© 2012 Cenresin Publications
www.cenresinpub.org

ASSESSMENT OF MAINTENANCE COST FOR PUBLIC BUILDINGS IN BAUCHI STATE

[1]Gambo M. J.; [2]Usman N. D.; [3]Ashen, M. J. and [4]Akoh S.E.
[1]Estate Management Programme, Abubakar Tafawa Balewa University Bauchi
[2]Department of Civil Engineering Technology, Federal Polytechnic, Bauchi
[3]Department of Estate Management, Plateau State Polytechnic Barkin Ladi
[4] Department of Building Technology, Federal Polytechnic Idah Kogi State
E-mail: mjgambs@gmail.com

ABSTRACT
An assessment of maintenance cost for public institutional buildings in Bauchi state was carried out and relevant literatures were reviewed. The present cost of constructing each selected public institutional building was determined by multiplying the Gross floor area to the construction cost per meter square as at year 2004. The present value of maintenance of each selected public institutional building was determined. The present value of maintenance of each selected public institutional building was computed using the present value of one naira per annum table (single rate). With the aid of regression analysis using stat view computer package, the result of analysis show a significant relationship between the values of maintenance cost and construction cost. A very weak correlation exists between initial cost of building and initial maintenance cost of public institutional buildings. The results show a very strong linear relationship between the present value of maintenance and gross floor area. The knowledge of the existence of such relationships serves as a guide to public and private administrators in planning for construction of buildings and design management for preventive maintenance.
Keywords: *Maintenance, Cost, Construction, Public Building*

INTORDUCTION
Maintenance culture is an attitude, which is sadly lacking in Nigeria, whether in the home, school or factory. Wahab (1995) asserted that the nation accords low priority to property maintenance. According to Musa (2001) the problem of maintenance posed a serious concern to whoever has the responsibility of providing fund for the procurement or provision of capital assets both at the public and private sectors especially with the present state of the nation's economy. The same economic set back has not left behind construction inputs, whose prices have escalated beyond the current economic situation in the country, which forced Nigerians to go from an attitude of replacement culture to an attitude of maintenance culture. However, maintenance starts the day, builder leaves site, materials, design, function, use and their interrelation determines the total maintenance cost needed for the building. The economic interest of client is also a determining factor for the maintenance of a building. There are evidences that a substantial part of our building stock, roads and other physical facilities are in danger of deteriorating below the point of economic repair. This is particularly true of government buildings, roads, facilities scattered all over the state where no efforts have been consciously made to budget against their maintenance (Iwuanyanwu, 1987). Rotimi and Mutallib (1995) said that this is partly due to the absence of appropriate benchmarks, which provide a basis for the analysis and assessment of the cost of

Corresponding Author: Gambo M. J.

undertaking such repairs with a view to determining its optimum level for such buildings. The declining maintenance of buildings has become a major problem to the construction industry.

CONCEPT OF BUILDING MAINTENANCE

According to Sidney (1991) permanent structure requires less attention than temporary ones. If the attention is delayed, what started as being something very minor is liable to turn quickly into an expensive operation? Thus, every part of the fabric needs regular inspection and some jobs need putting in hand as a matter of routine. Similarly, Seeley (1987) asserted that no building can exist throughout its life span without one form of maintenance or the other; this can be taken care off at the design stage in order to reduce the amount of subsequent maintenance work. Seeley (1997) opined that maintenance work on a building should commence from the day the contractor leaves the site. The necessity for maintenance work on buildings is noted in the fact that all buildings, as well as the materials and components therein, deteriorate or suffer loss in aesthetic, strength or functional value, with exposure to the elements of weather over time. The appearance and the span of a building as well, the quality of the materials would be affected depending on the manner of maintenance (Seeley, 1987).

NATURE OF MAINTENANCE

Building maintenance, it comprises three separate components viz, servicing, rectification and replacement.

a. **Servicing:** This is essentially a cleaning operation undertaken at regular intervals of varying frequency and is sometimes termed day – to – day maintenance. As more sophisticated equipment is introduced so more complicated service schedules become necessary. The frequency of cleaning varies such as floors swept daily and polished weekly; windows washed monthly etc.
b. **Rectification:** This is the work which usually occurs fairly early in the life of the building and arises from shortcomings in design, inherent faults in or unsuitability of components, damage of goods in transit or installation and incorrect assemblage. Rectification represents a fruitful point at which to reduce the cost of maintenance because it is avoidable. It is necessary to ensure that components and materials are suitable for their purpose and are correctly installed.
c. **Replacement:** This is inevitable because service conditions cause materials to decay at different rates, much replacement work stems not so much from physical breakdowns of the materials or elements as from moral deterioration of appearance. Hence, the length of acceptable life often involves a subject judgement of aesthetics of change.

Furthermore, the measurement of the length of life of a material is a very different technological problem due to the complex nature of the environment and the difficulty of determining how much a material may change before it is discarded.

Maintenance also embraces renovations which consist of work done to restore a structure, service and equipment by a major overhaul to the original design and specification or to improve on the original design (Robertson, 1990).

