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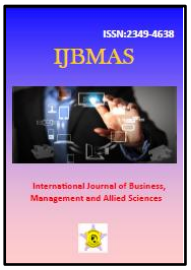
ANALYSIS OF AIR TRAFFIC CAPACITY IN NIGERIAN AIRPORTS

Ejem, E. A[1], Ibe, C. C.[2], Dike, D.N.[3], Chikwendu, D. U[4], Igboanusi, C. C.[5], Chukwu, O. E[6]

[1,2,3,4,5,6]Department of Transport Management Technology, Federal University of Technology, Owerri, Imo State, Nigeria.

Contact of Corresponding Author: ejemflagospel@yahoo.com



ABSTRACT

The paper is aimed at determining the capability of the airside facilities to accommodate aviation operational demand. The USA FAA methodology was utilized for the measurement of airfield capacity in this study. In consideration of the existing runway configuration, runway utilization patterns and 52506 operation counts, Lagos airport domestic wing Nigeria has been determined to have a daily demand ratio (D) of 240 operations and an hourly demand ratio (H) of 20 operations, and thus, an ASV of approximately 63006 operations. Capacity calculations indicated that a Nigerian runway configuration accommodates an ASV of 247, 123 annual operations. Based on the aircraft fleet mix currently utilizing Nigerian airports, this ASV seems appropriate through the planning period. The ASV during the period under study was highest at the domestic wing of Lagos Airport followed International wing of the same airport. Abuja domestic wing was next followed by Port Harcourt domestic wing. It is considered, therefore, that no significant increase to existing peak-hour runway capacity may be possible in the short term although there is spare capacity during the off-peak (shoulder) periods. Nigeria has, in theory, the option of having two additional runways available, to enhance the overall runway capacity of the airport. In practical terms, simultaneous operational use of these runways is unlikely to provide significant and consistent capacity benefits.

Key words: Airport, Capacity, Runway, Air Traffic and ATM

I. BACKGROUND TO THE STUDY

The capacity analysis for airport is composed of two distinct elements: the ability of airport facilities to accommodate existing and projected aircraft operations (airfield capacity) and the ability of airport facilities to accommodate existing and projected ground vehicle operations (airport access capacity). The capacity of an airfield is primarily a function of the major aircraft traffic surfaces (runways and taxiways) that composes the facility and the configuration of those surfaces, but it is also related to, and considered in conjunction with, wind coverage, airspace utilization, and the

availability and type of navigational aids. Airport access capacity is a function of the existing and/or future vehicular roadways located in the vicinity of the airport and their interface with the various airport specific access roads.

Economics are the driver behind the capacity problem. The increase in demands is directly related to the economic well-being of the communities being served and their Gross Domestic Product (GDP) (Airbus, 2000; Boeing, 2000). Practical airport capacity defined as the number of operations that can be accommodated in a given time period, considering all constraints incumbent to the airport, and with no more than a given amount of delay (Wells, 2000).Maximum throughput capacity or Saturation capacity may be measured as the number of operation that can be accomplished in a given period of time disregarding any delay that aircraft might experience and assuming that the aircraft will always be present, waiting to land or take-off (Wells, 2000, Ashford and Wright, 1992). Most earlier analytical models generated to estimate runway capacity such as that proposed by Harris (1972), subsequently extended by Amodeo, Haines and Sinha (1977) aimed to compute the average inter-arrival time between aircraft over the runway threshold given a certain mix of lead and trail aircraft. Idris et al, (2000), pilot reports, on-site investigations and statistical analyses of automatically recorded data indicate that runway capacity is the primary limiting constraint in the departure process at busy airports like Boston Logan International airport.

The steady increase in air travel demand in recent years has pushed the Nigerian airports to its limits, but it is the inability of the system of operation to expand accordingly that has caused delay. Indeed, with the system operation so close to its maximum capacity it is not usual for a relatively small local thunderstorm to cause wide spread delays far beyond the area affected by the weather. Since flights are generally not scheduled to surpass the capacity of Nigerian airports that the flight serve, then the researcher must assume that full theoretical capacity is not being achieved. So the researcher suggests that the first step towards a reduction of delays is a better management of the existing capacity. Having a uniform distributing of demand, or transporting more passengers per department would be relatively easy to implement short-term solutions.

