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# An Appraisal of Airport Terminal Performance: Evidence from Murtala Muhammed International Airport (MMIA)

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## Abstract

This study evaluates airport terminal operational performance and examines the effect of remodelling exercise at the Murtala Muhammed International Airport (MMIA). Using multiple regression analysis on panel data (2006 – 2014). The project was commissioned to upgrade MMIA infrastructure to a world-class standard, for a better service user experience. The results show that total cost, total assets, wages, and number of employees are major determinants of estimating aircraft passenger and cargo movement. The variables accounted for the R square is 99.8% for the aircraft movement, while the passenger movement is 93.3% and for the cargo movement is 99.5%, these are the relative total productivity of the MMIA terminal post investment. Terminal improvement assisted MMIA in coping with the increase number of passenger's traffic and aircraft movement, better than the pre-project era, in terms of improving operational performance. Therefore, it is recommended that MMIA increases the current input, by investing more in the terminal capacity to attract and accommodate larger aircraft. Moreover, increase in the airport productivity will generate more revenue that can be used to improve the quality of service for a better service user experience. To sustain the terminal infrastructure on long-term; the aviation policy makers and the implementers, should consider private-sector financing strategy as a way forward, instead of the current asymmetrical funding system.

**Keywords:** airport, terminal, performance, productivity, passengers, input/output

As one of the critical national assets, airport plays a major role in the nation socio-economic growth and advancement (Nwaogbe et al., 2013). Airport provides more than just landing and taking off space for the airlines, provides additional services such as, shopping mall, business pavilion, car parks, hanger, and storages for different users. Incidentally, in the last few decades' air transports have attracted investment from both government and private entities, especially in the developing countries. Although, some of these countries infrastructures are still struggling in coping with the growing numbers of passenger demand. Most passengers would like to spend as little time as possible on the terminals, as they do not appreciate long queue, repetitive security checks, crowded departure areas, queuing for boarding and a delayed departure. Unfortunately, this is not the case in some developing country's airports. The terminal infrastructures have limited capacity, making it difficult for them to accommodate any extra increase in demand from the service users. As noted by Barros & Ibiwoye (2012) airport terminal assessment is a valuable tool to the stakeholders such as governments, investors, and airport managements. As articulated by Vasigh & Howard (2012) terminal assessment can be used to identify a gap in operational performance, also provide data for a better understanding about the sector issues to the stakeholders. Thus, terminal evaluation can be challenging and complex, because of the so-called 'uniqueness' (heterogeneity and homogeneity) of the airport's structures (Wang, Liu & Zhao, 2012). Every airport operation is slightly different from the others, in terms of their characteristics. Perhaps for this simple reason, there is a need to contribute and update available information on the sector, for a healthy competition to improves and sustains service quality. Nwaogbe et al., (2017) suggests that industry-specific policy will encourage more private-sector investment and promote healthy competition within the industry.

### **Statement of Problem**

Given the fact that aviation industry is the nation gateway to the international marketplace, past and present governments have invested hugely over the years in the airport infrastructure development. The federal and state governments owned majority of the nation airport shares. A scheme known as public-private-partnership (PPP), through concession agreement is used to encourage private-sector involvement. In 2012, the government invested \$500 million in four major airports, including MMIA (NCCA, 2015). The investment was aimed to upgrade the nation's airports infrastructures to a world-class standard, for a better service user experience, and to encourage private-sector investment.

As Barros & Ibiwoye (2012) noted airport terminal assessment can produce important insight into the operational capacity and its attractiveness to the stakeholders, such as investors, passengers, and the public. Incidentally, the aviation stakeholders are interested to know the benefits from this exercise to the nation's aviation industry, especially to those airports like MMIA who benefited from it. The aviation experts are calling on the regulatory body for the introduction of official guidelines for productivity

appraisal, for those airports who benefited from the project. As this will assist management of these airports in identifying gaps and areas of improvement in their operational performance. It equips these airports with the capabilities to compete effectively at the local and international level.

To address the issue, selected dependent and independent variables from MMIA were measured quantitatively, using multi-regression analysis to find out the production level. The improvement of MMIA terminal infrastructure, has assisted the airport in coping with the increase number of passenger traffic and aircraft movement in terms of take-off and landing, this has improved the operational performance, and expanded the production level. Whilst, reducing the cost of operation. A former director general of the Nigerian Civil Aviation Authority Dr H. Demuren, recently granted an extensive interview to one of the national dailies; the Guardian newspapers on March 2, 2017, he maintains that the aviation sector contributed average revenue of \$450M and 0.8% of the GDP to the economy in 2015.

### **Aim and Objectives**

This study assesses General Aviation Terminal (GAT) operational performance, using selected variables such as passenger, cargo, and aircraft movement (dependent) - total assets, total cost, wages, and number of employees (independent), to measure production level at the airport. The study objectives are:

- To assess the present state of airport terminal performance.
- To assess the trend of terminal performance and productivity level.
- To develop policy recommendations on how gains made from the airport remodelling exercise could be utilised to facilitate sector development and sustainability.

### **Research Hypotheses**

These hypotheses will be tested to achieve the study aim and objectives;

- **H1:** There is no statistical significant relationship between aircraft movement and total cost, total assets, wages, and number of employees.
- **H2:** There is no statistical significant relationship between passenger movement and total cost, total assets, wages, and number of employees.
- **H3:** There is no statistical significant relationship between cargo movement and total cost, total assets, wages, and number of employees.

### **Research Rationale**

This study attempts to assess terminal productive level and update information available in the field, post remodelling project one a year ago. Thus, limited knowledge exists in this area of study – preceding studies on terminal productivity have overlooked

MMIA, after the revamp. Literature on this area of study is limited in the academia. As Barros, Nwaogbe & Ogwude (2015) argued that terminal evaluation aims to provide objective data for capacity utilization and for designing service user oriented policy. The study finding will be valuable to the stakeholders, such as airlines, investor, regulatory bodies, and the public.

### **Research Limitations**

The researchers encountered the following challenges; the airport authority and regulatory body were unwilling to give out relevant data initially, the panel data gathered ended in 2014. The data for 2015 was not ready and the airport terminal assessment was only carried out in MMIA, due to lack of data.

### **Airport Terminal Assessment**

Gillen and Lall (1997) defined airport as a complex and highly sophisticated system, with two major elements (airside and landside) generally known as the Air System. Among the concerns of airport industry is the performance and productivity measurement. Wanke, Barros & Nwaogbe (2016) studied productive efficiency of Nigerian airports using Fuzzy-DEA. In their study, Fuzzy Data Envelopment Analysis (DEA) was used in assessing the performance of these airport's productive efficiency. The result reveals that fewer significant contextual variables were identified as the efficiency drivers. When controlling for the fuzziness and randomness, capacity cost was found to be the only significant variable, in addition to a learning component represented by the trend. The study finding suggests that Nigerian airport's policy developer should focus on third-party capacity management – such as privatization - while fostering continuous improvement practice to sustain the learning curve. Barros, Nwaogbe & Ogwude (2015) studied the performance heterogeneity of 30 Nigeria airports using Stochastic frontier analysis (SFA) cost function from 2003-2013. From their analysis, they considered the endogenous managerial practices, ownership and regulatory control on the heterogeneous cost frontier. The study finding suggests that common policies can be defined for Nigerian airports based on the average values of the homogeneous variables, whereas segmented policies may be prescribed to account for heterogeneous variables. A new approach of the stochastic frontier adopts the Bayesian approach (Assaf, 2009, 2010a, 2010b). Recently, a new generation of stochastic models considered heterogeneity, such as the random model of (Barros, 2008a, 2008b), the Bayesian approach of (Assaf, 2010b), in assessing airport performance and output. Barros and Marques (2010) studied the efficiency of Mozambican airports with a random frontier and a fixed effects stochastic frontier and Bayesian stochastic frontier were adopted to capture the technical factor.

