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Operational Performance of Air Transportaion in Northern Nigeria Airports

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ABSTRACT

This study investigates the operational performance of selected airports in Northern Nigeria. Data used for the analysis are sourced from the Federal Airport Authority of Nigeria (FAAN) of each of the selected airports between 2001 and 2018. The study utilizes basic Data Envelopment Analysis (DEA) models: Charnes, Cooper and Rhode (CCR) model and the Banker, Charnes, & Cooper (BCC) model using MaxDEA 7 Software in running the analysis. The result from the CCR model shows the domestic and international airports that are operating at efficiency level of 100% (=1), and the result from the BCC model also shows all the airports that are operating at efficiency level of 100% (=1) in the study period. Furthermore, the result also shows the airport operating below efficiency level. Policy implications are made on how to regulate the aviation industry to meet the ICAO standard. Minimizing the input variables or maximizing the output variables will enhance the efficiency of the airports. Finally, the study recommends that the stakeholders and management of airports should encourage benchmarking to improve airport performance in the study area. Federal government should put in place adequate security in the airports to make the environment safe and improve the confidence of the passengers.

Keywords: airports, performance, productivity, efficiency and data envelopment analysis

INTRODUCTION

Deregulation of aviation industry promotes managerial coordination of the airports and portrays the need for clarification of objectives and setting up performance targets. The demand for air transport in Nigeria is on the increase, especially in respect of departing and arriving passengers, loading of cargo, arriving and departing of aircraft at the airport. This has attracted attention to Nigeria's airport system (Ladan, 2012; Graham 2011).

In today's economy, the airport represents a very significant image of every country around the world. Efficient, safe and customer-focused airports are germane to achieving economic growth (Smyth, 2008). Airport contributes majorly in poverty reduction and also in the aspect of work and leisure to people worldwide. It promotes economic growth by reducing the level of unemployment and improves revenue generation through collection of taxes (Nwaogbe, Wokili, Omoke, & Asiegbu, 2013).

Aviation industries are now in a tight competition because of the dereguatory reforms of air

transportation and airports. The competition has brought about organizational improvement across the aviation industry. The willingness or demand for the services of air transportation has been on the increase and has positively influenced the aviation sector and improved the global economy. IATA (2015) forecast that the willingness for air travel will grow at a yearly average rate of 4.1 percent, amounting to 7.3 billion passengers per year by 2034, doubling the 3.3 billion passengers in 2014. Therefore, a non-effective response to the rising willingness to travel by air might cause delays, congestion or flight cancellation at the airports. In other words, lack of capability in handling the traffic may lead to inefficiency (Nwaogbe, 2018).

The two key factors of productivity that are related to different sources and different policies which could also be required in operational performance are technical advance and technical efficiency change (Bezerra& Gomes, 2016). Therefore, it becomes very important to identify, analyse and evaluate all the relevant information concerning several aspects of the airport's performance. Granberg & Munoz (2013) explain that it is a difficult task to ensure that airports are always reliable, economical and efficient because of high rise in air transport demand experienced in recent years, likewise the operations of airport is very complex. Furthermore, in order to indicate the aspects of performance that could be improved in an airport, it is necessary to understand the present performance level of the airport. Due to increasing in demand for air transport, airport operators and professionals have recognized that most airports do not have adequate ability to handle passengers and baggage (Zidarova & Zografos, 2011).

Moreso, the insecurity of the passengers and baggage within the airport premises due to the lack of inadequate sophisticated screening equipment has the potential to cause more harm at the airports. Due to this problem, most passengers have lost their baggage or seeing their baggage being exchanged by someone at the luggage area of the terminal during congestion, thereby denting the image of the Nigeria aviation sector across the globe. Furthermore, the main challenges facing the Nigerian airports is inadequacy to thoroughly screen passengers and baggage due to employee inefficiency sprinkled with down-and-out security check, account for why passengers' witness luggage loss while on transit. For instance, the case of Zainab Aliyu, who travelled for lesser pilgrimage from Mallam Aminu Kano International Airport to Saudi Arabia in December 2018 was detained by the Saudi Arabia authority, for allegedly being in possession of banned substance. Studies on airports and airport operators have argued that airport ability to handle passengers and baggage in a traditional operational measure is no longer adequate (Zidarova & Zografos, 2011).