In addition, Cocanower and Voss (1998) opined that air traffic management system must ensure the safe and orderly flow of air traffic which will allow commercial operators the flexibility to effectively manage their economic assets. The globalization of the trade expansion has cause a boom in air travel. This rapid growth has not been matched by a similar expansion in the national airspace infrastructure resulting in congestions delay and widespread frustration. It is also interesting to know that a bank of arrivals is immediately followed by a bank of departures possibly reflecting on the day interconnectivity of flights. It is obvious that airline schedules to maximize passenger's convenience and utilization of aircrafts results to the peal of arrivals and department at certain of the day. The number of operations of these peak times often approaches or surpasses the capacity limits of the Nigerian Airports. The capacity of the system must grow and keep pace with demand lest it hamper transportation and the economic wellbeing that it signifies.

According to Ejem (2004) the worldwide commercial aviation accident rate has been nearly constant over the past two decades. Although the rate is absolutely very slow, increasing traffic over the years has resulted in the absolute number of accidents also increasing. Despite the event of September 11, 2001, the worldwide demand for air is coming two decades doubling or tripling by 2017 (NASA, 2002). However capacity assessment and also the air-space management in Nigeria has been so poorly organized that this has resulted to outright lack of confidence in the Nigeria air space by the globe community for the fear of Mid-air collisions.

More so, there is abysmal shortage of modern Airspace infrastructures in Nigeria to match with the growing global increase in Air travel. It is pertinent to mention that the infrastructure needed to ensure safety of airspace is not entirely determined by the number of aircraft operation in that air space, as there is a minimum requirement to be met (Ejem, 2004).The absence of adequate air navigational landing facilitates and existence of obsolete and nonfunctional air traffic safety

equipment also have adverse effects on the traveling public occasioned by flight delay, cancellation and diversion.

The broad aim of this paper is to evaluate the extent of aviation activities in Nigerian airport and airspace. This was achieved through assessment of the the extent of aviation activities in Nigerian airports and the evaluation hourly capacity of runways at various Nigerian airports. At the end the paper hopes to determine annual service volume at the various airports. A paper of this kind is expected to make theoretical and practical contribution to airspace management in Nigeria. It serve as a benchmark to government, organization and individuals concerned with formulating aviation policies and also provides a basis for closer scrutiny of the way and manner in which the Nigerian Airspace has been managed with a view for making recommendations for its optimization to airspace users especially in civil aviation.

II. METHODOLOGY

This is the evaluation method used to determine the capability of the airside facilities to accommodate aviation operational demand. Evaluation of this capability is expressed in terms of potential excesses and deficiencies in capacity.

The methodology utilized for the measurement of airfield capacity in this paper is described in FAA Advisory Circular 150/5060-5, Airport Capacity and Delay. From this methodology, airfield capacity is defined in the following terms:

• Hourly Capacity of Runways: The maximum number of aircraft that can be accommodated under conditions of continuous demand during a one-hour period.

• Service Volume (ASV): A reasonable estimate of an airport's capacity (i.e., the level of annual aircraft operations that will result in an average aircraft delay of approximately one to four minutes).

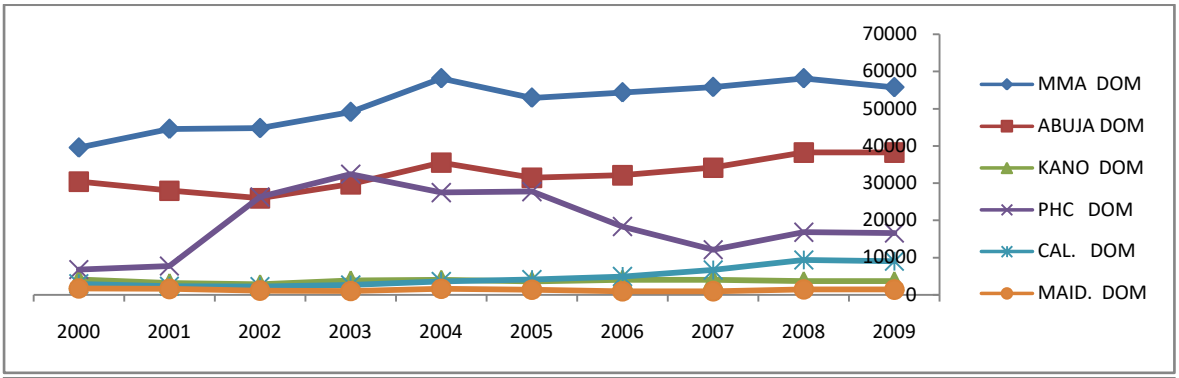
The capacity of an airport's airside facilities is a function of several factors. These include the layout of the airfield, local environmental conditions, specific characteristics of local aviation demand, and air traffic control requirements. The relationship of these factors and their cumulative impact on airfield capacity is examined in the following paragraphs.

