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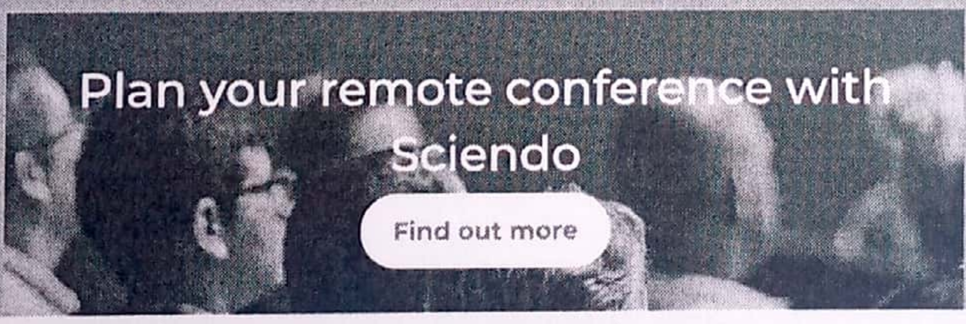

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Tue, Jul 13, 2021 at 10:47

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Kind regards

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Result of review process

Dear Author,

Please see below results regarding the review process of your manuscript entitled " **Analysis of Airport Operational Performance in Some Selected Airports of Northern Nigeria** ".

Reviewer 1 recommended publishing your manuscript in the LOGI – Scientific Journal on Transport and Logistics with major revision.

Reviewer 2 did not recommend publishing your manuscript in the LOGI – Scientific Journal on Transport and Logistics.

Remarks from reviewer 1:
Authors have prepared interesting paper with application of SFA on productive analysis of domestic and international airports in Nigeria.

However the hypothesis set in part 3.5 lead to general result – authors have proved by this what has already been found in practice.

1) Please improve scientific approach.

2) Please check the English then – the paper will be revised by native speaker and if there will be lot of mistakes in grammar, paper will be send to you for revision again.

Remarks from reviewer 2:
In the abstract there is the unfinished sentence "In the study". There are incorrect references to tables in the article (eg tables 4.3, 4.7). In Figure 1, the line graph for the TIE quantity is not appropriately chosen. The chosen hypotheses are very simple and it is clear from the logic of the airports operation, what there are the relationships

between passenger throughput, aircraft movement and the terminal capacity, as well as between aircraft movement and runway dimension. The content of the discussion does not correspond to the requirements for scientific discussion. In the conclusion, the same results are repeated as in the discussion.

Please rework the article according to the reviewers' comments, expand the list of literature, adjust the hypotheses, etc.

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Thank you very much in advance!

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Analysis of Airport Operational Performance in Selected Airports of Northern Nigeria

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Abstract: This study focuses on the overall airport operational performance of selected airports in Northern Nigeria using the stochastic Frontier Analysis (SFA) model. STATA version 7 software was used for the data analysis. Data collected from the Federal Airport Authority of Nigeria (FAAN) from all the selected airports from 2001 to 2018 included both domestic and international passengers in the given area. The study focused on measuring the operational performance of all selected airports; its results show that none of the airports under review showed 100% level of productivity benchmark. The study recommended that the airports in the given area can improve their technical performance by reducing the unit costs as well as some other inputs to increase efficiency.

Keywords: Airport, performance, productivity, efficiency, stochastic frontier analysis

1. Introduction

The Nigerian aviation industry has been deregulated since the mid-1990s, when the airports were commercialized and private airlines were granted lincence to operate in the country [1]. Moreso, [2] stated that the hub airport expansion for the international and domestic passenger traffic provides Nigerian residents, businessmen, and businesswomen with an improved offer in terms of travelling to various destinations, at a higher frequency, and for a lower price in terms of passenger fares within the West African sub-region.

Murtala Muhammed International Airport, Lagos, and Nnamdi Azikwe International Airport, Abuja have converted many Nigerian airports into feeders for the few hub airports in the country because of the population, economic situation, and political activities in Lagos and Abuja. Akanu

Ibiam Airport (Enugu) was rebuilt into a standard international airport and has been serving as a hub airport for the eastern part of Nigeria since 2013. Experts acknowledged that the liberalization of airport operation between the regions improves flexibility, competence, and professionalism in the aviation industry [3].

