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Impact of Passenger Movement and Aircraft Traffic Volume on Airport Maintenance Costs in Southwestern Nigeria

IKPO, I. J.[1]; OJO, G. K.[2*] and OLADIMEJI, O.[3]
[1]Department of Building, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.
[2]Department of Quantity Surveying, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.
[3]Obafemi Awolowo University Teachning Hospital, Ile-Ife, Osun State, Nigeria.

ABSTRACT: This paper examined and analysed airport passenger movement, aircraft traffic volume and maintenance cost allocation of airports in Southwestern Nigeria. This is to determine if the cost allocated to airport maintenance reflect the rate of deterioration initiated by airport passenger movement and aircraft traffic volume. Data from the Federal Airports Authority of Nigeria (FAAN) on the aircraft traffic volume, airport passenger movement, and maintenance operational costs available for a period of ten years were collated and analysed. Pearson bivariate correlation and binary regression analysis were used to test the strength of relationship between each of aircraft traffic volume, airport passenger movement and airport maintenance cost. The analysis showed weak contributions of aircraft traffic volume and airport passenger movement, and therefore could not significantly determine the maintenance cost for Southwestern Nigeria airports. Thus, the fund allocated to maintenance in airports did not necessarily put into consideration the rate of use of the airport facilities as important variables. The paper therefore recommended that appropriate measures should be put in place to accommodate required factors for adequate consideration while allocating maintenance cost of airports in Nigeria.

Keywords: Aircraft Traffic Volume, Airport, Maintenance Costs, Nigeria, Passenger Movement

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INTRODUCTION

Air transport is one of the important means of transportation which contribute significantly to the economic growth and development of any country in which Nigeria is not an exception. Evidence from the researchers (Aderamo, 2006, Yusuf, 2007; Button, 2008, 2009a,b,c; Button and Vega, 2008; Popescu, Keskinocak, and Al Mutawaly, 2010; Stephens and Ukpere, 2011; Alao, 2011 cited by Ladan 2012; Ladan, 2012; Aun, 2013; IATA, 2013; Nwaogbe, Wokili, Omoke and Asiegbu, 2013) identified various contributions of airport infrastructure and industry the economic growth of nations.

Nwaogbe *et al.* (2013) established that the air transport sector supports Gross Domestic Product and the employment of Nigerians as Airlines contribute over NGN58 billion to the economy and support 61,000 jobs in Nigeria. Despite this, Omoleke (2011) discovered that aviation industries are grossly underfunded; hence there is the need for improved funding from the government so as to enhance their performance.

Airports are specialized commercial estates that not only serve as major transportation network nodes, but as gateways into countries or states and therefore require adequate maintenance to promote the aesthetic impression attributable to the personality of such estates. According to Aderamo (2010), each airport is connected to the system through the airways and other airports with which it exchanges flights. This

*Correspondence to: Ojo, G.K., graceojo@oauife.edu.ng

implies that the airport is where all the activities of air transport are taking place; therefore, it should be given befitting and attractive outlook at all times through appropriate maintenance culture. This is supported by Omoleke (2011) who emphasized that airport required high maintenance cost and thus should be adequately funded.

The airport is one of the most vital elements in our air transportation system (Airport Maintenance Career Overview, 2011). In many third world countries, the development and sustenance of airports is exclusively a public sector's commercial venture. Commercial estates are said to cover the whole range of properties other than industrial buildings that are used for enterprises engaged in the buying and selling of products or services of which airport buildings are examples (Hillebrandt, 1985). However, studies on maintenance management of various kinds of commercial buildings, which provide viable and vital services, have not been as prominent as other property types such as residential buildings.

