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An evaluation of air transport operational performance of northern Nigeria airports

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ABSTRACT

This study investigates the performance of selected airports in the study area from 2001 to 2018. Data used for the analysis include passenger throughput, aircraft movement, cargo throughput, mail throughput (output index) and terminal capacity, runway dimension, apron capacity, screening point, ground handling equipment & number of employee (input index) were sourced from FAAN headquarters for each of the airport selected. In the study, Domestic and International travelers were studied for all the selected Airports in the study area. Basic Data Envelopment Analysis (DEA) was used as a technique for the analysis. MaxDEA 7 Software used in running the analysis. Operational performance measures were carried out, showing the airports that are operating at a productive and efficient level amongst the selected airports. From the analysis, the result show that, the international wing of Abuja International Airport, the Domestic wing of Abuja International Airport, the International wing of Aminu Kano International Airport and the Domestic wing of Maiduguri Airport were operating at efficient level of 100% (=1) only in 2018 while the rest of the selected airports are not productive and efficient in 2018 because they were operating below the efficiency score of =1 which is not the ICAO standard in terms of airport benchmarking. Policy implications were made on how to regulate the aviation industry to meet the ICAO standard by benchmarking the inefficient airports using those airports that were operating at =1 (100%) efficiency score.

Keywords: Airports, Performance, Productivity, Efficiency and Data Envelopment Analysis.

1. INTRODUCTION

Air transport is the fastest mode of moving people, goods, services, and information by aircraft through air routes established by appropriate authorized bodies between a specific origin and destination (Mobolaji and Ukpere, 2011).

The global air transport industry contribute significantly to the comfortability of lives and properties in our today's society, it improves economic growth and assists in poverty alleviation by providing employment opportunities and increasing revenues through taxes (Nwaogbe, Wokili, Omoke, Asiegbu, 2013).

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The key features of a typical airport include the runways, taxiways, craft parking areas, terminal buildings, hangars among other facilities that ensure safe, efficient, and low-cost functioning of an airport. The primary function of the airport is to serve as a terminal in an airline's network wherever the movement of passenger or freight is halted so that some "value-adding" activity (transfer, storage, retrieval, repackaging, and documentation) can be performed (Airport Council International, 2012).

The emergence of hub airport for the international and domestic passenger traffic through deregulation, offers Nigerian resident businessmen and women an improved offer in terms of access to their various destinations, at a higher frequency and at a cheaper rate within west African countries (Nwaogbe, Ogwude & Ibe, 2017; Nwaogbe, Wanke, Ogwude, Barros & Azad, 2018 and Ogwude, Nwaogbe, Pius, Ejem, & Idoko, 2018; Nwaogbe, 2018).

The hubs airport and spoke network enhance the connectivity (communication) to various country in terms of air transport system that successively contribute to high global and nations overall international trade and economic levels of productivity as well as the Gross Domestic Product (GDP) of Nigeria (Oyesiku, Onakoye, and Folawewo. 2013). Nnamdi Azikwe International airport, Abuja and Murtala Muhammed International airport, Lagos have displaced some of the Nigerian airports because of their functionality and better service they are operating (Barros, Wanke, Nwaogbe & Azad, 2017 and Nwaogbe, Wanke, Ogwude, Barros & Azad, 2018).

Within the aviation industry, service quality measures based on have been used typically for operational performance measurement and benchmarking functions. Moreover, regulators and governments would possibly use service quality assessment to reassure that, the passenger's perception on airports do not seem to be compromised (Bezerra and Gomes, 2016b). Recently, some approaches and ways typically applied among alternative or other transport industries seemed to have gained momentum. For example, analysis of passenger´s expectations as regards the airport service using the structural equation modeling approach show an advanced relationships among passenger´s perspective and airport Service Quality (ASQ) (Bezerra and Gomes, 2016b).