In order to determine the productive and efficient airports of both domestic and International airports in the study area, there is a need to evaluate the airports' operational performance in Northern Nigeria used as the output-oriented model of the two-basic model of DEA (CCR and BCC model) to analyse the collected data as to appreciate the critical role of airports in advancing the country in terms of economy growth and development.

Study Area

The Federal Airport Authority of Nigeria is a body saddled to oversee all activities in the Nigerian airports. The body has it's headquarters in Murtala Muhammed International airport Lagos to manage and coordinate all the nation's airports with assistance from the regulatory body (NCAA).

Table 1: Some selected airports in Northern Nigeria

Geopolitical zone	Abbreviation of Airports	Name and location of the airports
Northwest	KANO INTL	International wing of Mallam Aminu Kano Airport, Kano
	KANO DOM	Domestic wing of Mallam Aminu Kano Airport, Kano
	SOK INTL	International wing of Sultan Saddik Abubakar Airport, Sokoto
	SOK DOM	Domestic wing of Sultan Saddiq Abubakar Airport, Sokoto
North Central	ABJ INTL	International wing of Nnamdi Azikwe Airport, Abuja
	ABJ DOM	Domestic wing of Nnamdi Azikwe Airport, Abuja
	ILR INTL	International wing of Ilorin Airport, Ilorin
	ILR DOM	Domestic wing of Ilorin Airport, Ilorin
Northeast	MAID INTL	International wing of Maiduguri Airport, Maiduguri
	MAID DOM	Domestic wing of Maiduguri Airport, Maiduguri
	YOLA INTL	International wing of Yola Airport, Jimeta
	YOLA DOM	Domestic of Yola Airport, Jimeta

Source: Author's (2020).

LITERATURE

Akorede, Nwaogbe, & Omoke (2019) on assessment of productivity and efficiency in Nigerian airports, employed DEA to determine the traffic level that exists in all airport at a given level of input. The study shows that there is a very weak relationship between the input and output variables and policy implication recommended for improving airport efficiency.

Pius, Nwaogbe, Akerele, & Masuku. (2017) study on appraisal of airport terminal performance, evidence from Murtala Muhammed International Airport Lagos using multiple regression model to determine the production levels, operations capacity and attractiveness to the stakeholders. The study reveals that terminal infrastructure has assisted the airport in increasing passengers' traffic and Aircraft movement. It recommends that adequate fund must be provided for transport related projects.

Yoshimoto, Alves & Mauro (2018) in Airport Economic Efficiency Frontier use DEA to show the correlation between operational efficiency frontier and key economic driver through the use of more than one input and output for a given Decision Making Unit (DMU) to analyze five airports where two of the airports were found to be efficient. Suzuki, Nijkamp, Pels & Rietveld (2014) study on Comparative Performance Analysis of European Airport by means of extended DEA. They employed DEA to solve the methodology weakness and substantive weakness in the determination of airport efficiency.

In the same clime, Wang, Ta Ho, Min Feng & Kai Yang (2004) studied on comparative analysis of operational performance of Taiwan's major airport measured the operational performance of ten airport base on the association between the airport, passenger's, airline company and fire services. The result of the study reveals that the efficiency score of the airports are not the same. Fadare & Adeniran (2018) study on comparative analysis of public operated airport terminal and concessional terminal airport in Lagos Nigeria using spearman ranking model, the study reveals that passengers are satisfied 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 airports as it is a good strategy for enhancing quality of airport services and efficiency of airport operation and management.