Airports generate revenue and require very large infusion of capital financing (Ashford, Stanton and Clifton, 1997). Stephens and Ukpere (2011) ascertained that airports in Nigeria were grossly underutilized, there is need to know that level of utilization of these airports can be boosted if maintenance management is improved by enhanced budgetary allocation. Besides, worthwhile returns on the huge amounts spent by governments on such capital construction projects can be effectively realized if well planned maintenance programmes are put in place. Amba and Danladi (2013) identified high cost of maintenance and insufficient budgetary provision as part of challenges facing that aviation sector; consequently, they recommended improved funding by the required agency to meet up with any maintenance program put in place.

Despite increase in passenger volume, the infrastructure provided has not experienced a corresponding maintenance over the years (Ajanaku, 2008 cited by Ladan 2012).The decaying facilities, according to Ladan (2012), especially at international airports gives the country a bad image as airports are the first port of call for foreigners coming into the country. Hence, Oun (20130 suggested that airport maintenance should be given priority.

Mann, Saxena and Knapp, (1995) emphasized that forward planned maintenance programmes when introduced would minimize the menace of emergency maintenance with respect to total cost of inspection, repair, and most of all facility downtime. Airport maintenance operation goes beyond routine site work. It embraces facets of modern management such as planning, controlling, forecasting, coordinating, supervising, directing, commanding, and organizing of resources with a view to preserving or enhancing the life span of airports building, pavements and other relevant facilities.

Preventive maintenance operations are ideal for airport items such as lighting points that require minimal downtimes. This requires replacement as soon as symptoms of failure is exhibited or may be based on the predicted lifespan of the each item (Pitt, 1997 and Mirghani, 2001). On the other hand, where failure occurs, restorative, corrective or redemptive maintenance option has to be adopted (David and Arthur, 1989; El-Haram and Horner, 2002).

According to Battle (2003), maintenance costs are a high priority because of its significance when compared with the total operating costs. As an investment, the responsibility of maintenance of airport is expected to be borne out of the income generated. This income has to be dependent of the passenger volume rather than a direct injection of public funds from external sources (Horak, Range, Vos and Barnes, 2009). IATA (2013) reported that in 2012, strong economic growth in emerging markets resulted in an expansion of passenger traffic. This is expected to lead to increase in income which could form part of the fund required for high maintenance demand as a result of increase in the use of airport facilities. Hence, this necessitates consideration of passenger volume as significant factor in budgetary allocation for airport maintenance.

Series of studies (Aderamo, 2006; Smyth and Pearce, 2006; Yusuf, 2007; Bieger, Wittmer, Riklin, and Engeler, 2008; Button, 2008, 2009a,b,c; Button and Vega, 2008; Graham, 2008; Wittmer and Laesser, 2008; Bubalo, 2009; Cook, Tanner, Williams, and Meise, 2009; Nnodim, 2010; Popescu, Keskinocak, and Al Mutawaly, 2010; Stephens and Ukpere, 2011; Alao, 2011 cited by Ladan 2012; Ladan, 2012; Odidi, 2012; Wyman, 2012; Aun, 2013; IATA, 2013; Nwaogbe, Wokili, Omoke and Asiegbu, 2013) existed on air transport, airport development, air traffic flow, airline and airport infrastructure management. However, research on airport maintenance is very scarce which initiated the necessity of this research.

Base on this background, this paper established the relationship between airport maintenance cost, aircraft traffic movement and airport passenger movement. This is with a view to evaluating the contributions of aircraft traffic volume and airport passenger movement to cost of maintaining airport in Nigeria; and establishing the need to incorporate necessary factors into budgeting maintenance cost of airports. The analysis was based on the data obtained from the Federal Aviation Authority of Nigeria (FAAN).

Airport Revenue and Expenditure

Since the feasibility of developing and building, an airport rests heavily on the anticipated revenue and expenditure, the financial aspects of airport planning must take into consideration both revenues and expenses. Revenues are generated by the airport authority from two categorical means, namely, the operating revenue and non-operating revenue (Ashford, 1992). Operating revenue of airport can be subdivided according to how they are generated, these are the landing area which cater for the aircraft traffic movement, terminal area concessions which specifically takes care of the airport passengers before they are airlifted, airline leased areas, other leased areas, equipment rentals, resale of utilities and baggage handling. Non-operating revenue accrues from resources that are not directly connected to airport functions.

