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IMPLICATION OF FACILITIES DESIGN ON MAINTENANCE COST EFFICIENCY IN CORPORATE BUILDINGS

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Abstract
The study looked at the relationship between facilities design and maintenance cost of the facilities, identify the implications and suggests ways of minimizing these effects. It was a descriptive (survey) design research with a benchmark (standard) for hypothesis testing. The finding among others was that Facilities Management (FM) starts from the design stage. Also discovered was that little is known in Nigeria about facilities management - empirically, functionally and practically. All they know about FM is all about its theoretical framework.

Keywords: *Implication, Facilities, Design maintenance, Efficiency and Corporate buildings.*

Background to the Study

Facilities management according to Iroegbu (2010) is an evolving multidisciplinary profession. Worldwide, there is a trend towards managing facilities as and integrate whole. This is evident in the awareness of corporate organizations facilities manager's attempts to keep maintenances expenditure to the beeriest minimum (Akpan and Chizea, 2002).

Aside from locating and rectifying defects, an effective programme mean to curb maintenance cost must start with the design of the facility itself and must eventually justify itself only in terms of minimizing the investment, but also impacts on the overall efficiency of maintenance cost. This means that the efficient and effective design of facilities can facilitate and enhance performance, prolong the life span and reduce maintenance cost.

Kuhnke (1999) noted that a building's operating cost affects its market value, therefore, organizations must seek ways of flogging inefficiency in its management which if corrected would improve the net property. A skillful design can reduce the amount of maintenance cost and also make it easier to carry out work (Obodoh, 1999; Amobi, 2006). Major decisions at this stage according to Obodoh include among others, the selection of materials, forms of construction, orientation of building and user requirements.

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The emergence of facilities management can be traced to competition. It is competition that drives the business world to enhance quality and to re-engineer processes and look at the way in which work is carried out for improved performance (Alexander, 1996). A facility that is properly managed will minimize the property over head, achieve the best possible use, and return from facilities available (Faeatherstone and Baldry, 1998). Usually, there would always be changes in the settings of a facility, this however, needs to have anticipated and taken care of at the design stage.

Akpan and Chizea (2002) viewed that change is not what it used to be. Companies according to them must be able to implement new strategies and adapt to changes. Consequently, their facilities must have build-in flexibility to readily accommodate growth and reconfiguration, which if implemented, will reduce building maintenance cost. Therefore, with the growing awareness of the need to operate and manage facilities effectively, it is important according to Onwusonye (2004) that the whole construction team understands the long term implication of design decision relating to such matters as detailing, selection of materials and components and provision of access for maintenance purpose.

Objectives of the Study

The purpose of the study was to determine the implication of facilities design on maintenance cost efficiency in corporate buildings. In pursuant of this aim, the following objectives were set:

1. To assess the impact of design on maintenance cost.
2. To identify the cost element in the maintenance of corporate buildings.
3. To assess the impact of cost efficiency in corporate buildings on the performance of the facilities.

Research Questions

The following research questions guided the study:

a. In what ways can the impact of design on maintenance cost be assessed?
b. How can the cost element in the maintenance of corporate buildings be identified?
c. In what ways can the impact of cost efficiency in corporate buildings or the performance of the facilities be assessed?

Hypothesis

There is no relationship between facilities management design and maintenance cost efficiency.

Methodology

The population of the study was based on ten (10) corporate buildings located at Owerri capital city of Imo State, Nigeria. Corporate buildings were considered for this study as a result of the purported interest of their owners in facilities management process.

This location is been considered as a result of its social, political and economic importance, its geographical and logistics advantage. Equally considered to remove the bias that may arise through transportation cost of carrying out the research. Owerri Urban City lies on latitude 5.27 ON and longitude 7.000E, and is located within the tropical climate zone of Nigeria. It has a landmass of 130km2, lying at the junction of two rivers River Nwaorie and River Otamiri. The population according to the 2006 National Population Census result was 271,381 (NPC, 2006).

