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Abdulganiyu A. Oke, Nhigs

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IMPACT ASSESSMENT OF FACILITY MAINTENANCE COSTS ON THE SUSTAINABILITY OF BUILT ENVIRONMENTS IN NIGERIA

Abdulganiyu A. Oke, MNIQS
Dept of Quantity Surveying, Federal University of Technology, Minna, Niger State, Nigeria.
Nolubuisi Ogbonnaya.
Dept of Quantity Surveying, Akanu Ibiam Federal Polytechnic, Unwana Afikpo Ebonyi State, Nigeria.

Abstract
This paper provided empirical evidence on the implication of trends in maintenance costs for sustainable building preservation efforts. Specific objectives of the paper were the creation and comparison of annually updated indices for (a) selected components of maintenance costs, (b) inflation levels, and (c) annual salary for academic staff of professorial rank. The findings of this paper were limited by the use of the HATISS salary scale (basic emoluments only) as a proxy for the actual take home pay. This paper adds to existing building assessment methodologies by taking into account the implied sustainability of maintenance, given the incomes of tenants. The findings of the paper include that costs of maintaining a standard two bedroom bungalow building were in excess of the basic salary earned by a government employed worker of professorial rank. The least maintenance cost recorded was 63% higher than the highest earning of such worker. The paper thus recommended the opening up of easily accessed lines of credit for maintenance purposes built into mortgage loan packages. To ensure that proper effect is given to such strategies, a National Policy on Maintenance of Buildings and Infrastructure could be established independent of the existing policies on Construction and Housing.
Keywords: ***costs, indices, maintenance, salary, sustainability.***

Introduction

Maintenance works are of significance to national economies and low income settlements in terms of value added (GFCF and GDP). The construction of a dwelling unit constitutes a greater proportion of individual earnings/savings and cannot be replaced easily. Maintenance works are poorly funded in Nigeria, because specialized funding arrangements do not exist. Finance is usually provided on an ad-hoc basis, without recourse to long-term plans, as was the case with public post office buildings in Japan, (Kazunobu 2004). Public infrastructure owners are adopting innovative financing arrangements that essentially 'pulls' projects from the private sector, (Garvin and Cheah 2004).

In Nigeria as in most parts of the world major construction projects have been planned, designed, built, and delivered to the customer with little consideration of the costs, resources and systems required to operate, maintain and support the facility effectively. This practice is unsatisfactory since, over the life span of a building, the maintenance, repair and operating costs may be two or three times the initial capital cost (Spedding, 1994; Construction Technology Foresight, 1995; and Egan, 1998). Writing on Singapore, Aoieong et al., (2002) posited that construction industries need to reduce maintenance costs and subsequently entire life cycle costs of buildings. Such maintenance and repair costs can be quantified by: (i) the expenditure on rectifying the defects attributed to the shortfalls in design (Briffett, 1990; Al-Hammad and Assaf, 1997; Mselle, 1997; Tesfaye, 1997; Arditi and Nawakorawit, 1999), (ii) inferior construction workmanship (Assaf et al., 1995; Dunston and Williamson, 1999) and (iii) ineffective maintenance strategies (Kondo et al., 1990; Chew, 1994; Blanchard and Lowery, 1969; Shen et al., 1998; Lam, 2000).

In the light of the foregoing, this paper focuses on the collection and analysis of relevant data to provide empirical evidence on the implication of trends in maintenance costs for sustainable building preservation efforts. Specific objectives to be achieved will include the creation and comparison of annually updated indices for (a) selected

components of maintenance costs, (b) inflation levels, and (c) annual salary for academic staff of professorial rank. The scope of this paper covers only the generation of cost indices from secondary data, and the use of the indices for comparison purposes only. The findings of this paper are limited by the use of the HATISS salary scale (basic emoluments only) as a proxy for the actual take home pay of academic staff of professorial rank, which has been subjected to various reviews over the period of the study. The study is located in Minna, the host town for the Bosso Campus of the Federal University of Technology, from where the maintenance data was sourced (see Map 1and 2).

