POPULATION DENSITY AND MAINTENANCE BUDGET POLICY OF PUBLIC PRIMARY SCHOOL BUILDINGS IN MINNA, NIGER STATE

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ABSTRACT
This research work was carried out to measure the relationship between the growing population density of pupils and maintenance budget allocation to public primary school buildings. Also examined is the relationship between the population of pupils and classroom floor area available for learning purposes, this is to establish the fact that increase in population affects the rate of decay of public buildings. Using simple regression analysis model and testing at 95% confidence limit, it was established that the maintenance budget has a negative growth relationship with the population density which means that as the population density increases there is corresponding decrease in maintenance budget. The coefficient of determination (R-square) value is 3.90% with P.value of 0.559. The regression growth model which is expressed as, maintbgt = 1.479 - 0.015 popden shows a negative relationship. It was suggested that, to eradicate urban decay and achieve effective maintenance management of public buildings such as schools in the state, the factor of population density must be given due consideration when allocating maintenance budget.

Keywords: Budget, Deterioration, Maintenance, Population, Space.

INTRODUCTION

The performance of public buildings such as hospitals schools etc and their components depends, to a large degree, on continuous and planned periodical maintenance, which challenges owners and facility managers to institute precise planning based on a well-structured maintenance programme. Despite the ever-growing need for lower operational cost; facilities manager must ensure that facilities are constructed and maintained efficiently without compromising safety. (Shonet et al 2003).

However, maintenance provision is an important part of the total ownership costs of building, with recent research demonstrating that the cost of operating and maintaining a building can be approximately five times the cost of capital over the life of the building (Royal Academy of Engineering, 1998). Maintenance is generally described as the work undertaken to keep or restore a facility to an acceptable standard. Maintenance is characterized by a number of Sub-group operations and these are described in Holmes (1994) as response (normal, emergency) maintenance.

Flanagan and Norman (1983) established that the factors that influence the rates of maintenance include, rate of deterioration of the building and/or element, cost of maintenance, the disruption and disturbance of occupants and time required for maintenance and the relationship between the physical repair and the required physical, functional and economic life of the building. In this study, some of the factors highlighted above are examined to establish relationship.

BUILDING MAINTENANCE

According to Sharma (1998), the function of building maintenance is to keep the facilities and the building in optimum operating conditions so that the intended functions are performed satisfactorily. The aim of maintenance is to reduce the frequency and severity of failures so as to ensure the availability, efficiency and performance of the existing plant, equipment and building at a maximum level and to the standard of acceptance. In order to make the maintenance function more effectively, all the divisions or departments within the particular building must be involved. The concept of involving other departments in maintaining a building is known as tero-technology, which is concerned with the specification and design for reliability and maintainability of a building and its plant as well as installation and commission, modification and replacement along with feedback of information on various aspects. Indeed, it should be taken as a positive approach in order to obtain good results for all maintenance work. In reality, a maintenance department and its staff would not be able to monitor every corner of the building, to check every defect or overcome every problem related to building performance without getting co-operation from the other staff in the building. To enable tero-technology to function well there are a few aspects and actions that need to be satisfied before a total maintenance process can be operated. In general there are five objectives of building maintenance. They are (i) to maximize the availability of plant/equipment for productive usage (ii) to extend the life-span of a building and its plant/equipment by minimizing their wear and tear and deterioration (iii) to reduce the cost of lost production due to breakdown (iv) to ensure health and safety of building users and occupants (v) to uphold or give added value to the building for better market price.

Many cases have shown that most buildings fail to meet their objectives right from the moment they were declared complete. Many factors can be associated with these failures, such as poor construction, low quality of materials, site problems and bad design approaches. Moreover, after the building was occupied, cases such as vandalism, graffiti, incorrect use of facilities, pollution and poor maintenance are among the significant causes of building defects. Research has shown that 40 to 60 per cent of building defects were due to bad design (Ahmad 1989; 2001). This is something very serious because defects have been built-in since the building was on the drawing board. The question here is who is supposed to be blamed for these problems? Is it the inefficient designer or the maintenance manager and his staff for not being able to cope with their jobs? As we have observed, both parties never sit together to settle the issues amicably before the design gets off the drawing board. The same problems are repeated over and over again from one building to another.

