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Cost-In-Use: A Panacea For Sustainable Building Development In Nigeria

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ABSTRACT: *This paper advocates the need for cost-in-use assessment of the various components of any construction project to be embarked upon in the construction industry considering the present day global warming. Clients; private or public, usually lay emphasis on initial cost of developmental projects with little or no regard to the future costs of such projects. The cost implication of alternative artificial "(mechanical) and natural ventilation systems were investigated. The* ***Present value*** *(PV) of the future costs (annual and periodic) was assessed against the aesthetic and functional values of the various window systems to determine its sustainability. The study observed that a 20% additional initial cost could save the client from incurring 324% increase in future cost of using sliding windowpanes. It therefore believes that the application of the cost-in-use concept will enhance sustainable development of both private and public projects in Nigeria. The paper recommends that the services of the quantity surveyor should be employed at the design stage to offer informed cost advice on the effect of global warming and environmental degradation on the various building components for achieving sustainable development.*

Keywords: *Cost-in-use, Functionality, Present value, Sustainable development, Ventilation.*

I. INTRODUCTION

The phrase "penny wise pound foolish" cannot be more relevant to the Nigerian construction industry than now. One of the characteristics of the construction industry is the high capital outlay (initial) required for construction projects. Huge sums of money are usually required to finance construction projects, hence, Clients; public or private are greatly concerned with achieving their dream projects with the minimum possible cost at the expense other benefits. One of such is the risk of incurring high future costs arising from the usage/occupancy of the facility. Cost-in-use otherwise referred to as life-cycle cost, embraces the cost of an asset over its operating life, (Seeley; 1997[1]). In recent times, whole-life cost is used to replace the term cost-in-use though it means the same thing (Ferry, Brandon & Ferry; 1999[2]). It is a system of cost estimation which assesses both the initial capital required for the construction project and all other future costs that may arise after its completion and handing over to the owner.

For a building to be sustained, it has to be continually maintained over its life-cycle to an acceptable standard or at least in its original state. Also, it must be able to meet the basic needs of the occupants in terms of aesthetics, functionality, comfortability and structural stability. The level of comfort enjoyed in a building is a factor of the amount of heat contained within its internal environment which however depends to a large extent on the flow of air in and out of the building. Achieving this in the present day global environment is becoming a herculean task. The depletion of the ozone layer has continuously led to the available air on the earth surface being heated more than necessary (Akintola; 2007[3]). The external façade of the building also receives more heat from the sun which leaves the internal environment warmer (at times, hot) through conduction, during the day. At night, the excessive heat stored in the building during the day makes the building not so comfortable for the occupants. However, the rate of heat gain/ loss depends greatly among other things on the ventilation system incorporated into the building design.

Hence this paper purposes to highlight the benefits of assessing the whole-life cost of alternative window designs in achieving sustainable building development in view of the global warming and environmental degradation in Nigeria.

II. THE BUILDING

Shelter, otherwise referred to as building is generally accepted as one of the basic human needs while building construction is a major activity of the construction industry. Building is required to provide shelter for its inhabitants with all other facilities in place. Research have shown that the building (house) in which one lives to a great extent determines the persons character, attitude and way of live. In Nigeria, the number of housing facilities available to the populace is far from being adequate (Mustapha; 2002[4]). The provision of good and qualitative housing units has been the concern of the various government agencies. This is evident in the government housing schemes dated back to the colonial era (1920s) till date. Provision of quality housing units is one of the cardinal objectives of the NEED (Wahab; 2002[5]) and the MDGs (Ibrahim; 2006[6]). Despite all the effort by the government to provide adequate housing unit in Nigeria, little thought is given to its sustainability. The ability to sustain the various housing units developed in the past contributed to the failure of these schemes in reducing the acute shortage of housing provision in Nigeria. Hence, for the efforts of the Federal Government on MDGs to be effective, it must put into consideration the whole-life costing of future developments.

III. VENTILATION SYSTEM

One of the major components of the building structure is the window. Windows provide for light, ventilation and view within the building (Ching; 1975[7]). In building construction, the ventilation system is very essential. Window as a major element of the building falls within the external wall. The window performs various functions including lighting and ventilation (fenestration). For modern buildings, different types of windows design are available and in use. In recent times, the use of glazed sliding windows has been in vogue. In general, window can be classified into two categories; according to the method of opening or the material used. Window design by the method of opening ranges from casement (panel), to pivot (louver blades), double hung and sliding windows (Seeley; 1974[8]). Apart from the aesthetic values of these window types, they also present different values in terms of their ventilation performance. The wider the window element can be opened to let in fresh air, the higher the functional value irrespective of the material used. Architecturally, it has been noted that the performance/functional value of window design ranges from 100% panel, 100% louver blade to 50-66% fenestration for sliding windows (Ching; 1975[7]). It therefore holds that achieving a high level of fenestration in modern day building requires a trade-off between aesthetic and functionality. In other words, some other means of ventilation (mechanical) will have to be adopted to achieve effective ventilation within the building.