Map 1: Nigeria showing Niger State

Map 2: Niger State showing Bosso LGA (shaded)

Related Works

Methodologies for Maintenance Audits of Residential Buildings

The status of buildings/infrastructures should be ascertained at intervals through a maintenance audit. Pullen et al., (2000)'s method proposes seven key performance indicators (KPIs) that provide benchmarks for the asset management (AM) of medical facilities. These indicators however neglect factors such as building performance, intensity of use, and sources of personnel. O'shea et al., (2000) specified the building's age as one of the factors affecting performance. Barrett (1995) supports the evaluation of user-needs through a post-occupancy evaluation (POE) process as a management aid. Some building evaluation methods use statistical techniques in order to reduce the scope of the survey (Uzarski and Burley, 1997). In buildings that require rehabilitation or renovation, the diagnosis of deterioration is done using statistical, quantitative and analytical tools (Baba, 1990). Another model of evaluation, utilized in the renovation of military facilities (Reddy et al., 1993), is based on three functions: (i) physical parameters; (ii) functional parameters, such as geometry, safety, and system compatibility; and (iii) facility location and peripheral infrastructure.

Mailvaganam and Alexander (2000) developed a multi-phase procedural processing model of repair activities, which is based on user-friendly building evaluations. The Point Accumulation System, developed by Shen and Lo (1999), ranks a large number of buildings using three criteria: (a) the building's physical state; (b) the importance of the building's function; and (c) the influence exerted by its users. Fwa and Chan (1993) used neural networks to determine priorities in the rehabilitation and maintenance of infrastructures and highways. Spedding et al., (1995), developed a method termed the Multi-Attribute System, which utilized six criteria for the determination of maintenance priorities (Shen et al., 1998; Shen and Spedding, 1998). These were: (1) indispensability of the building, or the lack thereof; (2) physical condition of the building; (3) importance of the facility's use; (4) resultant effect on the users; (5) resultant effects on fabrics; and (6) effects on service provision.

Caccavelli and Genre (2000) summarized the current state of a building using a methodology made up of 50 elements, which are code-ranked as: a – good state, b – slight degradation, c – medium degradation, or d - poor state (requires replacement). Allehaux and Tessier (2002) implemented quality criteria to determine functional obsolescence of electro-mechanical systems in office buildings. Hayashi (2000)'s methodology had five parameters, in which the extent of planned maintenance activities actually implemented was assigned the highest-ranking parameter (0.4 out of 1.0). A joint research by CSIRO and Queensland University of Technology developed a prototype model to facilitate decision-making regarding the selling, the maintenance, and the reviewing of building portfolios. The model includes two principal indicators: the Property Standard Index (PSI), and the Hold/Sell Index (O'shea et al., 2000). The PSI is based on a series of factors relating to the physical condition of the building, its age, and its standard of building relative to newly constructed residential buildings (Johnston et al., 2002).

Institutional Arrangements for Environmental Preservation

Quality, environmental, and safety (QES) systems are an approach to doing business that attempt to maximize the competitiveness of an organization through the continual improvement of its product, services, people, and environment (Koehn and Datta, 2003). The ISO 14000 family addresses various aspects of environmental management. Since its adoption in 1996, more than 430,000 organizations in 158 countries have achieved ISO 14001 registration, the majority of which are in the manufacturing industry. (Pheng and Wee 2001). Indigenous Nigerian construction companies are yet to achieve ISO 14001 registration. Legislation has also contributed to the propagation of the ISO standards, as in Australia where construction organizations wishing to export their services must obtain ISO accreditation (Jones et al., 1997; Love and Li 2000). In Singapore and Hong Kong, explicit reference is made to ISO 9000, and certification is a prerequisite for contractors who wish to bid on certain public sector projects. Nigeria is however yet to legislate on the ISO standards in construction, proper implementation might lead to discernible benefits (ISO 1994b).

Overview of Cost Indices

A simple way to get a general sense of the price of a class of goods would be to take the (arithmetic) average of the price of each good. Price changes are reflected by computing the new value of the index, taking the average of the new prices. This approach meets one of the most basic criteria a price index should have: if the price of all the goods in the class goes up, then so does the price index. Index values are normalized so they are reported not in currency units, but rather in percentage terms. The most common way to do this is to take one year of the index as the "base" year and make that index value equal to 100. Every other year is then expressed as a percentage of that base year. In a normalized index the number 108, for instance, would mean that the cost for the goods concerned is 8% more in the current year than in the base year, (Chance, 1966; Diewert, 1993; Triplett, 2004).