Airports operational efficiency have been studied in different contexts, over the years by several authors (Tseng, Ho & Liu, 2008; Perelman & Serebrisky, 2010; Zhang, Wang-Liu & Zhao, 2012; Jaržemskienė, 2012), some of these writers went further in their quests to achieve a robust and reliable results, using technical factor as additional variable

in their investigations (number of runways, number of platforms, airport size, number of employees, number of flights, cargo volumes, number of passengers). Admittedly, the study of Vasigh and Haririan (2003) could not find any evidence to support the superiority of private owned airports, over the public ownership. While Oum, Yu, and Fu (2003) and Oum, and Zhang (2004) argued that airports owned through public-private-partnership (PPP), with majority of shares owned by the private entity were more efficient, than those airports owned completely by the government or a 100% public corporation. Despite a mounting number of studies assessing airport performance, most of these studies has focused on the ownership and privatization, only a hand full of them have addressed the relative productivity of (private versus public airports), in terms of operational and financial efficiencies. To this regard, a study was commissioned by Vasigh and Haririan (2003) to investigate the financial and operational efficiency of (private versus public airports) by using fifteen airports of similar hub sizes. The results shown that there is a statistically significant difference between the two type of ownerships. Public enterprises were shown to have better financial efficiency in this regard. For privatized airports, cost per runway was lower than that of the public airports; conversely, passenger per runway was higher for the public airports, than that of the private airports.

A study conducted by Sutia, Sudarma & Rofiaty (2013) investigated the relationship between 'human capital, leadership and strategic orientation' with company performance, especially the influence of human capital investment on airport performance. Most airports aim to maximize the movement of aircraft, while increasing efficiency level in their operations processes to achieve a sustainable competitive edge over their equals in the sector. Airport performance assessment is carried out for different reasons, for example, to attract investments, reduce a cost of operation, improve efficiency, monitor safety and environmental impact (Doganis,1992). Airport performance can be classified into two: efficiency and productivity evaluations. The difference between evaluation is the concept of maximum attainable outputs (Oum and Yu, 2004). Efficiency assessment is the maximum output that can be produced, and the available input is considered, while productivity take into consideration the actual outputs. Productivity is defined as the ratio of the outputs to inputs. Transport management experts in the service industry have adopted different concepts and tools in measuring airport productivity, including Single Ratio Analysis (SRA), multivariate ratio indexing, total factor productivity (TFP), Data Envelopment Analysis (DEA), and Stochastic Frontier Analysis (SFA). However, none of these methods used to have been proven to be more effective than the other.

### **Research Approach**

The study adopts a positivist philosophy and will therefore, by necessity follow a deductive approach applying quantitative method. After an extensive analysis and careful consideration of different approaches, the preferred approach was found to be the most appropriate for this research. This method allows the researchers to make use of *existing*

*econometric theory* to develop hypothesis, and adopt a neutral stance from the study, to avoid any accidental interference with the data collection.

### **Research Design**

This study is planned and structured to investigate the possible relationship between aircraft movement, passenger movement (dependent) and cargo to total cost, total assets, wages, and number of employees (independent), to establish the role of these constants on MMIA terminal performance and production level.

### **Sample Size and Sampling Procedure**

The production sample size process can be considered as desirable and undesirable output which may produce (u), a by-product of the production of (y). In the airport, terminal operation processes output is the passenger movement, aircraft movements and cargo throughput, the use of its infrastructure such as wages, number of employees, total cost, and total assets. The sample size is drawn from the airport terminal operational data statistics from 2006 – 2014, sourced from FAAN. MMIA was selected for this study, as a beneficial for the remodeling exercise and the busiest terminal in the country.

### **Sources of Data**

MMIA productivity data was sourced primarily from the statistical and operational department of the Federal Airport Authority of Nigeria (FAAN), including working papers, journals, textbooks, and the internet, including published and unpublished papers, such as seminar papers, thesis, and annual reports from the government agencies.

### **Data Analysis and Discussion**

Statistical Package for the Social Science (SPSS) and Microsoft excel were used to conduct various linear regression analysis. Descriptive statistics were used for data presentation, relationship and trends were displayed with tables, line graph and bar charts. The relationships between variables were tested using the coefficient of determination ( $R^2$ ). The significance level of the variables was tested using (F – Test) and (P – Test). The calculated F value is compared with the tabulated/critical F value to determine the level of significance for the relationships between variables, while (P) = probability value is compared with the significance level between the variables.

### **The Coefficient of Determination ( $R^2$ )**

The coefficient of determination ( $R^2$ ) measures the rate of variation in the dependent variable, explained by the independent variable. The coefficient has a result between zero and one (0 and 1), with a value of (1) demonstrating a great fit. The values are changed to percentage, to find out the strength of relationship.

The decision rule here states that:

- If  $R^2 \geq 50\%$  then relationship is strong.
- If  $R^2 < 50\%$  then relationship is weak.

### Decision Rule

The decision rule adopted for this study specifies when null hypothesis will be accepted or rejected. The region of rejection determines the proportion to the area in which the hypothesis null is rejected. The null hypothesis ( $H_0$ ) is rejected if the T-calculated (T-cal) or F-calculated (F-cal) is greater than the T-tabulated (T-tab) or F-tabulated respectively at P-value equal to 0.05. While it is accepted, if the T-calculated or F-calculated is less than T- tabulated or F- tabulated respectively at P- value equal to 0.05.

### F Test

The decision rule here states that:

- If  $F_{\text{calculated}} > F_{\text{tabulated}}$  then relationship is significant -  $H_0$  is rejected
- If  $F_{\text{calculated}} < F_{\text{tabulated}}$  then relationship is not significant –  $H_0$  is accepted

### P Test

The decision rule here states that:

- If P value < significance level (0.05) then relationship is significant (i.e. reject  $H_0$ )
- If P value > significance level (0.05) then relationship is not significant (i.e. accept  $H_0$ )

### Data Analysis and Discussion

Each analysis will be carried out using two set of variables, where one is the dependent variable (Y) and the independent variable/predictor (X). A multiple regression equation models usually generated from the formula:

$$\hat{Y} = \alpha + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \dots + \beta_nx_n$$

Where,  $y$  = dependent variable  
 $x_n$  = independent variable  
 $\alpha$  = constant and  
 $\beta_n$  = coefficient of x.