Sample and Sampling Techniques

Since the research dwells on the population consisting of corporate buildings occupied by corporate bodies. Only corporate organizations with reputable structures were chosen and considered for the study. The stratified sampling technique was used in the study. This is an applied sampling method, in which the population was grouped into some definite characteristics in the study (corporate buildings).

The approach used to identify these buildings were randomly selected for the study, where 20 occupants were randomly picked for sampling from each building, which brought the total to (200) two hundred sample size.

Instrumentation
The method used in gathering data for the study included the administration of questionnaire and reviews of the related literature which covered both primary and secondary source of information. The questionnaire was designed in such a way as to measure several factors. Efforts were made to simplify the questions for easy responds. Application checklists were also used in data gathering where necessary, and finally a benchmark- standard for the hypothesis testing.

Estimates of the Reliability of Test
Using the test retest estimate, interval of three (3) weeks, and using the Pearson Product Moment Correlation Coefficient, a correlation coefficient of 0.87 was obtained. The coefficient was high, meaning that the instruments used for the study were reliable.

Data Collection and Analysis
The Statistical Package for Social Scientists (SPSS) were used:

Table 1:
Distribution of Questionnaire to Buildings, Occupants, Managers and Owners.

S/N of Buildings	No of Administered questionnaire	No of Completed Questionnaire	%
1	20	16	80
2	20	14	70
3	20	10	50
4	20	12	60
5	20	15	75
6	20	7	35
7	20	8	40
8	20	11	55
9	20	12	60
10	20	9	45
Total	200	114	62%

A number of preliminary questions were directed at respondents to establish their socio-economic background. In view of this, 200 questionnaire were distributed equally amongst the selected (10) ten corporate buildings. This was to ensure that equal representations of respondents were ensured. Out of the 200 questionnaire distributed, only 114 were returned while only 112 responses were properly and correctly completed and subsequently used for the analysis. The analysis of the responses to the questions was by means of frequency distribution. Tables 1 14 apply in this regard.

Table 2:
Distribution of Respondents According to Age and Gender.

Options Age	Marginal Frequency Units	Relations/Frequency %	Cumulative Frequency
21-30	20	17.90	17.90
31-40	32	28.60	46.50
41-50	50	44.60	91.10
51-60	10	8.60	100
Total	112	100	-
Gender	-	-	-
Males	93.83	83.00	-
Female	190	17.00	100
Total	112	100	-

Table 2 above reveals the responses of respondents in relation to their age group.

Responses showed that majority of the respondents 50 (44.6%) of the respondents fall between agree group 31-40 years, (17.9%) falls between age group 21-30, while, 10 (8.9%) were over 50 years of age. The responses documented in table 2 above also indicated that 83% of respondents were male, while only 17% were female. The relatively large number of male was not unexpected and this highlights the dominance of male in the facilities management (FM) practice.

Table 3:
Respondents Highest Level of Education

Qualifications	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency %
HND	26	23.20	23.20
B.Sc.	76	67.20	91.10
M.Sc	10	8.90	100
Total	112	100	-

The responses in table (3) three above showed that majority of the respondents 76 (67.9%) represents those that have bachelor's degree qualifications as their highest level of education, 26 (23.2%) represented those that have HND qualifications as their highest level of education. The lowest relative frequency counts of 10 (8.9%) represents those with master, degree as their highest level of education, one may deduce that most of the respondents can read and understand the questionnaire and are qualified to know the importance of this kind of research hence, could be relied upon for useful and reliable information.

Table 4:
Respondents Organization year and Operation

Year of Operation	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
1-10	67	59.80	59.80
11-20	36	32.10	91.90
21-30	6	5.40	97.30
31+	3	2.70	100
Total	112	100	-

Table 4 above reports on how long respondents have been in operation, 67 (59.80%) represents those organizations between 1-10 years in operations, 36 (32.10%) have between 11-20 years in operation, 6 (5.4%) have between 21-30 years in operation, while 3 (2.70%) have more than 30 years in operations.