Ashford (1992) categorized airport total expenditure into operating expenses and non operating expenses. Operating expenses are associated with provision of airport services which is further categorized into maintenance cost and airport operational cost. Maintenance costs are required for the upkeep of facilities while operational costs are required for administration, staffing, utilities and to some extent security. Non-operating expenses are inescapable costs that they would have to meet even if the airport ceased operation. Typically, they include the interest payment on outstanding capital debt and amortization charges on fixed assets such as runways, aprons, buildings and other infrastructure.

Airport Maintenance Cost Budget

Cash management is critical to the airport; without proper attention, it can quickly make a healthy airport unhealthy (Bradon, 2009). Thus, an airport budget is an estimate of or a view into an uncertain future showing the peaks and valleys of cash flow. It can serve as a benchmark for evaluating actual or historical performance and can show when an airport might want to consider obtaining cash from sources other than the normal operations. An airport budget can alert the airport as to when a plan is failing and changes are required. It can also show who is responsible for generating cash, what consumes cash and can show when cash may be available to make the purchases of assets.

Some regional airport generally have maintenance budget allocations based on formulas which use annual aircraft movement or annual passenger movement as input that inevitably leaves an operational budget with a maintenance provision significantly lower than the actual requirement for the airside infrastructure for preservation, let alone improvement (Horak *et al*, 2009). Specifically, the aim of airport maintenance budget is to reduce managed expenditure over time as far as possible and replace it with variable expenditure. Maintenance budgets need to include cost for inspections, replacement of material or finishes, clearing and any unforeseen breakdowns or repairs. Budgeting for these items will become

accurate over time if detailed records of maintenance expenditure are kept. Budget need a simple control system, with regular and frequent reports on actual and committed expenditure.

New South Wales (NSW) technical advisory group (2004) explained that annual maintenance budgeted expenditure can be of three kinds, namely: committed, variable and managed expenditure. Invariably, the cost of all desirable work in any one year will exceed the budget. The airport maintenance manager then has to decide what is necessary in each year to maintain the asset within the funds available and what could be carried forward to the following years. This implies setting priorities for different works and exploring better and up to date maintenance practice (Facility Issues and Facility Management Link, 2009).

Maintenance cost in many airport operations is well in excess of a million naira every month (Oladimeji, 2010). The complex nature of this function, however, typically has prevented practices from taking form that would meet basic standards for cost budgeting and control. By bringing accounting, internal audit, and database mining skills to the problem, the ability to budget and control maintenance cost can finally match the complexity of the maintenance function (Richard, 2005). Thus there are proven three ways by which maintenance budget can be derived; these are conventional, formula and condition-based approach.

Conventional approach expresses the maintenance budget as a percentage of the annual budget. It is very often based on the previous year expenditure with minor adjustment. Its most serious drawback is that the budget available has no direct relation with the prevailing conditions of the airport and whose maintenance generating factors vary annually (Richard, 2005). This fact was emphasised by the Plant Maintenance Resource Centre (PMRC) (2002) who carried out a survey on maintenance costing and budgeting practices. The findings showed that budgets are prepared based on the previous year's budget, and that budgets were adjusted to meet management cost targets. In general, maintenance budgets appear to be prepared with a moderate level of detail.

In the formula approach, the annual maintenance budget is derived from some agreed formula which quantifies needs in terms of cost per unit area, as a percentage of current replacement cost, or use some other factors to project into the future needs (Richard, 2005). Like the conventional approach, this technique does not match budget with identified needs. The method also assumes a generic renewal pattern and does not allow for the varying life cycle of different building element/components.