Many statistical summaries were produced. These are  $R^2$ , standard error of estimate,  $t$  statistics for the  $\beta$ 's, an F statistic for the whole regression, leverage values, path coefficients.

### **Dependent and Independent Variables**

A total number of seven variables were selected and used for this study- dependent variables are; Aircraft, Passenger, and Cargo movements. The independent variables are; Wages, Total assets, Total cost, Number of employees. The variables are briefly described as follows:

- **Number of Employees:** the total number of staffs working at the airport at a given time (strategic, tactical, and the operational level).
- **Total Cost:** the combine cost of running airport operation, this include the total cost per passengers, total cost per aircraft movement, total cost per work load unit (WLU), operating cost per passenger, operating cost per aircraft movement and operating cost per work load unit (WLU). The cost is one of the major inputs that enhance good output in the airport.\
- **Total Assets:** the total worth of the infrastructures and other operational facilities of the airport.
- **Passenger Throughput:** is the number of passengers arriving or departing over a period of one year, excluding those passengers who are just transiting from the airport. A passenger who made a round-trip is counted as two Origination and Destination (O&D) passenger.
- **Aircraft Movement:** the total number of aircraft arriving or departing at the airport, including international and domestic traffic from both commercial and private airlines. The number of aircraft taking-off or landing, counted over period of one year. One arrival and one departure are recorded as two movements.
- **Freight or mail:** loaded or unloaded at the airport, counted in metric tons over the course of a year.
- **Wages:** salaries paid to the airport employees and contractors, on daily, weekly, or monthly intervals.

### **Data Presentation**

There are seven variables used as the model of this research work. These variables were used for the process of analyzing the raw data. The dependent variables are; Aircraft, Passenger, Cargo Independent variables are; Wages, Total assets, Total cost, Number of employees.



Table 1

Murtala Muhammed Airport Statistical Data

Year	Airports	Passengers (Pax)	Aircraft (No.)	Cargo (kgs)	Employees (No)	Wages (₦)	Total assets (₦)	Total cost (₦)
2006	MMA	2,141,667	53,151	605,043.00	1,000	87,150,849.00	23,034,629,987.00	1,070,833,500.00
	DOM							
2007	MMA	2,220,568	83,450	6,121,059.00	1,008	90,741,059.00	22,516,761,480.00	2,110,284,000.00
	DOM							
2008	MMA	2,220,568	83,450	8,031,784.00	1,106	67,741,034.00	24,251,676,148.00	2,240,284,139.00
	DOM							
2009	MMA	3,320,103	59,876	42,253,258.00	1,100	68,721,012.00	25,431,890,257.00	2,420,855,768.00
	DOM							
2010	MMA	3,864,858	71,922	33,916,885.00	1,103	70,286,601.60	24,946,782,220.00	2,430,944,532.00
	DOM							
2011	MMA	4,058,100	75,518	35,612,729.00	1,158	73,800,931.68	26,194,121,331.00	2,552,491,758.60
	DOM							
2012	MMA	4,220,424	78,538	37,037,238.00	1,204	76,752,968.95	27,241,886,184.24	2,654,591,428.94
	DOM							
2013	MMA	4,389,241	81,680	3,8518,727.00	1,252	79,823,087.71	28,331,561,631.61	2,760,775,086.10
	DOM							
2014	MMA	4,011,731	86,534	304,648.00	1,320	80,041,597.00	29,564,843,317.00	2,855,824,570.00
	DOM							

Source: FAAN (2016)

Table 2

Descriptive Statistics

Descriptive Statistics	Mean	Std. Deviation	N
Passenger (Pax)	2,895,823	1,383,421	9
No. Employee (No.)	1,139	106	9
Wages (N)	77,228,793.44	8,048,612.696	9
Total Asset (N)	2,342,033,178.43	8,200,453,692.020	9
Total Cost (N)	2,344,098,309.18	533,315,205.920	9

The descriptive statistics is shown on the table 2, are large and the implication is that the original data is sourced from the FAAN direct and it shows that the data is real, not estimated data. The original data used to compute the standard deviation is shown on the table 1.

Table 3  
Regression Analysis on Aircraft Movement

Anal ysis No.	Variables		Type of Model	Observations					Inferences		
	$x_1, x_2, x_3$ $x_4$	Y		Regression Equation	R/R <sup>2</sup> (%)	F <sub>cal</sub>	F <sub>tab</sub>	P <sub>value</sub>	Strength of Relationshi p	Rem ark	Action On Hypothe sis
1a	Airport terminal	Aircraft Movem ent	Multip le	Y = 9545.173+1.450E- 005+440.596- 1.975E-005	99.8/ 99.7	305. 722	6.39	0.00	Very Strong	SS	Reject H <sub>0</sub>

**Keys:** SS = Statistically Significant                      NSS = Not Statistically Significant  
Y = Dependent Variable (Aircraft Movement), ( $x_1, x_2, x_3, x_4$ ) = Independent Variable  
(Total cost, wages, total assets, and number of employee).

### Hypothesis 1 Analysis

The regression analysis was carried out to test the formulated hypothesis at 5% level of significance. (Analysis 1A) was carried-out to test the relationship between dependent variable (aircraft movement) and independent variable (total cost, total assets, wages, and number of employee). The coefficients of correlation (R) and determination (R<sup>2</sup>) observed respectively were 99.8% and 99.7%, as shown in the table 3 above. This implies that the relationship between dependent variable (aircraft movement) and independent variable (total cost, total assets, wages, and number of employee) was positive, multiple, and very strong. Therefore, increase in population density is accounted for because of the increase as the road density and vice-versa.

**H1:** There is no statistical significant relationship between aircraft movement and total cost, total assets, wages, and number of employees. Table 3 shows that the values of F-calculated was 305.722, which is greater than 6.39 as the value of F-tabulated. P- Value calculated is equal to 0.00. Since the p value is less than 0.05, so therefore alternative hypothesis is accepted since it is less than p-value 0-05, which means that there is a statistical significant relationship between aircraft movement and total cost, total assets, wages, and number of employees of the airport operational services. Also, there is a positively significant relationship between aircraft movement and the independent variables of the airports since *p-value* < 0.05. This implies that the higher aircraft movement operations in terms of take-off and landing, the higher aircraft traffic services, thereby increases airport operational performance. Wanke et al., (2016) states that operational performance of airports is the measurement of how productivity and efficiency of the airport are rated based on the input and output variable estimation.

Table 4

Regression Analysis on Passenger Movement

Anal ysis No.	Variables			Observations					Inferences		Action On Hypothe sis
	$x_1, x_2, x_3, x_4$	Y	Type of Model	Regression Equation	R/R <sup>2</sup> (%)	F <sub>cal</sub>	F <sub>tab</sub>	P <sub>value</sub>	Strength of Relationship	Remark	
2a	Airport terminal	Passenger Movement	Multiple	$Y = -1978404550 - 0.001 - 10934.132 + 0.001 - 0.014$	93.3/87.1	6.737	6.39	0.04	Very Strong	SS	Reject H <sub>0</sub>

**Keys:** SS = Statistically Significant      NSS = Not Statistically Significant  
 Y = Dependent Variable (Passenger Movement),  $(x_1, x_2, x_3, x_4)$  = Independent Variable (Total cost, wages, total assets, and number of employee).