In practice, those who are engaged in maintenance works must have a basic understanding of building design, building materials, regulations, structural systems and finishes. BOMI Institute (2003) has suggested that these persons must be familiar with maintenance procedures and equipment, ground condition and maintenance systems as well as construction techniques. This requirement must be fulfilled from initial design right through to building operation and maintenance. In this aspect, it was found that many of the problems are the result of mistakes made on the job sites that are directly related to design and failure to plan for the unexpected. Although most building defects can be associated with bad design, at the same time maintenance works are also inevitable, because it is the nature of materials to deteriorate over time with usage and exposure to the climate (Chanter and Swallow, 1996). However, the rate at which the deterioration of materials and components takes place, to some extent, is controlled by decisions that are made during the design stage. In the worst scenario, if maintenance works are neglected, decorations are filthy, gardens overgrown, fixtures and fittings damaged and the building vandalized. There is the danger that the owner most probably cannot recover his investment on the property. Therefore, it is the job of a designer to reduce the source of defects. It is as well necessary that the maintenance manager carries out preventive measures in looking after the building with commitment. These can only be done effectively from the design stage, leading to correct choices of materials and proper supervision of construction works.

CAUSES OF MAINTENANCE PROBLEMS

According to Stephen (2002) the causes emanate from deficiencies in design, construction, commissioning, tenancy work and maintenance. Many researchers have also observed that the generators or causes of maintenance problems could be looked at under three main divisions: the causes initiated during the design stage, causes initiated during the construction stage and causes initiated during the usage stage or the users' carefree attitudes. Speight (1968) was direct in his assertion that "It is at the design stage that the Maintenance burden can be positively influenced for better or for worse. Where the designer fails to make adequate consideration for minimizing maintenance problems, it always turns out to be a big problem when the building is eventually occupied for usage. The consideration for effective maintenance should therefore start from the design stage. Decisions taken at this stage should always have maintenance as one of the parameters for the building design.

Cheetham (1972) also describes how the occurrence of defects in the building fabric could result from many causes not related to designs such as unsuitable materials, incorrect assessment of loads and inadequate assessment of exposures. According to Arayela and Adams (2001) it is often said that building defects start on the drawing board, but in some cases, they can originate at an earlier stage. Design deficiencies could result in a building disaster if adequate attention is not paid to the design of bearing support, calculation errors, deformation, shrinkage problems, errors in assumed loading (especially wind), and changes in alteration of existing structures- all these could contribute substantially to building failures and disasters. Therefore adequate attention needs to be paid to these factors during design stage. Zubairu (2001) was explicit in his assessment of the contribution, in percentage terms, of certain factors to the problem of maintenance in government office buildings in Nigeria. They are as follows: Inadequate architectural design 6%, Inadequate Structural design 7%, Inadequate Electrical design 9%, Inadequate Mechanical design 11%, Poor Construction 12%, Use of poor quality components and materials 14%, Natural deterioration due to age and environment 18% misuse.

SPACE, POPULATION AND POPULATION DENSITY

A classroom is a place within a building where a class of students is taught. The Oxford Dictionary of Current English (2001), defines a classroom as a room in a school, college etc in which a class of pupils or students is taught for a lesson. The size of classroom in metre square is determined by the number of students being taught in the classroom. Aseidu (1992) also explains that the classroom is an important and complex place in the school. It is a place of social intimacy: children live closely together; even though they live with people before coming to school, they learn to live and work with a larger number of their peers in the classroom than outside. It is difficult for a child to live in isolation: they are all subject to the same rules and regulations and their stay in the classroom is involuntary. Children in the classroom are also held for the same purpose: to be able to read and write and also achieve the purpose of the school. However, a closer look at the above assertion shows that most of our secondary school classrooms do not meet the standard. Population density is defined as the size of a population in relation to the area, which is expressed as the number of individual per unit area. Wilkins (1976), explains that with regards to the height of secondary school classrooms, it should not be less than 3.0 metre for general-purpose classrooms and one square metre of floor area per student. Taylor (1973), also states that a classroom of 76.48 square metres for 50 students is high density and since this means overcrowding in the classroom, he suggests that the classroom should be large enough and should be about 8 by 10 metres for a class of 30 students.