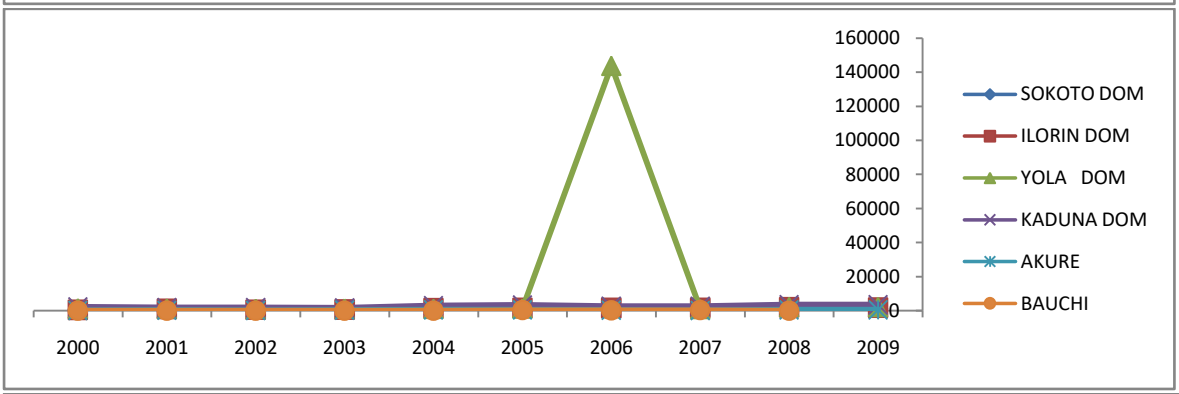
The data employed in this data is purely secondary. This was obtained from the statistics unit of the National Airspace Management Agency (NAMA) headquarter in Abuja. It covered flight information across all the Nigerian airports from 2000 to 2009.