**Hypothesis 2 Analysis**

The regression analysis was carried out to test the formulated hypothesis at 5% level of significance. (Analysis **2A**) was carried-out to test the relationship between dependent variable (passenger movement) and independent variable (total cost, total assets, wages, and number of employee). The coefficients of correlation (R) and determination (R<sup>2</sup>) observed respectively were 93.3% and 87.1%. This implies that the relationship between dependent variable (passenger movement) and independent variable (total cost, total assets, wages, and number of employee) was positive, multiple, and very strong.

**H2:** There is no statistical significant relationship between dependent variable (passenger movement) and the independent variables (total cost, total assets, wages, and number of employees). Table 4 shows the values of F-calculated observed respectively was 6.737, which were greater than the value of F-tabulated of 6.39, while the P-value was 0.04, this is also less than 0.05 of the p-value tabulated. This implies that there exists a statistically significant relationship between dependent variable (passenger movement) and independent variable (total cost, total assets, wages, and number of employees). Sarkis (2000) argues that various airport characteristics are evaluated to determine their relationship to an airport’s efficiency during the airport operational performance evaluation. In his study, efficiency measures are based on four resource input measures including airport operational costs, number of airport employees, gates and runways, and five output measures including operational revenue, passenger flow, commercial and general aviation movement, and total cargo transportation. The results of this study shows the significant relationship between the outputs (dependent variables) and inputs (independent variables) during their performance evaluation. Lin et al., (2013) studied on efficiency benchmarking of North American airports a comparative results of productivity index, data envelopment analysis and stochastic frontier analysis. From their study, the result shows that percentage of non-aeronautical revenue, passenger volume, average aircraft size, percentages of international and connecting traffic significantly affect airport efficiency estimates in all of the three alternative approaches used.

Table 5

Regression Analysis on Cargo Movement

Anal ysis No.	Variables		Type of Model	Observations					Inferences		
	$x_1, x_2, x_3,$ $x_4$	Y		Regression Equation	R/R <sup>2</sup> (%)	F <sub>cal</sub>	F <sub>ta b</sub>	P <sub>value</sub>	Strength of Relationship	Remark	Action On Hypothesis
3a	Airport terminal	Cargo Movement	Multiple	Y = - 40916380.369+0.0 22- 494143.218+0.024 -0.343	99.5/99. 0	98.631	6.3 9	0.00	Very Strong	SS	Reject H <sub>0</sub> ,

**Keys:** SS = Statistically Significant                      NSS = Not Statistically Significant  
 Y = Dependent Variable (Cargo Movement), ( $x_1, x_2, x_3, x_4$ ) = Independent Variable  
 (Total cost, wages, total assets, and number of employee).

**Hypothesis 3 Analysis**

The regression analysis was carried out to test the formulated hypothesis at 5% level of significance. Analysis 3A was carried-out to test the relationship between dependent variable (cargo movement) and independent variable (total cost, total assets, wages, and number of employee). The coefficients of correlation (R) and determination (R<sup>2</sup>) observed respectively were 99.5% and 99.0%. This implies that the relationship between dependent variable (cargo movement) and independent variable (total cost, total assets, wages, and number of employee) was positive, multiple, and very strong.

**H3:** There is no statistical significant relationship between dependent variable (cargo movement) and the independent variables (total cost, total assets, wages, and number of employees). Table 5 shows the values of F-calculated observed respectively was 98.631, which were greater than the value of F-tabulated of 6.39 while the P-values was 0.00 also less than 0.05. This implies that there exists a statistically significant relationship between dependent variable (cargo movement) and independent variable (total cost, total assets, wages, and number of employees). The dependent variable is the output while the independent variables are input. Bezić et al., (2010) study on airport efficiency using Data Envelopment Analysis (DEA), it provides estimates of the potential improvement that can be made by inefficient airports. The analysis has then been extended by utilising window analysis, which is useful for detecting efficiency trends of DMUs over time. It shows significant disparities in efficiencies among the airports over the period examined based on the outputs (dependent variable) and inputs (independent variable) used for the efficiency performance measures.

### Line Graph Discussion

The analysis is based on existing statistical relationship between X & Y

Aircraft Movement = Y

Number of Employees = X

H1 = X & Y

The regression equation is;  $Y = 59.594x + 6997.4$ .  $R^2 = 30.94\%$

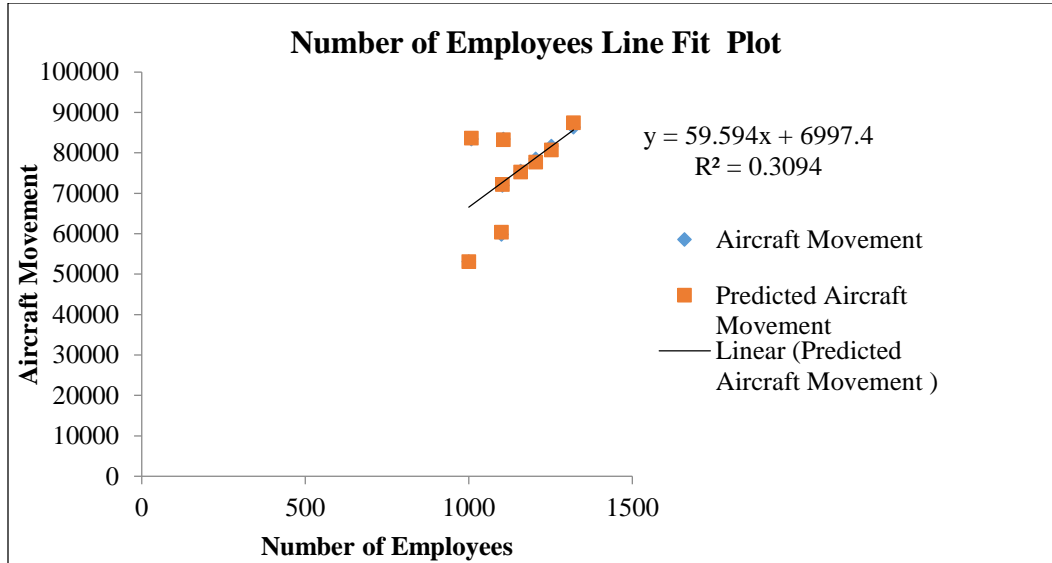


Figure 1. Number of Employees - Aircraft Movement

### Discussion (F1)

There is a weak relationship between the two variables (i.e. Aircraft and number of employee based on the  $R^2$  value of 30.94%). This means that number of employee figure is not a prime consideration when considering the aircraft movement in MMIA.