As a major component of the aviation sector, airporst play a key role in accelerating social and economic development at the regional, national, and global levels. Airports offer dynamic services with multiple inputs and outputs. With that, the airport sector facilitates domestic and international trade (by providing access to markets); creates employment opportunities related to both aeronautical and non-aeronautical activities; and enhances communication and integration between people, countries, and cultures through tourism, business activities and merchandise trade. Airports operate in different environments (large cities, remote areas) and serve users with various needs (business and leisure travellers), thus making efficiency assessments very challenging. Many stakeholders, including airlines, regulatory agencies, ground handling companies, and many others have various interests and objectives that further complicate the evaluation of airport performance [4]. This study aims to evaluate the operational performance of selected airports in northern Nigeria and the objective is to estimate the production function of the selected airports as well as to benchmark them against the global standard.

1.1 Literature Review

The researchers [5] adopted the Bayesian stochastic frontier to determine the technical efficiency of Mozambican airports. The study presented a functional form that introduces the risk of misspecification. They used SFA to test the statistical significance of each cost driver. Performance appraisal of some selected Nigerian Airport using Stochastic Frontier Analysis was addressed in [6]. The study concluded that organizations that possess unique resources can provide better/a wider range of services and meet service user demands more effectively than those without such resources. The study also recommended a single guideline for the operation of Nigerian airports in terms of the procurement and usage of resources.

Moreso [7] carried out a study on airport cost-efficiency using a homogenous SFA model on 10 Portuguese airports between 1990 and 2000. The author also published a study concerning the UK airports between 2000 and 2006 using the stochastic frontier analysis to describing airport heterogeneity and calculating their cost-efficiency.

Some researchers [8] studied the performance, heterogeneity, and managerial efficiency of African airports using stochastic frontier analysis. The research was conducted between 2003 and 2010 on a sample of thirty airports. The airports were ranked according to their technical efficiency, and common policies/strategies as well as individual policies/strategies by segments were proposed.

Studies by [9] used Stochastic Frontier Analysis to study the impacts of the competition between Italian airports on their technical efficiency in the period 2005-2008. The results of the study confirmed that the intensity of competition affects airport efficiency.

Cost effectiveness evaluation of Nigerian airports was dealt with by [10], who analyzed cost effectiveness of the airports together with their productivity. For the purpose of the analysis, Cobb-Douglas and Translong model were used to analyze ten (11) different airports operating in six Nigerian geo-political zones on the basis of multi-stage sampling in the years 2001-2013. The results represent an adequate network for improving the operational performance of the airports in Nigeria or other countries.

The study [12] analysed in more detail the efficiency of Nigerian airports in terms of handling imprecise data using a two-stage fuzzy approach. The study focused on assessing the efficiency of six major Nigerian airports in the period 2007-2013 by applying a two-stage fuzzy-based methodology suitable for handling imprecise data. Fuzzy data envelopment analysis models for traditional assumptions concerning scale returns are employed to assess the productivity of Nigerian airports over time. In the second stage, fuzzy regression based on different rule-based systems are used to predict the relationship of a set of contextual variables and airport efficiency. The results revealed the impact of operator and cargo type on efficiency levels, and determined the policy implications for Nigerian airports.

Furthermore, [13] studied the efficiency of Nigerian Airports using the Stochastic Frontier Model (Cost Function) that captures the impact of unobserved managerial ability. In the study, they utilized Alvarez, Arias, and Greene model (2004), referred to as the AAG model. Their findings show that contextual variables may, if allowed simultaneously will, control the impacts of managerial ability on the efficiency on passenger traffic, which is the major output of the air transport operation. Some researchers [14,15] also studied airport efficiency performance in Nigeria using the DEA-BCC model. It follows from the study that there is a highly significant relationship between the inputs (total assets, runway dimension, and number of employees) and the output, which is passenger and aircraft traffic during air transport operations. The study also proposes policy/strategies to turn inefficient airports into efficient.