Therefore, performance measure turns to a significant tool assisting the policymakers concerning the airport investment cycle. The main focus of airport performance measure has been progressively moved from measuring just an operational and financial performance to a more holistic and multidimensional approach, in which other aspects of the airport performance are equally relevant (Gillen, 2011; Skouloudis, Evangelinos & Moratis, 2012).

The airports efficiency involves production and consumption technologies for transporting passengers and cargoes. Performance measure is an important indicator used in managing the aviation industry due to the importance of transport service in every sector of the economy as a giant arm within the distribution of products and services by covering very wide markets. Performance (productivity and efficiency) is a claim to air transport manager since the productivity growth is a product of economic growth and welfare improvement. Technical advance and technical efficiency change are two key factors of productivity growth that are related to different sources then different policies could also be required (Bezerra and Gomes, 2016a). Therefore, it has become very important to identify, analyze and evaluate all the relevant indicators and information concerning several aspects of the airport's performance.

There is a need to evaluate the airports' operation performance because it will enable the Federal and state governments to see the reliance on airports for the economic development and growth of the country. Furthermore, it helps the air carrier to understand the airport that has the capability and capacity of accommodating their aircraft among the airport competitors during this era of deregulation. The evaluation will enhance the improvement of all investments by the federal government in numerous airports' infrastructural developments based on performance measures. These performance measures will educate the airport operators and also the national of the Federal Republic of Nigeria along with other privatized airports on the identification of the most efficient benchmarking of the airport and decision-making process by the major operators of airports and the users (Nwaogbe et al, 2018 & Ogwude et al., 2018).

Performance measurement of an airport is best analyzed in terms of productivity and efficiency, the Data Envelopment Analysis (DEA) model is used for such measurement. It is a non-parametric or homogenous frontier model adopted by a previous study on airport performance (Barros 2008, Barros and Marques 2010).

Gillen (2011) study addressed the mismatch between quality and level of service to different customer couples with mishandling of luggage and loss of personal items at each airport. In this present time, airports have become modern organizations delivery efficient and high quality of service to different customers including passengers, airlines, retailers and the user of airport (Gillen, 2011).

Previous studies suggest that customers should involve comparing the service rendered by each air service provider as to judge the quality of service and customer satisfaction (Wanke, Barros & Nwaogbe., 2016). The focus of this paper is to analyze the air transport operational performance using non parametric model of DEA. The objectives are to examine the operational performance of both domestic and international airports by comparing them in the study area.

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1.1 Study Area

The Federal Airports Authority (FAAN) was established in 1978. The Agency is saddled with some principal functions among which is to develop and maintain the nation's airports, all necessary operational facilities, and services for aircraft and excluding navigational aids, telecommunication facilities and air traffic control services.

Name of the airports from selected Airports in Northern Nigeria

Table1: Geopolitical zone Name of the Airports.

1. North-west

a. Malam Aminu Kano International Airport Kano, International wing

b. Malam Aminu Kano Domestic Airport Kano

c. Sultan Saddik Abubakar III International Airport Sokoto,

d. Sultan Saddik Abubakar III Domestic wing Sokoto

2. North-central

e. Nnamdi Azikwe International Airport Abuja, International Wing

f. Nnamdi Azikwe International Airport Abuja, Domestic wing

g. Abubakar Shola Saraki International Airport Ilorin

h. Abubakar shola Saraki Domestic Wing Ilorin

3. North-east

i. Maiduguri International Airport, Maiduguri, (International)

j. Maiduguri International Airport, Maiduguri, Domestic wing

k. Yola International Airport, Jimeta, International Wing

L. Yola International Airport, Jimeta, Domestic wing

2. LITERATURE REVIEWS

The operational performance of an airport includes activities that support the effective service delivery of passengers and cargo from one port of loading to a different port of off-loading. Today, the performance concept is gaining importance in particularly the services business. In general terms, operational performance can be defined as the rate of success obtained by an organization in a given period of time.