In a closely related manner, Oyesiku, Somuyiwa & Adewole (2016) worked on an evaluation of airport traffic system in Nigeria, examined airport operation efficiency and capacity utilization as influence by different airport traffic variables. Pearson product correlation is adopted to determine the significant relationship between variable collected from ten (10) different airports within the country. The variables are positively high and low concentrated in some cases, the study recommended that the use of technology will continue to see the industry and airports work towards a competitive advantage. Suzuki, Nijkamp, Pels & Rietveld (2014) on a study of comparative performance analysis of European airports by means of extended DEA. They employed DEA to solve the methodology weakness and substantive weakness in the determination of airport efficiency.

Furthermore, DEA only measures relative efficiency to the best practice within the particular sample. Thus, it is not meaningful to compare the scores between two different studies. SFA, on the other hand, accounts for measurement error, but is also criticized for requiring a pre-defined functional form in the estimation of the frontier. Comprehensive treatments of the two methodologies are available in several airport applications (Bazargan and Vasigh, 2003; Fung et al., 2008). Ferreira et al. (2010) contend that DEA model attempts to exploit the relationship between the outputs and inputs, weights of each variable (output/input) are defined. With DEA model, multiple inputs and outputs can be used for the assessment process, different from the non-parametric model (Lai, Potter, Beyon, and Beresford, 2015). As noted by Liebert (2011) many studies quantitatively assess performance and decision-making units (DMUs), using a range of econometric tools such as Multicriteria Decision Analysis (MCDA), Window Analysis (WA), Stochastic Frontier Analysis (SFA), and Censored Regression (Lin, Choo, and Oum 2013; Kao and Liu, 2011).

Merkert and Assaf (2015) studied on estimation of service quality perception and profitability of international airports are evidenced. In their study, they aim at investigating whether percieved airport quality has an impact on airport profit margins. In their analysis, two-stage Data Envelopment Analysis were used to estimate a single efficiency measure. Moreso, Lin, Choo, and Oum (2013) studied on efficiency benchmarking of North American airports, by comparing the results of productivity index, data envelopment analysis and stochastic frontier analysis. From the analysis of 62 Canadian and U.S airports, the emperical results reveal that the efficiency scores and rankings measured by alternative methods are quite similar to each other on the top 15 and bottom 15 ranked airports, whereas considerable diiferences exist among the airports.

Wanke, Barros & Nwaogbe (2016) studied the productivity and efficiency of Nigerian airports using Fuzzy-DEA to analyse the input and output variables sourced from FAAN. The result of the study indicates few variables as drivers of efficiency. The study recommends policy for Nigerian airports focusing on passengers' capacity measurement towards improving the learning component represented by the trend.

Nwaogbe, Wanke, Ogwude, Barros & Azad (2018) carried out a study on efficiency driver in Nigerian airports and considered 30 airports between 2003 and 2013. The study adopts multi-stage approach of bootstrap DEA-Censored and Quartile Regression and uses contextual variables related to the airports' ownership, location, and network connectivity on different efficiency percentiles. The study concludes that the impacts of the selected variables on airport efficiency is in between high and low efficiency.

Furthermore, Barros, Wanke, Nwaogbe& Azad (2017) studied on efficiency in Nigerian Airports

using Stochastic Frontier Model (Cost Function) that captures the impact of unobserved managerial ability. In the study, they utilize Alvarez, Arias and Greene (2004) - the AAG model. Their study findings show that contextual variables if allowed simultaneously will control the impacts of managerial ability on efficiency toward passenger traffic which is the major output of traffic in the air tansport operation. They also find out that variation inefficiency scores are more sensitive to labor than capital cost but indicate a negative impact of regulation and hub operations on efficiency levels (Barros et al., 2017).

Efficiency in Nigerian ports (Wanke, Nwaogbe & Chen, 2017) handling imprecise data with a two-stage fuzzy approach. This study focuses on assessing the efficiency of six major Nigerian airports from 2007 to 2013 by applying a two-stage fuzzy-based methodology adequate to handle imprecise data. More precisely, fuzzy data envelopment analysis models for traditional assumptions with respect to scale returns are employed to assess the productivity of Nigerian ports over the course of time. In the second stage, fuzzy regressions based on different rule-based systems are used to predict the relationship of a set of contextual variables on port efficiency. These contextual variables are related to different aspects of port service level, berth utilization, accessibility, cargo type, and operator type. The results reveal the impact of operator and cargo type on efficiency levels. Policy implications for Nigerian ports are derived.