Finally, [16] focused on measuring and explaining the evidence of efficiency and sustainability of Italian airports. The findings reveal that airport size, presence of low-cost carriers, and cargo traffic have a significant impact on the technical and scale efficiency of Italian airports. In other words, air transport privatization and deregulation can positively affect regional airport efficiency and sustainability.

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Table 1 List of airports, names, and location. Source: Federal Airport Authority of Nigeria

Airport abbreviations	Name and location of the airports
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
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
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

2. Data and methods

Data was collected from the departments of statistics of all selected airports via the Federal Airport Authority of Nigeria (FAAN). The study covered a period of 18 years (from 2001 to 2018), from six northern Nigeria airports. SFA model was used to carry out the analysis using the software STATA, version 11 .

2.1 Model specification

Stochastic Frontier Analysis (SFA) is a parametric statistical approach developed by Aigner et al., (1977). It is used to calculate efficient production frontier and enable the division of random error and efficiency factors. SFA is a well-known technique for determining the production frontier and efficiency score of any organization.

Mathematically, stochastic frontier analysis can be expressed as follows:

$$yi = f(xi;\ \beta).TEi\ ,\ [-] \qquad (1)$$

$$TE = \frac{yi}{f\ (xi,\beta)\ exp\quad (vi)}\ ,\ [-] \qquad (2)$$

$$\exp TEi = \frac{\exp\{\beta o+\ \beta t(lnx1it)\}+\ \beta t(lnx2it)+\ \beta t(lnx3it)+\ \beta t(lnx4it)+Vi+Ui}{\exp\ \{\beta o+\beta t(lnx1it)+\ \beta t(ln2it)+\beta t(ln3it)+\beta t(lnx4it)+Vi}\ ,\ [-] \qquad (3)$$

where: yi is passenger throughput [people]; TE is technical efficiency [-]

Taking the log of both sides,

$$ln(yi) = ln\{\ f(xi;\ \beta) + ln(ei) + vi\},\ [-] \qquad (4)$$

$$ln\ (yi) =\ \beta o + \textstyle\sum_{t=1}^{n} \beta t\ ln\ (xit) + vi - ui,\ [-] \qquad (5)$$

$$Log\ L = \frac{n}{2} ln\frac{\pi}{2} - \frac{n}{2} ln(\sigma 2) +\ \textstyle\sum_{i=1}^{n} ln\left(1 - \phi(z1)\right),\ [-] \qquad (6)$$

Assuming that there is n input with linear production function in logs, it can be defined that:

$$ui = -ln\,(ei), [-] \quad (7)$$

resulting in

$$ln(yi) = \beta o + \sum_{j=1}^{n} \beta j\, ln(xij) + vi - ui\,, [-] \quad (8)$$

Since *uí* was subtracted from *ln(ei)*, *ui* > 0 which confirms the earlier stated $0 < eí \leq 1$.

The Productivity output index used for this study under the stochastic analysis model are: *Y1* is Passenger throughput [people]; *Y2* is Aircraft Movement [n].

While the productivity input index to be used are:

X1 is Terminal capacity [-]; *X2* is Runway Dimension [m]; *X3* is Total operations cost [$]; *X4* is Ground Handling Equipment (GHE) [-]; *X5* is Number of Employees[n].

3. Result

Stochastic Frontier Analysis used for performing the analysis shows a robost result as regard to airport operational perfomance using some inputs and output variables.

3.1 Descriptive Statistics of SFA

Table 2 below presents brief descriptive statistics of the variables, which represent the selected twelve northern Nigeria airports subjected to the analysis using the Stochastic Frontier Analysis model.

Table 2 Descriptive statistic for the distribution of SFA. Source: authors

LnVariable	Description	Mean	Standard deviation	Minimum	Maximum
Ln Y_1	Natural log of passenger throughput	10.3115	3.4036	0.0000	15.167
Ln Y_2	Natural log of Aircraft movement	6.5626	2.6949	0.0000	11.0676
Ln X_1	Natural log of terminal capacity	5.3134	0.6482	3.9120	7.2442
Ln X_2	Natural log of runway dimension	11.9902	0.2239	11.5899	12.6603
Ln X_3	Natural log of total operation cost	19.1929	2.0234	14.3514	27.319
Ln X_4	Natural log of Ground handling equipment	2.4382	0.5090	2.0794	3.8501
Ln X_5	Natural log of the number of employees	5.1144	0.9623	3.2189	7.0553

3.2 Analysis of Production Function of Some Selected Airports

Table 3 below presents the calculated production function of each selected airport at a given level of both the dependent and the independent variables. The regression analysis results show the relationship between the dependent variables and independent variables as used in the study.