Airport Performance is the smart ranking with a hypothesized conception of the requirements of the role. So many areas of airport performance have been evolved by studies and skilled literature (Airports Council International, 2012; Hazel, Blais, Browne, and Benzon, 2011, Zografos, Modas and Salouras, 2013; Nwaogbe, Barros, Ogwude & Omoke, 2015; Nwaogbe et. Al, 2017, Nwaogbe et.al, 2018 and Pius, Nwaogbe, Akerele, and Masuku, 2017). The studies' contributions comprise relevant aspects of the multifaceted nature of airport performance depending on the approach and study´s objectives on a diverse set of key performance areas, as a result of industry best practices.

Airport Service Quality is the measurement of the standard of the service level of an airport and how well it has met the customer's expectation. The airport's quality or level of service can be assessed through Passengers, Airlines and Airport operators who have a different perception of an airport. Wiredja (2017) cited a conducted study on the level of airport service quality according to six distinctive service attributes: (i) staff courtesy (ii) processing time; (iii) security; (iv) comfort, (v) convenience; and (vi) information.

Rahaman, Abdullah, & Rahman, (2011) opined that service quality is the keyword for survival of organizations in the global economy, the delivery of high-quality service became a marketing requirement among air carriers as a result of competitive pressure compelling industry operators to deliver high-quality services (Masarrat and Jha, 2014). Sevice Quality of aviation industry reflects the passenger's perception of transit performance. Service quality is considered as a critical dimension of competitiveness (Pakdil and Aydin, 2007). Providing excellent service quality and high customer satisfaction is an important issue and challenge facing the contemporary service industry (Pakdil and Kurtulmusoglu, 2014). Park, Robertson & WU, (2004) defined service quality

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as a customer's overall impression of the efficiency of an organization and its services. Quality of service is a significant matterin both the governmental and non-government organization (Zahari, Yusoff and Ismail, 2008).

Wanke, Barros, and Nwaogbe (2016) assessed the productivity and efficiency of Nigerian airports using Fuzzy-DEA to capture the input and output measurement obtained from the airports. The result indicate fewer significant contextual variables as efficient driver because of the joint usage of bootstrapped regression model and fuzzy-DEA, when controlling for fuzziness and randomness capacity, cost was found to be the only significant variable. The study designed policy for Nigerian airports focusing simultaneously on the third party capacity measurement such as privatization while improving the learning component represented by trend.

Nwaogbe, Pius, Balogun. Ikeogu and Omoke (2017) conducted a study on the quality of service at International Airport of Mallam Aminu Kano, using regression model analysis. The result of service quality analysis shows that there is a statistically significant relationship between passengers' views and the service qualities of the airlines.

Fadare and Adeniran (2018) studied on comparative analysis of publicly operated airport terminal and concessional terminal Airport in Lagos Nigeria using spearman ranking model, the study revealed that the airport users feel satiated with the Airport operational service of concession terminal than the airport service quality provided by public operated Airport terminal. It is recommended that the airport concession should be adopted by major Nigerian Airport as it a good strategy for enhancing airport service quality and efficiency of airport operation and management.

Pius, Nwaogbe, Akerele, and Masuku. (2017) studied on the appraisal of airport terminal performance: evidence from MMIA Lagos using a multiple regression model to determine the production levels, operations capacity and attractiveness to the stakeholders. The study reveals that facilities in the airport terminal, helped the airport in handling the increasing number of passenger traffic and Aircraft movement in terms of landing and take-off, It recommended that adequate funds must be provided for transport-related project.

Sutia, Sudarma & Rofiaty (2013) conducted a study that investigated the relationship between 'human capital, leadership and strategic orientation' with company performance, particularly the influence of human capital investment on airport performance. Most airports aimed at maximizing the movement of aircraft, whereas increasing performance levels within their operations processes to attain a higher competitive edge over their rivals in the sector.

3. METHOD AND DATA

Panel data collected from the statistics department of all the selected airports. The study covered a period of 18years from 2001 to 2018, due to the dimension in the characteristic of airports variables covered from six northern Nigeria airports. DEA model was used for the analysis with the aid of MAXDEA 7 software in running the analysis and obtaining results.

