

*Full Length Research Paper*

# **Airport capacity utilization in Nigeria: A performance and efficiency analysis**

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**Most airlines in Nigeria fly at about the same time of the day creating great strains on airports' runways and air traffic management. This study examines air traffic flow: recorded landings and take-offs times, arrival times and time between arrivals and times spent in the airport. The data collected were analyzed using the queue theory to know the airport turnaround time and the rate of usage of the airport as well as time variation in usage pattern. The results showed that the airport was grossly underutilized; most domestic traffic movements had two main peaks (morning and evening) with the headway been dangerously close. There is grave danger in clustered take-offs and landings so it was advised that to boost airport capacity utilization staggering of airlines' schedules should be encouraged.**

## **INTRODUCTION**

Transport is a very important sector of any economy hoping to grow and develop though it is not a sole prerequisite for development and growth. Other factors like commerce, social and civil peace, technology, and environmental stability are equally important. The ability for transport to have significant impact on the economy is its ability to meet the needs of the majority of the populace, the poor and middle class in particular.

Air transport is relatively expensive when compared with other modes of transport like road, rail and water transportation. However, air transport is the fastest of these modes and the choice for medium and long distance movements for those in positions of authority and the rich. There is therefore, the temptation for governments in the developing countries to lay more emphasis on its provision and promotion at the expense of other modes that are more relevant to the needs of the governed populace.

Increase in global wealth and life longevity and relative reduction in global level of poverty has made demand for

air transportation to be on the rise in the last two decades. In the UK, this debate has been heightened by the publication of a strategic framework for expansion of airport and runway capacity over the next 30 years (United Kingdom's Department for Transport (DfT), 2003). Failure to accommodate this growth would have serious ramifications for tourism, the finance sector, and other businesses that rely on world markets (Darling, 2003). Aviation will thus continue to play an important role in the future prosperity of the Nigerian and world economies.

However, transport infrastructures are quite expensive to put in place. In fact the decision to build one is very expensive too as resources are limited and there are several sectors of the economy that share these limited resources which must also be considered in resource allocation.

Building of airports or any such infrastructures can only be justified when the facilities are optimally utilized. Developing economy like Nigeria, air transport will not be a priority sub-sector of the transport sector in terms of resource allocation. Therefore, would it be justifiable to invest heavily in airports at the expense of road and rail, both of which are the prime carrier of the majority? Airport capacities already in place must be adequately utilized to remain meaningful for the allocated resources and to attract more. Are the airports' capacity adequately utilized?

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**Abbreviations:** MMA, Murtala Mohammed Airport; DPH, design peak hour.

Developing countries such as Nigeria are facing the twin pressures of economic growth and environmental protection in the 21<sup>st</sup> century. Gössling (2000) opined that transport demand management needs to be carried out in accordance with the principles of sustainable development and the maintenance of ecological environment so that we can attain the objective of coordinating the needs of the present without compromising the ability of future generations to meet their own needs.

Airport capacities are increasingly getting smaller and needs to be expanded. DfT (2003) suggested that 90% of business travelers wanted the UK government to take to action to increase runway and terminal capacities at Heathrow. Following this, the case runways and terminals have been increased with the building of Terminal 5. In Nigeria, the same is the case as the Murtala Mohammed Airport (MMA) and Port Harcourt Airport had their runways increased recently. Few industries have developed and grown as rapidly as air transport. Traffic congestion in both developed and developing countries is getting worse; as the capacity of networks cannot increase at a rate to match the increase in demand (Stephens, 2003). However, are the arguments for increasing and increased capacity justifiable, particular in developing countries where in most cases capacities are often underutilized but vaguely seen as over-utilized?

Bubalo (2009) studied productivity of 58 European airports and its use of infrastructures, based on the annual and design peak hour (DPH) runway and terminal demand using benchmarking to know the role of capacity utilization in airport performance. To make airports comparable regarding the capacity of airport system to serve demand, Bubalo made effort to isolate peer group with productivity characteristics. He also proposed for the purpose of benchmarking a rule-of-thumb methodology for isolating an airport's DPH.

### Objectives of the study

The main objective of this study is to analyze the performance and level of efficiency of MMA and to determine the types of capacities with the view of finding their levels of utilization.

### Research questions

In line with the above objectives the following questions were addressed:

1. What types of capacities exists in the airport?
2. What are the levels of these capacities utilization?
3. What is the airport average turnaround time?
4. What is the traffic intensity at the airport?
5. What is the airport waiting-to-service ratio?
6. What is the average headway at the airport?
7. Is the traffic volume well spread over time or clustered together within certain time(s)?

For the purpose of this study the MMA is chosen as the case study. This is because this airport serves main aviation hub in the Nigerian aviation industry for domestic and international traffic (cargo and passengers).