Table 3 Output summary of production function. Source: authors

Regression Statistics				
Multiple R	0.7960			
Root MSE	2.2617			
R-Square	0.4676			
Adjusted R-square	0.4549			
Number of observations	216			
Variables	Coefficient	Standard Error	t-test	P > | t |
Constant	68.789	10.2085	6.895	0.000
Ln Terminal capacity	0.646	0.3103	2.09	0.038
Ln Runway dimension	-6.027	0.9489	-6.83	0.000
Ln Total cost	0.113	0.1201	0.775	0.428
Ln GHE	0.435	0.5983	0.815	0.476
Ln Employee	1.783	0.2785	6.505	0.000

3.3 Comparison of actual airport productive efficiency using SFA and Cobb-Douglas production function

The study compared the performance efficiency results obtained through the SFA using half normal and exponential distribution model with the results of the production function obtained through the Cobb-Douglas as shown in Table 4 below. The result shows the coefficients, standard error, and T-ratio with the calculated values of the variables used are interrelated, and the error term shows the technical inefficiency and elminates random noise. The exponential distribution tends to eschew all inaccuracies from the analysis presented in Table 4 below.

Table 4 Comparison of Cobb-Douglas production frontier and SFA estimates. Source: authors

COBB DOUGLAS PRODUCTION FRONTIER				STOCHASTIC FRONTIER ANALYSIS ESTIMATES					
				Half-Normal			Exponential		
Estimates	Coefficient	Standard Error	T-ratio	Coefficient	Standard Error	T-ratio	Coefficient	Standard Error	T-ratio
Constant	68.98	10.2085	6.895	53.610	3.484	17004.3	51.904	6.359	8.105
Ln Tmc	0.646	0.3103	2.09	0.918	0.131	8998.33	0.759	0.251	3.015
Ln Rwd	-6.027	0.9489	-6.83	-4.638	0.328	-15504.1	-4.542	0.613	7.345
Ln T.cost	0.113	0.1201	0.775	0.146	0.199	1193.6	0.045	0.066	0.70
Ln GHE	0.435	0.5983	0.815	-1.158	0.378	-4837.2	-0.723	0.340	-2.13
Ln Emp	1.783	0.2785	6.505	2.043	0.081	17506.1	1.944	0.145	13.40
Sigma (σv)				61.5E+05	0.046		0.499	0.088	
Sigma (σu)				3.363	0.180		2.095	0.176	
Sigma (σ^2)				11.66	2.403		4.665	0.709	
Lamda (λ)				15.55	0.205		4.378	0.224	
Log K				-432.107			-420.198		

3.4 Estimation of productive efficiency scores of domestic and international airports in given area using SFA

Table 5 below presents estimated SFA the productive efficiency results of each airport in the period 2001-2018. The efficiency of each airport is measured in percentage. Airports are considered productive and efficient only if the observation level equals 100% (the productive frontier). Airports with the efficiency score below 100% are considered inefficient. Combined output and input variables were analyzed and the efficiency level of the airports is estimated by obtaining values from 0 and 1 as efficiency score. It shall be noted that any airport operating below an efficient score of 1 (100 %) is not productive and efficient while the SFA estimated result for this study shows that all the airports are inefficient. The airports can improve their productive efficiency by increasing the level of input variables to produce an effective output level.

