CONTEMPORARY ISSUES ON ENVIRONMENTAL DEVELOPMENT

5TH EDITION

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Chapter One

Relationship Between Building Design Deficiency and Post-Occupational Maintenance Cost in Selected Public Buildings in Enugu Metropolis

Chukwu, C.

Introduction

Housing is one of the basic needs of people in all civilized societies. The provision of housing for people has multiple dimensions. Such as political, economic, social, psychological and ethical. This is why modern political governance in both development and developing countries have made housing provision a cardinal point of political governance and mandate. Given the past growth in the population and urbanization in developing countries, provision of housing is continuously a pressing challenge. People need houses. Nigeria has a population of 170 million people. This population is growing at 3.5% per annum. This can give an idea of the number of people that need housing. Various federal and state administration had tried to provide housing through various housing Estate. The speed of the need for houses has driven the speed of provision of houses for the growing people. This has increased the speed of home design by architects, engineers and draftsmen. Indeed, there is multiple speed in material selection and production, house construction and house maintenance. These systems of level speed result in gaps in specified codes of house provision. Given the low regulatory and supervisory management of the housing provision sector, there are evidences of design deficiencies in houses constructed and delivered to needy house buyers and house owners who are often in a hurry to pack-in.

Such house buyers and owners are not prepared to identify design deficiencies, construction deficiencies, material selection deficiencies, sub-surface deficiencies, post-occupational maintenance costs, main fabric deficiencies, internal finishers' deficiencies. Soon after occupation (post-occupational stage) the design deficiencies begin to bear their costly faces in the forms of rain water penetration of the walls, poor rain water discharges, improper material selection stagnant water formations, poor access for people and materials for maintenance, paint decay, cracks in the walls, dampness of the walls, inadequate structural support and unstable foundations post-occupational stakeholders' complaints begin to flow in. Post-occupational maintenance begins to rise. Health and life-threatening signs begin to occur. This scenario justifies the study on the effect of house design deficiencies on post-occupational maintenance costs. The assumption is that reducing house design deficiencies will reduce post occupational maintenance costs, increase house buyer or owner satisfaction, and reduce the incidence of collapsed building or voluntary demolition of houses as result of confirmed design deficiencies.

Many authors, analysts and practitioner in building construction design and post-occupational maintenance management have emphasized the implications of build

design, construction and maintenance deficiencies through the horror of collapsed buildings which were traced to design deficiency. In December 10, 2016 a church building collapsed in Uyo, the capital of Akwa-Ibom state of Nigeria. That incident killed 60 people. In September 12th, 2014 the Synagogue building Collapsed trapping 300 people and killing over 116 people.

In July 18, 2006, 28 people lost their lives when a 4-storey building went down due to faulty construction (Oloyede, 2010). Indeed, building design is the starting point of quality housing delivery to purchases and owners. In the same thinking building design deficiency cost cuts across all stages of building project. In this study the focus is mainly on housing design deficiency and the effect on post-occupational maintenance costs. This permits the researcher to examine the link between the dependent and independent variable. For instance, "what is the effect of structural support deficiency on post-occupational reconstruction by the house purchaser or own?" what is the effect of building foundation deficiency on building crack maintenance costs in public building. The aim of this study is to examine the relationship between building design deficiencies and post-occupational maintenance cost in public building in Enugu Metropolis.

Literature Review

Brief Historical Presentation of Public Building

Public buildings in Enugu Metropolis can be traced to the early days of Enugu Metropolis in 1909 when Albert Kitzon led a team Europeans to Enugu. Thereupon in 1917, Enugu was given the status of an urban center to cater for employees of the newly discovered coal industry in Enugu. Sir Frederic Lugard supported the development triggered off the construction of houses for human and corporate needs. John Holt Kingsway stores, UAC and colonial offices all started the history of public buildings in Enugu Metropolis.