### Domestic air network structure

The domestic air network structure in Nigeria has so far linked only the state capitals though not all state capitals are connected by air at this moment. State capitals without air links are Abakaliki, Abeokuta, Ado-Ekiti, Asaba<sup>1</sup>, Awka, Bauchi, Birnin-Kebbi, Ebonyi, Gombe, Katsina, Lafia, Lokoja, Oshogbo, Umuahia, Uyo, Yenogoa, Yobe, and Zamfara. Reasons for their lack of airports range from proximity to capitals with large airports to lack of market potentials.

The number of routes that link each airport varies depending on the level of demand. Using this, the airports can be classified into two: those with total number of routes less than the average number of 8 routes (low hierarchy) and those with above average number of routes (high hierarchy).

From Figure 1 which shows the 63 routes that make up the major routes, it is obvious that Lagos airport is the main air hub in Nigeria which is reflected by the clustered air routes. Abuja, Kano and Port Harcourt airports are other sub-hubs. Lagos, Abuja, Kano, Port Harcourt and Calabar airports are all international airports.

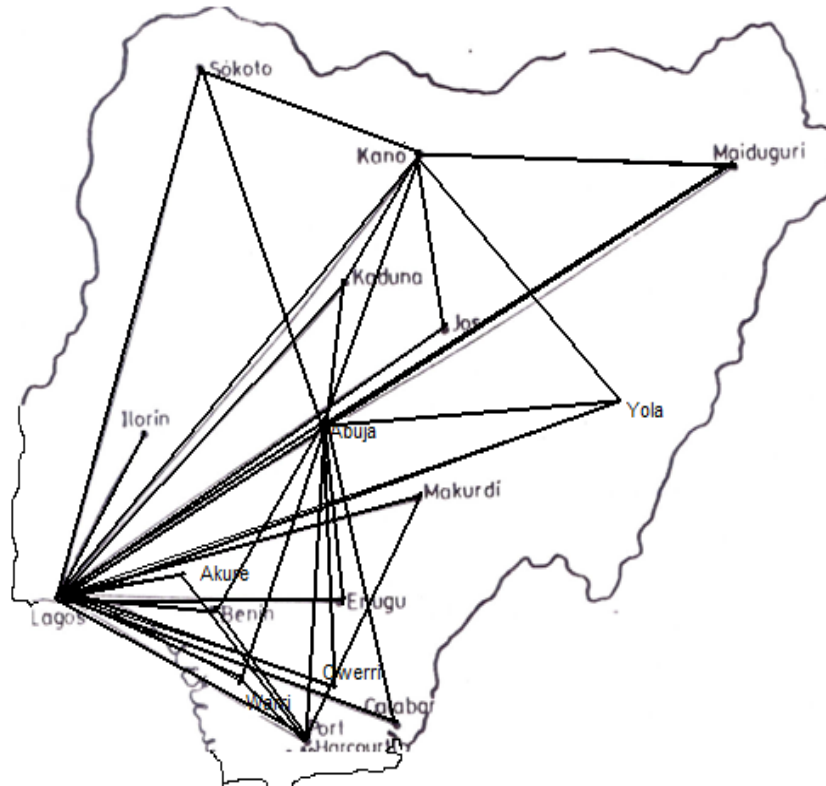
The domestic route network is also made up of 51 minor routes (Figure 2) that are most served by helicopters and small airplanes. Most of the traffic here (passenger and aircrafts) are of corporate bodies that carry staffers and light equipments between points of operations. These routes also serve as feeder routes to the major routes. The implication of this is that most Nigerian domestic air travelers are concentrated along a few major routes and these routes are the ones air carriers fly the most.

The operational network of carriers in Nigeria exhibited the hub and spoke pattern in which the aircraft begin flights from a central point and return to the same point.

