

# FACTORS AFFECTING MAINTENANCE COST OF INSTITUTIONAL BUILDINGS

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## ABSTRACT

Building maintenance management in institutions and organisations with sizeable building assets is a complex and multi-faceted process that involves planning, directing, controlling and organizing resources for the sustenance of the building's physical, functional and operational performance. The purpose of this research work is to propose ways of optimizing maintenance expenditure of institutional buildings in Nigeria. Based on review of literatures, factors impacting maintenance costs were categorized into four categories comprising of; building characteristics, political factors, technical and administrative factors respectively. A questionnaire survey of maintenance departments' staff of tertiary institutions in Lagos State was conducted and the data were analyzed using the statistical packages for social science (SPSS). The study reveals the predominant factors affecting maintenance costs of institution buildings to include; age, floor area and vertical spread of buildings, poor building designs, improper coordination of incorporated building services and deferred maintenance. The study recommends a review of maintenance policies for institutional buildings with a view to equipping the maintenance organisations with competent hands and skilled personnel to handle maintenance activities of critical systems and services in institution buildings.

*Keywords: Costs, Maintenance, Factors, Institutional-Buildings, Strategy*

## INTRODUCTION

Maintenance of existing building stock is by no means a small responsibility for organizations and government institutions as significant expenditures are incurred annually on maintenance related activities. Generally, the totality of maintenance cost is expected to comprise the cost of materials, labour, site overheads, equipment/plant cost, head office cost and profit. In most part of the world including Nigeria however, experience and historical data has shown that there are other costs for which provision should be made following the unprecedented development of maintenance need. It is not surprising that Chanter and Swallow (2007) posit that the cost of maintenance work is usually higher than the cost of new construction work.

Maintenance cost is the total cost or budget set aside to keep, restore or improve a building. Maintenance cost differs in various places owing to some peculiarities such as building location, availability of resources, lack of funds, non-availability of building materials, inadequate transportation and many others. Mbachu and Nkado (2004) express that high maintenance costs have negative implications on key stakeholders in particular, and the industry in general. To the client, high maintenance cost implies added costs over and above those initially agreed upon at the onset, resulting in less returns on investment. To the end user, the added maintenance costs are passed on as higher rental / lease costs or prices. To the consultants, it means inability to deliver value for money and could tarnish their reputation and result in loss of confidence reposed in them by clients. To the contractor, it implies loss of profit through penalties for noncompletion, and negative word of mouth that could jeopardize his/her chances of winning further jobs, if at fault.

Hence this study will investigate the factors affecting maintenance cost of institutional buildings in Lagos state with a view to sensitizing maintenance managers and stakeholders in the maintenance management of institution buildings on measures at optimizing maintenance expenditures.

### **Statement of the Problem**

The wealth of many nations is determined by the level of their infrastructures while a nation's standard of living is also based on the quality of housing for the public in such a nation (El-haram and Horner, 2002). Nigeria as a developing nation is struggling with infrastructural deficit due low budgetary provisions for new infrastructure by government and extremely challenging economic climate on the part of private investors who are constraint by stringent monetary policies. In spite of this, defects in both private and public sector facilities are highly visible; most public facilities are in a state of disrepair. Quest for effective maintenance management of physical assets in tertiary institutions are by no means the least of the challenges facing management and stakeholders in the education sector. This study therefore sets to investigate the factors that impact on the costs of maintenance of buildings in tertiary institutions in Nigeria.

### **Aim of the Study**

The aim of the study is to assess factors that affect maintenance cost of buildings in tertiary institutions in Nigeria.

### **Objectives of the Study**

- (i) To assess the operational state of institutional buildings in Lagos state.
- (ii) To examine the factors affecting cost of maintenance of the institutional buildings in Lagos state.
- (iii) To assess maintenance management strategies adopted in maintenance of institutional building.

### **Research Hypothesis**

- There is no significant difference in factors affecting maintenance cost of federal institution buildings and state institution buildings.