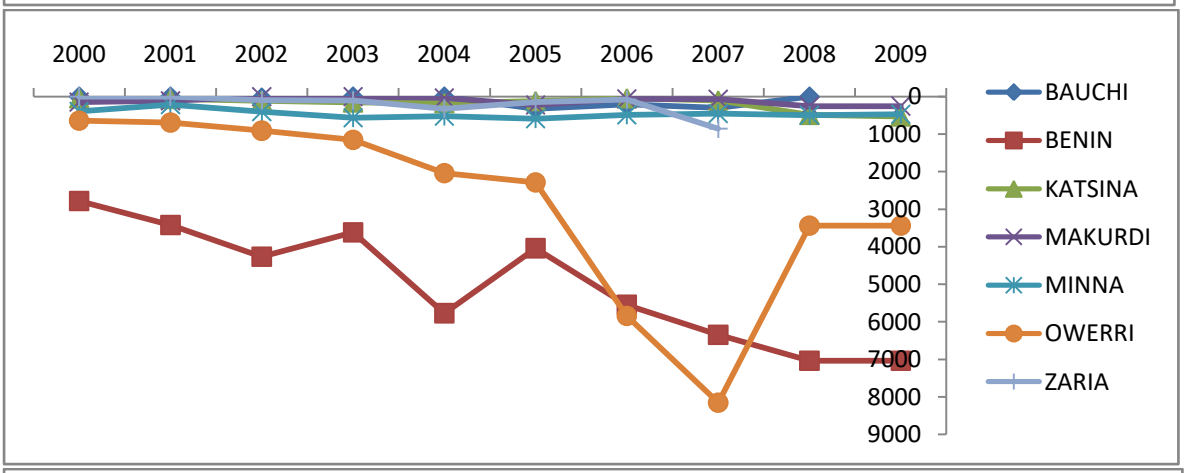
III. RESULTS AND DISCUSSION

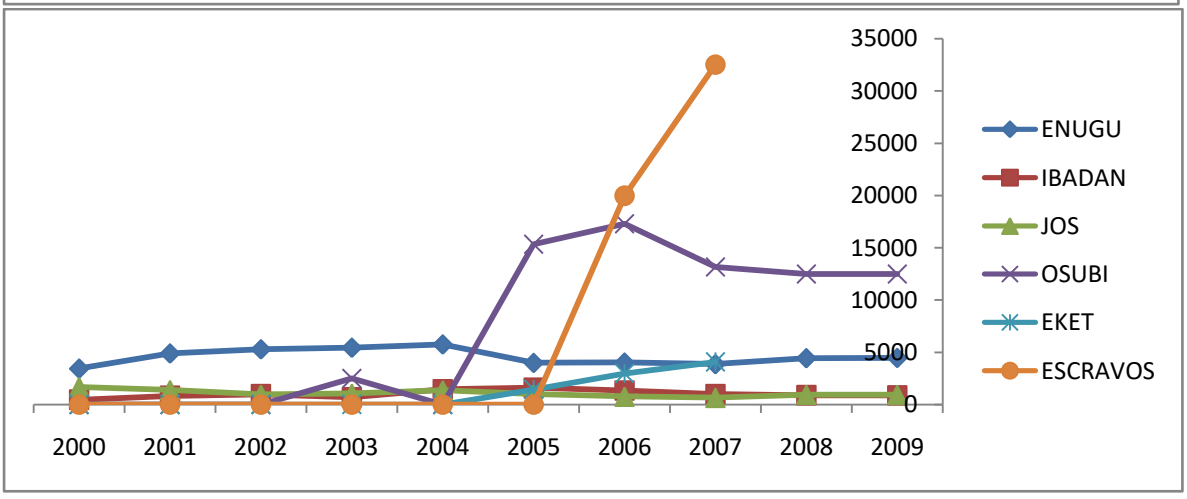
In figures 1, passenger volumes and ATMs of Nigerian international airports in 2000 to 2009 are shown, ranked by the size of traffic volume. The biggest airport is Lagos with 15 million passengers and 117,383 flight movements. Due to capacity problems— Lagos has two parallel runways with operations dependent on each other.Kano is the second biggest airport in Nigeria, with 10085 ATMs (and 1502634 passengers). The Lagos traffic volume stayed slightly constant in these years (2005, 2006 and 2007). Presently, Abuja has become an airport with growing hub functions as it was Kano airport and ranked second after Lagos. In 2002 to 2007, Abuja had a traffic volume of 1091760 passengers and 13381 ATMs. Great deals of the passengers are using the airport for business flights, primarily into populated areas. The catchment area of Lagos airport is the Lagos, Ibadan and Abeokuta metropolis with people, predominantly living in urban areas, which it has to share with other airports, in particular Ibadan which presently handles domestic traffic only. Unlike Lagos, has one functional runway though contract for the second runway has been awarded so that flight operations are independent.

In airport were handled by the airport. Port Harcourt has two runways crossing each other which handled 514808 passengers and 8121 flight movements in 2002 to 2007. Sokoto handled roughly half of Port Harcourt traffic and has to rely on a single runway. A great part of these movements may be suppressed and diverted to other airports if lack of runway capacity wouldbecome a problem for scheduled and non-scheduled commercial operations.