Table 5:
Respondents Professional Qualifications

Professional Qualification Count	Marginal Frequency	Relations/Frequency %	Cumulative Frequency
NIESV	67	59.80	59.80
NIQS	13	11.60	71.40
NIA	15	13.40	84.80
NIOB	6	5.40	90.20
NSE	11	9.80	100
TOTAL	112	100	-

The responses documented in table 5 above show that the highest relative count 67 (59.80%) represents those that are members of NIESV the Nigerian Institute of Estate Surveyors and Valuers, while 15 (13.40%) represents those that are members of NIA Nigeria Institutes of Architects. Others are NIQS 13 (11.60) NSE, 11 (9.80) and NIOB 6 (5.40%) i.e Nigerian Institute of Quantity Surveyors, Nigerian Society of Engineers and Nigerian Institute of Building, respectively. From the analysis, the large number of Estate Surveyors and Valuers in facilities management may not be unconnected with the relevance of the profession to the practice of Facilities Management (FM).

Table 6:
Respondents Years Experience

Year	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
1-5	32	28.60	28.60
6-10	41	36.60	65.20
11-15	21	18.80	84.00
16-20	10	8.90	92.90
21+	8	7.10	100
Total	112	100	-

From table 6 above, the responses show that majority of the respondents 41 (36.60) represents those that have between 6-10 years experience on the job, 21 (28.60%) has been 1-5 years experience on the job, 21 (18.80%) has been 11-15 years experience, 10 (8.90%) has been 16-20 years experience; while 8 (7.10%) has about 21 years experience on the job.

Table 7:
Respondents Organization Core Operation

Core Operation	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
Real Estate	64	57.10	57.10
Oil and Gas	32	28.60	85.70
Banking	11	9.80	95.50
Insurance	5	4.50	100
Total	112	100	-

Table 7 represents (57.10%) indicating that their companies' core operation is real estate, oil and gas followed with 32 (28.60%) respondents, 11 (9.80%) indicated that their companies are also, into banking, while 5 (4.50%) respondents gave their companies' core business to be in insurance.

Table 8:
Respondents Organization Annual Expenditure on Maintenance

% of Expenditure (N)	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
1-5%	37	33.00	33.00
6-10%	58	51.80	85.00
11-15%	8	7.10	91.90
16-20%	6	5.40	97.30
21+	3	2.70	100
Total	112	100	-

Maintenance % of the organization's total expenditure was rated in table 8 above, 58 respondents representing 51.80% indicated that the maintenance expenditure was between 6-10% of the total companies' expenditure, 37 (33.00%) respondents indicated between 1-5% of their companies expenditure go to maintenance, while the least respondents 3 (2.70%) indicated their companies cost of 21% of the total company's expenditure. What this means was that, not much of the companies' attention or budget was given to maintenance.

Table 9:
Respondents Organization Interest on the Building Occupied

Interest on Building	Marginal Relations/Frequency Frequency % Count		Cumulative Frequency
Owner Occupied	78	69.60	69.60
Leased Premises	12	10.70	80.30
Development Leases	22	19.70	100
Total	112	100	-

Table 9 shows that the interest of the organization on the building being occupied shows that majority of respondents, 78 (69.60%) represents those whose organizations own the property, while 22 (19.70%) of the respondents shows organizations with development lease of the land. 12 (10.70%) of respondents indicated that their organizations leased the premises.

Table 10:
Respondents Building Age

Respondents	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
1-10	20	17.90	19.90
11-20	31	27.70	45.60
21-30	25	22.30	67.90
31+	36	32.10	100
Total	112	100	-

Table 10 above shows the ages of the buildings surveyed. Ironically, 36 (32.10%) of the respondents indicated that their organizations' building are over 30 years, 31 (27.70%) indicated organizations' buildings are between 11-20 years old, while 25 (22.30%) and 20 (17.90%) of the respondents indicated that their organizations' buildings are between 21-30 years and 1-10 years old respectively.

By this analysis, it shows that buildings above 20 years have moderate maintenance culture which also represents the organizations that devote not less than 10% of their annual budget to maintenance.