After the attainment of independence in 1960, Enugu became the capital of Eastern Region of Nigeria. This status triggered off more needs for public buildings. Thereupon public building like African Continental Bank Tower of 4 storey building, University of Nigeria Enugu Campus, University of Nigeria Teaching Hospital, Akanu Ibiam International Airport, Federal Government College, Enugu, Enugu State University of Science and Technology, Institute of Management and Technology, Enugu, Federal School of Dental Technology, Nnamdi Azikiwe Stadium, Queens School. Thereafter the phenomenon of public buildings evolved into public housing Estates such as Artisan Estate, Trans-Ekulu Housing Estate, Government reserved Estate, Ebeano Housing Estate, Riverside Housing Estate, Abakpa Nike housing Estate, Real Estate Uwani, Government House Estate, Harmony Estate, Fidelity Estate, Network Estate, Lakeside Estate, Trinity Estate, Victory Estate, Liberty Estate, etc. these Estates were sponsored by Enugu State Housing Development Corporation (ESHDC 2013).

The building designs in these Estates are different. Similarly, their design deficiencies are different. In the same thinking their post-occupational maintenance costs are different. The effect of the building design deficiencies on post-occupational maintenance cost are different.

Building Design Deficiency

According to Chola, Ishak and Ramly (2007), building design deficiency occurs when architects, engineers, draughts people, masons etc do not respect specified or defined codes or quality standards of specific design projects indeed it is designing building structure outside specified codes. Such design defects give building users negative perception of home utility and suitability (Eziyi Offia Ibem et al 2013). Such negative perception creates low user design satisfaction. Examples of building design deficiencies are inadequate structural support, designing building on rocky ground which encourage unstable foundations, low integration of user-occupier needs-expectation, low integration of weather and climatic conditions resulting in building exposure to poor rain discharge, poor rain run offs, poor shade from the hot rays of the sun, designing building with difficult access for human and equipment access and mobility, designing building that encourage heat producing materials in already hot building location, designing buildings without complete and accurate drawing and documentation.

Components of Building Design Deficiency

According to Ramly (2006), Ishak, Chohan and Ramly (2007: pp 115 - 124) identify four sectors of building design deficiency. There is the main fabric which involves walls, floors, roof and windows, internal finishes which include; ceiling and wall finishes, special design features involving special air vent, decorative support. The fourth is cleaning and housekeeping (post-occupational maintenance). Most of these works are not direct on maintenance cost but are very strong on the consequences of design deficiencies.

Major Causes of Building Design Deficiency

According to Ishak, Chohan and Ramly (2017: pp 115 - 124) the causes of building design deficiency can be many and valid. Some of the causes are inadequate detailing, poor thermal expansion consideration, poor access for human and equipment mobility during maintenance resulting in low quality maintenance or outright non maintenance which deteriorates further the building, poor integration of weather-climatic conditions resulting in poor rain water discharge building costs (Chohan et ali (2010) Ede (2010). Oloyede (2010) identify both natural and non-made cause under made-made causes are design flaws, ageing, material fatigue, extreme operational environmental condition.

Yedum, Durodola and Akinjare (2011) found out that defective design was ranked the 4th greatest causes of building collapse in Nigeria. The researchers recommended that

city planners should be empowered by law to monitor and report any projects of temporary fencing, excavation conversion, alteration or addition to existing structures in building within their area of watch. The researchers agreed that the causes of frequent building collapse are diverse and go outside the scope of design deficiencies

Consequences of Building Design Deficiency

These have been identified as paint decay cracks on walls, poor ventilation, poor selection of materials, damages to drain poor access and mobility of human maintenance labour and equipment poor rain water discharge, pounding and water logging of house surroundings Okpala (1992).

Post-Occupational Maintenance Cost

Post-occupational maintenance is a vital component of public building life cycle and user satisfaction and utility cycles. Financially maintenance cost consumes about 10% of the total value of a public building. The cost is higher if design deficiencies are higher. Ishak, Choham and Ramly (2007) and Sims (2001) Kansai International Airport which was opened 1994 has been sinking. The Kansai International Airport Authorities have spent USD 2.1 billion on repairs or maintenance. Maintenance management is such cast discipline that touches on maintenance process review, maintenance information flow, main logistics and supply chain flow, design of prevention and predictive maintenance.