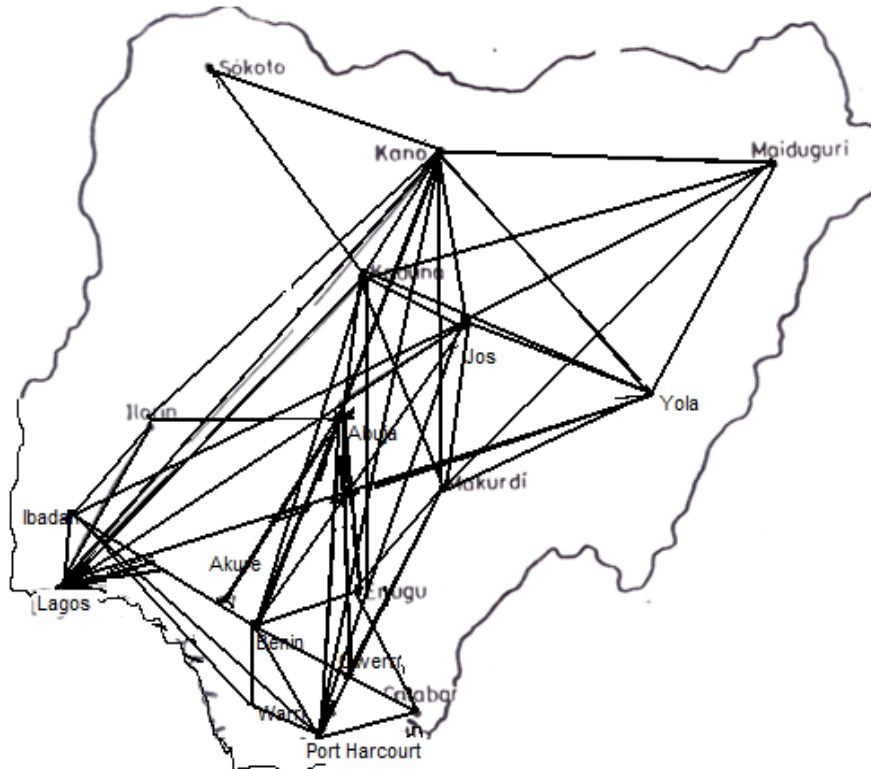
### Theory of the study

Capacity utilization is a concept in economics which refers to the extent to which an enterprise or a nation actually uses its installed productive capacity. Thus, it is refers to the relationship between actual output that 'is' produced with the installed equipment and the potential output which 'could' be produced with it, if capacity was fully used. If market demand grows, capacity utilization will rise. If demand weakens, capacity utilization will slacken economists and banker often watch capacity utilization indicators for signs of inflation pressures.

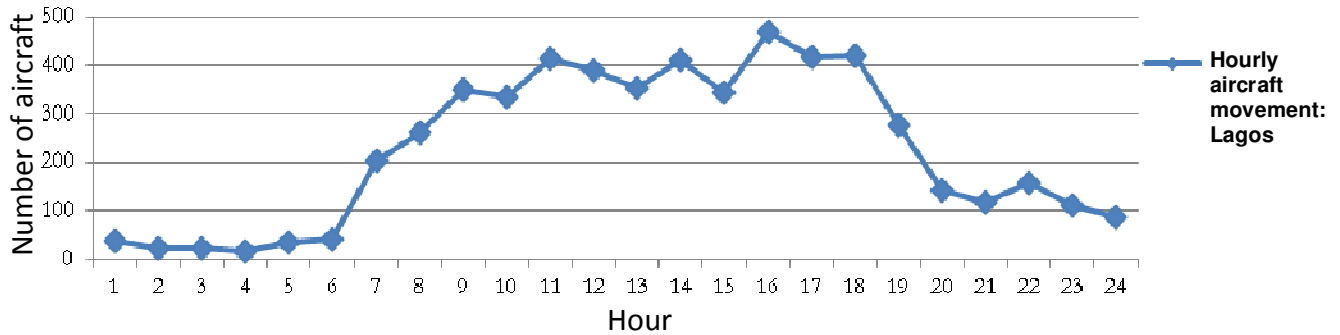
<sup>1</sup> Airport in this state is under construction.



**Figure 1.** Major domestic air routes in Nigeria  
Source: Field work.



**Figure 2.** Minor domestic air routes in Nigeria.  
Source: Field work.



**Figure 3.** Hourly Air traffic in Lagos.  
Source: Field work.

It is believed when utilization rises above somewhere between 82 and 85%, price inflation will increase. Excess capacity means that insufficient demand exists to warrant questioning the need to expansion of output (Stephens, 2003).

One great way to measure capacity utilization is to use ratio of actual output to the potential output. Therefore, airports terminal apron occupancy rates and the rates of utilization of runway may serve as a measure of capacity utilization for an airport so that the probability of no aircraft ( $P_0$ ) at the terminal apron on landing/taking off on a runway is given by

$$P_0 = c! (1 - \rho) / (c\rho) \sum_{n=0}^{c-1} \frac{(c\rho)^n}{n!} (1 - \rho)$$

Where  $c$  = number of aprons in the airport,  $\rho$  is traffic intensity,  $n$  = integers from 0 to  $(c-1)$ . Facilities that process variable traffic flow such as the airport are known to behave in a special way, in that arrival for service at these facilities is irregular and unpredictable and capacities of the facilities cannot be expanded to meet the demand of the arriving traffic. The service and arrival rates varies on hourly, daily, weekly, monthly and or annual basis and of great importance is the waiting-to-service ratio ( $w/s$ ).

Arrival rate is  $\mu$  = number of aircrafts in system/ total time between arrivals

Service rate is  $\lambda$  = number of aircrafts in system/ total service time.

**Data analytical tools**

To analyze the data generated a queue theory model was developed and used to calculate aircraft delays, airport capacity utilizations and runways headway for the airport in particular to know the causes of delays (if any) and the deviation(s) from achieving optimal capacity utilization levels (for airport and runways), and the installed runway headway. Mega Stat program was used for time series analysis to forecast domestic air transportation demand for the next ten years.

**Limits and limitations**

The research work is limited to the domestic air transportation traffic to and from airports within Nigeria as well as study of airport facilities in the country. However, due the vast size of the country, cost and time constraint restricted the study to just the few airports that are carefully selected to cover major hubs and all the regions in the country where primary data were gathered allowing the collection of secondary data from Federal Airport Authority of Nigeria (FAAN), National Civil Aviation Authority (NCAA) and National Airspace Management Agency (NAMA). The selected airport for primary data collection was MMA Lagos.