Furthermore, Nwaogbe, Pius & Idoko, (2017) also estimate on eight Nigerian airports (domestic and international terminals) production functions using Cobb Douglas model. In the study, frontier analysis is designed for these airport terminals, to compare their productive efficiencies with that of their frontiers. The function estimation is introduced and guided by econometrics theory. A bespoke trans-log is adopted for data presentation. Both output and input parameters are regressed, to achieve an ideal production frontier of these airport terminals, using a panel data 2005 – 2015. The study findings reveal that only one terminal is operating at the efficiency level (PHC DOM). While, other terminals studied for this study are operating at decreased efficiency; ABJ DOM, ABJ INT'L, KAN DOM, KAN INT'L, MMA DOM, MMA INT'L, and PHC INT'L. The significances of individual variables such as "employees' number and total asset" are positive and valued at 5.32 and 91.82 respectively. While terminal capacity and total costs valued, at - 0. 27 and - 0.17, the results reveal that there is decreased productivity at some of the nation's airports. Variables' elasticity test confirms that only "the employee numbers" is elastic, while other variables assessed are inelastic. Therefore, to improve and overcome complex operational challenges, the airport's management will need to focus their investments on differentiating their operational capabilities. For instance, terminal efficiency can be enhanced by increasing the current number of gates and they should be tactically managed to ensure their effective use. This can be achieved by positioning them in public or limited use space, but then not for preferential use only, as this will be counter-productive. Terminal's operator and management should develop localized strategies to increase their current productivity level, for instance, expand and revamp the existing terminals, to accommodate congestion caused by an increase in passenger traffic (Nwaogbe, Pius & Idoko, 2017).

METHOD AND DATA

Charnes, Cooper, & Rhodes (CCR model, 1978) have come up with a mathematical programming approach which has managerial decision-making orientation particularly adept at estimating efficiency and inefficiencies in multiple input and multiple output production correspondences. BCC-DEA model is an advanced performance measurement technique that

can be used for evaluating the relative efficiency of the decision-making unit (DMUs). It is a linear programming approach upgraded by Banker, Charnes & Cooper in 1984. MaxDEA Version 7.0 software of DEA are adopted for the analysis.

Model formulation

Productivity index = (1)

Efficiency = (2)

CCR Projection Formulas'

(3)

y (4)

Where the symbol "*" denotes an optimal value. These are sometimes referred to as the "CCR Projection Formulas" because Charnes et al. (1978) show that the resulting χio ≤ ×io and ^yro≤yro correspond to the coordinates of a point on the efficiency frontier.

BCC Projection Formulas'

Max Z = **(5)**

Subjected to:

≤ 0, j = 1,....n, (6)

(7)

vi ≥ ε, uí ≥ ε, uo is free sign.

This can be translated mathematically as thus:

(FP_o) = Max θ = (8)

Subjected to:

≤ 0 (9)

Where

θ = efficiency score

n = Number of airport

m = volume of input

u = Volume of the output

y = quantity of the output s,

x = quantity of the input

v = volume of the input

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

Input variables (10)

Output variables (11)

Where output variable includes:

Y_1 = Passenger throughput

Y_2 = Aircraft movement

The input variables include:

X_1 = Terminal capacity

X_2 = Runway dimension
X_3 = Total operations cost
X_4 = Ground handling equipment
X_5 = Number of Employees

RESULTS AND DISCUSSION

This model presents the results of estimating pure technical efficiency at the given scale of operations between technical efficiency and scale efficiency to know if the airports are operating at increasing, decreasing or constant returns. Airport with efficiency score of 1 (100%) are said to be efficient and those below the efficiency score of 1 (100%) are said to be technically inefficient.