3.1. Model formulation

DEA is a performance measurement technique that can be used for evaluating the relative efficiency of the decision-making unit (DMUs). The airports now will serve as the DMUs. Efficiency is derived and part of productivity realized where it is a ratio of actual output attained to standard output expected (Sumanth, 1984). Mali (1978) expressed together the terms of productivity, effectiveness, and efficiency as follows:

$$\text{Productivity Index} = \frac{Performance\ achieved}{Resources\ consumed} \quad (1)$$

$$\text{Efficiency} = \frac{U\ weigh\ output\ of\ DMU}{V\ weigh\ input\ of\ DMU} \quad (2)$$

This can be mathematically translated into:

$$(FP_\theta)\ \text{Max}\ \theta = \frac{U1y1o+U2y2o+\ldots\ Unyno}{V1y1o+V2y2o+\ldots\ Vmymo} \quad (3)$$

Subject to:

$$\frac{U1\,y1j+U2y2j+\cdots Unynj}{V1X1j+V2X2j+\cdots VmXmj} \leq 0 \quad (4)$$

$V_1, V_2 \ldots\ldots V_m \geq 0$

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$U_1, U_2 \ldots\ldots U_n \geq 0$

Where θ is efficiency score

m = volume of input

u = Volume of the output

y = quantity of the output s,

x = quantity of the input

In addition, if each variable is to examine in term of virtual input and output, then we can have the following each:

$\sum_{i=r}^{m} Vrxro$ input variables (5)

$\sum_{i=r}^{n} Uryro$ output variables (6)

Where output variable include:

y_1 = Passenger throughput

y_2 = Aircraft movement

y_3 = Cargo throughput

y_4 = Mail throughput.

The input variables include:

x_1 = Terminal capacity

x_2 = Runway dimension

x_3 = Apron capacity

x_4 = Screening point

x_5 = Ground handling equipment

x_6 = Employee

4. RESULT AND DISCUSSION

In running the analysis, the variables used for the study are described various significant relationship between the variables as shown in the tables 2 below. This summary of the result presented the actual values productive efficiency scores by various airports and at different periods for simplicity and compatibility from the DEA software used. Output oriented model of DEA was used for the analysis to run Constant Return to Scale which one of the basic DEA models.

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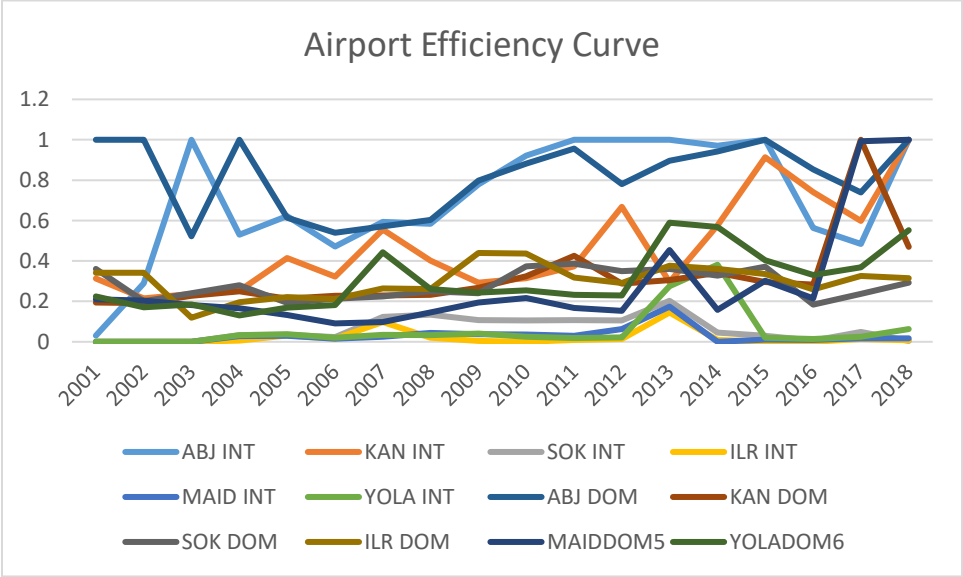
Table 2: Technical Efficiency Summary of CCR-DEA Model Result (Constant Return to Scale)