**Aircraft movement and runway usage**

The movement pattern of aircrafts<sup>2</sup> was illustrated and this revealed the number of aircrafts that flies in and out of airports. From Figure 3, it is obvious that aircraft traffic is higher during the day than at night. The night flights are usually long distance international flights and all domestic flight that are scheduled take place during the day.

The headway calculated from data showed that Lagos is the busiest with an aircraft arriving every seven minutes. The installed capacity is five minutes interval so one might think the airport is under-utilized. However, during it busiest hours in the day (0800 hour – 1700 hour) the headway was as low as two minutes thirty seconds. This is dangerous and was the cause of the crash of Aviation Development Company ADC Airline into the Lagos Lagoon in Ejirin, The airline was trying to avoid head-on collision with an aircraft that was taking off on the running northwards instead of southwards<sup>3</sup>. Airlines should be discouraged from fixing schedules too closely with one another and when accepting flight plans airport operators should cross check domestic operators with those of international operators to make sure a safe distance is kept between each arrivals and departures respectively.

Looking at the Table 1, one can easily conclude that the airport’s terminals are under-utilized as the number of airplanes at the airport at one point in time is 14 whereas the airport can handle 20 at the terminals and more off the terminal apron.

Air planes spend an average of 101 min at the airport indicating a good turnaround time. The traffic intensity is slightly high at 0.69, resulting to having, at any point in time, 3 airplanes cycling above the airport waiting to land. This indicates the runway is over-utilized and there is need for capacity expansion. However, the results showed that at any point in time there are 14 airplanes at the airport

<sup>2</sup> See data on Appendix 1

<sup>3</sup> Takeoffs in Lagos airport are done running southwards along the runways towards the Atlantic ocean

**Table 1.** Result of queue theory calculation at MMA, Lagos.

Total time btw arrivals	38073.02	Minutes
Total waiting before landing	4199.00	Minutes
Total time taking for discharging of passenger	37115.01	Minutes
Total time taken to load passenger	34494.02	Minutes
Total aircraft idle time at apron	439306.56	Minutes
Total wasted time before take-off	26840.00	Minutes
Total turnaround time	525460.60	Minutes
Total number of planes (landed/taken-off)	5475	
Arrival rate, $\lambda$ = number of planes/total time btw arrivals	0.143802624	
Service rate (at the airport), $\mu$ = number of planes served/total service time	0.01041943	
Service rate (at the apron terminals), = number of planes served/total service time		
Average waiting time before landing = total waiting time before landing/number of planes landed	0.766940639	Minutes
Traffic intensity, $\rho = \lambda/c\mu$ (where $c = 20$ )	0.69006953	
Probability of no plane in the airport $P_0 = \frac{c!(1-\rho)^c}{(c\rho)^c + c!(1-\rho) \sum_{n=0}^{c-1} \frac{c!}{n!} (\rho)^n}$	0.00000355	
Average time a plane spend in the airport = $[(\rho c)^2/c!(1-\rho)^2c\mu] P_0 + 1/\mu$	100.7325051	Minutes
Average time a plane spends in the queue (including times there is no queue)	1.76223E-05	Minutes
Average number of planes in the airport	14.48413894	Planes
Average time a plane spends in the queue (including times there is no queue) = $(\rho c)^c P_0/c!(1-\rho)^2c\mu$	3.28	Planes
Probability of queuing on arrival before landing	0.02	
Probability of not queuing on arrival before landing	0.98	
Arrival rate, $\lambda$ = number of planes/total time btw arrivals	0.143802624	planes/minutes
Service rate (at the airport) $\mu$ = number of planes served/total service time	0.01041943	planes/minutes
Average time wasted by airplanes before take off	4.902283993	Minutes

Source: Field work.

that is 0.7 capacity utilization rate and does shows that there might be no need to expand airport runways to reduce waiting to land times. The reduction in queue can be achieved by staggering landing/arrival times so that they do not cluster at any particular period as indicated on Figure 1.

#### **Air ticket purchasing points and customers' perceived airline problems**

Early purchase of tickets often attracts some discount as it gives the carrier funds ahead of the contractual carriage and ample time to plan for the expected/booked traffic. On the part of the passenger it gives him/her ample time to concentrates on other issues that might require attention. Ability to plan is essential for both the carriers and the passengers. 79% of airport users in Lagos (Table 2) purchase their tickets at the airport and that add to time spent by airplanes at the airport.

Air travelers in Lagos quite appreciates the need to purchase tickets of airlines away from the airport as 13 % of them see the lack of airline sales outlets in the town/city as a problem (Table 3).

#### **Terminals at the airports**

Domestic terminals in Nigerian airports are usually not catered for as much as their international counterparts. This can be observed in the adequacy of the terminal buildings' air-conditioning system and the crowd handling capacity of the terminal.