Aircraft Movement (Y) Regressed Against Wages (X)

The regression equation is  $Y = 3E-05x + 72941$ ,  $R^2 = 0.03\%$

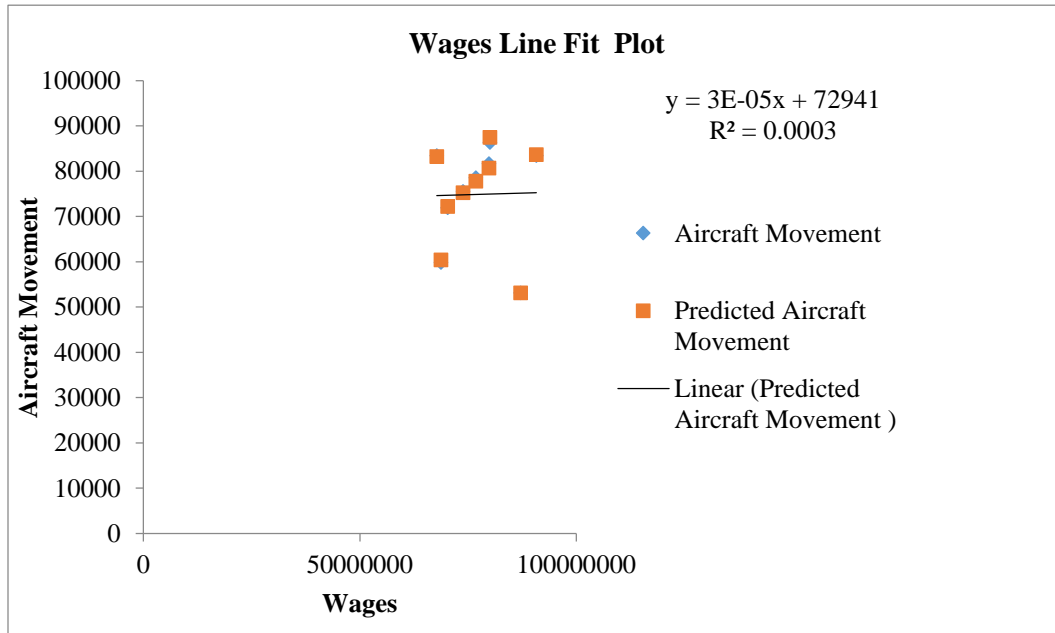


Figure 2. Wages - Aircraft Movement

### Discussion (F2)

There is a very weak relationship between the two variables (i.e. Aircraft movement and wages based on the  $R^2$  value of 0.03%). This means that wages figure is not a prime consideration when predicting aircraft movement.

Aircraft Movement (Y) Regressed Against Total Assets (X)

The regression equation is  
 $Y = 2E-06x + 21299$   
 $R^2 = 18.53\%$

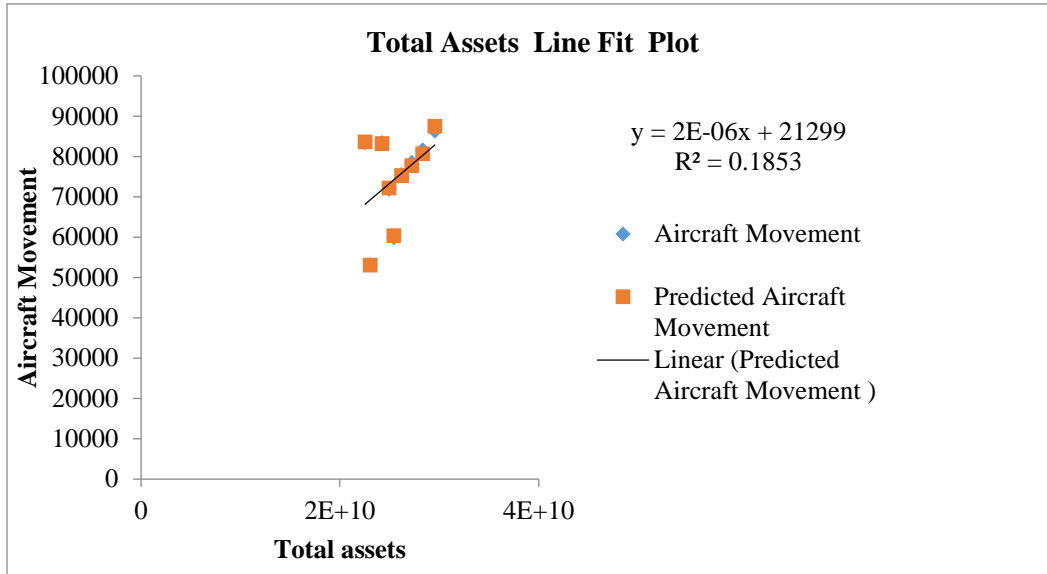


Figure 3. Total Assets - Aircraft Movement

### Discussion (F3)

There is a very weak relationship between the two variables (i.e. aircraft movement and total assets based on the  $R^2$  value of 18.5%). This means that total asset's figure is not a prime consideration in predicting aircraft movement.

Aircraft Movement (Y) Regressed Against Total Cost (X)

The regression equation is

$$Y = 1E-05x + 40545$$

$$R^2 = 46.91\%$$

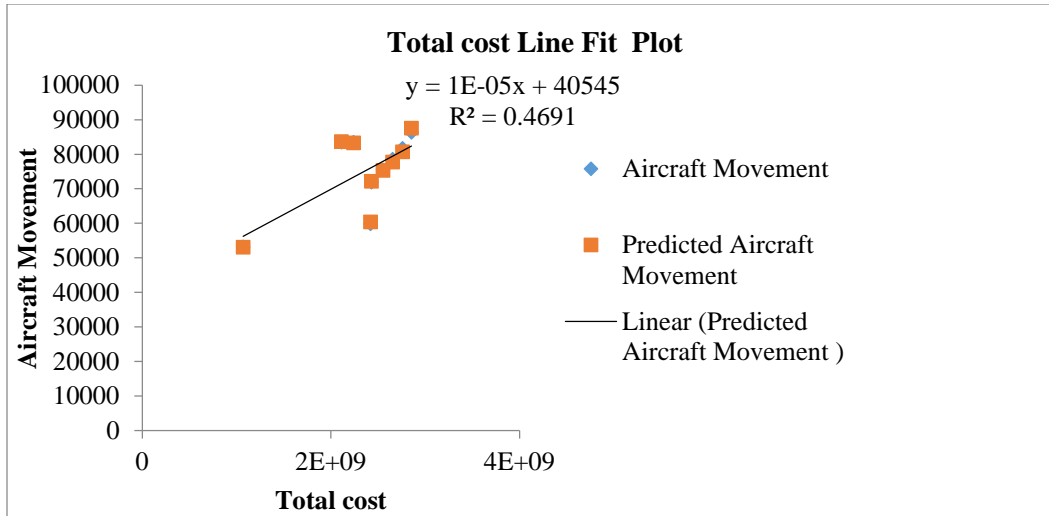


Figure 4. Total Cost - Aircraft Movement

#### Discussion (F4)

There is a weak statistical relationship between the two variables (i.e. Aircraft movement and total cost based on the  $R^2$  value of 46.9%). This means that total cost figure is not much of a prime consideration when considering aircraft movement.