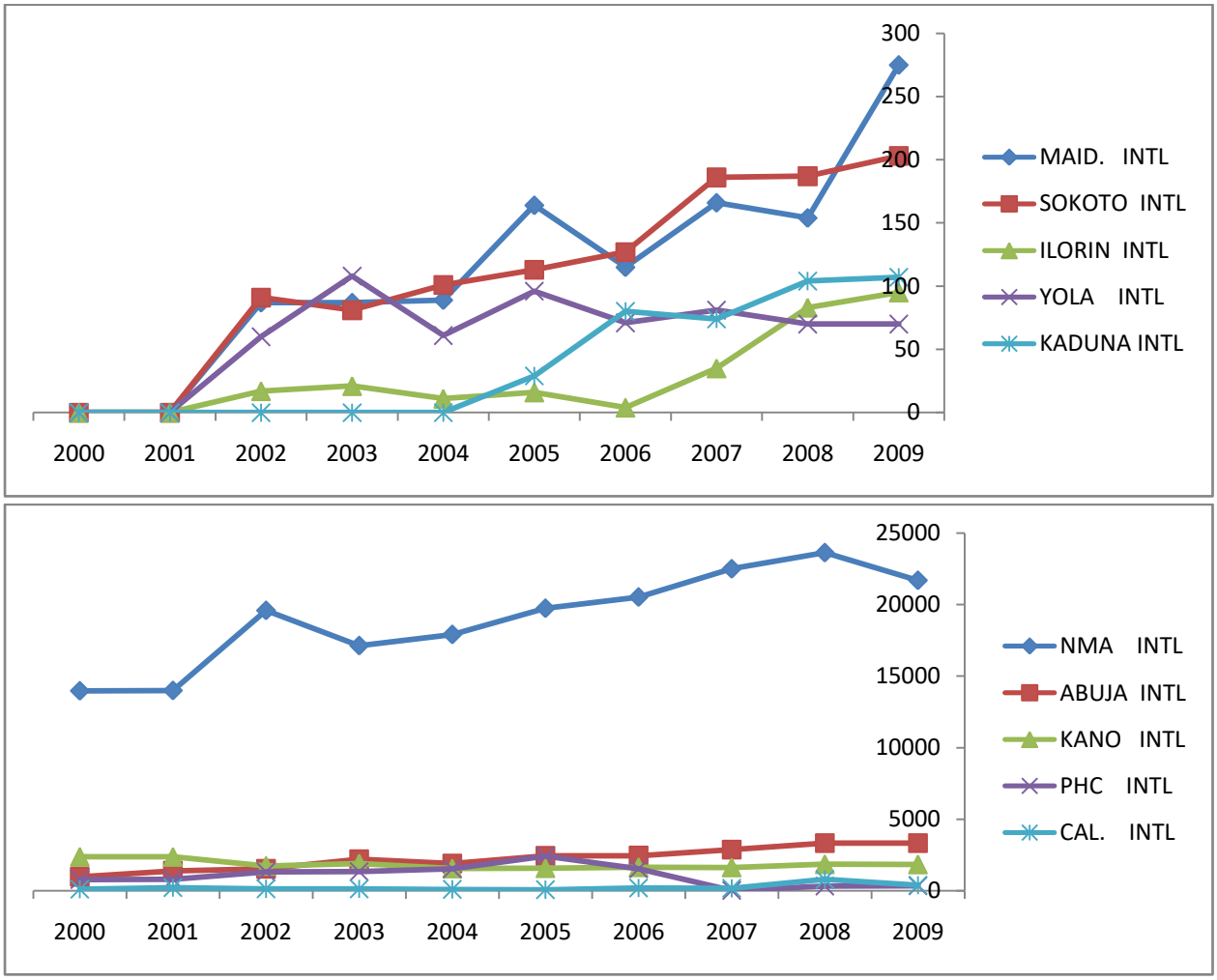


Figure 1: Number of ATMs at Nigerian International airports in 2000 to 2009

All other international airports have single runways for the traffic with scheduled and charter flights. They are located in Yola, Calabar, Ilorin, Maiduguri and Kaduna, with traffic volumes ranging from 19178 in Ilorin and 111163 in Yola. AkwaIbom has been added to the category of international airports only recently when it was supplied with a runway long enough to handle flights with aircraft types typically operated in scheduled and charter traffic, that is, the B 737 and A 320 family.In addition to the network of international airports there are 25 domestic airports which serve to some degree the same task; that is, to provide access to the national and international services in scheduled and charter traffic. Altogether these airports handled 1088505 movements, which carried 42 million passengers, about 69% of the total air traffic volume of Nigeria.

Determination of capacity figures for Nigeria will utilize the throughput method of calculation. These formulae, applying information generated from preceding analyses, illustrate capacity and demand in terms of the following results:

- Hourly Capacity of Runways
- Annual Service Volume (ASV)

The following capacity computations provide assistance in evaluating the ability of the existing airport facilities, both airside and landside, to accommodate forecast demand.It can be concluded from the preceding that Nigeria has a substantial number of domestically distributed airports- almost 30 airports with nearly 40 runways serving the public air transport system of a population of over 150 million people- but with the traffic heavily concentrated at a few airports, which are more or less working at capacity level. More than one third of the Nigerian passenger traffic is handled by Lagos alone, and almost two-thirds of the total is served by the three airports at

Lagos, Abuja and Port Harcourt. Are there chances or inherent mechanisms to change this concentration towards a more evenly distributed utilization of airport infrastructure?