75.21% of air travelers using the Lagos airport agreed that the

air-conditioning system was okay while 81.82% of users of Abuja airport said same. This should not be unexpected as the two airports are the most important airports for domestic and international traffic. They are in fact the main national gateways by air and their domestic terminal should be befitting for national gateways' linkage to other cities and towns.

The Abuja airport's terminal and the GAT in Lagos are relatively new while the Murtala Mohammed Airport (MMA)2 in Lagos is brand new and their newness could also add to the fact that their terminals have relative good cooling system. Worthy of note is the Owerri airport that can be said to also be relatively new but was said to have inadequate air-conditioning system by 69.19% of its users. This is case of poor maintenance culture that is prevalent in Nigeria's handling of public infrastructures. Maiduguri airport recorded quite a huge percentage (87.58%) of it users claiming that the terminal's air-conditioning system is inadequate. The heat of the desert would definitely mean more air-conditioning is going to be required at that airport. (Tables 4 and 5) Lagos is the major hub and has high level of capacity utilization as perceived by the air travelers.

#### **Passenger checking-ins**

From (Table 6) the air travelers responses one can say that the check-in facilities at the visited airport were inadequate as just 20.07% of them agreed that they were okay. 56.48% said they were not adequate. This could mean longer check-in times and queues for departing air travelers. Matters could be made worse if there are delays in departure times for departing flights. However, 47.25% of

**Table 2.** Ticket purchasing points

Sales point	Lagos	%
The airline's sales outlet in town	652	10
Travel agency in town	452	7
Internet	251	4
The airline's sales counter in the airport	4965	79
Total	6320	

Source: Field work

**Table 3.** Air travelers' problem.

Problem	Airport							
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri
	(%)							
Poor ground services	62	55	38	40	41	56	39	20
Fewer sales outlets	13	11	5	8	10	37	11	16
Poor on-board services	46	44	25	29	36	45	49	56
Reliability of flight schedules	58	51	32	24	25	35	45	28

Source: Field work.

**Table 4.** Is the terminal building air-conditioning adequate?

Response	Airports								Total	%
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri		
Yes	4753	2651	191	213	189	428	1006	138	9569	60.56
No	1567	589	429	267	176	250	1982	973	6233	39.44
Total									15802	

Source: Field work.

**Table 5.** Do you feel the terminal building is over-crowded?

Response	Airports								Total	%
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri		
Yes	4753	2651	191	213	189	428	1006	138	9569	60.56
No	1567	589	429	267	176	250	1982	973	6233	39.44
Total									15802	

Source: Field work.

air travelers using Maiduguri airport agreed that the airport has adequate facilities to meet the demand of departing passengers at check-in points and time.

When checked with the check-in delays on the Table 7, one will have to agree that the check-in facilities at the Maiduguri airport are actually adequate. In general, 55.92% of the interviewed air travelers experienced check-in delays of over ten minutes. 14.01% were delayed for less than two minutes. 10.57 and 19.5% were delayed for about five and ten minutes respectively. Analyzing it on airport basis Lagos airport had 78.81% of its domestic users been delayed for more than ten minutes, 14.13, 5.02 and 2.04% been

delayed for check-in for about ten minutes, about five minutes and less than two minutes respectively. Abuja airport recorded check-in delays of passengers of 45.40, 28.67, 16.17 and 9.75% for more than ten minutes; about ten minutes; about five minutes and less than two minutes. It was only in Calabar, Kano and Maiduguri airports that over 20% of the respondents were delayed for less than two minutes (21.39, 25.37 and 70.57% respectively). Only Maiduguri had less than 10% recorded for delays of more than ten minutes. The differences experienced in the levels of delays was caused by the volume of traffic and the speed of processing the delays at the different airport as all the terminals have just on

**Table 6.** Is there adequate facility to satisfy departing passengers while awaiting check-in?

Response	Airports								Total	%
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri		
Yes	865	313	128	125	89	170	956	525	3171	20.07
No	3965	1956	295	199	145	321	1746	298	8925	56.48
Just okay	1490	971	197	156	131	187	286	288	3706	23.45
Total									15802	

Source: Field work.

**Table 7.** Check-in delays.

Delay	Lagos airports
less than 2 min	129
about 5 min	317
about 10 min	893
more than 10 min	4981

Source: Field work.

**Table 8.** cost of check-in delays.

	Airport							
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri
Total time lost in hours	1409.80	473.45	95.37	72.17	56.23	87.97	373.35	66.22
Total cost/hour in Naira	124034.20	41654.13	8390.36	6349.22	4947.41	7739.31	32847.33	5825.74
Average cost/hour in Naira	19.63	12.86	13.53	13.23	13.55	11.41	10.99	5.24

Source: Field work.

check-in entry point each. The service system operates on first-come-first-served basis. Perhaps, should the service points be increased, the delays might be minimized or eliminated totally.

At nineteen naira sixty-three kobo Lagos airport, on average cost the most to check-in. It was followed by Jos (N13.55k), Owerri (N13.53k), Enugu (N13.23k), Abuja (N12.86k), Calabar (N11.41k), Kano (N10.99k) and Maiduguri cost the least at five naira twenty-four kobo (Table 8).