### **Literature Review**

Effective building maintenance can contribute immensely to reducing the lifecycle cost (LCC) of a building through optimal maintenance execution at the operation and maintenance phase of a building's lifecycle. Moreover, the reduction of building maintenance cost can be achieved through deep understanding of building maintenance cost concepts. Al-arjani (2002) asserts that governments of developing countries all over the world commit considerable expenditure to maintenance and operations of buildings but according to chanter and swallows (2007), the backlog of repair and maintenance work are depriving these country's building stock from attaining minimum acceptable maintenance level consequently, the deterioration of these building stock are growing at an unacceptable rate.

Francis, Yik and Lee. (2002) posit that building maintenance management is an operation that involves interaction or combination of technical, social, legal and fiscal determinants that govern and manage the use of buildings. For instant, the state of facilities in an academic institution may impact the quality of academic service delivery. In other words, the assets of

tertiary institutions must be in optimum operable performing state at all times in order to deliver quality education. Institutions asset comprises funds, technology, human capital, equipment, plants and buildings. Although, human capital is institution's most significant resource, because tertiary educations are labour intensive, building is the most valuable asset of the institutions. Specifically, institutional buildings are procured to create a suitable, conducive, and adequate environment to support, stimulate and encourage learning, teaching, innovations and researches (Olanrewaju, Khamidi and Idrus, 2010). The cost of maintaining buildings consumes a great portion of the limited resources available for running organisations and institutions.

According to El-haram and horner (2002) and Ali (2009) factors that affect maintenance cost of buildings can be divided into four groups of variables comprising building characteristics, political factors, technical and administrative.

Building characteristics parameters comprises; the building size, building age, function, height of building, type of structure, finishes, building materials and building components. Sonthya (2006) opine that building characteristics are different in terms of the building amenities provided in the building as well as facilities and services available.

El-Haram and Horner (2002) identified technical and administrative factors which affects maintenance costs of buildings as poor workmanship and poor quality of spare parts and materials, poor maintenance management, budget constraints, failure to execute maintenance at the right time and poor budgetary control. The selection of the maintenance management team and staff is closely related to the maintenance factors that affect the housing maintenance cost.

Besides, the factors that have been stated, there are other factors that affect the building maintenance cost such as third-party vandalism and poor or lack of training (El-Haram and Horner, 2002). These factors can impact building maintenance cost Due to the inflexibility of buildings, institutions, organisations and occupiers need to have clear strategies to manage, control and develop buildings profitably (Zulkarnain, Zawawi, Rahman, Mustafa, 2011).

## **METHODS**

A structured questionnaire was designed and used as the principal instrument for obtaining data for this study. The questionnaires were targeted at maintenance resource persons in the maintenance departments of the surveyed tertiary institutions in Lagos State. Selection of respondents for this study was by simple random sampling method.

A total of 80 questionnaires were administered to the targeted respondents, of the 80 administered questionnaires a total of 50 questionnaires were retrieved and duly completed representing 63% response rate. The returned questionnaires were scrutinized for errors, omissions, completeness and inconsistencies and were found to be adequately completed and therefore suitable for analysis. The data collected was processed and analysed with the aid of Statistical Package for Social Sciences (SPSS). Frequency tables, bar charts and mean score were used for the descriptive statistic while the spearman's rank correlation and Chi-square were used to test the hypothetical statement formulated for this study.

## **RESULTS**

Table 1 shows the demographic details of respondents; the table shows that more of the respondents were male with a percentage of 74% while the female respondents amount to 26%. This implies that greater number of the workforce of the maintenance department of the various institutions were men.

The table further shows that majority of the respondents' are learned hence their ability to comprehend the questions articulated in the questionnaire and to respond accordingly.

The buildings in the various institutions are used for different purposes and are classified accordingly as shown in table 2. 48% of the respondents expressed that the buildings they manage in the institutions are essentially multi-purpose in nature while 18% of the respondents reported that the buildings within the scope of their operations as maintenance personnel are basically used for academic purposes. Such building comprises; auditoriums, lecture theatre halls, workshops among others.

