterministic queuing model, regression, and econometric model etc. In this paper work flight delay data was collected from 50 respondents and regression model was used to identify the most potent delay factors.

3. MATERIALS AND METHODS

Lagos state lies within the Coordinates $6^{O}27'11"$N 3º23'45"E/6.45306ºN 3.39583ºE. It used to be the capital of Nigeria until 12th December 1991 when it lost that status to Abuja. However, till today Lagos remains the commercial nerve centre of Nigeria. The climate of Lagos is that of a typical savannah climate. There are two rainy seasons with the heaviest rains falling from April to July and a weaker rainy season in October and November. The main dry season is accompanied by harmattan wind from the Sahara desert which is between December and early February. The average temperature in January is 27ºC, while July is the 25ºC. On the average the hottest month is March, with a mean temperature of 29ºC, while the coolest is July.

Murtala Muhammed International Airport (MMIA) Ikeja was officially commissioned on the 27th of October, 1979. It is the nation's busiest airport, with three terminals (cargo, international, and domestic) the international and cargo terminals runs for 24 hours daily while the domestic terminal (also known as MM2) runs for 16 hours daily. The Lagos airport has two runways namely runway 18 Left (18L) which is often referred to as the domestic runway and runway 18 Right (18R) sometimes called international runway. MMIA forms part of Kano Flight Information Region (FIR) which is also referred to as Lagos sub sector of the Nigerian airspace. This part of the Kano sub FIR is composed of a total of 13 Aerodromes. It is characterized by a total of 12 air routes with their reporting points. Two of the routes run from one end of the area to the other. They are UR984 which runs from Opala North West to Ralin to the South East of the Lagos Sub FIR, while UA609 runs from the South West at Polto and terminates to the South East at Ikrop. Other routes within the study area start and terminate at one half of the area. That is, it does not Kris cross the entire study area. For instance, UR603 starts from the south east of the Lagos Sub FIR but does not go beyond the south.

The study area shares boundary with other airports like Akure to the East, Ibadan airport to the north east, and Cotonou to the west while the southern part is characterized by the Bight of Benin which is part of the Atlantic Ocean. At present, the control of aircraft along the Atlantic Ocean beyond a particular point is not within the jurisdiction of Nigeria.

Yahaya [9] stated that in year 2008 there were a total of 5,136,920 passenger movements and 77,472 aircraft movement while in year 2009 a total of 5,644,572 passenger movements and 84,588 aircraft movement. This shows an increased number of passengers' movement and also an increased movement of aircraft. With this volume of traffic operating in and out of Lagos daily and the increase in the use of aircraft as a means of transportation, the task of ensuring air traffic safety and reduced delay must not be toiled with.

An average of 32 airlines operators makes daily use of the Lagos airspace. Flights are either scheduled or non-scheduled. From the Nigerian Airspace Management Agency statistics department (for year 2011), 87% of the daily flights in MMIA were scheduled flights. MMIA recorded an average of one hundred and forty (140) daily arrivals (40 were international flights

while 100 were domestic flights respectively) and one hundred and forty-eight (148) daily departures (38 were international flights while 110 were domestic flights respectively). The study population is on the scheduled flights of the airline operators in Lagos airport.

Three airlines were purposely selected from an average of 32 airlines operators that makes use of Lagos airspace because of their high frequency to Lagos airspace and they operate both domestic and international flight. The data was collected from 50 respondents through a structured questionnaire specifically from the staff of the three airlines operating staff. Information was solicited about the possible causes of delay flight. The questionnaire administered to the airline operators covered their years of experience in aviation industry, factors that are associated with air traffic delay, technical and operational reasons for flight delay and number of delay experienced in a week etc. Multiple Regression Analysis was used to analyse the data obtained with the aid of computer software package for social sciences (SPSS). This was done in order to establish the relationship between Air Traffic Delay (dependent variable) and the following identified independent variables: bad weather, aircraft maintenance, aircraft fuelling, congestion of the airspace, flight documentation, late boarding, baggage handling, VIP movement, aircraft damage. Furthermore, to look at the impact of each of the predators on the dependent variable (Air Traffic Delay).

$$Y = a_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots + b_nX_{n+}e$$

Y= dependent variable
a_0 = Slope/intercept
$b_1 – b_n$ = Regression co-efficient
$X_1 – X_n$ = independent variables
x_1 = baggage handling
x_2 = aircraft damage
x_3 = bad weather
x_4 = ACFT fuelling
x_5 = VIP movement
x_6 = aircraft maintenance
x_7 = flight documentation
x_8 = pax late boarding
x_9 = air traffic congestion
e = error term

4. RESULTS AND DISCUSSION

Result from Table 1 shows that the linear combination of Bad Weather, ACFT Maintenance, ACFT Fuelling, Air Traffic Congestion, Operations Flight Doc., Pax late Boarding, Baggage Handling, VIP Movement and ACF Damage were significantly related to $F(9,41) = 78.796$ $P<0.01$. The multiple correlation coefficient was 0.972, indicating that approximately 97% of the variance of the AIR Traffic Delay can be accounted for by the linear combination of Bad Weather, ACFT Maintenance, ACFT fuelling, Air Traffic Congestion, Operations Flight Doc., Pax late Boarding, Baggage Handling, VIP Movement and ACF Damage and this yielded an R-Square of 0.945 accounting for 95% of the delay in air traffic movement at Muritala Muhammed International Airport. It equally shows the overall measure of the strength of association of all the independent variables with the dependent variable.