The condition based approach incorporates a thorough survey of the conditions of airport to identify needs of maintenance works. One of such condition is to determine the frequency and the magnitude of use of airport facilities through the major services it provides. Though it is accurate, more time consuming and a costly exercise that is difficult to be adopted on an annual basis. Thus, this method aids a comprehensive maintenance programme, which according to Don and Plexus (2009), should reduce capital repairs and unscheduled shutdowns and repairs.

There were various studies on maintenance with most of them focusing on building construction such as residential, commercial, educational and public projects. These include Alner and Fellows (1990), Al – Zubaidi (1997), Duffua *et al.* (2000), Mirghani (2001), Amerilla *et al.* (2002), Chen *et al.* (2002), El- Haram and Horner (2002), Shohet *et al*. (2003), Shohet (2003), Shohet and Lavy (2004), David (2005), Oladapo (2005), Marilyn (2006), Iyaloo Ya (2007), Azlan (2009), Alberto *et al*. (2010) Joseph (2010), Kenny (2010), Olanrewaju (2010). Also previous researches on maintenance cost include Slater (1982), Richard (2005) Oparinde (2010), Ojo *et al.* (2011), However, few works have been in existence on the airport maintenance, for instance, airport pavement management (Barling, 1998). There was dearth of literature on maintenance of airport in relation to airport passenger movement and aircraft traffic volume (Oladimeji, 2010). Hence this paper focused on the impact of airport

passenger movement and aircraft traffic volume on maintenance cost of airport with aim of determining the importance of airport passenger movement and aircraft traffic volume as part of variables for arriving at the maintenance cost of airport in Nigeria.

RESEARCH METHOD AND DATA ANALYSIS

Data was obtained from the Federal Airport Authority of Nigeria (FAAN) Operational Headquarters in Ikeja, Lagos State, Nigeria which include aircraft traffic volume, airport passenger movement and maintenance cost for a period of 10 years in Murtala Mohammed Airport (MMA), Ibadan and Akure Airports. Pearson bivariate correlation analysis which reflects the degree of linear relationship between two variables that ranges from +1 to -1, was used to measure the strength of relationship between airport maintenance cost and aircraft traffic volume; and also between airport maintenance cost and passenger movement.

An empirical investigation using regression analysis was used to test the level of relationship between airport maintenance cost (AMC) as the dependent variable and each of aircraft traffic volume (ATV) and airport passenger movement (APM) in the form AMC = a + b (ATV) and AMC = c + d (APM), where an increase or decrease in AMC is associated with an increase or decrease in ATV and APM. To achieve this, data in Tables 1, 3 and 5 were employed and detailed results of the correlation coefficient (R), coefficient of determination (R^2) and level of significance are shown in Tables 2, 4 and 6. Two sets of hypothesis were proposed to determine if the maintenance cost allocated to airport maintenance reflect the rate of deterioration initiated by aircraft traffic volume and airport passenger movement. The two hypotheses are:

Hypothesis 1:

H_0: There is no significant relationship between airport maintenance cost and aircraft traffic volume

H_1: There is a significant relationship between airport maintenance cost and aircraft traffic volume

Hypothesis 2:

H_0: There exists no significant relationship between airport maintenance cost and airport passenger movement.

H_1: There exists significant relationship between airport maintenance cost and airport passenger movement.

The significance of the relationship was based on a 0.05 level of significance.

Table 1: Maintenance Cost, Aircraft Traffic Volume and Airport Passenger Movement for MMA, Ikeja

Year	Airport Maintenance Cost (N)	Aircraft Traffic Volume	Airport Passenger Movement (No)
1	4,450,050	45,920	1,968,056
2	4,332,903	25,600	2,078,921
3	8,817,339	64,070	2,366,218
4	23,251,349	73,853	2,649,821
5	50,996,000	72,071	2,748,423
6	99,665,760	55,123	2,328,442
7	67,495,025	59,431	2,373,602
8	108,837,893	57,050	2,380,364
9	80,918,488	53,247	1,923,007
10	122,391,724	52,045	1,813,422

Source: Federal Airport Authority of Nigeria Annual Reports.