Building maintenance can be commercial public building. Such maintenance need repair products. Such repair projects can be back of the home maintenance, ground and exterior facades, lobbies and common areas, public restrooms, living rooms, replacement cost, cost of maintenance assessment, actual repair cost, preventive maintenance cost demolition cost. According to Levitt (2011) building maintenance cost is a function of usage of the building, the construction, the design and the location.

Literature Review

This study is strongly founded on the theories of public building respect for specified codes which architects, construction engineers, workmen and general labour are bound by professional ethics to respect. The study benefits from the building theories of design stage material selection stage, main fabric design stage, main fabric design stage, sub-surface project work, internal finishes building maintenance cost, owner-occupier needs-expectations as input in building design (Ihak, ChohanRamly 2007), (Eziyi et al; 2003).

The theory of residents' perception of the quality of public housing has shown that residents of public building have the capability to hold direpe mind pictures of the suitability of residential buildings. Cases of dissatisfaction trigger high post-occupational maintenance cost connected with re-design, reconstruction,

inaccessibility and mobility of human beings and material equipment. (EziviOffialbem et al 2013), Levitt (20)

Conceptual Framework of the Study

The study focuses on the effect of public building design deficiencies on their post-occupational maintenance costs in Enugu Metropolis. This permits the researcher to define the dependent and independent variables. In this study the dependent variable is post-occupational maintenance cost (POMC) while the independent variable is public building design deficiencies (PBDD) where POMC = post-occupational maintenance costs, PBDD = Public building design deficiencies. The next conceptual level is to break down the macro variable of (POMC) and (PBDD) into micro variable indicators that can generate data for analysis. Such analysis sought to establish any links between the independent and dependent micro variable indicators. Any statistical relationship about 50% is considered significant and therefore was interfered as having direct effect on the dependent macro variable.