Will and Ovresat (1978) recommended that, classroom sizes for elementary schools should range from 76.5 square meter to 103.5 square meter and the number of students in a classroom should not exceed 30. He also specifies that the standard size for secondary schools buildings range from 67.5 to 81 square metre with maximum capacity of 25-30 students per classroom. They further state, that the area of classroom is increasing with the realization that small classrooms of the past have been the greatest handicap to the educational program.

However, bigger classrooms can be made to take care of higher population density, as increase in building size reduces cost of construction. Seeley (1983) while supporting this assertion maintains that increase in size of buildings usually reduces unit cost per square meter of floor area. The prime reason of this is that on-cost is likely to account for a smaller proportion of total cost with a larger project, or expressed in another way, they do not rise proportionately with increase in the plan size of a building. Classroom expansion cannot be discussed in isolation of population density, which necessitates the expansion of the classrooms. Lewis (1982) defines population density as the number of people living in a unit area. He expresses it as follows: **Population density =**

Total estimated population per total area. He posits further that, an area could be densely populated, sparsely populated or moderately populated.

Onokerhoraye, (1985) opines that the density of population is an expression of the ratio between population and a given unit size. He also emphasizes the different types of population densities, which include classroom, occupational, nutritional, man or land use and agricultural density. General purpose classroom as we have in secondary schools have a smaller student requirement; and could be designed for reasonable comfort to carry a reasonable number of students without imposing distress on individual occupants. This suggests that there may be a lower limit to the space that should be available to every student in a classroom. Neufert and Neufert, (2000) indicate the following amounts of space per student in general purpose classroom: 0.80 – 0.95meter square in average comfort and 0.60meter square under the most cramped conditions. Education psychologists have a more generous idea of spatial allocation in a classroom. Wilkins (1976) requires a classroom to provide 1metre square of floor area per student. The population density of a given classroom therefore affects the space that is available to each student in the classroom; the rule is that the higher the population density, the lower the space available to each student in the classroom and the lower the classroom population density the greater the space available to each student in the classroom.

Blair *et al* (1975) stated that no organism, regardless of its potential and basic qualities, could survive in the absence of a favourable environment. Therefore, classroom expansion, which is an environmental factor, is crucial to the academic survival and performance of secondary school students. The population density in a classroom could have an impact on the overall grade of the student being taught in that classroom. The reason behind this is that classroom size has been established to affect the learning process, and a student's performance in any subject is a product of how well the subject has been learned. In a highly populated classroom, the lack of familiarity increases tension and concentration on other issues like manners and body language. This condition inhibits learning. Also the learning of names and faces of fellow students defuses the anxiety of class participation and learning (Kornfeld, 1994).

Research studies indicated that class size (human and physical) should not be studied in isolation. Problems related to goals, curriculum teacher's skills and class procedures must be considered in determining the effects of class size on learners' growth. In his contribution Cohen (1991) adds that the quality and usefulness of school rooms for transmission of verbal information depends on two basic parameters: form in terms of solid structure and quantity of reverberation time, and profitable line measurements of the school from the acoustic point of view. It is well accepted in the scientific community that prolonged exposure to high-intensity in community or work settings is often harmful to the health and behaviour of large segments of the exposed population. Noise in the learning environment can originate from with as well as outside the school building. Both forms of noise can have major effects on student behaviour and academic performance.

RESEARCH OBJECTIVES AND METHODOLOGY

The main objectives of the study are to examine the relationship between (i) population density of public primary schools and Maintenance expenditure (ii) budget allocation to primary schools and maintenance expenditure (iii) population of pupils and floor space available and (iv) population of pupils and maintenance budget. The research work focuses on the Maintenance expenditure of public primary schools in Minna metropolis to be precise Chanchaga Local Government Area. The research methodology consists of the following schemes (i) Critical literature Survey (ii). Field survey, using a structured questionnaire and extracting relevant data from available records (iii). Statistical analysis of data obtained in the field survey. (iv). Development of quantitative indicators for Maintenance expenditure for public primary schools. The data used in the study were obtained from planning and statistic Department, SUBES Niger State from 1995 to 2005.