Table 2: Correlation and Regression Analysis Values for the Hypothesis Tested for MMA

Description	R-values	R^2	Sig
Hypothesis 1	0.137	0.019	0.705
Hypothesis 2	- 0.184	0.034	0.611

FINDINGS AND DISCUSSION

Relationships between AMC, ATV and APM in MMA, Ikeja

Regression analysis result revealed the relationships between airport maintenance cost (AMC) and each of aircraft traffic volume (ATV) and airport passenger movement (APM) in MMA represented by these equations:

$$AMC = 31830000 + 453(ATV)$$

$$AMC = 117900000 - 27(APM)$$

The result in Table 2 showed a weak but positive relationship between AMC and ATV (R = 0.137) and statistically insignificant at F > 0.05. The coefficient of determination R^2 = 0.019 which implies that 2% of the variation of maintenance cost can be attributed to ATV, the remaining 98% may be due to other variables which are factors that need to be investigated. A weak and negative relationship exist between MC and APM (R= -0.184) and statistically insignificant at F > 0.05. The coefficient of determination R^2 = 0.034 which also implies that 3% of the variation of maintenance cost can be attributed to ATV, the remaining 97% may be due to other variables. The relationships were not statistically significant. It can be concluded that ATV and APM as variables are not statistically sufficient to determine AMC in Murtala Mohammed airport. There should be other variables not considered in this paper which are very germane in determining AMC in MMA. These variables are recommended in this paper to be identified, assessed and given apposite concern.

Relationships between AMC, ATV and APM in Ibadan Airport

The result of the regression analysis showed the relationships between airport maintenance cost (AMC) and each of aircraft traffic volume

Table 3: Maintenance Cost, Aircraft Traffic Volume and Airport Passenger Movement for Ibadan Airport

Year	Airport Maintenance Cost (N)	Aircraft Traffic Volume	Airport Passenger Movement (No)
1	137,687	854	1,300
2	118,072	456	950
3	162,605	554	1,244
4	533,827	698	1,228
5	1,237,608	507	1,106
6	3,119,688	729	2,126
7	1,829,313	539	1,065
8	2,949,538	425	472
9	2,118,265	432	471
10	3,835,599	381	467

Source: Federal Airport Authority of Nigeria Annual Reports.

Table 4: Correlation and Regression Analysis Values for the Hypothesis Tested for Ibadan Airport

Description	R-values	R^2	Sig
Hypothesis 1	-0.413	0.171	0.236
Hypothesis 2	- 0.231	0.053	0.521

Table 5: Maintenance Cost, Aircraft Traffic Volume and Airport Passenger Movement for Akure Airport

Year	Airport Maintenance Cost (N)	Aircraft Traffic Volume	Airport Passenger Movement (No)
1	119180	432	0
2	94526	176	0
3	145670	334	0
4	359509	312	0
5	881727	406	179
6	2426424	345	61
7	1422802	360	142
8	2294082	454	316
9	1647543	419	316
10	2653479	338	311

N/B: The zero values in the first four years indicate that there was no commercial operation
Source: Federal Airport Authority of Nigeria Annual Reports.

Table 6: Correlation and Regression Analysis Values for the Hypothesis Tested for Akure Airport

Description	R-values	R^2	Sig
Hypothesis 1	0.352	0.124	0.318
Hypothesis 2	0.763	0.583	0.01