Table 11:
Respondents Organization Buildings' Floor Level

No of Floor	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
1-5	55	49.10	49.10
6-10	22	28.60	68.71
11-15	25	22.30	91.00
6-20	7	6.30	97.30 100
21-25	3	2.70	
26-30	-	-	-
Total	112	100	-

From table 11 above, 49.10% of the respondents' organization buildings on between 1-5 floors, 25 (22.30%) have their organizations' buildings on between 11-15 floors, 22 (19.60%) and 3 (2.70%) respondents have their organization buildings on between 16-20 floors and 21-25 floors, respectively.

Table 12:
Respondents Building Services

Service of the Building	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
Generator/Set	All	112	-
Lift/Elevator	101	101	-
Central A/C's	87	87	-
Parking Lots	All	112	-
Sewage	97	97	-
Total	112	100	-

All the respondents indicated that their organization buildings are serviced with generating sets, parking lots, 101 respondents indicated that their organizations buildings are serviced with sewage system and central air conditioners system.

Table 13:
Organizations Building Materials Types

Materials	Wall	Roof	Floor	Total
Sandcrete	101	-	-	101
Wooden	-	-	10	10
Mould	-	-	-	-
Concrete	12	82	20	112
Rug	-	-	96	96
Screed	87	-	55	112
Tiles	10	-	99	108
Long Span Aluminum	-	1-5	-	105
Corrugated Iron Sheet	-	-	-	-
Felting	-	45	-	45
Paint	All	-	-	112

All the buildings surveyed have different types of materials used in the construction and finishing of the buildings, for instance, 101 respondents indicated that their organization building were built with sandcrete block walls, 105 respondents indicated that their organization buildings are roofed with long span aluminum roofing sheets, while 99 respondents indicated that their organization buildings are floor finished in titles.

Table 14:
Building Floor Design

Types of Floor Design	Marginal Frequency Count	Relations/Frequency %	Cumulative Frequency
Open	5	4.40	4.40
Closed	30	26.80	31.20
Light Partitioned	77	68.80	100
Total	112	100	-

Table 14 above shows the floor designs of the buildings. 77 (68.80%) respondents indicated that their organization buildings are petitioned with light materials, 30 respondents indicated closed floor designs in their organizations buildings, and 5 respondents indicated open floor design in their organization buildings.
Specific Treatment of Data

Table 15:
Average Cost of Maintenance of each of the (10) Sampled Buildings

S/N	Average Total cost of Maintenance	Average cost of Building Defect	Average Cost of Services	% Cost of Maintenance (Building)	% Cost of Services on Total Cost
Building	Per Annual	Per Annual	Per Annual	Per Annual	Per Annual
1	18,500.000	5,550.000	12,950.000	30%	70
2	20,500.000	12,300.000	8,200.000	60%	40
3	20,500.000	7,275.000	13,225.000	35%	65
4	23,000.000	8,625,000	14,375.000	37.5%	62.5
5	24,000.000	9,168.000	14,832.000	37.5%	62.5
6	24,700.000	12,844,000	11,856.000	52%	48
7	25,000.000	14,375,000	10,625.000	57.5%	42.5
8	25,100.000	12,801,000	12,299.000	49.5%	50
9	25,750.000	13,647,500	12,102,500	53%	47
10	30,000.000	19,500.000	10,500.000	65%	35

The above table shows the average cost of maintenance of each of the ten sampled buildings per annum. It also indicates the average cost of structural defects and its (%) percentage on the total maintenance cost e.g. walls, floors, roofs, doors, windows etc, and the average costs of providing maintaining services and its (%) percentage on the total maintenance cost per annum i.e. security, clearing waste management and disposal, lifts, air conditioning systems etc.
Also, the table is arranged in hierarchical order from the lowest maintenance cost to highest.

Table 16
Cost Elements of Corporate Buildings

S/N	Item	Response	Total
1	Security	All	112
2	Generating Set	All	112
3	Bore-hole & Water Treatment Plant	97	97
4	Escalator	1	1
5	Lift	110	110
6	Parking Lot	98	98
7	Convenience	100	100
8	Floor	67	67
9	Ceiling	40	40
10	Roof	All	112
11	Door	All	112
12	Clearing	All	112
13	Wall	77	112

The table 16 shows the response obtained from the field survey vide the questionnaire. These costs as earlier mentioned occur under three running/heading structural maintenance cost, acquisition/installation and services costs.