Methodology of the Research

Spurred on by a growing notion that market-oriented policies can better achieve sustainability goals (Cowan, 1998; Heyes, 1998; Achanta 1999), guidelines have emerged on the environmental issues likely throughout the building construction process (CIRIA, 1994; BSRIA, 1996; Woolley, 1997). Maintenance requirements of buildings are however not yet exclusively subjected to building assessment schemes. Unfortunately, existing schemes are predominately focused on environmental improvement in the areas of environmental protection, but fail to acknowledge the broader social and economic dimensions (Goodland, 1994, 1995; Guy and Kibert, 1998; Curwell and Cooper, 1998; Cooper, 1993, 1999). These dimensions are those that have to do with the levels of expenditures associated with the maintenance of buildings, as well as the affordability of such expenditures with respect to the occupants/owners of such buildings. This paper adds to existing building assessment methodologies by taking into account the implied sustainability of maintenance, given the incomes of tenants. Data on costs

incurred in the maintenance of eight units of 2-bedroom bungalow flats were obtained over a seven-year period. The costs were detailed under four elemental components (see Table 1 below), which were then compared to inflation and income levels of likely tenants.

Table 1: Raw data for analysis

Year	Maintenance Costs[a]					Inflation Rate[b] (%)	Income[c] (HATISS GL15)
	Plumbing	Carpentry	Electrical	Painting	Total		
2001	15,657.00	88,936.50	25,664.88	122,400.63	261,602.75	16.90	120,816.00
2002	22,822.88	109,768.63	36,417.50	146,050.75	316,636.25	13.10	127,380.00
2003	26,325.00	129,713.13	44,966.25	169,040.25	378,310.88	13.90	133,944.00
2004	28,363.75	131,988.75	49,182.50	195,967.63	403,606.88	15.40	140,508.00
2005	47,007.50	158,849.25	60,698.00	235,233.13	563,081.50	17.90	147,072.00
2006	91,670.00	302,481.50	120,187.38	462,681.88	1,044,273.00	8.40	153,636.00
2007	55,785.00	199,032.00	86,412.50	282,668.75	632,755.75		160,200.00

Sources:
[a] Works/Maintenance Department, Federal University of Technology, Minna (2007)
[b] Bursary Department, Federal University of Technology, Minna (2007)
[c] Central Bank of Nigeria (2007) *Annual statement of accounts* CBN, p89.

Results and Discussions

The indices created from the data in Table 1 are presented below in Table 2. Four line charts were developed from the indices and are presented as Figures 1 – 4.

Table 2: Indices for maintenance costs, inflation and income levels

Year	Maintenance Cost Indices[a]					Inflation Rate[b] (%)	Income[c] (HATISS GL15)
	Plumbing	Carpentry	Electrical	Painting	Total		
2001	100	100	100	100	100	100	100
2002	146	123	142	119	121	78	105
2003	168	146	175	138	145	82	111
2004	181	148	192	160	154	91	116
2005	300	179	237	192	215	106	122
2006	585	340	468	378	399	50	127
2007	356	224	337	231	242		133
Average	**262**	**180**	**236**	**188**	**197**	**84**	**116**

Source: Computed from Table 1

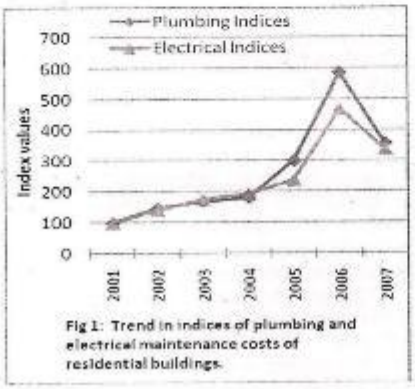

Fig 1: Trend in indices of plumbing and electrical maintenance costs of residential buildings.

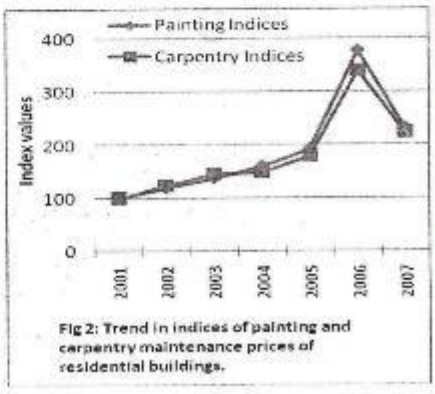

Fig 2: Trend in indices of painting and carpentry maintenance prices of residential buildings.