Table 4.1: Technical efficiency summary of BCC-DEA model result (variable return to scale)

DMU	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN
ABJ INTL	0.03077	0.038528	0.072715	0.102698	0.198983	0.061993	0.068327	0.08361	0.102502	0.145335	0.15306	0.173059	0.214664	0.450004	0.250011	0.242347	0.761268	0.262998	0.189604
KANO INT	0.049676	0.049165	0.053372	0.054953	0.059601	0.078705	0.078909	0.064729	0.052121	0.056794	0.064712	0.17718	0.04063	0.070509	0.056553	0.064537	0.190135	0.202466	0.081375
SOK INTL	0	0	0	0.085145	0.087087	0.050876	0.172452	1	0.1458	0.144475	0.137997	0.130937	0.964663	0.056805	0.036708	0.007977	0.038244	0.002877	0.170114
ILR INTL	0	0	0	0.006433	0.026618	0.01569	0.114032	0.019098	0.003723	0	0.007712	0.012209	0.121064	0.007869	0.001196	0	0.044897	0.005082	0.021424
MAID INTL	0	0	0	1	0.587165	1	0.569009	1	0.628837	0.769912	0.43495	0.696196	1	0	0.110006	0.099214	0.010091	0.39267	0.461003
YOLA INTL	0	0	0	0.065197	0.074085	0.040675	0.060957	1	0.070517	0.042377	0.036045	0.035948	0.469761	1	0.034337	0.025031	0.328789	0.113507	0.188735
ABJ DOM	0.464949	0.509445	0.577014	1	0.748382	0.576817	0.619869	0.843968	0.853753	0.949941	0.992473	0.78731	0.896008	0.944171	1	0.854547	0.043663	1	0.759017
KAN DOM	0.205977	0.199049	0.247549	1	1	0.247762	0.635481	0.246362	0.628315	0.674423	0.605114	0.32462	0.305004	1	1	0.366517	0.739799	0.470615	0.54981
SOK DOM	1	0.461213	1	0.560682	0.360496	0.497644	0.445527	0.458087	0.424355	0.669278	0.678075	0.609989	0.669061	0.551958	0.636148	0.316373	1	0.487397	0.60146
ILR DOM	1	1	1	0.375413	0.657738	1	0.771242	0.65631	1	1	0.981432	1	0.93546	1	0.983232	0.800148	0.401851	1	0.864601
MAID DOM	0.363938	0.363553	0.384932	0.360026	0.269398	0.161434	0.144262	0.273678	0.383237	0.475731	0.346822	0.34385	1	0.15918	0.304969	0.281228	1	1	0.423124
YOLADOM	1	0.421817	0.42509	1	1	1	0.566809	0.946758	0.805401	1	0.719096	0.63723	1	1	0.983474	0.761268	1	1	0.848164
MEAN	0.3429425	0.253564	0.313389	0.467546	0.422463	0.3943	0.353906	0.549383	0.42488	0.494022	0.429791	0.410711	0.634693	0.520041	0.44972	0.318266	0.812005	0.494801	0.429869

Source: Authors' computation, (2020).

Table 4.1 above shows the result of DEA-BCC model with pure technical efficient score = 1, airports with technical efficient score =1 are international wing of Sultan Saddik Abubakar III Airport Sokoto in 2008, international wing of Maiduguri Airport in 2004, 2006, 2008 and 2013, international wing of Yola Airport Jimeta in 2008 and 2014, domestic wing of Nnamdi Azikwe International Airport Abuja 2004, 2015 and 2018, domestic wing of Mallam Aminu Kano International Airport in 2004, 2005, 2014 and 2015, domestic wing of Sultan Saddik Abubakar III Airport Sokoto in 2001, 2003 and 2017, domestic wing of Ilorin Airport is efficient in 2001, 2002, 2003, 2006, 2009, 2010, 2012, 2014 and 2018, domestic wing of Maiduguri Airport in 2013, 2017 and 2018 and domestic wing of Yola Airport is efficient in 2001, 2004, 2005, 2006, 2010, 2013, 2017 and 2018.