After determining the hourly capacity for each potential runway use configuration, a weighted hourly capacity of the entire airports can be calculated. The weighted hourly capacity takes into consideration not only the aircraft mix index, but also the percent utilization of each possible runway use configuration. The weighted hourly capacity for Nigerian airports was determined to be approximately as follows:

TABLE 1:ANNUAL SERVICE VOLUME OF NIGERIAN AIRPORTS

S/No	Airport	Weighted hourly capacity Cw (operations per hr)	Ratio of annual demand to average daily demand D	Ratio average daily demand to average peak hour demand H	Annual Service Volume ASV
1	MMA DOM	24	177	12	51295
2	ABUJA DOM	8	356	11	32356
3	KANO DOM	1	336	11	3693
4	PHC DOM	5	356	11	19217
5	CAL DOM	2	340	7	4761
6	MAID. DOM	1	336	4	1345
7	SOKOTO DOM	1	301	3	903
8	ILORIN DOM	1	328	4	1312
9	YOLA DOM	4	349	11	15691
10	KADUNA DOM	1	334	8	2674
11	MINNA DOM	1	230	2	460
12	AKURE DOM	1	194	2	388
13	BAUCHI DOM	1	86	1	86
14	BENIN DOM	1	333	8	4988
15	EKET DOM	1	283	3	848
16	MAKURDI DOM	1	114	1	114
17	ENUGU DOM	1	350	7	4546
18	*ESCRAVOS	2	350	8	5246
19	IBADAN DOM	1	335	3	1068
20	JOS DOM	1	356	3	1068
21	KATSINA DOM	1	184	1	184
22	OSUBI DOM	2	349	11	7321
23	OWERRI DOM	1	318	9	2861
24	ZARIA DOM	1	159	1	159
25	MMA INT'L	9	89	24	19067
26	ABUJA INT'L	1	172	13	2237
27	KANO INT'L	1	168	11	1852
28	PHC INT'L	1	173	6	1035
29	CAL. INT'L	1*	114	2	227
30	MAID. INT'L	1*	114	1	114
31	SOKOTO INT'L	1*	109	1	109
32	ILORIN INT'L	1*	28	1	28
33	YOLA INT'L	1*	62	1	62
34	KADUNA INT'L	1*	39	1	39

In consideration of the existing runway configuration and runway utilization patterns, Lagos airport domestic wing Nigeria has been determined to have a daily demand ratio (D) of 289 operations and an hourly demand ratio (H) of 24 operations, and thus, an ASV of approximately 51295 operations. The above table shows the ASV for all the airports in Nigeria calculated using traffic data for ten years (2000 to 2009).

Capacity information contained in the previous table indicated that a Nigerian runway configuration accommodates an ASV of 187,354 annual operations. Based on the aircraft fleet mix currently utilizing Nigerian airports, this ASV seems appropriate through the planning period.

