



## Architects' View on Design Consideration that Can Reduce Maintenance Cost

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### Abstract

*Buildings are designed with the intent of lasting for a certain period of time. Building maintenance in different building typology is described as multi-faceted activities which involve planning, directing, controlling and organizing resources for the sustenance of the building's physical, functional and operational performance. The research focused on ways cost of maintaining a building was done, effectively or efficiently with the influence of the design approach used. Literatures of works pertaining to building maintenance were reviewed to identify the various impacts, influences that a building design would have on the cost of maintaining any building type. Maintenance departments of educational institutions were surveyed and data analyzed. The study revealed that maintenance culture of buildings could either be positive or negative, based on the quality of design approach used. The study recommends a proper review of building codes and regulations by organizations intending to erect building structures with a view of designers to specified standards and prevent excess maintenance cost in the future.*

**Keywords:** Design Considerations, Maintenance culture, Maintenance strategy, Maintenance cost

### 1. Background to the Study

The Architect as the head of the design team plays a very crucial role in affecting the cost of building projects. From the very moment the Architect begins conceptualizing ideas for any building construction via design, it is in that moment that one begins to affect the life cycle in the area of cost of the building construction. It is high time that Architects and allied professionals pay close attention to maintenance needs of the proposed buildings. With choices at the design stage, the architect can retain the value of the investments going into a building project. For this reason, the design stage is very crucial; every line in the design and every instruction the architect issues would determine the building performance. The emergence of the topic of cost in almost every construction work is one that is seldom far from the minds of the clients, the designer and construction team (Hughes, Champion & Murdoch, 2015).

Building maintenance is the most economical way of keeping the building and equipment in their best form for normal use. To preserve the building design, to retain the construction and all other building components, the Architect needs to put in mind the maintenance type. Maintenance

enhances the quality of a building structure to meet modern requirements in order to prolong the life span of the building. It is required to ensure the safety of building occupants. Shohet and Straub (2013), made it clear that there are increasing demands on maintenance programme to provide tools that will support maintenance planning. This is also confirmed by Olagunju (2012) who also noted that the absence of appropriate tools for predictive maintenance of existing buildings can have a detrimental effect on the future of such buildings. It is necessary to carry out maintenance works for the safety of users and properties in the buildings, to also preserve the physical condition of the buildings and keep the buildings in good operational state at all times. Appropriate building maintenance can be achieved by providing maintenance tools for all public buildings, (Izobo-Martins, 2014).

Furthermore, Izobo-Martins et al. (2014) emphasized that maintenance is not important to all building types in any location. Regardless the cost of construction, all buildings would at a point has maintenance consequences. Building requires adequate maintenance as they get older, although the price of materials and labour will always rise along with inflation and standard of living. In many instances, building owners and users spend billions of avoidable cost each year on excessive maintenance and replacement of components in their buildings. Less attention is given to maintenance needs. Many building owners, private and government rather let buildings deteriorate into a state from which it is very difficult and costly to recover (Assaf, et.al, 2011). Building maintenance is a seriously ignored area by building owners and occupants. Our environment comprises of a lot of physical infrastructural investments and therefore undergoes some changes with time. These changes can take place either in terms of technology or physical structure. It is therefore of paramount importance that these infrastructural facilities which include public buildings are effectively maintained in order of these facilities to offer maximum architectural, aesthetical and economic functions.

Shohet and Straub (2013) discussed increasing demands on maintenance program to provide tools that will support maintenance planning. Olagunju (2011) affirmed that the lack of appropriate tool for predictive maintenance on existing buildings and infrastructure can have detrimental effect in future. Maintenance of the built environment has impacts on the whole nation (Khasreen, Banfill, & Menzies, 2009). Such impacts should become paramount to building designers and owners in order to reduce cost. The conditions of the surroundings in which we live and learn and work has high impacts on the productivity. Maintenance management of buildings is a multifarious subject in the real sense of facilities management. Zubairu (2010) attributed the array of abandoned and epileptically functioning of facilities in the public buildings in Nigeria to poor or lack of maintenance. The qualities of the physical environment where people live, work and go about their daily activities can have massive impact in their way of life, behavior and thinking. This could bring about positive or negative impact on the people and their lifestyle. One of the critical problems confronting the Nigeria governments is the poor maintenance practice and culture, despite that they are the owners of many public buildings.