Bower (2008[9]) observed that current guidelines suggest that a general ventilation system should be able to provide a continuous air-exchange rate of either 15 cubic feet per minute (cfm) per person (or 1/3 of an air change per hour (ACH), whichever is greater). Considering Ching's[7] performance rating of the different ventilation systems earlier identified, the panel and the louver blade windows will achieve the 15cfm per person while the sliding window will only be able to provide 7.5cfm per person.

Commenting on the level of air exchange in houses without mechanical ventilation systems as observed from another study during a heat period, Bower (2008[9]) noted that 90% of the houses had an average "natural" ventilation rate less than 1/3 ACH for at least a full month. 70% of the houses had a natural ventilation average below 1/3 ACH for the entire period. Based on this study, he concluded that most houses need mechanical ventilation to meet up with what is required for a comfortable accommodation.

IV. COST-IN-USE

The term cost in use is a technique of cost assessment in which both the initial cost and the future running costs of a building project are reduced to a common measure as explained by Seeley (1984[10]). Though argued to be obsolete grammatically, its application is very relevant as it means the same thing with total cost (Seeley; 1997[1]), whole-life cost (Perry, Brandon & Perry; 1999[2]) and Life-cycle cost (Fuller; 2008[11]). It encompasses the cost of erection, operating and maintaining the property throughout its life span as shown in fig. 1. Another term that is synonymous with cost-in-use is life-cycle cost analysis which is a method of assessing the total cost of facility ownership. It takes into account all costs of acquiring, owning, and disposing of a building or building system. It is especially useful when project alternatives that fulfill the same performance requirements, but differ with respect to initial costs and operating costs, have to be compared in order to select the one that maximizes net savings. While the cost-in-use techniques can be used to assess the cost of a building element, it can also be applied to mechanical and electrical installations within the building and to the project as whole.

However, the usage of these techniques within the industry is not without some setbacks. The first and the most important of such is the attitude of developers to the future costs of the project. Secondly, there is difficulty in forecasting future costs especially in an unstable economic environment like Nigeria.

Cost-in-use of construction projects/ components can be assessed by using the Present value cost which brings all the estimated future cost to be incurred to a “Present value”. This can also be achieved by calculating the Annual equivalent cost in which the initial and the running cost are assessed on an annual bases using the “Sinking fund factor” or through the Years Purchase where all the costs, both initial and future (annual) are calculated using the (YP) “Year Purchase”.

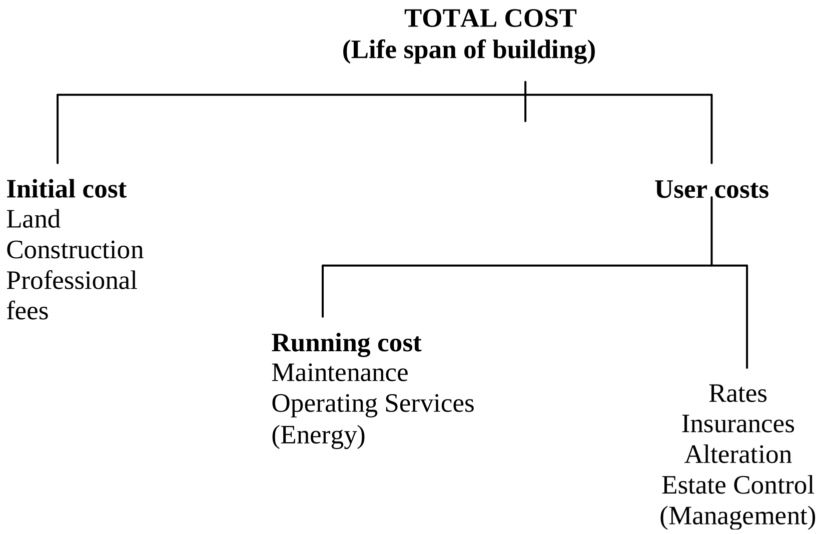

Figure 1: Life cycle cost
Source: Seeley, (1984)

V. METHODOLOGY

The methodology involves a survey study of three major types of **glazed** window designs. It includes the compilation of cost data for the different types of window designs under consideration. It also considers data on the level of comfortability of the window designs in respect to ventilation. Information on the use of additional ventilation systems within the building to achieve optimum ventilation was also collated. The different window designs considered for the purpose of the study are - the Panel, Louver blade and Sliding window panes for window size 1200mm x 1200mm. For adequate ventilation within the building structure, a window design of Panel or Louver blades requires additional ventilation from Ceiling fan while Sliding window due to its performance value requires the use of an Air conditioning system for effective ventilation (Bower, 2008[9]).