DATA ANALYSIS, RESULTS AND DISCUSSION

The data used for analysis is presented in table 1. The table shows the values for total budget for maintenance work for the state, the amount budgeted for maintenance of primary schools, population density of pupils, population of pupils, floor area available for learning and number of schools maintained each year for the period 1995 to 2005 under review. Table 2, gives the summary of regression analysis for the four experiments conducted. In experiment one, two variables budget allocation and maintenance budget were tested at 95% confidence limit. It was observed that the variables have positive correlations.

The regression model maint bdgt = 1.770 + 0.0696bdgt showed a positive linearity which means that as total budget for maintenance increases, the maintenance budget for primary schools also increases. The R-square for the linear model is 81.79% further transformation of the result into linear and non linear models showed improvement. For the logarithm, quadratic and cubic models the R-square values are 85.25%, 95.08% and 95.08% respectively. This means that an improvement on the total budget allocation will affect the maintenance budget for primary schools.

The variables tested in experiment 2, were population of pupils and maintenance budget for the primary schools. The study here shows a very weak correlation between the variables tested. There were no significant linear and non-linear relationships between population of pupils and maintenance budget. The R-square values for the linear and non linear regression models are 2.50%, 1.80%, 5.40%, 5.40% and 0.50% for, linear, logarithmic, quadratic, cubic and growth models respectively.

The probability values (P-values) for both linear and non-linear regressions range from 0.640 to 0.93% which are higher than .005 level of significance. The negative linearity in the equation model, maint budgt = 5.068-7.91E-005 pupils, shows that as population of pupils increases, maintenance budget decreases which means that the result is not significant.

Table 1.0 Values For Total Budget, Maintenance Budget, Population Density of Pupils, Population of Pupils, Floor Area Available For Learning And Number Of Schools Maintained.

Year	Budget Allocation **N'million**	Maintenance Cost **N'million**	Population Density	No of Classroom	Floor area **m^2**	Population of pupils	No of Schools maintained
1995	60.40	1.80	26.05	8	576	15007	3
1996	60.70	1.17	5.08	8	576	2925	2
1997	61.20	1.80	5.94	8	576	3421	4
1998	61.20	1.80	6.39	8	576	3678	3
1999	70.80	4.80	28.34	8	576	16325	3
2000	68.40	4.90	7.39	8	576	4258	3
2001	122.80	7.00	6.79	12	864	5865	3
2002	123.00	7.00	3.45	12	864	2982	4
2003	122.00	6.90	3.60	14	1008	3625	4
2004	120.00	6.90	1.90	14	1008	1911	4
2005	134.00	6.35	7.90	13	936	7378	5

Source: Planning Research and Statistic Dept, SUBES, Niger State.

The correlation between the variables is low with 'F' values calculated lower than the 'F' values tabulated. This reveals that there are no significant linear and non-linear relationships between variables tested. Similarly, the growth model shows a negative linearity in the regression equation model, maint bdgt = 1.398 – 1004E-005 pupils, which means that growth in the population of pupils does not affect maintenance budget positively.

In experiment 3, there are no significant linear and non-linear relationships between maintenance budget and population density. The R-square values for both linear and non linear regression are 8.40%, 15%, 18.30%, 18.90% and 3.90% for linear, logarithm, quadratic, cubic and growth models respectively. The probability values (P-values) for linear and non-linear range from 0.239 to 0.668, which are greater than 0.05, level of significance. The analysis also revealed that correlation between the variables was very low with 'F' values calculated lower than the 'F' values tabulated. The negative linearity in the equation, model, maint bdgt = 5.322 – 0.079 popden, shows that the increase in population density does not bring about an increase in maintenance budget. Similarly, the growth regression model, maint bdgt = 1.479 – 0.015 popden, confirms the picture showed in the linear regression equation. This shows that maintenance budget is not growing as population density grows in public buildings.

In the study the relationship between the population of pupils and the available floor areas was tested at 95% confidence limit. It was noticed that the two variables have strong negative linearity which is expressed as florarea = 825.25 – 0.04 populs. This means that, space is not increased as the population of pupils is increased. This further shows that a unit space available for learning is constantly subjected to stress at any given time thus by implication the rate of decay of the building is likely to accelerate.

The probability values for linear and non linear regression range from 0.280 to 0.557, which are greater than 0.05 level of significance. Similarly, the growth model florarea = 6.689 – 1.8E-0.05 populs did not give any significant improvement rather it confirmed the negative linearity of the linear model.