Table 4.2: Summary of CCR-DEA model result of technical efficiency (2001-2018)

DMU	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN
ABJ INTL	0.030432	0.038151	0.071954	0.101767	0.142261	0.052561	0.057931	0.070889	0.086907	0.122025	0.127904	0.144615	0.179382	0.349284	0.20892	0.202515	0.158885	0.219772	0.131453
KANO INT	0.04918	0.048595	0.053249	0.054807	0.058862	0.078582	0.077931	0.063829	0.051396	0.056004	0.063944	0.162391	0.040274	0.070372	0.056003	0.06441	0.03809	0.202465	0.071688
SOK INTL	0	0	0	0.071989	0.074329	0.045661	0.123686	0.133802	0.10721	0.106235	0.103162	0.09936	0.639311	0.043106	0.027987	0.006082	0.037014	0.002814	0.090097
ILR INTL	0	0	0	0.005167	0.024349	0.014348	0.105974	0.015673	0.003253	0	0.006389	0.010221	0.102133	0.006574	0.001151	0	0.0086	0.004399	0.017124
MAID INTL	0	0	0	0.024008	0.022366	0.013185	0.019148	0.035294	0.027399	0.024313	0.019601	0.040766	0.110374	0	0.006628	0.005424	0.01068	0.010943	0.020563
YOLA INTL	0	0	0	0.029702	0.033751	0.01451	0.024507	0.023325	0.028171	0.016929	0.009518	0.013921	0.177008	0.595915	0.012913	0.009268	0.017035	0.053772	0.058903
ABJ DOM	0.464949	0.506737	0.568428	1	0.726375	0.575843	0.615158	0.808595	0.848836	0.94041	0.987534	0.786406	0.896008	0.944049	1	0.854427	0.73965	1	0.792411
KAN DOM	0.138653	0.135259	0.177533	0.41113	0.365596	0.17477	0.245171	0.246313	0.284835	0.345161	0.44124	0.291745	0.30475	0.344842	0.295641	0.283696	1	0.226892	0.317402
SOK DOM	0.562985	0.374793	0.996978	0.445194	0.198953	0.380931	0.314209	0.364588	0.337416	0.530534	0.543836	0.494946	0.548329	0.510953	0.540264	0.273042	0.352583	0.455628	0.457009
ILR DOM	0.775464	0.775414	0.342728	0.210158	0.560403	0.594108	0.665542	0.626759	1	1	0.759775	0.699698	0.880047	1	0.869869	0.687627	0.841794	0.789473	0.726603
MAID DOM	0.204156	0.1843	0.14163	0.118438	0.097775	0.070194	0.070329	0.099499	0.127773	0.133977	0.118223	0.085012	0.245255	0.158764	0.222092	0.164598	0.812843	1	0.22527
YOLADOM	0.255718	0.180645	0.186318	0.233474	0.301399	0.327522	0.195931	0.451287	0.391417	0.395657	0.351249	0.348877	0.385921	0.568307	0.632814	0.518858	0.603852	0.918627	0.40266
MEAN	0.20679475	0.186991	0.211568	0.225486	0.217202	0.195185	0.209626	0.244988	0.274551	0.305937	0.294365	0.26483	0.375733	0.382681	0.322857	0.255829	0.385086	0.407065	0.275932

Source: Authors' computation, (2019).

Table 4.2 above shows the DEA-CCR model result for the selected airports. The table presents the efficient airports are with efficiency scores of 1 (100%) while the airports below efficient level of 1 (100%) are not efficient. Domestic wing of Nnamdi Azikwe International Airport Abuja is efficient in 2004, 2015 and 2018, domestic wing of Mallam Aminu Kano Airport in 2017, domestic wing of Ilorin Airportin 2009, 2010 and 2014 while domestic wing of Maiduguri Airport is efficient only in year 2018. The least inefficient airport is the international wing of Sultan Saddik Abubakar III Airport Sokoto with an inefficiency score of 0.002814 in 2018 followed by International wing of Ilorin Airport with an inefficiency score of 0.003253 in 2009, the model produces the domestic wing of Nnamdi Azikwe International Airport Abuja with an average efficiency score of 0.830421. This result corresponds to the result of Akorede, Nwaogbe & Omoke (2019).