Public buildings play a major role in the development of a nation and these developments cannot be over-emphasized. For a public building to perform efficiently and effectively, maintenance cost needs to be considered in the yearly budget of government and overall construction team. This depends on the nature of buildings and some factors such as maintenance tools, strategies, policy, plan, training, fund, culture, experts and user's attitude. The conditions of the building can be measured by maintenance managers at intervals. All Public buildings are prone to defects due to their permanent and lengthy usage. All building components deteriorate at a greater or lesser rate depending on materials and method of construction, environmental conditions and the use of the buildings (Faremi, & Adenuga, 2012).

Neglect of maintenance has grasping results with rapidly increasing deterioration of a building exterior accompanied by harmful effects on the contents and occupants (Seeley, 1987) as cited by Cobbinah, P. J. (2010). Therefore, buildings are too valuable assets to be neglected or abandoned, building maintenance is the most economical way of keeping the building and equipment in their best form of normal use, to preserve the building design and to retain the construction and all building components without minding the maintenance type, (Izobo-Martins et al., 2014). Furthermore, the maintenance work should not be limited to only the functional places,

maintenance of urban infrastructure is a complex task that is even more difficult with taking decisions to prioritize aspects to be maintained. Durodola and Oloyede (2011) avowed that buildings that implement facilities management as asset management tools are more active in service delivery. This is a confirmation that maintenance management should predominate in the running of public buildings in Nigeria. Since it has been tested and confirmed to be a good tool. According to Iyagba, (2005) it is an impossible act to design or construct buildings which are maintenance free. However, maintenance issues can be minimized by good architectural design, standard construction, using ideal methods and styles ensuring that they are carried out by skilled experts or competent craftsmen doing this by using suitable codes of installation, requisite building materials and methods. Management of any process involves assessing performance, and maintenance management of buildings is no exception (Zubairu, 2010). When maintenance policies and strategies are put in place in buildings, it ensures the highest safety standards. Therefore, designing with maintenance policies and strategies of buildings must improve overtime. It ensures the most economical way to keep the building and equipment in the best of form for normal use, given the original design and materials.

*'We want to retain the expensive things of life that cost nothing because the cheaper things cost less' John Ruskin.*

Almost every individual wants the expensive things in life at a cost-effective price thus the need to maximize the resources at your disposal. A lot of people when talking about building cost focus on the initial cost of construction and not on the overall life cycle cost which includes the cost of maintenance of the building. According to the Oxford dictionary, maintenance is the process of keeping something in good condition- which in this case involves buildings. A building that is not well maintained or requires too much of maintenance often don't endure up to their expected life cycle. This is because they will begin to deteriorate or will be too much of a financial burden in terms of keeping up with the maintenance of the building; which can lead to demolition of the structure. This can however be avoided if the Architects takes into contemplation the need for careful and systematic planning, monitoring, budgeting and implementation. The interrelation that exists between the design and the life cycle of a building is one that is non-negligible.

The life of a building is one that is of importance at the briefing stage; although often not considered (Wood, 2003). A building that had or has to have major or many major repairs or has been demolished at an early stage in its expected life cycle is majorly associated with faults in its design. The idea of increasing building life expectancy is also affiliated with the excellence and extent of maintenance that is passed out. A building that is properly maintained are expected to have a good life duration. This would be appreciated, as long as the design has not brought about the need for excessive maintenance cost. Therefore to establish the relation between the expected lifespan, design and maintenance of a building, it can be concluded that faults in design can increase the maintenance activities of a building and also shorten the lifespan of a building (Ishak, Chonan, & Ramly, 2007). Maintenance is characterized by the many activities and interests with the aim of promoting sustenance at all times within environmental development to achieve the value of money spent. It can also be described as a set of routine activities aimed at preserving environmental development. It is now important to consider maintenance issues in the design process that would be a way to improve the performance of the existing building facility. Buildings require efficient maintenance programmes to enable them to be serviced properly and to meet up with their life spans. All buildings deserve to be maintained, regardless of the cost of their construction since they all have maintenance consequences.