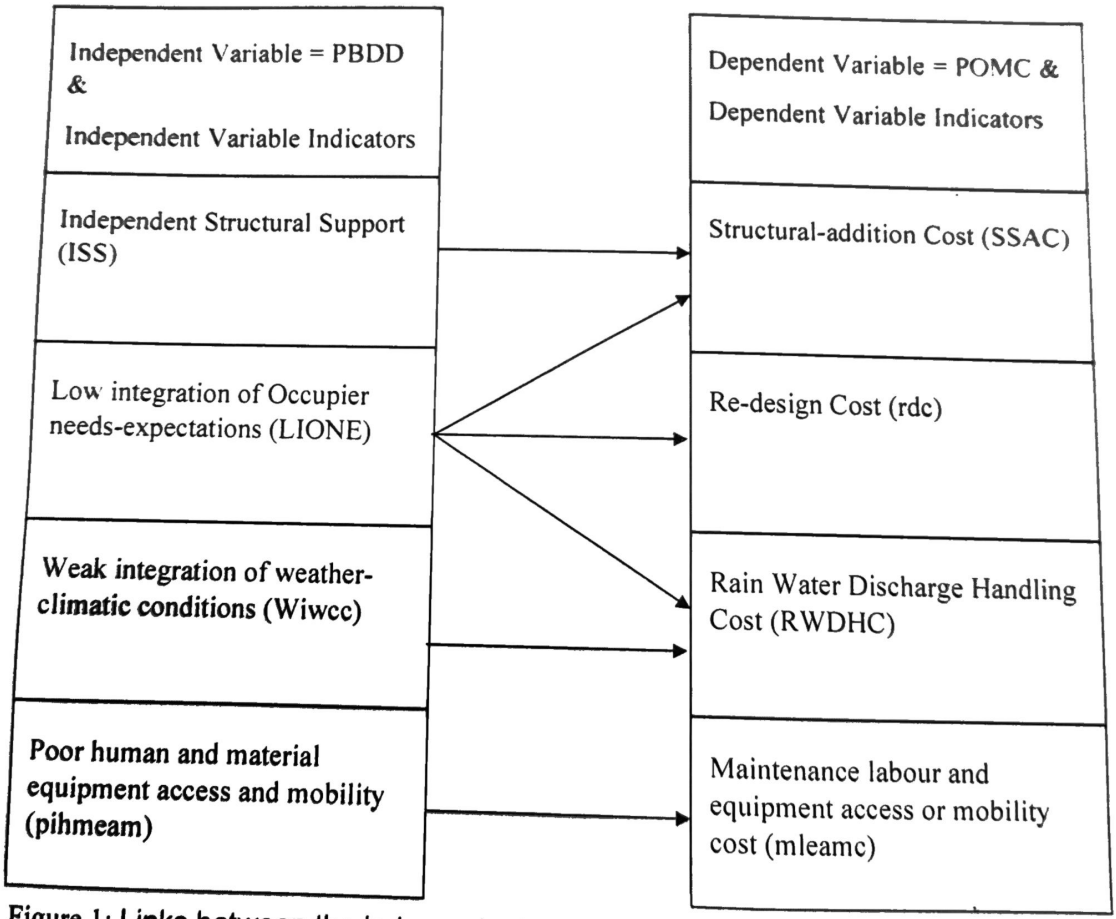

Figure 1: Links between the independent and dependent micro variable indicators

Source: Field Survey, 2017

Methodology

The design of this research is in two forms. The first form consisted of review of existing works on the subject matter. This design assisted in the conceptual understanding of the variables of the study. The second design was a survey using a questionnaire as an instrument for data collection. Indeed, this design incorporated both the theoretical and empirical designs.

The population of the study is non-finite. This permits the use of proportion to determine the sample. The model according to Onwe (1998: pp 19 - 20), Yamane (1964: pp 20 - 25) Osuala (1993: pp 41 - 46), Asika (1991: pp: 20 - 25) the model states that:

$$N = \frac{Z^2Pq}{e^2}$$

Where:

N = Required Sample Size

Z = Z -Statistics

P = Proportion of respondents for yes in a pilot survey

q = Proportion of respondents for No in a pilot survey

e = Maximum level of error at 5%

Pilot Survey was carried out to determine Pg proportions. Ten respondents were asked the question. "Do you approve the design work for your house". The finding showed that 80% answered No while 20% answered yes. These data were fed into the model of proportion.

$$N = \frac{(1.96)^2 \times 0.2 \times 0.8}{(0.05)^2}$$

$$N = \frac{3.8416 \times 0.2 \times 0.8}{0.0025}$$

$$N = \frac{0.614656}{0.0025}$$

$$N = 246$$

This sample was distributed to the participating Housing Estates. Table 1 demonstrates the distribution of the sample size. The criteria of distribution are location and number of houses for Estate.

Tale 1: Distribution of Sample Size

S/NO	Housing Estates	No of Sample Assigned	Percentage (%)
1.	Artisan quarters	10	4.0
2.	Trans-Ekulu	26	11.0

3.	Ekulu East	13	5.0
4.	GRA	20	8.0
5.	Riverside Housing	8	3.0
6.	Maryland Estate	5	2.0
7.	Government House Estate	10	4.0
8.	Republic Layout	8	3.0
9.	Harmony Estate	8	3.0
10.	Lake Side Estate	5	2.0
11.	Ebeano Housing Estate	6	2.0
12.	Independence Layout Estate	15	6.0
13.	Golf Course Estate	20	8.0
14.	Fidelity Estate	22	9.0
15.	Trinity Estate	20	8.0
16.	Victory Estate	20	8.0
17.	Coal City Garden Estate	10	4.0
18.	Liberty Estate	20	8.0
	Total	**246**	**100%**

Source: Field Survey, 2017

Table 1 shows the number of questionnaire sent to each housing Estate. The instrument used to collect data was a structured questionnaire organized in sections corresponding to the objectives of the study. Each section contained four propositions carrying the research variable indicators. Each respondent was requested to rate the research propositions on a scale of SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree.

A team of 5 research assistants led by the researcher administered the 246 questionnaire. Each number was assigned three Housing Estates. Each research assistant was coached for 8 hours of 1 hour per week on the questionnaire administration protocol and logistics.

Each research assistant was paid an honorarium not less than ten thousand Naira (₦10,000) for questionnaire administration, collection and submission within seven days. Transportation and welfare were taken care of by the researcher.