Table 4.3: Average pure technical efficiency score of DEA-BCC model for the selected airports

Airports	Inefficient score	Ranking	PTIE (%)
ABJ INT'L	0.189604	9	81.04
KAN INT'L	0.081375	11	91.86
SOK INT'L	0.170114	8	82.99
ILR INT'L	0.021424	12	97.86
MAID INT'L	0.461003	6	53.39
YOLA INT'L	0.188735	10	81.13
ABJ DOM	0.759017	3	24.10
KAN DOM	0.54981	4	45.02
SOK DOM	0.60146	5	39.85
ILR DOM	0.864601	1	13.54
MAID DOM	0.423124	7	57.69
YOLA DOM	0.848164	2	15.18
Average	42.9869%		

Source: Author's Computation (2019).

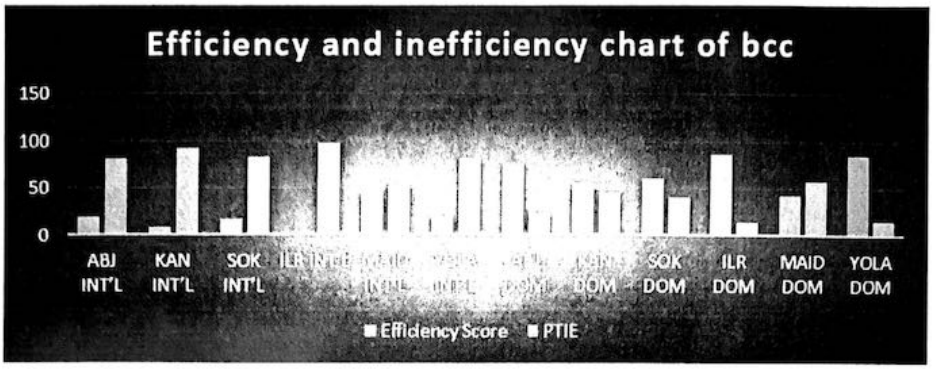

Fig. 4.1: DEA-BCC efficiency and inefficiency chart

Table 4.3 above shows the mean estimated result of DEA-BCC with the technical efficiency score of 100% and the technical inefficiency score of not equal to 100%, the table also shows the technical efficiency average score of international wing of Abuja, Kano, Sokoto, Ilorin, Maiduguri and Yola airports are 18.96%, 8.14%, 17.01%, 2.14%, 46.10% and 18.87% respectively. The technical efficiency average score of domestic wing of Abuja, Kano, Sokoto, Ilorin, Maiduguri and Yola airports are 75.90%, 54.98%, 60.15%, 86.46%, 42.31% and 84.82% respectively. The average efficiency estimation of both the international and domestic airports in the study area shows that none of the airport is operating at efficiency score of 100%, this means that all the airports in the study area are averagely inefficient.

This result reveals that the DEA-BCC analysis gives a robust result because BCC model is an advanced and improved model than CCR-model. It is also shows inefficient airports operating below the efficient score = 1 (100%) while the least inefficient airport is SOK INT'L with an inefficiency score of 0.002877 followed by Ilorin International with an inefficiency score of 0.005082 in 2018 respectively. This result is corresponds to Nwaogbe (2018).