The maintenance of structures affects the sustainability of the structures. Sustainability is a key factor to consider in design; not only for environmental reasons, but it also promotes architectural quality and it has economic advantage (ECDGE, 1999). Sustainability allows for economic savings through efficient design with reduction in the buildings' environmental footprint (Braganca, Vieira, & Andrade, 2014). The importance of considering sustainability in the design stage of a project curbs the subsequent need for finding long term solutions for issues that may arise. The choice of the architect begins to show when the client has occupied the building. If the architect specifies sustainable materials and designs a sustainable building he will be able to reduce the ultimate life-

cycle cost of the building. A sustainable approach to design will require an integrated design process and a more involved approach rather than a conventional design process. (Braganca, Vieira & Andrade, 2014). Likewise, a high quality design will ensure maximum and efficient performance of building through its life cycle.

In an attempt to find a relationship between building design and maintenance, (Ramly, 2006) indicates that there are four sections of the design of buildings that should be considered. These should be regarded as important if there is a decrease in unplanned maintenance works at the post-occupancy stage and they are;

- i. Building Exterior; Wall, floors, roofs, doors and windows;
- ii. Internal finishes; Ceiling, wall and floor finishes;
- iii. Special design features; Decorative elements for doors, glass, windows, air vents etc. and
- iv. Cleaning and housekeeping of building components.

The study explained that the designer must have proper knowledge on the use of specified materials and the consequences they have. There is always movements of building materials that do affect the building in a number of ways, which sometimes cause cracks in walls and faults in structures. If thermal expansion of the materials is not put into consideration, it sometimes result in distortion of joints that are meant to be impermeable which will result in penetration of water and/or loss of adhesion. Absence of architectural detailing or presence of inadequate detailing will lead to deterioration of building. When architectural detailing is vague, workers on site construct what they deem fit to be in place. This can collide with what the architect envisioned as this can result in faults in the building because what has been constructed is not of adequacy. Likewise, insufficient detailing will lead to inadequate elements of the building, such as Insufficient detailing of projections and other water protecting building elements. Doing that would result in the decay of the surface of the buildings and lead to deterioration of reinforcements leading to the need for early and expensive material intervention. (Cooks & Hinks, 1992). Incorrect material selection can add to maintenance burdens financially, they can also constitute to the issues of thermal movement, distortion or failure of the structure at an early stage.

## 2. Statement of Problem

Many Nigerian public buildings are often inadequately maintained (Izobo-Martins, 2014). Windows, doors and other buildings elements in buildings frequently show evidence of lack of maintenance and repair. Some of the public buildings or institutions have low or no maintenance policies and strategies. These have resulted in such buildings being in dilapidated state and leaving some buildings abandoned. Lack of maintenance by the authorities and occupants of facilities often leads to reduced lifespan of these buildings (Melvin, 1992; as quoted by Cobbinah, 2010), and does not make them to function according to their needs and expectations. The problem of ownership of buildings is basically occupants regarding it not as their own property but a state or federal government property. They handle it without due care which has largely resulted in the conditions in which most public buildings find themselves (Cobbinah 2010). Most users of some buildings do not treat these buildings as their own and therefore have passive relationship to the efficient use and maintenance of the buildings. Most offices in some area of Lagos are dilapidated and lack the basic necessities and amenities such as toilet due to its state of deterioration and dilapidated offices. New buildings are being constructed without proper maintenance policies and strategies in place (Izobo-Martins et al., 2014). Some of the public buildings in Nigeria show frequent wall cracks, rotten wood members, leaking roofs, damaged window and faded wall paint. Lack of maintenance of some police buildings including police cells in recent times have resulted in jailbreaks in some police stations in the country leading to the escape of hardened criminals in custody (Cobbinah, 2010). Some educational institutions especially basic schools hold classes in the open air at the mercy of the weather (Izobo-Martins et al., 2014).

Furthermore, Khasreen, Banfill, & Menzies (2009), established that buildings incur costs over their life time; these include initial capital costs, operating costs, and maintenance, disposal and finance costs. From that statement, it became obvious that the architects' attitude towards initial versus the whole life cost of the building can significantly influence the specification of building

materials and the maintenance. All elements that make up a building wear out at either a greater or lesser rate which is dependent on materials and methods of construction, environmental conditions, use of buildings. It is highly desired to create buildings that do not require maintenance but this it is not feasible. Nonetheless a lot can be done at the design stage to minimize the amount of subsequent maintenance works and costs. A close look at Nigerian environment shows poor building maintenance pattern among buildings owners/occupiers. It was discovered that most of the public buildings are left unattended to, the major preoccupation then seemed to be, construction of big edifice without considering subsequent maintenance of such a property. Thus maintenance of building in Nigeria tends to be a sort of burdensome one, and it is also load with a lot of problems which tends to hampers it and makes it a sort of extraordinary task. The above problems could be countered by considering certain virtues in total. It is believed that if the principle of considering maintenance in the cause of designing could be applied by Architects. It is obvious that maintenance of the building will however ensure that the building is restored thereby increasing its life span.