A combined 66.6% of the air travelers in all the airports agreed not to have enjoyed their time while waiting to be checked-in. This is poor customer satisfaction. The airport and airlines must do something to change this situation. Should the passengers be forced to wait, they should do so in a good environment and atmosphere. Recall that most claimed the air-conditioning system of the terminals was not adequate.

From Table 9, Only 17.23% said there was some form of entertainment while they were waiting. Lagos airport (had 17.5, 40.24, 29.54 and 12.72%), Abuja airport (had 14.85, 37.38, 29.17 and 18.61%), Owerri airport (had 13.87, 38.06, 28.23 and 19.84%), Enugu airport (had 21.25, 31.04, 27.92 and 19.79%), Jos (had 24.38, 30.14, 33.15 and 12.33%), Calabar (had 16.22, 41, 28.61 and 14.16%), Kano (had 15.63, 29.89, 32.9 and 21.59%) and Maiduguri (had 25.29, 27.18, 34.47 and 13.05%) of respondents agreeing that "Yes, there was some form of entertainment"; "No, I didn't but had no choice"; "No, I didn't but was able to finish my discussion with my escort; and "No, I hate to ever wait" respectively.

### Airport lounge ratings

An airport can easily be rated by the level of comfort, convenience and security enjoyable at the airport's lounge. The lounge is where passengers wait before being called to board flights. Some airlines have their personal lounges particularly those offering international services. Airlines running domestic flights in Nigeria do not operate personal lounges hence the study only asked question about the airport's lounge in the different airports where this study was carried out.

Majority of the air travelers believe that the airports should be rated as "three-star" airports as 36.31% of the air travelers rated them so. 30.69% rated them to be "four-star" and 22.79% rated them as "two-star" and just 0.78% sees the airports as "five-star".

Among the international airports Maiduguri airport was rated "four-star" by 48.51% of its air travelers. Lagos airport was second with 41.95% of the air travelers rating it as "four-star". This is shown in Table 10.

The reason for Lagos to have gotten this rating could be due to the recent opening and use of MMA2. One would have even expected the airport to have enjoyed better rating since the question was directly associated with the new terminal.

### Ground crew efficiency

Once a flight touches ground the next most pressing desire of the

**Table 9.** Did you enjoy your waiting time?

Response	Airport								Total	%
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri		
Yes, there was some form of entertainment	1106	481	86	102	89	110	467	281	2722	17.23
No, I didn't but had no choice	2543	1211	236	149	110	278	893	302	5722	36.21
No, I didn't but was able to finish my discussion with my escort	1867	945	175	134	121	194	983	383	4802	30.39
No, I hate to ever wait	804	603	123	95	45	96	645	145	2556	16.18
Total									15802	

Source: Field work.

air travelers is to retrieve their valuables stowed within the cargo-hold of the aircraft and exit from the airport. Most are therefore in a haste to get their luggage and as a result are conscious of the time taken to effect the retrieval. This retrieval time can be used as yardstick measure the efficiency of an airline ground operation. However, for this study only the aggregated responses of the air travelers for the airports was used since the questionnaires were administered prior to departures and no passenger will be willing to be interviewed once he or she has his or her luggage.

They were therefore asked "How long it took to retrieve luggage when the airport was last used?" the result is shown in Table 11. From the result, Lagos airport had a computed cost of time wasted for retrieval to be seventeen naira ninety kobo. This was the highest meaning the airport users experience longer time retrieving the valuables at the airport than at any other airport in the land. Owerri had the cheapest cost at one naira forty kobo.

### Domestic air traffic growth

The growth of air travel has always been expected to keep growing<sup>4</sup>. This growth is however being mitigated against by the hike in global oil prices caused mainly by an ever increasing demand for oil, fears of disruption in supply and panic pricing (that seems to be favoring the oil producers and the oil companies). The Nigerian air transport industry is not immune from this and so one should expect a slump in traffic that will be occasioned by increased airfare.

By 2017 the domestic air traffic is expected to rise to 10,129,886.8 passengers as shown on Table 12. This is a significant growth but the value might not be up to this should there be in place a relatively fast and reliable rail links connecting the major cities like Lagos-Abuja-Kaduna-Kano and Lagos-Benin-Port Harcourt-Calabar, Lagos-Benin-Onitsha-Enugu, Port Harcourt-Umuahia-Enugu-Jos-Maiduguri amongst others being proposed.

With growth expected in air traffic volume there is need to allow more carrier into the sub-sector. This will further reduce the likelihood of the monopolistic tendencies that usually prevail when the market is considerably large and the a few carriers operate in the market.

The industry is such that capital and technology ready acts barriers to entry and such barriers can be enforced by making sure no sub-standard aircrafts and equipments are ever employed.