The questionnaire was subjected to a mock administration to 20 residents of an Estate not included in this research. Their responses show 100% questionnaire completion rate and 90% content understanding of the instrument. Only two propositions were rejected in the form of "Have no idea". The two propositions carrying "no idea" were expunged from the draft. The second approach of validating the instrument was the vetting of the project supervisor who approved the contents.
The reliability of the instrument was derived from its validity at 90% content understanding and 100% completion rate. These were interpreted that contents of the instrument addressed the real life perception and experiences of the respondents.

Two methods of data analysis were adopted. The first method consisted of the use of percentage frequencies. The second method consisted of the test of hypotheses using the non-parametric tool of chi-square (x^2). The formula for chi-sqaure distribution is given as;

$$X^2 = \frac{\sum fo - fe)^2}{fe}$$

Where;

fo = ***observed frequencies***, fo = ***expected frequencies and*** Σ = *summation code*

Decision Rule = if X^2 calculated is ≥ then reject HO and accept HA (Ejionueme and Enudu 2016).

Data Presentation and Analysis

This section presets the responses of 149 respondents in data format. Tables 2 to 7 contain the various research data in percentages and absolute numbers.

Table 2: Response intensity of the questionnaire

Housing Estate	No. of Questionnaire Administered	No. of Questionnaire Returned	Percentage Returned
Artisan quarters	10	5	
Trans-Ekulu	26	20	

Ekulu East	13	10	
Government Reserve	20	10	
Riverside Estate	8	5	
Maryland Estate	5	3	
Government House Estate	10	4	
Republic Layout	8	3	
Harmony Estate	8	4	50.0
Lakeside Estate	5	3	60.0
Ebeano Estate	6	6	100.0
Independence Layout	15	10	67.0
Golf course Estate	20	12	60.0
Fidelity Estate	22	10	45.0
Trinity Estate	20	15	75.0
Victory Estate	20	10	50.0
Coal City Garden Estate	10	5	50.0
Liberty Estate	20	14	70.0
Total	246	149	61.0

Source: Field Survey, 2017.

Table 3: **Personal** Data of the Respondents

Proposition	Responses	Number	%
1. Age of Respondent	30 - 40yrs	28	19.0
	41 - 51yrs	49	33.0
	52 -yrs plus	72	48.0
	Total	149	100
	Male	100	67.0

2. Gender	Female	49	33.0
	Total	149	100.0
3. Marital Status	Married	109	73.0
	Single	40	27.0
	Total	149	100.0
4. Educational Status	BSc/HND	110	74.0
	BSc/HND plus	39	26.0
	Total	149	100.0

Source: Field Survey, 2017.

Table 3 shows the data that 121 (81.0%) of the respondent were between the ages of 41 - 52 and above which corresponds to the cultural and economic cycle of living in housing Estates.

Table 4: Relationship between Inadequate Structural Support in Design and Cost of Additional Structures

Propositions	Responses	Number	%
5. Inadequate Structural Support in your building has resulted in adding more structures at a cost	SA	80	54.0
	A	60	40.0
	D	-	-
	SD	9	6.0
	Total	149	100.0
6. No worries paying for the cost of additional structural support in your house	SA	80	54.0
	A	20	13.0
	D	49	33.0
	SD	-	-
	Total	149	100.0
	SA	100	67.0
	A	49	33.0

7. The additional cost for additional structural support is significant	D	-	-
	SD	-	-
	Total	149	100.0
8. Readiness to provide and pay for additional structural structures to enhance your safety and security	SA	80	54.0
	A	20	13.0
	D	20	13.0
	SD	29	20.0
	Total	149	100.0

Source: Field Survey, 2017

Table 4 reveals that on average 82.0% of the respondents agreed that there is a relationship between inadequate structural support and post-occupational maintenance. Such costs are rate significant by all the respondents (100.0%). This is proving that design deficiencies resulting to inadequate structural support generally result in significant post-occupational maintenance cost.

Table 5: Relationship between low integration of owner-occupier Needs-Expectations in building design and re-design cost by the house occupier.