It would be hard to find one best solution to promote safety and reliability of maintenance activities or to determine and describe deterioration factors in general. The manner of usage of a building can result in disrepair and exposure to natural forces. Human activities responsible for the deterioration and decay of building includes failure to clean and carry out routine maintenance apart from poor design. There is high ignorance on the parts of the designers which causes deterioration and decay, failure to promote awareness of maintenance needs by all users' the building and adopting a negative attitude of waiting until emergency measures are required. Others are presence of chemical, fire, faulty design, construction, materials and systems as well as vandalism, (Adenuga, 2010). However, Olagunju (2011) explained that deterioration can however be avoided or rectified through maintenance of the building. Planned and unplanned maintenance can make the necessary impact only if the financial regulator of the building through correct diagnosis of defects ensures that funds are made available for such a purpose. Failure to undertake regular maintenance of a building will ultimately in reduce the life span of the building and finally leads to abandonment and demolition.

Adejimi (2011) advised Architects to put in maintenance consciousness into design since people build only for them not to maintain the buildings. Furthermore, the study established the need for Nigerian architects to imbibe maintenance culture as a life style. This would be a major factor of the possibility of designing little maintenance building and low maintenance needs. It also recommended a model of maintenance management in buildings designed by Architects.

### **3. Objective**

This paper therefore examined Architect's opinion on building design and the implication on maintenance cost. To this end therefore, this study is about studying an approach through maintenance cost can be reduced through building designs.

### **4. Methodology**

#### *4.1 The Research Design*

Data for the study are from a systematic random sample using of about 10 percent of the 720 Architects which is the sample in this study. Questionnaires, are the main instruments tools adopted in this study. The population for the study comprises professionals who are registered architects with Nigerian Institute of Architects and Architects Registration Council of Nigeria practicing consulting, contracting and building development firms, some are working in Federal /State ministry of works and housing. The questionnaire was distributed at the Annual general meeting which took place at Abuja in November; 2015. Out of 72 questionnaires distributed, 60 of them were properly finalized, returned and careful considered to be useable. Primary data was collected through questionnaires whilst secondary data was extracted from journals, text books, lecture notes, seminar papers and occasional publications. The data were processed and analyzed using SPSS20 statistical analysis software, descriptive statistics using mainly simple percentage.

## 5. Data Presentation

In this section, data collection and analyses are presented in relation directly to the stated objectives of the study that assisted. The instrument used in the collection of data and its subsequent analysis are clearly identified including the characteristics and nature of data collected and treatment of the data. Ten variables were adopted in all.

**Table 1:** Ranking of factors affecting maintenance cost in building design.

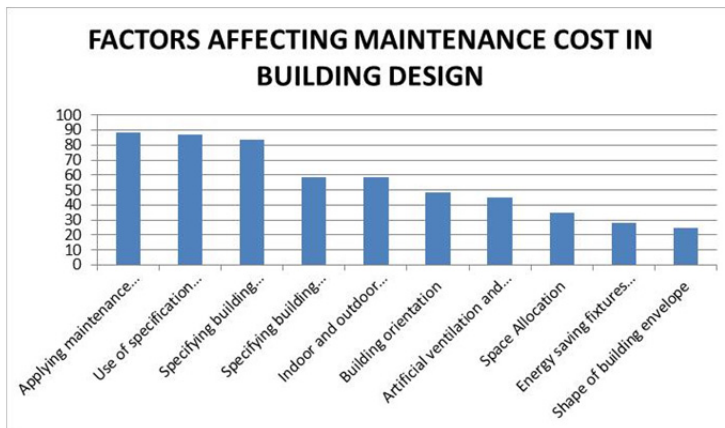
Factors	Frequency	Percent	Rank
Applying maintenance strategies	53	88.3	1st
Use of specification documents	52	86.7	2nd
Specifying building population	50	83.3	3rd
Specifying building population	35	58.3	4th
Indoor and outdoor signage	35	58.3	4th
Building orientation	29	48.3	6th
Artificial ventilation and lighting	25	41.7	7th
Space Allocation	21	35	8th
Energy saving fixtures and fittings	17	28.3	9th
Shape of building envelope	15	25.0	10th