Table 4.4: Estimation of airports average efficiency score DEA-CCR model and ranking (2001-2018)

Airports (DMU)	Inefficiency score	Ranking	TIE (%)
ABJ INT'L	0.131453	7	86.45
KAN INT'L	0.071688	9	93.49
SOK INT'L	0.090097	8	90.81
ILR INT'L	0.017124	12	9825
MAID INT'L	0.020563	11	98.02
YOLA INT'L	0.058903	10	94.03
ABJ DOM	0.792411	1	16.96
KAN DOM	0.317402	5	66.37
SOK DOM	0.457009	3	55.04
ILR DOM	0.726603	2	27.17
MAID DOM	0.22527	6	77.14
YOLA DOM	0.40266	4	59.87
Average	27.59%		

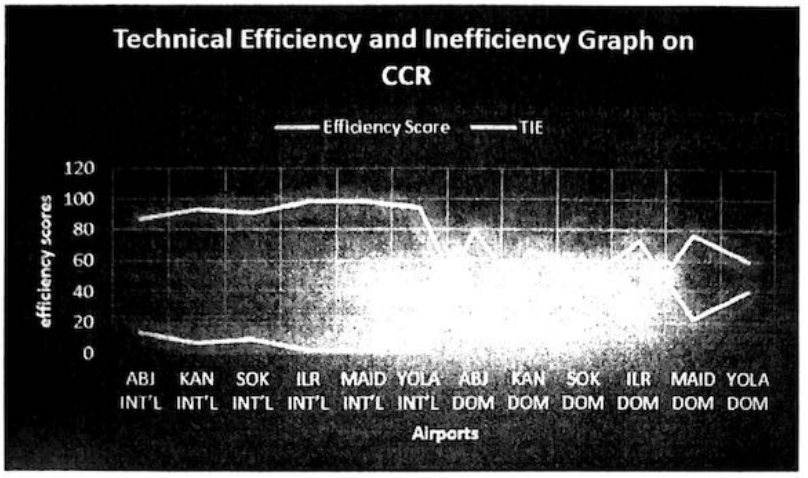

Fig. 4.2: Technical efficiency and inefficiency graph of DEA-CCR

Table 4.4 above shows the average result of DEA-CCR model of each airport for this study. The results present two (2) airports that are operating most under efficient score level, they are the domestic wing of Abuja and Ilorin with mean value of 79.24% and 72.66% respectively. Three of the airports are operating below 50%, these include the domestic of Sokoto and Yola at 45.70% and 40.27% respectively. Only the domestic wing of Kano Airport at 31.74% is experiencing constant return scale. Furthermore, the following airports Maid Dom at 22.53%, Sok Int'l at 9.19%, Yola Intl at 5.89%, Maid Int'l at 1.98% and Ilr Int'l at 1.746% are functioning beneath their efficiency scale size and thus, sustaining increase return to scale. Average efficiency score under CCR-model is 28.03% while average inefficiency score is 71.96%, this is revealing the fact that the relationship existing between dependent and independent variables is hanging on the size and value of the data set. The efficiency score is 0.001151 at Ilr Int'l in 2015.

In total, decrease returns-to-scale (DRS) is conformed to be the cardinal form of scale inefficiency in the study area. Habipkocak (2010) conducted a study by using an input-oriented DEA model to measure the effectiveness of 40 Turkish airports for the year 2008. The result of the study confirms that Data Envelopment Analysis (DEA) is the most commonly used technique for efficiency estimation.

CONCLUSION

The study concludes that only four (4) airports are operating efficiently under DEA-CCR model with efficiency score of 1 (100%), these airports include the domestic wing of Nnamdi Azikwe International Airport, Abuja, domestic wing of Mallam Aminu Kano International Airport, Kano, domestic wing of Ilorin International Airport and domestic wing of Maiduguri International Airport. The average technical efficiency obtained under CCR-model is 31.237%, meaning that there is prospect to improving the technology inaccuracy by 68.87% for inefficient airports in the study area to operate under efficiency score of 100%. This study under DEA-BCC model presents a robust result which shows that ten (10) out of the twelve (12) selected airports operate efficiently at efficiency score of 100% for at least once for the period covered by this study. This result testifies to the fact that DEA BCC-model is an upgraded and advanced model and produces a robust result than CCR model. This finding recommends that the stakeholders and

management of airports should encourage benchmarking as to ensure a reliable aviation sector and encourage public partnership to ensure accurate airport performance in the study area. For the aviation industry to be economically buoyant, socially vibrant and environmentally friendly, the federal government should place adequate and maximum security measures in the northern Nigeria.

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