Table 3 shows the maintenance strategy adopted by the maintenance departments of the various institutions in addressing maintenance issues. Respondents were asked to assess the frequency at which the three articulated maintenance strategies are used in their maintenance operations using 5 point likert scale of; Always, Often, Sometimes, Rarely, and Never in descending order of 5 to 1 respectively. The analysis shows that corrective maintenance was the most frequently adopted strategy for maintenance works executed by the maintenance departments, which implies that most of the maintenance work done were undertaking after a failure or breakdown had been reported. Preventive maintenance ranks second inferring that on some occasions, maintenance work are carried out based on a routine schedule for maintenance activities. The table also shows that Conditioned-based maintenance is rarely used as a strategy for maintaining systems and equipment in the surveyed buildings.

From the analysis, the age, size of buildings, vandalism by users, faulty design and poor incorporation of building services are the top five dominant factors that impact the costs of maintenance of tertiary institution buildings. The impacts of these factors were rated high on maintenance costs. The result implies that as a building age, the costs of maintenance increases. Also, the frequency and volume of replacement of parts and spares in and old building is likely to be more than in new buildings as systems wear and tear due to use; pipe corrodes and joints leaks, roof leaks and paints fades while a number of defects grow with the building age.

The result also shows that damage arising from poor handling of systems and services in the buildings by users contribute immensely to the increased cost of maintenance in tertiary institution buildings. Errors attributable to poor designs in the architecture, services and specifications of buildings at the pre-construction phase of a building are seen to impact the costs that are eventually incurred on maintenance throughout the life of a building. Furthermore, poor integration of building services ranked as the fifth factor that affects maintenance cost as embedded services without adequate provision for maintenance access would result in breaking of walls, floors and related surfaces before maintenance activities can be carried out on underneath services.

### **Test of Research Hypothesis**

H<sub>0</sub>- There is no significant difference in the factors affecting maintenance cost of Federal owned and State owned tertiary institution buildings

H<sub>1</sub>- There is significant difference in the factors affecting maintenance cost of Federal owned and State owned tertiary institution buildings

The analysis of variance was used to test the formulated hypothesis and the results is as shown in table 5. At 5 percent, level of significance when P – value is <0.05, majority of the variables (factors) have significant difference between the data that is being compared or tested. Analysis of variance result in respect of testing the above perception of respondents' as regards

factors affecting maintenance cost of institutional buildings indicated that the calculated F-value for vandalism by users ( $F_{cal.}=9.808$ ) is higher than the tabulated F-value ( $F_{tab}=9.78$ ) at a 5% level of significance, hence null hypothesis is to be accepted which infers that there is no significant difference in the factors affecting maintenance cost of federal and state institutional buildings. Majority of the other factors identified are also accepted at 1% to 5% significance level with the exception of delay and failure in reporting maintenance problems, building services, poor budgetary control, and third party vandalism having the calculated F-value been less than the tabulated F-value, therefore, allowing for the alternative hypothesis been accepted that is  $H_1$ .

Conclusively from Table 5, the high ranked factors indicated an calculated F-value which is greater than the tabulated F-value; hence the results suggest that the null hypothesis be accepted inferring that there is no significant difference in the factors affecting maintenance cost of Federal owned and State owned institutional buildings.

## **DISCUSSION**

From the analysis, building age ranked top as the factor that affects tertiary institution buildings' maintenance cost. This justifies the position of Lateef (2008) that one of the essential factors that need to be measured in the allocation of maintenance budgets is the building age. This is probably due to the need of additional maintenance works to be carried out in older buildings. For example, major refurbishment and retrofitting of building equipment or elements need to be implemented when a building has reached its economic life span (Ali, 2009). Following the building age as a top ranked factor is the Building area or size, this factor determines the amount an organization or institution allocate towards maintenance activities. According to MCB UP Ltd (1987), building services and maintenance accounts are relatively high, covering 20-45% of the total building running costs, even at the lowest estimate. This statement is justified by the findings of this research work, whereby the poor integration of building services and faulty design ranked within the first five factors that affect building maintenance cost. Hence, the timely maintenance of building services is necessary to avert premature and frequent breakdown of building systems and service failure. Adequate attention should also be given to the scrutiny of building services design at the pre-construction stage of new buildings with a view to identify errors or poor design proposal at an early stage of the building life.