The analysis is based on the existing statistical relationship = Y & X

Passenger Movement = Y

Number of Employees = x

The regression equation is

$$Y = 6919.5x + -4E+06$$

$$R^2 = 81.6\%$$



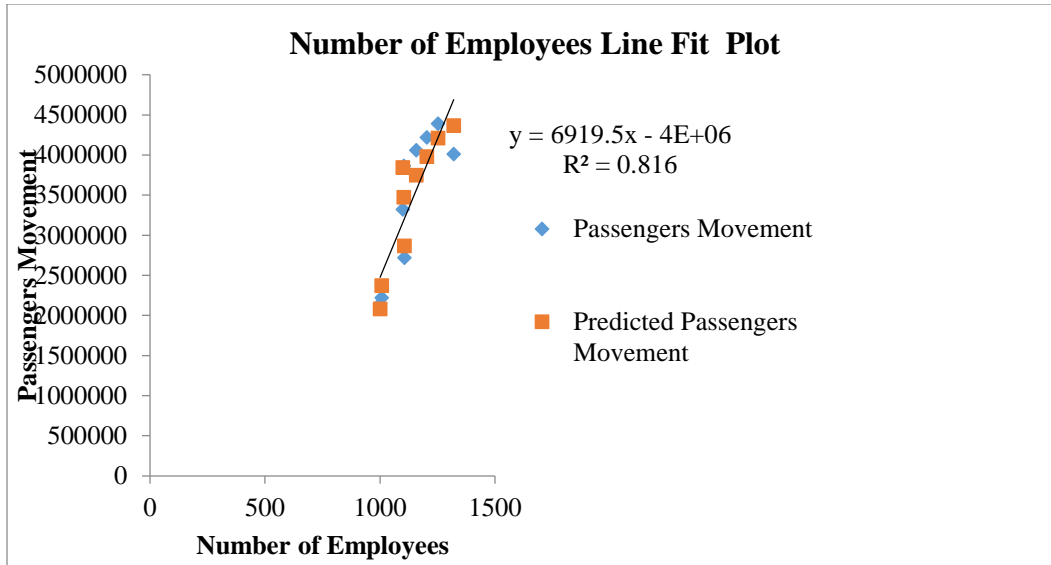


Figure 5. Number of Employees - Passenger Movement

### Discussion (F5)

There is a very strong significant statistical relationship between the two variables i.e. Passenger movement and number of employees based on the  $R^2$  value of 81.6%. This means that number of employee figures is a prime consideration when considering passenger movement.

Passenger Movement (Y) Regressed Against Total Assets (x)

The regression equation is  
 $Y = 0.0003x - 5E+06$   
 $R^2 = 86.7\%$

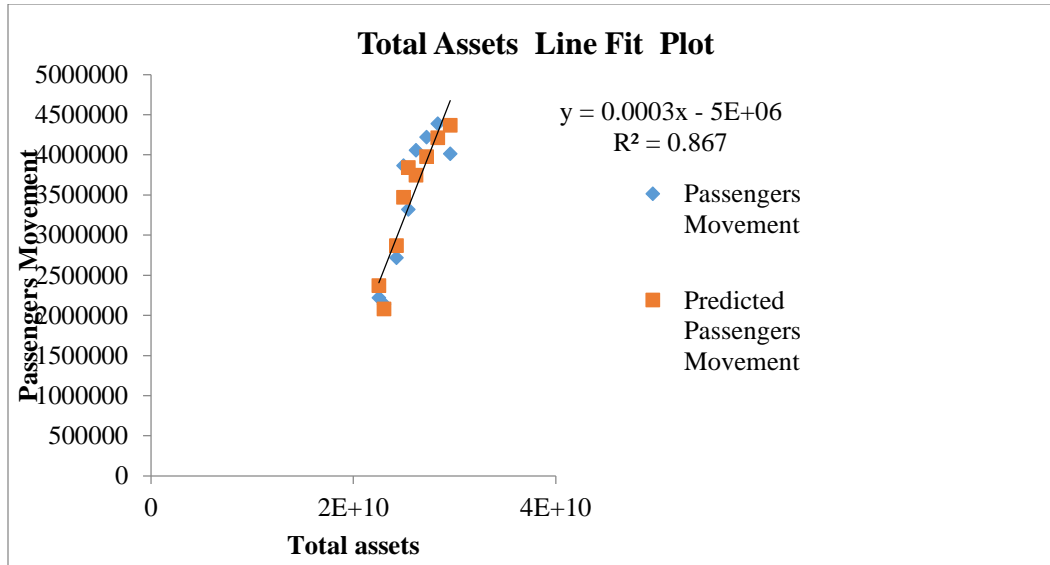


Figure 6. Total Assets - Passenger Movement

**Discussion (F6)**

There is a very strong significant statistical relationship between the two variables i.e. Passenger movement and total assets based on the  $R^2$  value of 86.7%. This means that total assets figure is a prime consideration when considering passenger movement.

Passenger Movement (Y) Regressed Against Wages (x)

The regression equation is  
 $Y = -0.0441x + 7E+06, R^2 = 18.95\%$

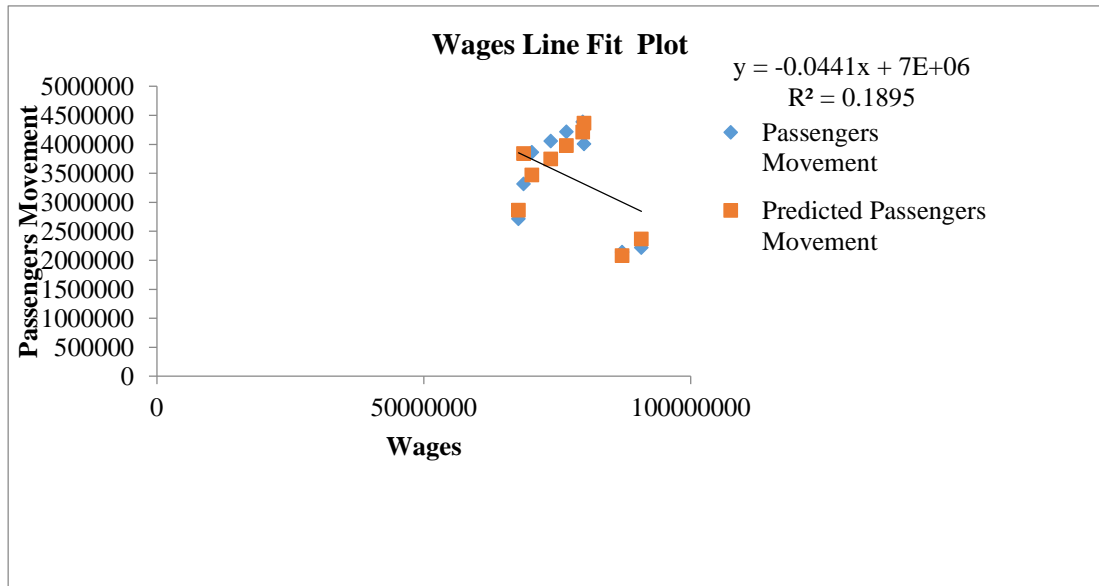


Figure 7. Wages - Passenger Movement

### Discussion (F7)

There is negative and very weak statistical relationship between the two variables (i.e. passenger movement and wages based on the  $R^2$  value of 18.9%). This means that wages figure is not a prime consideration when predicting passenger movement.