DMU	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ABJ INT	0.030437	0.289882	1	0.530659	0.622102	0.471884	0.594208	0.583707	0.77944	0.921214	1	1	1	0.971002	1	0.563131	0.484728	1
KAN INT	0.313465	0.214832	0.236506	0.253599	0.414106	0.323282	0.555151	0.401476	0.292949	0.31532	0.373716	0.668574	0.296156	0.575645	0.913811	0.741688	0.598048	1
SOK INT	0	0	0	0.032431	0.034754	0.022956	0.123686	0.133802	0.10721	0.106235	0.106509	0.105856	0.202824	0.045924	0.03012	0.006545	0.048422	0.003943
ILR INT	0	0	0	0.006311	0.031461	0.016142	0.097834	0.020356	0.00384	0	0.008536	0.014123	0.14476	0.009025	0.001178	0	0.013277	0.007901
MAID INT	0	0	0	0.027695	0.029679	0.015513	0.025409	0.044151	0.036863	0.035305	0.029295	0.062606	0.173939	0	0.010287	0.008418	0.016831	0.017589
YOLA INT	0	0	0	0.033234	0.037765	0.020438	0.03452	0.033265	0.040175	0.024143	0.018148	0.021037	0.274707	0.381494	0.019936	0.014458	0.025459	0.06216
ABJ DOM	1	1	0.522366	1	0.614259	0.540275	0.57173	0.602703	0.797527	0.882617	0.956472	0.78055	0.896008	0.94169	1	0.853448	0.738679	1
KAN DOM	0.194203	0.191392	0.228073	0.250497	0.213394	0.228269	0.229704	0.232364	0.267914	0.32457	0.425913	0.287386	0.305004	0.342335	0.295495	0.283008	1	0.470615
SOK DOM	0.36124	0.200689	0.239709	0.279242	0.193453	0.213175	0.224497	0.249543	0.240479	0.373383	0.386641	0.35018	0.360159	0.32789	0.372133	0.184045	0.237603	0.292119
ILR DOM	0.341635	0.341635	0.119289	0.196661	0.220613	0.212419	0.263948	0.260747	0.43965	0.436548	0.317911	0.291152	0.375856	0.360504	0.335405	0.258601	0.325626	0.314898
MAIDDOM5	0.210616	0.203171	0.181594	0.166535	0.131973	0.090898	0.097546	0.14593	0.194592	0.215989	0.168071	0.153253	0.45353	0.158519	0.301526	0.214771	0.993004	1
YOLADOM6	0.224664	0.170247	0.185032	0.130507	0.168655	0.181605	0.443371	0.261293	0.244114	0.254017	0.231834	0.228714	0.589533	0.568307	0.404049	0.330426	0.368514	0.551941

Source: Author



Source: Author

Fig.1 Airport efficiency curve

From Table 2, the result shows the twelve selected airports from three geo-political zone of northern Nigeria. It shows various efficiency scores of the Constant Return to Scale of the DEA-CCR model. The efficiency score ranges from 0.003943 to 1 from 2001 to 2018. From the DEA output-oriented model, any airport operating below 1 as a score is not productive and efficient, while those airports operating at a score of =1 are productive and efficient airports because they have ability to transformed the input into the output. The outcome of the study shows that, ABJ INT'L is efficiency with efficient score of =1 in year 2003, 2011, 2012, 2013, 2015 and 2018 respectively, KAN INT'L is efficient with efficiency score of =1 only in the year 2018, ABJ DOM is efficient with efficiency score of =1 in year 2001, 2002, 2015 and 2018, KAN DOM is efficient with efficiency score of =1 in only 2017 while MAID DOM is efficient with efficiency score of =1 in year 2018 while the least inefficient airport is ILR INT'L follow by SOK INT'L with inefficiency score of 0.003943.