Also, the type of building materials used for the construction of buildings was ranked as the sixth factor affecting maintenance cost of institutional buildings. According to Hanim (2008), the price of building materials has been on the increase because of the escalating cost of raw material and high operational costs incurred at the production of construction materials. Consequently, maintenance cost has increases significantly overtime especially when there is need for significant replacement or upgrade in the buildings arising from deteriorations or prolong defects. This finding aligns with the findings of Nor Haniza et al. (2007) and Cheung and Kyle (1996) that improper or poor material selection is one of the dominant factors affecting housing maintenance cost over the life of a facility or building component.

Furthermore, this study reveals that failure to execute maintenance as at when due may result in an increased in the costs of such maintenance activity when the activity is eventually carried out. This concurs with the position of Narayan (2003), stating that failure or delay to execute maintenance tasks at the right time may cause further deteriorating impacts and further burden the overall cost of executing the repair or replacement work. This also agrees with the findings of Suttell (2006) that maintenance is not expensive when compared to what might need to be spent if the system is allowed to degrade and fail ultimately.

## CONCLUSION

Building age, building size, vandalism, faulty designs, poorly integrated building services, substandard building materials, and failure to execute maintenance at the right time were seen to high degree of influence as factors responsible for high cost of maintenance in institutional buildings, this study therefore recommends that annual audit of buildings in tertiary institution be consistently conducted by skilled maintenance personnel to afford the maintenance organizations the opportunity of tracking changes or otherwise in the performance of building elements, systems, and services in the buildings as they age. The procedure for such an audit should be expressly defined and documented within the maintenance organization policy with a view to ensure that such audit fulfills the purpose for which it is conducted. Competent personnel should be resourced and included in the audit team so that all critical systems in the buildings can be properly examined in the course of the audit. Also, routine maintenance and repair works should be timely to avoid further deterioration. Building designs should be critically reviewed at the preconstruction stage from maintenance perspective by experienced maintenance personnel with a view to achieving ease of maintenance at the operation and maintenance phase of the building.

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## APPENDIX

**Table 1: Demographic Details of Respondent**

<b>Demographic Data</b>	<b>Frequency</b>	<b>Percentage</b>
<b>Gender</b>		
Female	13	26
Male	37	74
Total	50	100
<b>Academic Qualification</b>		
OND	11	22
HND/B.Sc./B.Tech	23	46
M.Sc./M.Tech	12	24
PhD	4	8
Total	50	100

**Table 2: Building Classification**

<b>Building classification</b>	<b>Frequency</b>	<b>Percentage</b>
Administrative Block	7	14
Academic Block	9	18
Recreational Block	1	2
Utility Block	9	18
Multi-purpose	24	48
Total	50	100

**Table 3: Maintenance Management Strategy Adopted by the Department**

<b>Maintenance Management Strategy</b>	<b>N</b>	<b>Mean</b>	<b>Rank</b>
Corrective Maintenance	50	4.54	1
Preventive Maintenance	50	2.96	2
Condition-based Maintenance	50	2.30	3

**Table 4: Factors Affecting Maintenance Cost of Institutional Buildings**

<b>Factors affecting maintenance cost</b>	<b>N</b>	<b>Std deviation</b>	<b>Mean</b>	<b>Rank</b>
Building age	50	0.639	4.40	1
Building area or size	50	0.607	4.28	2
Vandalism by users	50	0.536	4.28	2
Faulty design	50	0.771	4.24	4