BUILDING MAINTENANCE

Building maintenance is defined as "work undertaken in order to keep, restore or improve every part of a building, its services and surroundings to a currently acceptable standard and to sustain the utility and value of the building" (Seeley, 1997).

Building Maintenance Strategies: These can be divided into three: Corrective, preventive and condition -based maintenance.

Corrective Maintenance: Corrective maintenance is the simplest type of maintenance strategy, where an element in a building is used until it breaks down. It covers all activities, including replacement or repair of an element that has failed to a point at which it cannot perform its required function. Corrective maintenance is sometimes referred to as failure based or unplanned maintenance. Corrective maintenance tasks often take place in an ad hoc manner in response to breakdowns or user requests (David and Arthur, 1989).

Preventive Maintenance: These were introducing to overcome the disadvantages of corrective maintenance by reducing the probability of occurrence of failure and avoiding sudden failures. This strategy is time – based maintenance, planned maintenance or cyclic maintenance. Preventive maintenance tasks are performed in accordance with a predetermined plan at regular fixed intervals which may be based on operating time (David et al, 1989).

Condition – Based Maintenance: Condition – based maintenance is the maintenance carried out in response to a significant deterioration in a unit as indicated by a change in monitored parameter of the unit condition or performance (Kelly and Harris, 1978).
The condition – based maintenance concept recognizes that a change on condition and / or performance of an item is the principal reason for carrying out maintenance. In this strategy, maintenance tasks are determined and planned by efficiently monitoring the building's elements such as walls, floors, roof and service equipment such as boilers, pumps, and heating system, to identify which element or piece of equipment requires maintenance before a major failure occurs. To gain the full advantage of applying condition – based maintenance, the condition of an item must be monitored to identify whether there is any evidence of change from a normal to an abnormal condition (David et al, 1989).

METHODOLOGY

Data were obtained from Federal Office of Statistics and Central Bank of Nigeria. Stat view computer package was used to analyze the data.

Analysis of Variance (ANOVA): Analysis of variance was used to estimate how much a total variation can be attributed to a certain assignable cause of variation and how much can be attributed by chance in any set of sample (Ashen, 2004) the chance is reported as the P – value. At 5 percent, level of significance when P – value is <0.05, there is a significant difference between the data that is being compared or tested.

Paired – test for Significant Difference: The paired t – test tested the hypothesis that the mean of the difference between pairs of Construction Cost and Maintenance Cost, Construction Cost and Gross Floor Area or Maintenance Cost and Gross Floor Area is equal to some hypothesized value, usually set at Zero. A hypothesized value of zero is equivalent to the hypothesis that there is no difference between the two samples. The paired t – test compares the two samples and determines the likely hood of the observed difference occurring by chance. The chance is reported as the P – value. A P – value close to 1 means it is very likely that the hypothesized and sample means are the same, since it is very likely that such result would happen by chance if the null hypothesis of no difference is true. A small P – value (for example, 0.01) mean it is unlikely (only a one in 100 chances, that is, 1% chance) that such a difference would occur by chance if the two means were the same.
A high P – value indicates that the data does not contradicts the null hypothesis while a low P – value leads to the rejection of the null hypothesis. The t – value reported from the calculation expresses the difference between the mean and hypothesized value in terms of the standard error. If the computed t – value is larger than the critical t – value (from statistical tables), the alternative hypothesis is rejected at 95 percent confidence level.
Regression Equation is simply given by;

$Y = a + b\,x$

Where:

Y = Dependent variable

X = Independent variable

The regression a and b are given by the regression expression.

a. $= \frac{\sum XY - nxy}{\sum X^2 - nX^{-2}}$ $a = y - bx$

Where:

$X = \frac{\sum N}{N}$ and $y = \frac{\sum Y}{N}$

DEVELOPMENT OF REGRESSION MODELS

Simple regression models were developed after confirming the relationship between the variables. The following models were developed:
Case 1: Present Cost of building and Maintenance Cost of buildings.
Case 2: Initial Cost of buildings and Initial Maintenance Cost of buildings.
Case 3: Gross Floor Area and Present Value of Maintenance Cost.

DISCUSSION OF RESULTS

Based on the results of the analysis on data carried out, an evaluation of the assessment of maintenance cost for public building in Bauchi State was determined.

The results sows that regression models were developed to predict the likely cost of buildings and maintenance cost of buildings in the public construction projects (Table 1) Linear relationship into form of Y = a + bx were obtained. Hence, the following models were developed:

Y = 1895166.888 + 0.714x for Present Cost of Buildings and Maintenance Cost of buildings.

Y = 945991.452 + 0.223x for Initial Cost of Buildings and Initial Maintenance Cost of buildings.

Y = 818400.480 + 19781.648x for Gross Floor Area and Present Value of Maintenance. Based on the analysis of the cost construction and the Present Value of Maintenance in the year 2004, the results show a Positive relationship. This suggest that when the Cost of Constructing Public Institutional Buildings increases as a result of materials, labour or other factors, the Maintenance Cost also increases.

Table 2 revealed a very strong relationship between the initial Cost of Construction and the Initial Maintenance Cost of the building. This means that as the Initial Cost of building increases in size, so also the Cost of Maintenance.