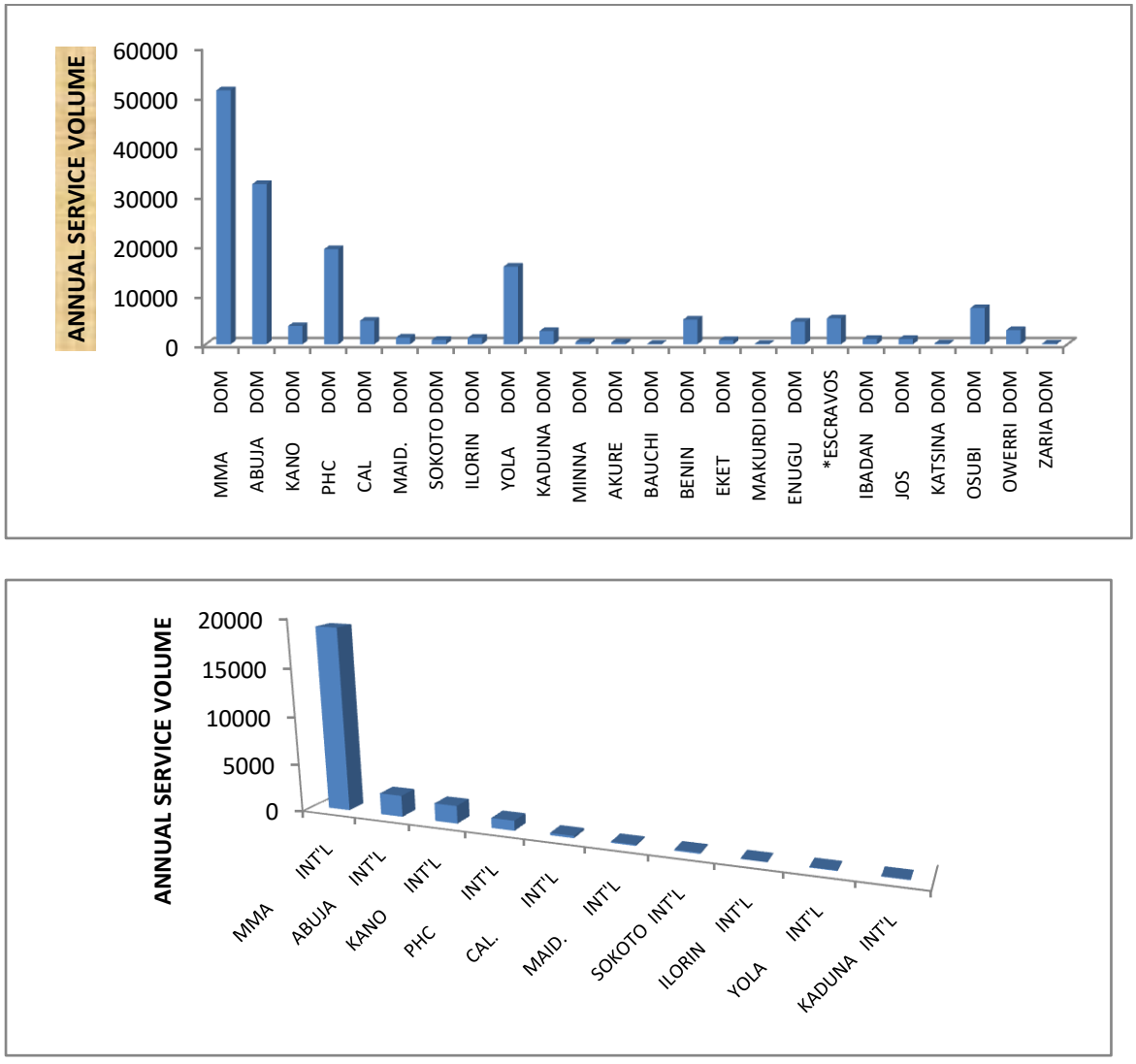


Figure 2: Capacity assessment of Nigerian Airports

The ASV during the period under study was highest at the domestic wing of Lagos Airport followed International wing of the same airport. Abuja domestic wing was next followed by Port Harcourt domestic wing.

TABLE 2:CORRELATIONS AMONG KEY CAPACITY VARIABLES

	Peak Hour Demand	Number Of Runways
Annual Service Volume	0.94	0.68
Daily Demand	0.95	0.91

From the above table, it is clear that annual service volume of Nigerian Airport is determined by about 94% of runway capacity at peak hour and 68% by the number of runways at airports. Hence, most existing runways in the present airport system have not attained their designed capacity limitations. In addition, at peak hour operation, the present runway configurations seem to impede

on capacity with a correlation coefficients of 0.95 and 0.91 with respect to peak hour demand and number of runways respectively. Hence hub airports such as Lagos and Abuja need improved runway configurations especially at peak periods.

IV. CONCLUSION

Capacity information indicated that a Nigerian runway configuration accommodates an ASV of 187,354 annual operations. Based on the aircraft fleet mix currently utilizing Nigerian airports, this ASV seems appropriate through the planning period. The ASV during the period under study was highest at the domestic wing of Lagos Airport followed International wing of the same airport. Abuja domestic wing was next followed by Port Harcourt domestic wing. As with other airports, declared runway capacities have increased on an incremental basis over a period of years, as seen from a comparison between total annual aircraft movement of 177,627 in 2007and total annual aircraft movement of 198,182 in 2008 for Nigerian airports.

The airlines serving Nigerian airports were opposed to deterioration in level of service and preferred standard to be maintained with an emphasis on additional capacity being provided through improvements in procedures rather than deterioration in service levels. In the meantime, there are ongoing programme to increase runway capacity on an incremental basis under the auspices of the runway expansion programme in certain airports, in particular, the Abuja runway capacity enhancement programme. There have also been discussions about the simultaneous use of runways. To do so would require the NAMA to develop arrival and departure procedures that would be required for simultaneous operations of the two runways. It is intended that once a runway is re-opened then it would be used on a tactical basis by ATC. Lastly, there are night restrictions on the use of the runways in Nigeria. It is published as a non-instrument runway and requires lighting to operate at night.

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