## SUMMARY AND FINDINGS

This study has considered the issue of domestic air network structure, aircraft movement, airports' capacity utilization, assessment of airport services and facilities:

Study discovered that there two main types of domestic air networks in Nigeria: major and minor domestic air network. The major air network connects the main airports in Nigeria namely: Lagos, Abuja, Kano, Port Harcourt, Calabar and Owerri with majority of the airlines flying to these airports from Lagos and IRS from Abuja. This network carries over 85% of the domestic traffic. The minor air network is made up of flights still to and from the airports listed above but with additional flight to airfields that probably serve the interests of a minority in the cities or towns where the airfields are located. Most times the traffic is essentially business travelers. All the airlines fly using hub and spoke operation. Lagos is the hub of all except IRS that flies from Abuja as its hub and only Arik Air has two hubs, which are Lagos and Abuja.

### The advantages of hub and spoke operations

1. It enables the possibility of centralised maintenance services at the hub since most of the aircraft will operate to and from there.
2. The control of aircraft movements is made easy and since the control of schedules is a prime necessity, this is an advantage.
3. The sales aspect of the business is given a boost by the presence of central node.

### The disadvantages of hub and spoke operations

1. Aircraft and crew utilization is difficult to rationalise, since extremity of the network is isolated from its neighbours and aircraft must return directly.

<sup>4</sup> See Table 12



**Table 10.** Airport lounge ratings.

Rating	Airport																Total = 15802
	Lagos		Abuja		Owerri		Enugu		Jos		Calabar		Kano		Maiduguri		
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	
5 star	12	0.19	9	0.28	11	1.77	2	0.42	11	3.01	56	8.26	11	0.37	11	0.99	0.78
4 star	2651	41.95	979	30.22	175	28.23	56	11.67	78	21.37	145	21.39	226	7.56	539	48.51	30.69
3 star	1652	26.14	1002	30.93	273	44.03	98	20.42	145	39.73	171	25.22	1969	65.90	427	38.43	36.31
2 star	1254	19.84	897	27.69	134	21.61	120	25.00	111	30.41	278	41.00	687	22.99	121	10.89	22.79
1 star	751	11.88	353	10.90	27	4.35	204	42.50	20	5.48	28	4.13	95	3.18	13	1.17	9.44
Total	6320		3240		620		480		365		678		2988		1111		

Source: Field work.

**Table 11.** Cost as a result wasted time awaiting luggage retrieval.

	Airport							
	Lagos	Abuja	Owerri	Enugu	Jos	Calabar	Kano	Maiduguri
Total lost time in hours	1278.92	455.67	267.22	100.17	246.82	268.38	430.78	315.05
Cost per hour	112519.09	40089.55	23509.72	8812.66	21714.93	23612.37	37900.32	27718.1
Average cost per hour	17.9	6.38	3.74	1.40	3.45	3.76	6.03	4.41

Source: Field work.

2. Apart from the hub station, traffic flow through each other point is low in most cases and this tends to make station costs proportionately higher than they would be with a more even and bigger flow.

3. Weather will be a vital consideration at the central station (airport), for since the majority of the routes start and finish at this point, bad weather at the hub will affect most of the airline schedules has its in Kano.

4. Most domestic flight operations takes place during the day and most are closely packed together indicating a daily peak and off-peak periods. The peak periods are in the mornings

and in the evenings but some airports like Lagos do have a single peak period that extends from 7 o'clock am to 8 o'clock pm. The effect of the crowded peak time flights that airport's headways are significantly lowered and this can be dangerous for flight safety. For example, Lagos has an installed headway of 5 min between successive take-offs and landings but during the peak period the headway could be as low as 2.5 min.

It was discovered that above 67% of air travelers acquire their flight tickets at the airport as they are about to travel. Nineteen percent of them got theirs from the airlines' sales outlet in towns,

11% from travel agencies in the town and just 4% via the internet. This could mean a low internet penetration amongst air travelers and reflected the so-called Nigerian syndrome of "last minutes rush". Majority of the airlines had similar problem of having to have a long queue of air travelers trying to get flight tickets at the airport.

The use of travel agency is low amongst the air travelers for all the airlines. Only Nicon Air had above 30% patronage via the agencies but a dismal showing for sales made at its own sales outlets in towns. Worthy of note is the fact that the newly established Arik air has been able to get the travel agencies to be selling about 20% of its

**Table 12.** Time series analysis of future domestic air passenger traffic.

<b>Regression analysis</b>							
	0.856		r <sup>2</sup>				
	0.925		R				
	723459.673		Std. error of estimate				
	12		Observations				
	1		Predictor variable				
	Domestic passenger traffic		Dependent variable				

Variable	Coefficient	Std. error	t (df=10)	p-value	confidence interval	
					95% lower	95% upper
Intercept	a =	2,203,955.4103				
t	b =	466,231.2587	60,498.7371	7.71	1.63E-05	331,431.6727 601,030.8448

<b>ANOVA</b>					
Source	SS	df	MS	F	p-value
Regression	31,084,136,887,726.6000	1	31,084,136,887,726.6000	59.39	1.63E-05
Residual	5,233,938,979,808.0900	10	523,393,897,980.8090		
Total	36,318,075,867,534.7000	11			