Passenger Movement (Y) Regressed Against Total Cost (x)

The regression equation is

$$Y = 0.0014x + 244508$$

$$R^2 = 79.41\%$$

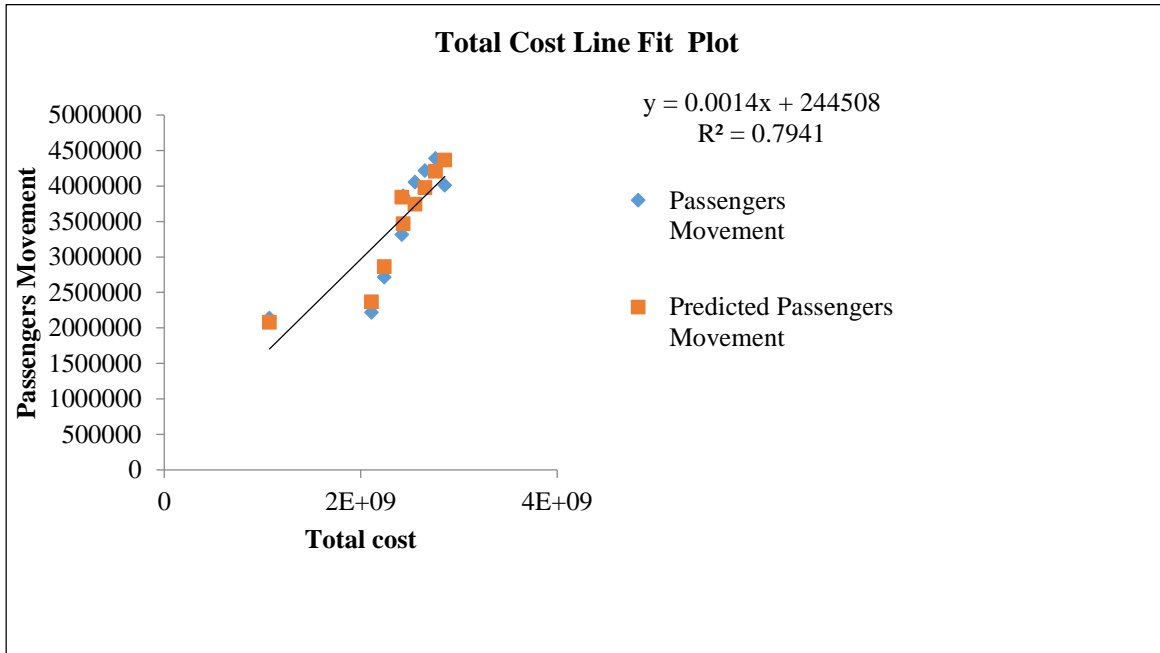


Figure 8. Total Cost - Passenger Movement

**Discussion (F8)**

There is a strong significant statistical relationship between the two variables (i.e. Total cost and passenger movement based on the  $R^2$  value of 79.4. %). This means that total cost figures are prime consideration when considering passenger movement. Analysis is based on the existing statistical relationship;

Cargo (Y) and Number of Employees (x)

The regression equation is

$Y = 116559x - 1E+08$

$R^2 = 55.7\%$

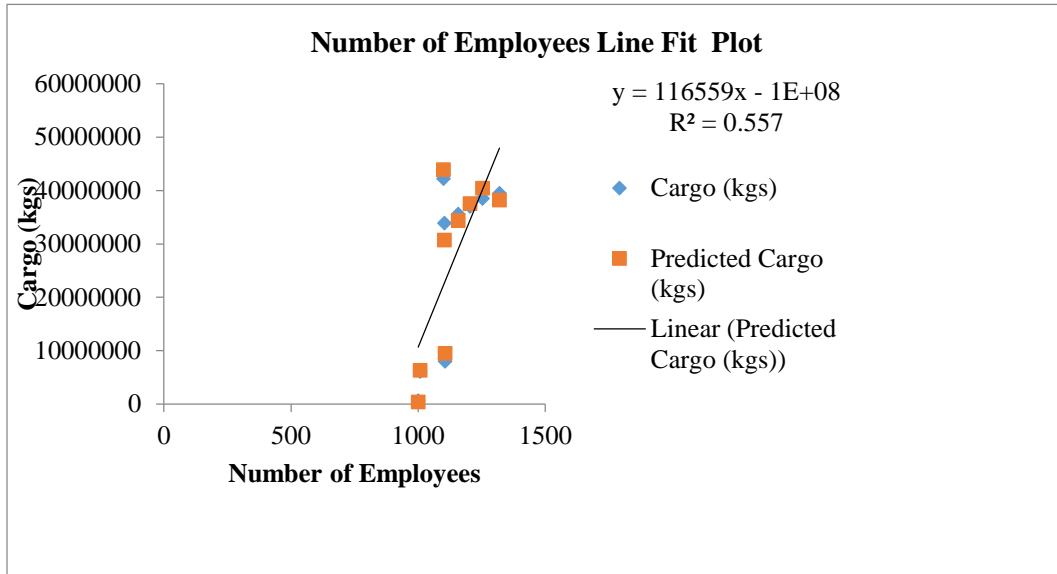


Figure 9. Number of Employees - Cargo

### Discussion (F9)

There is a strong significant statistical relationship between the two variables (i.e. Cargo and number of employees based on the  $R^2$  value of 55.7%). This means that number of employee figures is a prime consideration when considering cargo.

### Cargo (Y) Regressed Against Total Assets (X)

The regression equation is

$$Y = 0.0057x - 1E+08$$

$$R^2 = 65.24\%$$

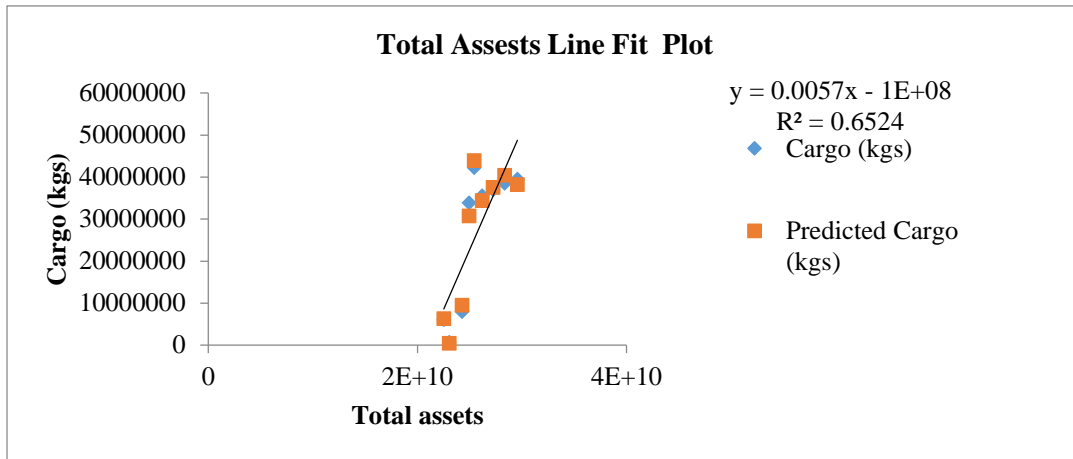


Figure 10. Total Assets - Cargo

**Discussion (F10)**

There is a strong significant statistical relationship between the two variables (i.e. Cargo and total assets based on the  $R^2$  value of 65.24%). This means that total assets figure is a prime consideration when considering cargo.