The estimated future (running and user) costs in Naira were multiplied by the “**Present value factor**” from the Present value of ₦1 and Present value of ₦1/annum tables (Ferry, Brandon & Ferry; 1999[2]). The cost parameter is as shown in TABLE I below. All costs are entered as amounts in naira. The operating cost in ₦ is the cost of using the alternative power supply to run the ventilation systems since power generation in Nigeria is more or less unavailable on the average. The running cost (₦) is calculated assuming that the alternative power supply is used 4hours on daily basis for a year. On the average, it is observed that a 1kv power generator will use up four liters of fuel in four hours, therefore the total operating cost per annum is calculated using the pump price for fuel in Nigeria (₦65:00/litre average cost)

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According to Bluejay (2003[12]), a medium window-unit AC requires 1000 watts of electricity/hour (1kW/h) while a 42" ceiling fan on low speed requires 24 watts in 10 hours (0.24 kW/h). This implies that a medium sized AC window unit will consume **four** times of what the 42" ceiling fan will consume in an hour.

VI. DATA ANALYSIS AND DISCUSSION

The aesthetic and the performance values are as shown TABLES I and II as follows. The Panel window with low to medium aesthetic value has 100% performance value, Louver window has medium and 100% aesthetic and performance values respectively while Sliding window with high aesthetic value has 50-66% performance value. It implies that though aesthetically acceptable, the performance value of the Sliding window is on the average. This is likely to reduce with the increasing level of global warming.

Table I: Cost Data for Different Window Designs

Window type/ Cost element	Panel (Casement) ₦. K	Louver blade ₦. K	Sliding panes ₦. K
Value: Aesthetic	**Medium**	**Medium**	**High**
Performance	**100%**	**100%**	**50-66%**
Additional vent. Sys (Mechanical)	**C/ f (2,500.00)** **12,000.00**	**C/ f (2,500.00)** **6,000.00**	**AC (35,000.00)** **10,000.00**
Initial cost of window	**0.00**	**0.00**	**0.00**
Maintenance cost/annum	**(1,000.00)**	**(1,000.00)**	**0.00**
Replacement every 5 yrs	**0.00**	**0.00**	**(14,000.00)**
Servicing of add. vent.every 5 yrs	**48, 000.00`**	**48,000.00**	**48,000.00 X4 (192,000.00)**
Operating cost/annum (4hrs/day)			
Inflation rate -5%			
Int. rate – 25%, 10 yrs			

Source: Market survey (2010)

The difference in the initial cost of the three different designs is not so significant. An additional cost of ₦6, 000.00 (100%) is required as the initial costs of panel windows as against louver windows with the same level of functionality. The difference between the initial cost of the sliding and the louver window is ₦4, 000.00 (60% increase for sliding window) with a difference of ₦4,165, 140.00 (326%) future cost, and a difference of ₦ 2,000.00 (20% increase for panel window) and N4, 159,140 (324%) initial and future costs for sliding and casement windows respectively. The high initial cost of Panel (casement) window is paid for by its high performance value (100%). The Louver window costs the least both at the initial and future with 100% performance value. However, it requires the replacement of broken blades at 5 years interval. The initial cost of installing the Sliding window is on the average while it has the highest future cost, but for its aesthetic and modern value, clients do not take it as significant. The difference in the future cost is however very significant and is bound to increase given the current increase in global warming.

Though the differences in the initial costs are not so significant compared to the differences in the future costs, the significant difference in the future costs has its implication for the construction industry, especially the building owners. The cost is prone to increment as long as the ozone layer depletion continues and the level of deforestation increases. An additional cost of 20% at the point of installation for panel window will save the building owner as much as 324% future cost which will be required to run additional ventilation system.

Table 2: Present Value of the Cost Elements

Window type/ Cost element	Panel(Casement) ₦. K	Louver ₦. K	Sliding ₦. K
Initial cost of the window	12,000.00	6,000.00	10,000.00
Initial cost of Mechanical Ventilation	2,500.00 (42"ceiling fan)	2,500.00 (42"ceiling fan)	35,000.00 (Air Conditioner)
Maintenance cost of add. Vent/ann. x 25.71	0.00	0.00	
Replacement every 5 yrs x 32.8	32,800.00	32,800.00	0.00
Servicing of additional vent. every 5 yrs x	0.00	0.00	0.00
32.8	1,234,080.00	1,234,080.00	459,200.00
Operating cost add vent/annum x 25.71	=	=	4,936,320.00
	1,281,380	1,275,380.00	=
Total Cost (PV)			5,440,520:00

Source: Market Survey (2010)

VII. CONCLUSION

From the foregoing, it is obvious that Clients are not well informed of the future implication of their design choices. Choice of building components are made based on the aesthetic values and what is generally in use by other building owners irrespective of its functional value. Therefore, for sustainable building development, there is need for concerned effort to be put in place by the professionals involved in the building industry especially the Architects and the Quantity surveyors. The whole life cost of any building development should be painstakingly considered right from the design stage. Therefore the following are recommended;

a. There is need to sensitize the construction industry's client on the choice of building elements in respect of global warming and environmental degradation.

b. The architect should show more concern for the functionality and future costs of the building elements to be used at the design stage.

c. Cost advice should be sought when making design decisions to salvage the risk of incurring excessive future cost.

d. The services of professional quantity surveyor in giving cost advice to both the architect and the building owner is more paramount now than ever before.

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