Building services	50	0.591	4.24	4
Building materials	50	0.872	4.12	6
Deferred maintenance	50	0.746	4.12	6
Poor maintenance tracking	50	0.807	4.04	8
Budget constraint	50	0.845	4.02	9
Poor quality of spare parts	50	0.892	4.02	9
Low concern for future maintenance	50	0.869	3.98	11
Lack of quality control	50	0.781	3.96	12
Delay and failure in reporting maintenance problem	50	0.778	3.92	13
Poor workmanship	50	0.839	3.90	14
Poor budgetary control	50	0.918	3.88	15
Third party vandalism	50	0.800	3.82	16
Poor or lack of training	50	0.847	3.76	17
Non standardized components/materials	50	0.967	3.62	18

**Table 5: Analysis of variance for research hypothesis**

Variables		Sum of Squares	df	Mean Square	F	Sig.	Remark
Vandalism by users	Between Groups	11.579	3	3.86	9.808	0.000	Accept H <sub>0</sub>
	Within Groups	18.101	46	0.394			
	Total	29.68	49				
Building area or size	Between Groups	12.414	3	4.138	12.213	0.000	Accept H <sub>0</sub>
	Within Groups	15.586	46	0.339			
	Total	28	49				
Delay and failure in reporting	Between Groups	7.173	3	2.391	5.276	0.003	Accept H <sub>1</sub>
	Within Groups	20.847	46	0.453			
	Total	28.02	49				
Building services	Between Groups	8.683	3	2.894	7.724	0.000	Accept H <sub>1</sub>
	Within Groups	17.237	46	0.375			
	Total	25.92	49				
Building materials	Between Groups	8.296	3	2.765	4.646	0.006	Accept H <sub>0</sub>
	Within Groups	27.384	46	0.595			
	Total	35.68	49				
Non standardized components/ materials	Between Groups	5.434	3	1.811	2.377	0.082	Accept H <sub>0</sub>
	Within Groups	35.046	46	0.762			
	Total	40.48	49				
Poor	Between Groups	10.037	3	3.346	4.616	0.007	Accept H <sub>0</sub>

<b>Variables</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>	<b>Remark</b>
workmanship	Within Groups	33.343	46	0.725			
	Total	43.38	49				
Poor quality of spare parts	Between Groups	13.051	3	4.35	6.908	0.001	Accept H <sub>0</sub>
	Within Groups	28.969	46	0.63			
Poor maintenance tracking	Total	42.02	49				
	Between Groups	6.821	3	2.274	4.038	0.012	Accept H <sub>0</sub>
Budget constraint	Within Groups	25.899	46	0.563			
	Total	32.72	49				
Deferred maintenance	Between Groups	5.374	3	1.791	3.013	0.039	Accept H <sub>0</sub>
	Within Groups	27.346	46	0.594			
Poor budgetary control	Total	32.72	49				
	Between Groups	5.96	3	1.987	2.534	0.068	Accept H <sub>0</sub>
Faulty design	Within Groups	36.06	46	0.784			
	Total	42.02	49				
Low concern to future maintenance	Between Groups	1.676	3	0.559	0.557	0.646	Accept H <sub>1</sub>
	Within Groups	46.104	46	1.002			
Third party vandalism	Total	47.78	49				
	Between Groups	14.951	3	4.984	5.325	0.003	Accept H <sub>0</sub>
Poor or lack of training	Within Groups	43.049	46	0.936			
	Total	58	49				
Low concern to future maintenance	Between Groups	10.443	3	3.481	4.199	0.010	
	Within Groups	38.137	46	0.829			Accept H <sub>0</sub>
Third party vandalism	Total	48.58	49				
	Between Groups	2.91	3	0.97	1.129	0.347	Accept H <sub>1</sub>
Poor or lack of training	Within Groups	39.51	46	0.859			
	Total	42.42	49				
Poor or lack of training	Between Groups	6.513	3	2.171	2.378	0.082	Accept H <sub>0</sub>
	Within Groups	41.987	46	0.913			
	Total	48.5	49				