Cargo (Y) Regressed Against Total Cost (X)

The regression equation is

$$Y = 0.0256x - 3E+07$$

$$R^2 = 67.47\%$$

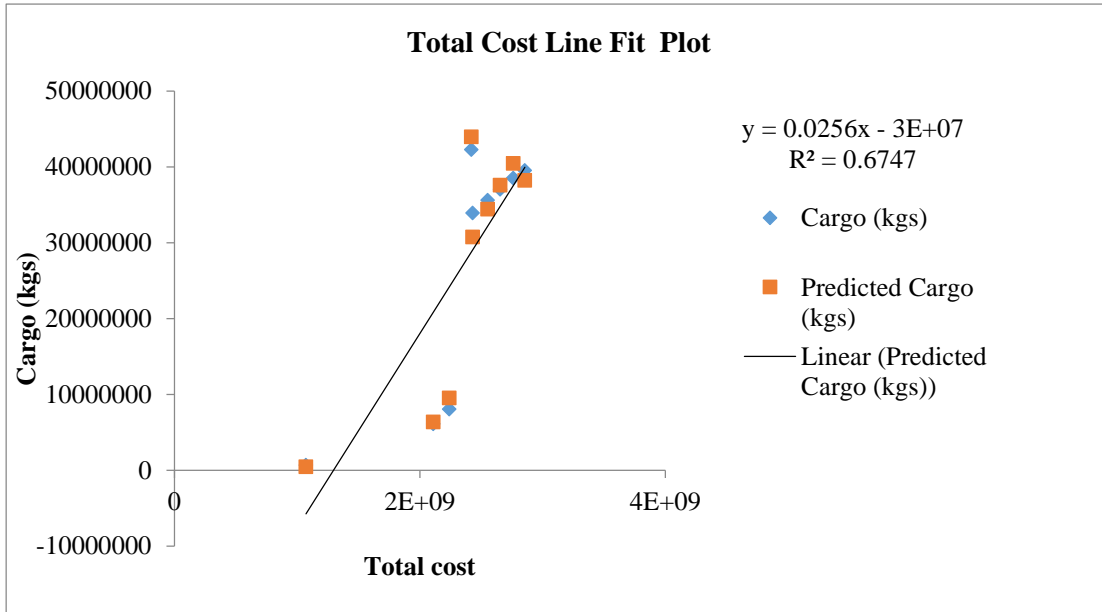


Figure 11. Total Cost - Cargo

**Discussion (F11)**

There is a strong significant statistical relationship between the two variables (i.e. Cargo and total cost based on the  $R^2$  value of 67.47%). This means that total cost figure is a prime consideration when considering cargo.

**Cargo(Y) Regressed Against Wages (X)**

The regression equation is  
 $Y = -0.985x + 1E+08$   
 $R^2 = 22.74\%$

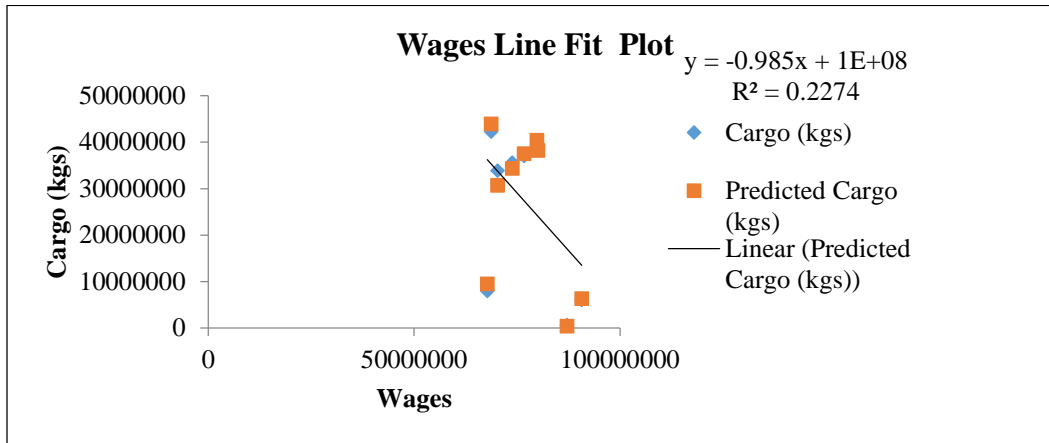


Figure 12. Total Wages - Cargo

### Discussion (F12)

There is a weak relationship between the two variables i.e. Cargo and wage's based on the  $R^2$  value of 22.74%. This means that total cost figure is not much a prime consideration when considering cargo.

### Conclusion

A quantitative analysis was used to assess airport terminal performance, post remodeling exercise. In the empirical investigation, a multi regression analysis was used, and the paper presented several variables. The results reveal that  $R$  and  $R^2$  for (H1) were observed respectively at (99.8% and 99.7%). This confirms that there is a relationship between dependent variable and independent variables, they were positive, multiple, and very strong. The  $R$  and  $R^2$  for (H2) were observed respectively at 93.3% and 87.1%. This shows that dependent variable and independent variable relationship were positive, numerous and very robust. While,  $R$  and  $R^2$  for (H3) were observed at 99.5% and 99.0% respectively. This indicates that there is a relationship between dependent variable and independent variable, was constructive, multiple, and solid. Interestingly, the variables accounted for the  $R$  square was 99.8% for the aircraft movement, while, passenger movement was 93.3% and the cargo was 99.5%. The figures are the relative total productivity of the MMIA terminal, after the substantial investment on infrastructure upgrade. In summary, the terminal infrastructure improvement, assisted MMIA in coping with the increase number of passenger's traffic and aircraft movement, better than the pre-project era, in terms of improving operational performance and increasing capacity.



### **Recommendations**

- Sustaining government spending on the nation's airports will continue to benefit the aviation sector and contribute to the nation's economy positively, through job creation and increase in tax revenues.
- Encourage private-sector investment to increase development and competition within the industry that guarantees long-term sustainability.
- While stressing on the importance to provide adequate funding for air transport - related projects, innovative methods of funding should be considered, for instance, the use of external sovereign bond, World Bank Funded Private-Public Partnership, and African Development Bank Infrastructure Fund.

In addition, to government increasing effort towards fostering critical national infrastructures such as airports. To improve and sustain terminal performance can be an expensive practice and time consuming that may need at least a decade to be fully accomplished, especially in the developing countries. For instance, inadequate industry-specific policies and standards. This policy option is modest in terms of costs and if well-planned and structured, it would tremendously enhance airport performance and productivity. The above recommendations can only be achieved, if there is sufficient data for the aviation policy makers to formulate industry-specific policies that will attract long-term investors. Thus, there is a need for airports to strengthen their capacities on the collection and storage of reliable data on terminal performance and productivity, to contribute or update available information on the sector.

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