(ATV) and airport passenger movement (APM) in Ibadan airport to be represented by the equation:

$$AMC = 3660000 - 3687(ATV)$$
$$AMC = 2259000 - 628(APM)$$

The result in Table 4, showed a weak and negative relationship between AMC and ATV (R = 0.413) and statistically insignificant at F > 0.05. The coefficient of determination $R^2 = 0.171$ which implies that 17% of the variation of maintenance cost can be attributed to ATV, while the remaining 83% may be due to other variables which are factors that need to be investigated. Also, there was a weak and negative relationship between AMC and APM (R= -0.184) and statistical insignificant at F > 0.05. The coefficient of determination $R^2 = 0.053$ which also implies that 5% of the variation of maintenance cost can be attributed to ATV, the remaining 95% may be due to other variables. The relationships were not statistically significant, it can therefore be concluded that ATV and APM as variables were not statistically sufficient to determine airport maintenance cost in Ibadan airport. Other variables contributing to 95% of this variation which were not considered in this paper should be properly evaluated to determine their percentages of contribution to AMC.

Relationships between AMC, ATV and APM in Akure Airport

Regression analysis showed the relationships between airport maintenance cost (AMC) and each of aircraft traffic volume (ATV) and airport passenger movement (APM) in Akure airport represented by these equations:

$$AMC = -409200 + 4513(ATV)$$
$$AMC = 468003 + 5558(APM)$$

The result in Table 6 showed a weak but positive relationship between MC and ATV (R = 0.352) and statistically insignificant at F > 0.05. The coefficient of determination $R^2 = 0.124$ which implies that only 12% of the variation of AMC can be attributed to ATV, while the remaining

88% may be due to other variables which are factors that need to be investigated; also, the relationship was not statistically significant. The relationship between AMC and APM was strong and positive (R= 0.763) and statistically significant at F <0.05. The coefficient of determination $R^2 = 0.583$ which implies that 58% of the variation of maintenance cost can be attributed to APM, the remaining 42% may be due to other variables. This implied that APM significantly contributed to AMC whereas ATV did not significantly contribute to AMC in Akure airport. This may suggest that aircraft traffic volume and airport passenger movement were not adequately considered when allocating money for maintenance. The result is not unexpected because Oladimeji (2010) identified factors affecting fund allocation to airport maintenance in Southwestern Nigeria to include airport expenditure, airport revenue, aircraft traffic movement and airport passenger movement. He also determined the strength of relationship between these factors and the maintenance cost, and therefore concluded that fund allocation to maintenance was influenced by the availability of money and not necessarily on the rate of use of its facility expresseed in the number of passenger movement and aircraft traffic volume. Therefore, this confirmed the result of this research. Although, Horak *et al.* (2009) noted that annual aircraft volume and passenger movement are commonly used to determine airport maintenance budget, this study established that other factors were also considered in determining Nigerian airport maintenance cost.

CONCLUSION

This paper developed a relationship between airport passenger movement, aircraft traffic volume and maintenance cost allocation of airports in Southwestern Nigeria to examine the importance of the airport passenger movement and aircraft traffic volume in determining cost of maintenance of airports. The result revealed that ATV contributes positively to AMC in MMA and Akure airport but negatively in Ibadan airport. APM contributes negatively to AMC in MMA and Ibadan airport but positively in Akure airport. These contributions were weak and not statistically significant except APM in Akure which was strong and statistically significant. Thus, it can be concluded that the rate and use of the airport facilities were not given due consideration during allocation of fund to airport maintenance in Southwestern Nigeria.

Positive contribution of APM to AMC in Akure may be due to the fact that the more the passenger movement which leads to increase in the use of airport facilities, the more the need for maintenance which implies increased maintenance cost of the airport. However, negative contribution indicated that

In addition to annual aircraft volume and passenger movement that should be used to determine airport maintenance budget, there is the need for formulation of an appropriate algorithm that will enable airports maintenance managers estimate airport facilities need. Also, it is expedient that all necessary factors are taken into consideration to achieve an adequate and reasonable budget for airport maintenance in Nigeria. Future research can investigate contributory effect of the passenger movement and aircraft traffic volume on the maintenance cost using multiple regression analysis technique. Also, other factors should be identified and evaluated.

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