Table 3 indicate a statistical relationship between the Gross Floor Area and the Maintenance Cost. This shows that when the Gross Floor Area of the building increases, the Maintenance Cost also increases.

CONCLUSION

Judging by the result of the analysis, there is a significant relationship between cost of construction and cost of maintenance. As the Cost of Construction increases so also the Cost of Maintenance. Gross Floor Area is another factor that determines the Cost of Maintenance. However, a weak relationship exist between the initial cost of construction and initial cost of maintenance. Hence, this cannot be use to determine the cost of maintenance.

RECOMMENDATIONS

- A maintenance cycle for a standard period of five years is recommended in order to reduce the cost of maintenance.
- Funds allocated for building maintenance should be sufficiently budgeted for and made readily available.
- Maintenance should be considered at the design stage.
- Preventive maintenance method is recommended for public institutional buildings.

Table 1: Present Values (Cost) of Maintenance Cost of Building Present Value of Maintenance

Present Cost of Building Year 2004 (N)	Present Value Maintenance Cost as at 2004 (N)
3,152,000	1,388,459.15
5,625,600	1,867,308.35
5,582,300	373,266.80
8,662,900	4,132,649.99
3,512,000	687,967.85
1,690,100	2,898,310.64
8,921,450	10,030,378.63
2,995,000	2,850,369.13
1,920,000	850,575.52
1,882,000	1,081,820.06
9,291,000	703,175.63
3,150,000	2,482,303.45
1,929,592	963,083.71
2,150,000	2,674,895.96
6,130,210	5,572692.62
4,120800	2,152,265.38
1,481,200	378,151.26
4,872,000	2,632,525,61
1,436,000	1,314,783.00
2,673,000	1,385,664.85
3,182,900	2,559,340.45
1,153.000	513,438.32
1,283.000	605,168.07
1,629,000	494,880.31

Table 2: Initial Cost of Building and Initial Maintenance Cost of Building

Cost of Building (Initial) (N)	Maintenance Cost (Initial) (N)
553,282.91	320,000
1,270,291.00	430,361
1,720,000.00	591,202
1,900,000.00	1,212,000
2,150,000,00	225,000
509,250.00	850,000

1,511,000.00	3,289,437
1,720,000.00	1,332,000
650,000.00	500,000
692,000.00	410,000
1,629,320.00	5,150,000
629,000.00	836,779
2,160,000.00	1,160,000
825,931.00	365,000
750,221.00	1,250,000
1,529,221.00	1,250,000
1,992,300.00	1,391,700
420,911.00	450,000
2,130,000.00	1,230,200
359,000.00	430,000
1,212,310.00	896,000
1,821,000.00	1,196,000
312,029.00	332,000
392,032.00	720,150
839,366.00	320,000

Table 3: Gross Floor Area of Building (M^2) and Present Value of Maintenance Cost as at Year 2004

Gross Floor Area of Building (M^2)	PV Maintenance Cost at 2004 (N)
143	1,388,459.15
256	1,867,308.35
253	373,266.80
392	4,132,649.99
160	687,967.85
77	2.898,310.64
405	10,030378.63
136	2,850,369.13
87	850,575.52
85	1,081,820.06
422	11,020,571.35
136	703,175.63
143	2,482,303.45
88	963,083.71
97	2,674,895.96
278	5,572,692.62
187	2,152,265.38

67	378,151.26
221	2,632,525.61
65	1,314,783.00
122	1,385,664.85
145	2,559,340.45
52	513,438.32
58	605,168.07
74	494,880.31

REFERENCES

Ashen, M. J. (2004). Application of Economic Indicators to predict Construction Cost Escalation for Residential Buildings. Building Department, University of Jos.

David, W.W. and Arthur, B. (1989). "Management to maintain quality in Buildings". Proceedings of Implementation of quality in construction, Pp 212 – 18.

Iwuanyanwu, E.C. (1987). Landed Assets Management and Maintenance Culture for Nigeria. Paper presented at the 17th Annual Conference of the Nigeria Institution of Estate Surveyors and valuers.

Kelly, A. and Harris, M.J. (1978). Management of Industrial Maintenance, Butterworth, London.

Musa, D.A. (2001). Provision and maintenance of Engineering Infrastructure for Technological Development in Nigeria. Fahimta publishing company, Kaduna.

Robertson, J. (1990). The planned Maintenance of Building and Structure, I C.E. London.

Rotimi, J.A. and Mutallib, M.O. (1995). A paper titled: Economic Consideration Works, Proceedings of the International conference on Maintenance of Engineering Facilities in Developing Countries, Gabon, Botswana.

Sidney, R. (1991). Property Maintenance, Planned Preventive and the Maintenance Contract Vol. 10, no. 2, 12 – 14.

Seeley, I.H. (1987). Building Maintenance. 3rd edition, Macmillan Press Ltd. Nottingham.

Seeley, I.H. (1997). Building Maintenance. Macmillan Press Ltd. Hampshire, England.

Wahab, K. A. (1995). Adequate and Affordable Housing for Nigeria in the 21st Century Housing today. Journal of the Association of Housing Science , Vol. 4, No. 3.