Table 5 SFA estimated efficiency score in the years 2001 - 2018. Source: authors

Airport abbreviations	Efficiency Scores	Ranking	TIE (%)
ABJ INTL	0.424915	5	57.51
KAN INTL	0.120539	10	87.95
SOK INTL	0.165216	8	83.95
ILR INTL	0.085441	11	91.46
MAID INTL	0.231759	7	76.83
YOLA INTL	0.130707	9	86.93
ABJ DOM	0.642003	1	35.8
KAN DOM	0.055293	12	94.48
SOK DOM	0.550622	2	35.8
ILR DOM	0.46933	4	53.07
MAID DOM	0.513922	3	48.61
YOLA DOM	0.358177	6	64.19
Average score	0.312327019		

$$TEi = \frac{y1\ (output)}{f\ (xi,\beta).exp\ (vi)\ (frontier)}, [-] \quad (9)$$

$$exp\ TEi = \frac{exp[\beta o+ \beta t(lnx1it)]+ \beta t(lnx2it)+ \beta t(lnx3it)+ \beta t(lnx4it)+Vi+Ui}{exp\ \{\beta o+\beta t(lnx1it)+ \beta t(ln2it)+\beta t(ln3it)+\beta t(lnx4it)+Vi}, [-] \quad (10)$$

where: *TEi* is Technical Efficiency [-].

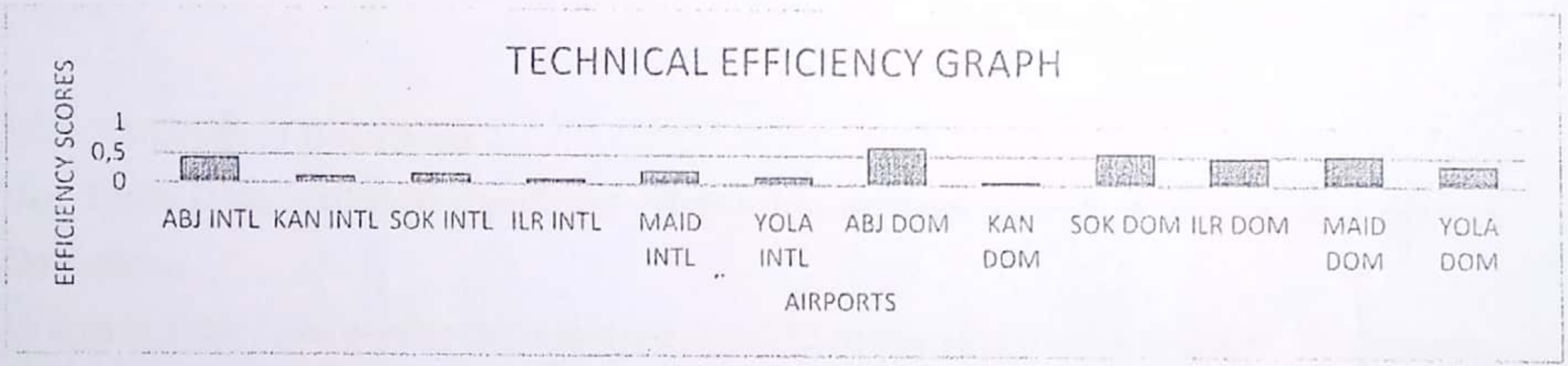

Fig. 1 Airports technical efficiency and inefficiency according to SFA in the period 2001 - 2018. Source: authors.

Hypothesis testing

The formulated hypothesis was tested using the Wald test, which is a parametric test applied in the stochastic frontier analysis to find out whether the explanatory variables used are significant input variables or not.

Rule statement: If the probability-value is < 0.05 (5 %), the null hypothesis is rejected while the alternative hypothesis is accepted.

3.5.1 Analysis of Hypothesis 1

H_{01}: There is no statistical association between passenger throughput, aircraft movement, and the terminal capacity.

Table 3 shows that the calculated p-value is 0.038, which is lower less than the tabulated value (0.05), which indicates there is a statistically significant positive relationship of passenger throughput, aircraft movement, and terminal capacity. This study thus rejects the null hypothesis and confirms the alternative hypothesis on the existence of a statistically significant relationship of passenger throughput, aircraft movement, and the terminal capacity. This implies that passenger throughput is a determinant of aircraft movement terminal capacity utilization; the higher the passenger throughput, the higher the number of aircraft movements, and the more terminal capacity occupied. Moreover, [17] focused on the appraisal of airport terminal performance. Using the data from MMIA Lagos, they used a multiple regression model to determine the production levels, operations capacity, and attractiveness for the stakeholders. The study reveals that terminal infrastructure helps the airport in terms of landing and take-off; adequate funding thus must be provided for the transport-related project.