	T	Y'	Residual	
	0	2,203,955.410	1,671,043.5897	
	1	2,670,186.669	-85,802.6690	
	2	3,136,417.928	-806,138.9277	
	3	3,602,649.186	-857,036.1865	
	4	4,068,880.445	-684,618.4452	
	5	4,535,111.704	-135,778.7040	
	6	5,001,342.963	-169,817.9627	
	7	5,467,574.221	105,526.7786	
	8	5,933,805.480	530,739.5198	
	9	6,400,036.739	439,670.2611	
	10	6,866,267.998	150,512.0023	
	11	7,332,499.256	-158,299.2564	

Durbin-Watson = 0.84

<b>Predicted values for: domestic passenger traffic</b>		<b>95% Confidence Interval</b>		<b>95% Prediction Interval</b>	
t	Predicted	Lower	Upper	Lower	Upper
13	8,264,961.8	7,152,014.5	9,377,909.0	6,306,111.5	10,223,812.0
14	8,731,193.0	7,494,509.4	9,967,876.7	6,699,487.0	10,762,899.0

Table 12. Contd.

15	9,197,424.3	7,834,903.4	10,559,945.2	7,086,759.5	11,308,089.1
16	9,663,655.6	8,173,728.8	11,153,582.3	7,468,587.3	11,858,723.8
17	10,129,886.8	8,511,355.9	11,748,417.7	7,845,574.0	12,414,199.6
18	10,596,118.1	8,848,049.3	12,344,186.8	8,218,264.6	12,973,971.6
19	11,062,349.3	9,184,002.0	12,940,696.6	8,587,146.0	13,537,552.6
20	11,528,580.6	9,519,358.2	13,537,803.0	8,952,650.2	14,104,511.0
21	11,994,811.8	9,854,227.2	14,135,396.4	9,315,157.9	14,674,465.8
22	12,461,043.1	10,188,693.6	14,733,392.6	9,675,003.8	15,247,082.4

Data	
t	Domestic passenger traffic
0	3,874,999
1	2,584,384
2	2,330,279
3	2,745,613
4	3,384,262
5	4,399,333
6	4,831,525
7	5,573,101
8	6,464,545
9	6,839,707
10	7,016,780
11	7,174,200

tickets to the flying public. The importance of the use travel agency aside the well before departure sales it also helps market the airlines. Aero Contractors Air and Bellview air customers should be experiencing longer queues at the sales counters of these airlines because 74 and 72% of them actually purchased their tickets at the airport. Amongst the mega carriers only Arik Air had below 60% of its travelers getting their tickets from its sales counter at the airport.

5. Poor ground service was the most pressing problems as seen by the air travelers. This was followed by poor on-board services; poor reliability

of published flight schedules and fewer sales outlets of airlines in the cities.

6. Majority of the air travellers sees the terminal air-conditionings as been adequate though the terminals were thought to be over-crowded by about 60.56% of them. Only 20.07% of the air travellers were satisfied with the adequacy of the check-in facilities at the terminals but 56.48% felt otherwise.

7. The airports experienced lots of check-in delays. 55.92% of the air travellers had delays of more than 10min, 19.5% (about 10 min), 10.57% (about 5 min) and 14.01% (less than 2 min). This

exerted quite some cost on the air travellers and based on their average income the most expensive airport to use (in terms of delays) was seen to be Lagos (at nineteen naira sixty-three kobo) and the cheapest to use was Maiduguri (at five naira twenty-four kobo). As expected only 17.23% of the air traveller enjoyed their time waiting to be checked in.

#### Relationship of findings to previous studies

The present result agrees with the study of Bubalo

(2009). His study showed the effect of capacity utilization on service quality, that is measured "aircraft delay", which sharply increases with runway capacity utilization, as airside congestion rises as saturation is approached. An extension of this study is possible to monitor the effect of peak and off peak pricing capacity utilization over time.

### Implications

If the hypotheses of this study are sustained the conclusion could then be confidently reached that airline attributes are more important determinants of airline choice than socio-economic variables of air travelers. Apart from enhancing quality of service of air transport, the findings of this study will enable the individual airlines to take positive steps towards the provision and management of better and more efficient aviation services.

### RECOMMENDATIONS

In the light of the results of this study, the following recommendations are made to policy-makers that might be of assistance in planning for a sound and efficient air transportation system:

1. Due to the fact that most airlines have few aircrafts it becomes very difficult to fly out from many airports. Hence most use Lagos as the hub of their operations. There is a danger in this type of operation as bad weather in the hub region will lead to a disruption all flights to the hub from other airports.

2. National Airspace Management Agency (NAMA), National Civil Aviation Authority (NCAA) and Federal Airport Authority of Nigeria (FAAN). should ensure that flights schedules are spread out as much as possible to avoid congestion of traffic and its associated problems.

3. Airlines should encourage the purchase of their tickets to be done away from the airports and possibly online to reduce handling cost at the airports in particular and total cost of operations in general.

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