TABLE 2.0 SUMMARY OF REGRESSION ANALYSIS

Expt No.	Variables X	Variables Y	Type of Analysis	Result of Experiment: Regression Model	R^2	FTab	Fcal	PValue	Inference	Remarks
1.01	Budgt alloc	Maint budget	Linear	Maint budgt=-1.770 +0.0696Bdgtall	8.179	5.12	40.44	0.0001	Very Strong	SS
1.02			Logarithm	Maint budgt = -24.034 + 6.420bdgt	85.25	5.12	51.99	0.0001	Very Strong	SS
1.03			Quadratic	Maint budgt =-25.610 +0.635bdgt-0.003bdgtall²	95.08	4.46	77.31	0.0000	Very Strong	SS
1.04			Cubic	Maint budgt +=-25.610 +0.635bdgt-0.003bdgtall² +19.16bdgt³	95.08	4.46	77.31	0.0000	Very Weak	N.S
2.01	Popul	Maint budget	Linear	Maint budgt =5.068 -7.91E-005 Populs	2.50	5.12	0.234	0.640	Very Weak	N.S
2.02			Logarithm	Maint budgt =8.737-0.489populls -0.00	1.80	5.12	0.227	0.802	Very Weak	N.S
2.03			Quadratic	Maint budgt =3.553 0.00populs -2.79 E-008 Populs²	5.40	4.46	0.802	0.227	Very Weak	N.S
2.04			Cubic	Maint budgt=3.131+0.0001 populs -6.29 E-00r populs 2+1.38E-012populs³	5.40	4.35	0.134	0937	Very Weak	N.S
2.05			Growth	Maint budgt =1.398 -1.04E -005 populls	0.50	5.12	0.049	0.830	Very Weak	N.S
3.01	Popden	Maint budget	Linear	Maint budgt =5.322-079 populen	8.40	5.12	0.823	0.388	Very Weak	N.S
3.02			Logarithm	Maint budgt =6.847-1.185 popden	15.00	5.12	1.587	0239	Very Weak	N.S
3.03			Quadratic	Maint budgt =7.817-6667 popden +0.019 popden²	18.30	4.46	0.897	0.445	Very Weak	N.S
3.04			Cubic	Maint budgt =7.269 -0.420 popden-0.010 popden²+0.001 opden ³	18.90	4.35	0.543	0.668	Very Weak	N.S
3.05			Growth	Maint budgt =1.479-0.015popden	3.90	5.12	0.369	0.559	Very Weak	N.S
4.01	Populs	Floor Area	Linear	Florarea=825.205-0.014populs	12.80	5.12	1.322	0.280	Very Weak	N.S
4.02			Logarithm	Florarea =1583.517-99.453populs	12.20	5.12	1.25	0.292	Very Weak	N.S
4.03			Quadratic	Florarea =71550+0.24populs-2.0E-000Pupuls²	15.20	4.46	0.717	0.517	Very Weak	N.S
4.04			Cubic	Florarea=114.47-0./197Popul +3.10E-005 Popul² -1.3E-009 Popul³	2430	4.35	0.748	55.7	Very Weak	N.S
4.05			Growth	Florarea=6.689-18E-005 populs	12.70	5.12	1.30	0-.283	Very Weak	NS

Source: Researcher's Analysis of data 2008

NS= Not significant, SS= Significant, Popden=Population Density; Maint bdgt=Maintenance budget: Populs =Population of pupils, Florarea=Floor Area, Tbdgt Alloc=Total Budget Allocation

CONCLUSION AND RECOMMENDATION

In conclusion, the research work has shown from the variable tested that there exists some relationships between them. There was a significant statistical relationship between budget allocation and maintenance budget. The other three experiments showed that there is no significant statistical relationship between the variables. Therefore the following are recommended:

1) Allocation to maintenance of public schools should be double or tripled, base on the established relationship between total budget allocation and maintenance budget, if maximum result will be achieved.
2) The factor of population density should be given due consideration when planning maintenance budget.
3) The percentage growth in the population of pupils should be reflected in the total cost budget of maintenance.
4) The likely rate of decay of public building such as schools can be reduced if the unit space available for learning or use is not stressed as a result of over population. Population of pupils should be tired to the available space that is, in relation to enrollment of pupils.

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