3.5.2 Analysis of Hypothesis 2

H_{02}: There is no statistical significant relationship between aircraft movement and runway dimension.

As seen in Table 3, the p-value calculated is 0.00 < 0.05 compared to p-value tabulated. This indicates that there is a statistically significant relationship between the aircraft movement and the runway dimension. This study thus rejects the null hypothesis and accepts the alternative hypothesis on the existence of a statistically significant relationship between aircraft movement and runway dimension. This implies that the better the condition of the runway dimension and the larger the dimension of the runway, the safer the aircraft landing and take-off is. Moreover, the safer the runway and the greater its dimension, the higher number of aircraft will use the airport, thus increasing the productivity and efficiency of the airport. [2]

4. Disscussion

The table presents the average value, the standard deviation, the minimum, and the maximum value of the variables used for the purposes of the study. The total cost (input variable) achieves the highest maximum value of 27.319. This is followed by passenger throughput (output variable) with the value of 15.167, runway dimension (input variable) with the value of 12.6603, and finally aircraft movement (output variable) with the value of 11.0676.

The table also shows the coefficient of each variable, standard error, t-value, and the p-value, where the t-value shows the ratio and significancy of each variable for other variables; it can also be used to test the hypotheses. Terminal capacity, total cost, ground handling equipment, and the number of employees are highly significant with a positive t-value of 2.09, 0.775, 0.815, and 6.505, while the runway dimension is also significant, with a negative t-value of -6.83, which implies a decrease in the efficiency level. The R2 value of 47 % implies that the aircraft movement in the study area is explained by the explanatory variables. It shows 45.49 % of modified R, which explained the percentage at which the independent variables explained the dependent variables. The Multiple R with a value of 0.7960 shows the overall existing relationship of 79.60 % between the independent variables (passenger and aircraft) and dependent variables (Terminal, runway, total cost, GHE, and the number of employees).

Table 5 presents the overall average of the technical inefficiency score of the domestic and international airports in the area under review. According to the results, the most efficient airport is ABJ DOM, with the efficiency score of 64.20 %, followed by SOK DOM with the efficiency score of 55.06 %, MAID DOM (51.39 %), ILR DOM (46.93 %), all of them operating at the above-average level of the efficiency score. The remaining eight (8) airports include MAID DOM with the efficiency score of 13.07 %, KAN INT'L (12.05 %), SOK INTL (8.54 %), ILR (23.17 %), YOLA INT'L (13.07%), KAN DOM (5.52 %), and ABJ INTL with the mean efficiency score of 42.49 %. SFA result estimated the average efficiency score to be 31.23% and the average inefficiency score of 68.77 % for the airports in the given area. Coelli et al. (2005) believe that most of the output-oriented measurings of technical efficiency is the ratio of observed output to the corresponding stochastic frontier output. The policy implication resulting from this study indicates that reducing the number of employees by making airports in the given area more efficient would be a befitting solution for these airports to minimize the costs and other input variables to improve the efficiency level. The decreasing return-to-scale is observed to be the predominant form of scale inefficiency in the northern Nigeria aviation industry. Finally, the two hypothesis testing show that there is a statistical significant relationship between the dependent variable and independent variables used for the analysis.

5. Conclusion

The study concludes that the results of airport operational performance estimated through the SFA model show that none of the airports is operating under an efficiency score of 100% during the study period.

The results of the analysis show that none of the airports operating in the northern region are operating at 100% efficiency level. Three of the airports analysed show 50% efficiency level and above while the remaining airports are operating below 50% efficiency level. Ilorin International airport (ILR INT'L) is the least efficient airport with the score of 0.085441. This indicates that such an airport should be closed down or privatized. The SFA result estimated the average efficiency score in the given area to be 31.23 % and the average inefficiency score of 68.77 %. The study recommended the airports in the area under review to improve their technical efficiency by reducing their unit costs as well as some other inputs to increase their efficiency. Finally, the government should find a way to start public privatisation or concession of the airports (airport reform), which could make some airports try to improve their efficiency level.

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