However, the insecurity facing northern Nigeria at large affected the operational performance of some airports. Insecurity is from the factors that crumble and drawback the airport's operational performance from meeting their technical efficiency.

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Table 3: Descriptive Statistics of the airports' output and input

	Mean	Std. Deviation	N
PAX	314746.92	739818.296	216
ACRFT	5589.33	12675.207	216
CARGO	741509.81	2074311.196	216
MAIL	132412.93	588752.410	216
TMNAL CAPCTY	248.43	171.790	216
RWYDIMSN	169656.25	55039.678	216
APRON DMSN	224.17	177.904	216
SCRNNGPNT	3.08	4.620	216
GHE	13.58	10.643	216
EMPLOYEES	268.44	270.437	216

Source: Author

Table 3 shows the descriptive statistics of both the input and out variable collected from the statistics department of FAAN for twelve (12) selected airports from 3 geo-political zone of northern Nigeria.

Table 4: Correlation Matrix of 12 selected airports

	Pax	Acrft	CRG	Mail	Tmc	RwyD	AprnD	Scrnpnt	Ghe	Emp
Pax	1	0.983	0.031	0.127	0.081	0.126	-0.191	0.563	0.261	0.638
Acrft	0.983	1	-0.028	0.563	0.057	0.098	-0.250	0.517	0.193	0.598
CRG	0.031	-0.028	1	0.429	0.421	0.372	0.590	0.497	0.669	0.584
Mail	0.127	0.056	0.429	1	0.167	0.192	0.170	0.601	0.666	0.502
Tmc	0.081	0..57	0.421	0.169	1	0.704	0.476	0.226	0.377	0.457
RwyD	0.126	0.151	0.372	0.192	0.704	1	0.452	0.293	0.410	0.515
AprnD	-0.191	-0.250	0.590	0.170	0.476	0.452	1	0.115	0.377	0.321
Srnpnt	0.563	0.517	0.497	0.601	0.226	0.293	0.115	1	0.913	0.836
Ghe	0.261	0.193	0.669	0.666	0.377	0.410	0.377	0.913	1	0.794
Emp	0.638	0.598	0.584	0.502	0.457	0.515	0.321	0.836	0.794	1

Source: Author

Table 4 shows the correlation analysis matrix in the dependend and independend variables data collected from twelve selected airports in the study area. For passengers against Terminal, it read 0.081 (8.1%) meaning there is a very weak relationship between the input and the output. Between aircraft and runway show 0.098 (9.8%) the analysis shows that there is the presence of a very weak relationship between some aircraft movement and runway dimension. There is a strong relationship between cargo and GHE with 0.669 (67%) and likewise between mail and screen point 0.601 (60%) as shown in the table above. There is a significant relationship between the employee and passenger throughput with a score of 0.638 (64%). Finally, the correlation shows a significant relationship between the input and output variables used for the analysis in the study area.

5. CONCLUSION

In conclusion, this paper empirically evaluated the airport's operational performance of some selected airports of northern Nigerian. Constant Return to Scale of CCR-DEA model were used to evaluate the operational performance of the selected airports in Nigeria by estimating the productive efficiency of the airports. MAXDEA 7 software was used to analyze an output-oriented CCR-model (Constant Return to Scale) to examine the overall Technical efficiency of the six selected airports which comprises of domestic and international wing in some selected area of northern Nigeria between year 2001-2018. The result shows all the domestic wing and International airports of the selected airport that are productive and efficient with an efficiency score of =1 (100%) from 2001 to 2018. The implication is that the stakeholders and the government need to benchmark the airports that are not efficiently using efficient airports as a standard for inefficient airports.

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Declaration of conflicting interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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