Table 17:
Computer Weighted Mean for Facilities Performance and Service Performance.

A/B Criteria	Weight Service	Mean Facility	P=BXC Total Impact
Working Environment	15	43	0.30
Facility Maintenance Cost	198	17	0.34
Effective Utilization Services/Facilities Space Utilization	39 333	36 29	0.14 0.97
Ventilation Natural/Artificially	42	44	0.19

Table 18:
Evaluation Matrix for Facilities/Maintenance performance

Criteria I Spire of Performance	A Staff Weight	B Facilities Performance 0-10	P = BXC
Working	51	X	0.30
Facilities Cost	198	X	0.34
Effective Utilization	39	X	0.14
Productivity/	333	X	0.10
Performance	42	X	0.19
Total		Impact zone	0.07

The result of evaluation matrix in tables 17 and 18 above obtained in an overall figures of 68, which shows that the cost efficiency in corporate building performance of the facilities affects the cost of facilities, cost efficient management and maintenance, effective utilization of the working space.

N/B: Rating Scale: 0-45 poor, 41-75 fair, and 76-100 good.

Establishment of Benchmark (Standard) for Testing of Hypothesis.

Table 19:
Computation of Unit Cost, and Variance of Services.

A Building	B (N) Units Cost	B(N) (UC- BI... 10) UC	TUPI (N)
1	18,500	2,210	74,660
2	40,000	-19,290	7,430
3	17	3,710	54,630
4	17,500	3,210	51,863
5	19,500	1,210	79,899
6	17,500	3,210	62,222
7	18,500	2,210	67,083
8	25,000	-4,290	80,000
9	27,000	-6,290	80,000
10	17,500	3,210	64,610
	? B = 218,000	-	-

The study finally arrived at the bench-mark (Standard) figure by computing each building's mean unit cost and an allowance of 5% was provided for random error i.e error (inefficiencies) due to fatigue or other uncontrollable ones. The difference is the benchmark which is the critical value. Hilton, Mahar and Selto (2000) remarked that exceeding this value (benchmark) result to inefficiency.

Findings

The result of the findings shows that:

i. From the introduction and the review of related literature, it was discovered that facilities management starts from the design stage. This can be seen from the way the buildings were designed in terms of floor, heights, roofs, floor space, locations of services etc.

ii. Studies on maintenance cost efficiency in buildings showed that maintenance should be incorporated at the design stage so that potential maintenance complications can be arrested at their source.

iii. In Nigeria, little is known about empirical research on facilities management from the perspective of facilities design and maintenance efficiency.

iv. In most of the sampled buildings, designs have been a major problem in achieving maintenance cost efficiency.

v. Deficiencies in the design and other maintenance problems may not be unconnected with the lack of professional facilities managers in the system.

vi. Finally, in most of the organizations sampled, Estate Surveyor/Valuers, Architects, Builders, Surveys and Engineers were used as facilities managers.

Conclusion

By way of conclusion, the researchers hereby suggests that since some effects in facilities may not be due to design fault, but construction, the site personnel can be just as guilty of promoting deterioration of buildings by bad workmanship, inadequate supervision and the substitution of poor materials, components or fixings. In view of these problems, there is a constant need for stringent control of both the work on site as well as the materials used for the construction through careful supervision of building work at all stages to complement good designs, specifications and detailing by the designers.

Recommendations

Based on the findings, the following recommendations have been proffered:

1. Further studies in facilities management should be practical, functional and empirical.

2. For a maintenance cost efficiency to be achieved in maintenance of corporate buildings, design should be properly taken into consideration.

3. Since maintenance expenditure usually constitute one of the most critical items of operating expenses in most facilities as revealed in (table 14) the study in order to keep it in check; it is very importance that the whole construction team understands the long term implications of design decision relating to such matters as detailing, selection of materials and components, and provision of access for maintenance purposes.

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