Propositions	Responses	Number	%
9. If building design do not meet your needs-expectations, you engage in some forms of re-design	SA	120	80.0
	A	29	20.0
	D	-	-
	SD	9	6.0
	Total	149	100.0
10. Preparedness to incur the cost of re-design works to correct the initial design deficiency	SA	60	40.0
	A	40	27.0
	D	20	13.0
	SD	29	20.0
	Total	149	100.0
	SA	88	59.0

11. Cost of re-designing building structure is significant	A	10	7.0
	D	-	-
	SD	51	34.0
	Total	149	100.0
12. It is common for house occupiers to pay for re-designed structures of their houses	SA	60	40.0
	A	89	60.0
	D	-	-
	SD	-	-
	Total	149	100.0

Source: Field Survey, 2017.

Table 5 reveals that on average 83.0% of those surveyed agreed that there is relation between low integration of owner occupier needs-expectation in building design and the post-occupational maintenance cost. The maintenance cost is significant according to (66.0%) of respondents

Table 6: Relationship between Weak Integration of Weather-climatic Conditions during building design and Rainwater Discharge Handling Cost

Propositions	Responses	Number	%
13. House owners and occupiers spend money handling rain water discharge, direct sun rays, wall dampness associated with bad home design	SA	60	40.0
	A	50	34.0
	D	-	-
	SD	39	26.0
	Total	149	100.0
14. Rain hitting your walls, roofs windows, doors are generally traceable to house design deficiencies	SA	70	47.0
	A	30	20.0
	D	-	-
	SD	49	33.0
	Total	149	100.0

15. Cost of handling rainwater discharge in your house increases with ages of building	SA	30	20.0
	A	45	30.0
	D	40	27.0
	SD	34	23.0
	Total	149	100.0
16. Cost of handling rainwater discharge in your house increases with age of building	SA	80	54.0
	A	69	46.0
	D	-	-
	SD	-	-
	Total	149	100.0

Source: Field Survey, 2017

Table 6 shows that on average 73.0% of those surveyed agreed that there is a relationship between weak integration of weather-climatic conditions during building design and Rain Water Discharge handling cost after occupation of such buildings. Respondents are totally agreed such costs are traceable to weak design of handling rather than weather and climatic condition (100.0% and 67.0%).

Table 7: Relationship between Weak Poor Human and Material Equipment Access and Mobility and Maintenance Labour and Equipment Cost

Propositions	Responses	Number	%
17. Insufficient space access and movement of human labour and equipment discourage prompt maintenance works on four building	SA	60	40.0
	A	20	14.0
	D	30	20.0
	SD	39	26.0
	Total	149	100.0
18. Poor access and mobility of maintenance labour and materials increase cost of maintenance	SA	100	67.0
	A	49	33.0
	D	-	-

	SD	-	-
	Total	149	100.0
19. Poor space and movement of people and materials contribute significantly to rapid deterioration of paint, decoration structures and total maintenance costs	SA	60	40.0
	A	89	60.0
	D	-	-
	SD	-	-
	Total	149	100.0
20. Building design that fails to provide enough planned space for access and mobility increases the cost of preventive and curative maintenance	SA	60	40.0
	A	60	40.0
	D	20	13.0
	SD	9	7.0
	Total	149	100.0

Source: Field Survey, 2017

Table 7 shows that on average response, 84.0% of the respondents agreed that there is relationship between poor human and material equipment Access and mobility and cost of maintenance labour and equipment. The more space, access and mobility are integrated in a building the lower the cost of prompt response to maintenance and cost.

4.2 Data Analysis

The method of data analysis used is test of hypotheses using the tool of X^2 (chi-square) statistics.

Ho: There is no significant relationship between inadequate structural support (ISS) during building design and building structural additional support costs in public building in Enugu Metropolis.

Hi: There is Significant relationship between inadequate structural support (ISS) during building design and building structural additional support costs in public building in Enugu Metropolis.