Findings from the research objective delved into separate contributions of the nine explanatory variables (Table 2), six out of the nine variables independently made significant contribution to Air Traffic Delay in MMIA though at different degree. The most potent contributor happen to be bad weather (β = 1.693) with p-value of 0.007 and is statistically significant at 0.05, the implication is that as weather situation get worst the level of air traffic delay increases. This is closely followed by Air Traffic Congestion with (β= 0.748) with p-value of 0.005 therefore air traffic congestion is an effective predictor for air traffic delay. Flight documentation and Baggage handling has (β = 0.813) and (β = 0.401) contribution respectively and they were equally significant at 0.05.

Similarly, Pax late boarding and VIP movement has (β = 0.371) and (β = .319) respectively, ACFT fuelling made the least contribution with (β = 0.313) and all of them were significant at 0.05. The implication is that Bad Weather, ACFT Fuelling, Air Traffic Congestion, Operations Flight Doc., Pax late Boarding, Baggage Handling and VIP Movement contributed to air traffic delay, with the exception of bad weather that is natural all airline operators should improve their services in these area of their operation.

Conclusively, factors that contribute to flight delays are more significant than the other. The most significant delays in Lagos Airport are bad weather and fuelling of aircraft. It should therefore be noted by service provider and regulating agencies that flight schedules should be spread out as much as possible to avoid congestion. Focus should be on the causes of flight delay and effort should be made to reduce it.

Table 1. Analysis of variance

Multiple R		0.972			
R Square (R^2)		0.945			
Adjusted R. Square		0.933			
Standard Error		0.266			
Analysis of variance table					
	DF	**Sum of squares**	**Mean square**	**F-ratio**	**Sig.**
Regression	9	50.085	5.565	78.796	.000
Residual	41	2.896	0.071		

Table 2. Analysis of identified variables

Coefficients[a]						
Model		**Unstandardized coefficients**		**Standardized coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-1.310	.294		-4.460	.000
	X1	.777	.192	.401	4.037	.000
	X2	-.662	.396	-.476	-1.672	.102
	X3	2.409	.851	1.693	2.829	.007
	X4	-.657	.264	-.313	-2.489	.017
	X5	.009	.062	.011	.149	.882
	X6	-.672	.303	-.319	-2.218	.032
	X7	-1.205	.544	-.813	-2.214	.032
	X8	.393	.120	.371	3.279	.002
	X9	1.528	.508	.748	3.006	.005

a. Dependent variable: air traffic delay

5. CONCLUSION AND RECOMMENDATION

Basically from this work we have come to know that certain factors which contribute to flight delay are more significant than others. The most significant factor which contributes to flight delay in Lagos airport is bad weather. The implication is that as weather get worst or as bad weather increases air traffic delay equally increases. This in turn means that the traffic volume in terms of passenger traffic will reduce and invariably have a greater effect on the resources of the airline. Furthermore, this variable usually occurs during periods of adverse weather such as harmattan haze, heavy rain and microburst activities in the vicinity of thunderstorms or thick fog. In such situations aircraft may be subjected to holding in the air for weather improvement. Moreover, since airlines operate on schedules, whenever the schedules were disrupted as a result of harmattan haze or dust spell, it could result to loss of revenue and extension of working hours by the airline staff, pending improvement of feasibility. As to the passengers, flight delays, cancellations, reschedules, diversions and air returns arising from bad weather could lead to loose of business and unbudgeted expenditure while those on either transit or flight connection could miss their flight.

The service provider and the regulating agency that is NAMA -Nigerian Airspace Management Agency and NCAA - Nigerian Civil Aviation Authority should ensure that flight schedules are spread out as much as possible to avoid congestion of traffic and its associated problems. NAMA should liaise with airline operators and establish a proper air traffic capacity flow management (ATCFM) system. This involves the allocation of slots to aircrafts.

Airline operators should dedicate some staffs to focus on flight delay. These staffs will focus on the causes of flight delay and work towards reducing it (if it is manmade). They will also inform passengers (via text messages or phone calls) of flights which might be delayed before a scheduled departure time NAMA should liaise with NIMET and airline operators so that pilots should have a proper meteorological briefing session before any departure.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=1063&id=20&aid=9707