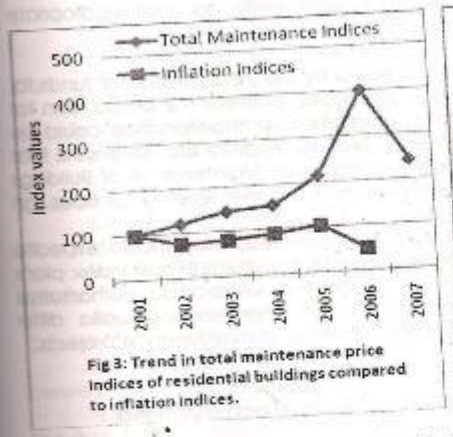

Fig 3: Trend in total maintenance price indices of residential buildings compared to inflation indices.

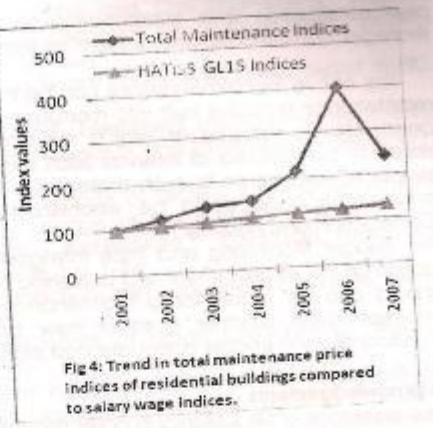

Fig 4: Trend in total maintenance price indices of residential buildings compared to salary wage indices.

Index values for maintenance spiked in 2006, accompanied by a noticeable drop in 2007. This might be attributed to the cyclical nature of maintenance costs, which mount gradually, drop, and then repeat the same cycle all over again. All elemental maintenance costs showed marked increase over base year costs. Some of the increase over base year costs might be due to increased maintenance needs and rising inflation levels. However Figure 3 showed that not all of the increase in maintenance costs is explained by inflation levels, given that average increases are 84% for inflation and 197% for maintenance costs. The non-availability of an index of construction prices made corroboration of accelerated increase in construction costs above general prices (represented by inflation levels) difficult. Figure 4 presented a worrisome scenario of income levels that increased at faster than inflation levels (116% compared to 84%), but slower than maintenance costs (116% compared to 197%).

Implications of the Results

Although as at the time of this study the buildings studied were owned and maintained by the Federal University of Technology Minna, they represent the type of buildings and standard of maintenance that workers of the rank considered by this paper aspire to own. The findings of this paper implied that where buildings identical to the ones studied here are owned by workers of comparable rank, their earnings would not be able to sustain the required standards of maintenance. Costs of maintenance might be subject to a faster rate of increase than general prices; further research is however needed to confirm this inference.

Conclusions, Recommendations and Implementation Strategies

This paper concludes that: -

1) Costs of maintaining a standard two bedroom bungalow building are in excess of the basic salary earned by a government employed worker of professorial rank. The least maintenance cost recorded was 63% higher than the highest earning recorded.
2) Over the period of the study the costs of maintaining a standard two bedroom bungalow building more than trebled. The rate of increase in the costs of maintenance was far higher than the rate of increase of inflation.

This paper thus recommends the opening up of easily accessed lines of credit for maintenance purposes similar to those canvassed for the construction of houses. It appears to be a pointless exercise to provide loans for house ownership, and none for house maintenance. This would only encourage the accelerated creation of urban slums. It is also recommended that efforts be directed towards establishing the aspects wherein

new construction and maintenance works differ significantly, so that appropriate strategies can be designed for them separately.

The above recommendations can be implemented by the incorporation of funds for maintenance purposes built into mortgage loan packages. Whereas the actual loan for construction is released at Year 0, the fraction earmarked for maintenance could be slated to be released at intervals such as Year 5, Year 10, Year 15 etc. To ensure that proper effect is given to such strategies, a National Policy on Maintenance of Buildings and Infrastructure could be established independent of the existing policies on Construction and Housing.
The Budget Monitoring and Price Intelligence Unit of the Presidency should expedite action on the establishment and publishing of an authentic construction cost index: plans should also be made for a Maintenance Cost Index. This will provide authoritative information on whether costs of new construction and maintenance works differ significantly, and enable adequate cost planning and control of maintenance projects.

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