Table 8: Propositions Capturing

Propositions Capturing (Ho)	Agree	Disagree	Total
Proposition 5	140	9	149

Proposition 6	100	49	149
Proposition 7	149	0	149
Proposition 8	100	49	149
Total	489	107	596

(a) Calculation of Cell Values:

$$\frac{489 \times 149}{596} = 122.3 \qquad \frac{107 \times 149}{596} = 26.7$$

$$\frac{489 \times 149}{596} = 122.3 \qquad \frac{107 \times 149}{596} = 26.7$$

$$\frac{489 \times 149}{596} = 122.3 \qquad \frac{107 \times 149}{596} = 26.7$$

$$\frac{489 \times 149}{596} = 122.3 \qquad \frac{107 \times 149}{596} = 26.7$$

Tale 9 Table of Contingence

Decision Rule:

If X^2 calculated (92.2) is ≥ X^2table, then reject Ho and accept Hi.

X^2calculated >X^2 table (5.991). We accept therefore Hi i.e there is significant relationship between inadequate structural support in building design and building additional structural support costs in public building in Enugu Metropolis.

Observed F (O)	Expected F (E)	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
140	122.3	17.7	306.2	2.5
100	122.3	22.3	497.3	4.1
149	122.3	26.7	712.9	5.8
100	122.3	22.3	497.3	4.1
9	26.7	17.7	313.3	11.7
49	26.7	22.3	712.9	18.6
0	26.7	26.7	712.9	26.7
49	26.7	22.3	497.3	18.7
			X^2 = Calculated	92.2

Hypothesis 2

Ho: There is no significant relationship between the low integration of owner-occupier needs and expectation (Lione) in public building design and re-design cost by owner-occupier of public building in Enugu Metropolis.

Hi: There is significant relationship between the low integration of owner-occupier needs-expectations (Lione) in public building design and re-design cost by owner-occupier of public building in Enugu Metropolis.

Table 10: Table of Contingence

Propositions Capturing (Ho)	Agree	Disagree	Total
Proposition 9	149	0	149
Proposition 10	100	49	149
Proposition 11	98	51	149
Proposition 12	149	0	149
Total	496	100	596

(a) Calculation of Cell Values:

$$\frac{496 \times 149}{596} = 124 \qquad \frac{100 \times 149}{596} = 25$$

$$\frac{496 \times 149}{596} = 124 \qquad \frac{100 \times 149}{596} = 25$$

$$\frac{496 \times 149}{596} = 124 \qquad \frac{100 \times 149}{596} = 25$$

$$\frac{496 \times 149}{596} = 124 \qquad \frac{100 \times 149}{596} = 25$$

Table 11: Table of Contingence

Observed F (O)	Expected F (E)	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
149	124	25	625	5.0
100	124	24	576	4.0

98	124	26	676	5.5
149	124	25	625	5.0
0	25	25	625	25.0
49	25	24	576	23.0
51	25	26	676	27.0
0	25	25	625	25.0
			X^2 = Calculated	120.1

Decision Rule:

If X^2 calculated (120.1) is ≥ X^2table, then reject Ho and accept Hi.

X^2cal. (120.1)>X^2 table (5.991). We accept Hi, therefore there is significant relationship between low integration of owner-occupier needs-expectations (Lione) in public building design and re-design cost by owner-occupier of public building in Enugu Metropolis.

Hypothesis 3

Ho: There is no significant relationship between the weak integration of weather-climatic conditions in public building design and rain water discharge handling cost in public building in Enugu Metropolis.

Hi: There is significant relationship between weak integration of weather-climatic conditions in public building design and rain water discharge handling cost in public building in Enugu Metropolis.

Table 12: Proposition Capturing

Propositions Capturing (Ho)	Agree	Disagree	Total
Proposition 13	110	39	149
Proposition 14	100	49	149
Proposition 15	75	74	149
Proposition 16	149	0	149
Total	**434**	**162**	**596**

(a) Calculation of Cell Values:

$$\frac{434 \times 149}{596} = 108.5 \qquad \frac{162 \times 149}{596} = 40.5$$

$\frac{434 \times 149}{596} = 108$ $\frac{162 \times 149}{596} = 40.5$

$\frac{434 \times 149}{596} = 108.5$ $\frac{162 \times 149}{596} = 40.5$

$\frac{434 \times 149}{596} = 108.5$ $\frac{162 \times 149}{596} = 40.5$

Table 13: Table of Contingence

Observed F (O)	Expected F (E)	O - E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
110	108.5	1.5	2.3	0.0
100	108.5	8.5	72.3	0.7
75	108.5	33.5	1122.3	10.3
149	108.5	40.5	1640.3	15.1
39	40.5	1.5	2.3	0.0
49	40.5	8.5	72.3	1.8
74	40.5	33.5	1122.3	27.7
0	40.5	40.5	1640.3	40.5
			X^2 = Calculated	96.1

Decision Rule:

If X^2 calculated (96.1) is $\geq X^2$table, then reject Ho and accept Hi.