Application of maintenance strategies ranked the highest among the factors that affect the maintenance cost in building design with 88.3% followed by the use of specification documents with 86.7%, then specification of building population with 83.3%. These three factors were the most significant. Other factors ranked in descending order include, educating the building users and use of indoor and outdoor signage which both had a percentage of 58.3, building orientation with 48.3%, artificial ventilation and lighting with 41.67%, space allocation with 35%, energy saving fixtures and fittings with 28.33% and shape of building envelope with 25%.

## 6. Discussion of Findings

From our findings maintenance cost would reduce if the factors listed above are considered when architects are designing buildings. The major problems with maintenance are that architects do not put it into consideration when designing as observed from the analysed data.

This study established that most public buildings were designed without maintenance manual and most users lack maintenance culture, all of which reduce the life of the building.



**Figure 1:** Factors affecting maintenance cost in building design



The figure above showed that the factors affecting the maintenance cost in building design as ranked by the respondents. According to the research, the application of maintenance strategies was the most selected factor by the respondents while the shape of the building envelope was the least selected.

Based on the findings in the study in order to reduce maintenance cost of a building from the inception stage of the design, the architect should have proper knowledge of space and cost management. They should be abreast with all the changing trends and materials in the construction industry in order to make proper decisions that will save cost and reduce wastage of resources and materials. This will give value to the building design and help increase the life cycle of the building. It is also recommended that more detailed research should be done on factors that influence the cost of a building structure. Standard measurement should be applied at the initial stage of design in order to avoid wastage of materials.

The result in Figure 1 showed that 53 out of 60 of the respondents amounting to 88.3% indicated that applying maintenance strategies contributed majorly to reduction in maintenance cost. This is an indication that maintenance strategies are the key drivers in reduction of maintenance cost. Therefore, justifying the reason for considering maintenance issues at the design stage. Use of specification and specifying building population accounting for 86.7% and 83.3% respectively, this indicates that they are vital factors affecting maintenance cost in building design. This further highlights a fact that these two factors should be considered relevant at the conceptual stage of building design by the Architects in order to reduce long run maintenance cost. Energy saving fixtures and fitting with shape of building envelope amount to 28.3% and 25.0% respectively. This is an indication that these factors are the least to be considered in planning for reduced maintenance cost in building design.

From the discussion and findings so far, there is a lack of effective national maintenance policy, laws and regulations to compel both state government and Architects to carry out maintenance. There is majorly no maintenance documentation and maintenance manual in the office or on projects of the investigated Architects who are the respondents. Public buildings maintenance is handled like maintenance of individual buildings since many professionals are only using their discretion and experiences over time. Another hurdle to maintenance strategies of public buildings is funding. Inadequate funds and delays in the release of funds by government were found to have contributed significantly to the present state of public buildings.

## 7. Concluding Remarks

The architect while considering aesthetics should not forget the cost implication of his design. A design must not be costly to be beautiful therefore the architect should try to design a simple but not basic envelope especially if the building is not a monumental one, like a museum. The factors stated in the study when taken into consideration while designing will reduce the maintenance cost of the building. Some maintenance problem can be avoided by better design, detailing, and improved specification writing of building materials but this should be done with proper consideration of environmental conditions. Finally, this study concludes that:

1. Maintenance would be better if maintenance strategies are applied while designing buildings.
2. There is need to have and enforce the use of building standards, codes and regulation.
3. Readily available and sustainable materials should be specified by the architect and his specifications should be followed judiciously.
4. Professionals should cultivate the habit of maintenance plan at the design stage of a building.
5. Changes in building during construction need to be documented with the required maintenance strategies.
6. Signage should be installed within and around buildings in order to help educate the users.

## 8. Contributions to Knowledge

This study has demonstrated that appropriate design would influence the maintenance cost in public buildings. The contribution to knowledge of this research could be viewed in respect of its

immediate contribution to the body of knowledge. This study adds to the body of knowledge by suggesting factors that influence the maintenance cost of buildings with regards to design. As in previous research, the use of maintenance strategies cannot be overemphasized in addition with high consideration of the other nine factors. To this end therefore the factors stated in this study should be applied by architects in the design of buildings.

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