X^2calculated (96.1) is $>X^2$ table (5.991). We accept Hi, which implies that there is significant relationship between weak integration of weather-climatic condition in public building design and rain water public building and rain water discharge handling costs in public building in Enugu Metropolis.

Hypothesis 4

Ho: There is no significant relationship between poor human and material equipment access (Pihmea) in public building design and maintenance labour handling cost in public building in Enugu Metropolis.

Hi: There is significant relationship between poor human and material equipment access (Pihmea) in public building design and maintenance labour and equipment

access and mobility cost (Mleac) during post-occupational maintenance stage in public buildings in Enugu Metropolis.

Table 14: Propositions Capturing

Propositions Capturing Ho	Agree	Disagree	Total
Proposition 17	80	69	149
Proposition 18	149	0	149
Proposition 19	149	0	149
Proposition 20	120	29	596
Total	434	162	596

(b) Calculation of Cell Values:

$$\frac{498 \times 149}{596} = 124.5 \qquad \frac{98 \times 149}{596} = 24.5$$

$$\frac{498 \times 149}{596} = 124.5 \qquad \frac{98 \times 149}{596} = 24.5$$

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$$\frac{498 \times 149}{596} = 124.5 \qquad \frac{98 \times 149}{596} = 24.5$$

Table 15: Table of Contingence

Observed F (O)	Expected F (E)	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
80	124.5	44.5	1980.3	15.9
149	124.5	24.5	600.3	4.8
149	124.5	24.5	600.3	4.8
120	124.5	4.5	20.3	0.2
69	24.5	44.5	1980.3	80.8
0	24.5	24.5	600.3	24.5
0	24.5	25.5	600.3	24.5

29	24.5	4.5	20.3	0.8
			X^2 = Calculated	156.3

Decision Rule:

If X^2 calculated (156.3) is ≥ X^2table, then reject Ho and accept Hi.

X^2calculated (156.3) is >X^2 table (5.991). We accept Hi, therefore, there is significa relationship between poor human and material equipment access in public buildi design and post-occupational maintenance labour and equipment access and mobili cost in public building in Enugu Metropolis.

Summary of Findings, Conclusion and Recommendations

The following findings were made:

1. There is significant relationship between inadequate structural support building design and post-occupational additional structural support costs public building in Enugu Metropolis (82.0%, X^2= 92.2, n = 149, p = 0.05).

2. There is significant relationship between low integration of owner-occu needs-expectations in public building design and post-occupational re-des cost by owner-occupier in public building in Enugu Metropolis (83.0%, X^2= 12 n = 149, P = 0.05).

3. There is significant relationship between the weak integration of weat climatic condition in public building design and post-occupational rain w discharge handling cost in public building in Enugu Metropolis (73.0% X^2= 9 n = 149, p = 0.05).

4. There is significant relationship between poor human and material Equip Access and Mobility and Post-occupational maintenance labour and equip cost.

Conclusion

The study revealed that the valuable indicators of public building design deficie are significantly related with the variables of post-occupational maintenance c public buildings in Enugu Metropolis. It was concluded that there is a signi positive relationship between public building design deficiency and occupational maintenance cost. It was also concluded that for any change in building design deficiency, there is a corresponding change in post-occupa maintenance cost.

Recommendations

The following recommendations are made;

1. Architects and engineers responsible for public building design should be sensitive to the financial cost of any design deficiency. Design deficiencies produce significant impact on pre-occupational maintenance cost.

2. Public building designers should integrate the variables of adequate structural support, building occupier needs-expectations, weather-climatic conditions in location of buildings, and human and material equipment access and mobility in public building in Enugu Metropolis.

3. Public building design managers should research more into the design deficiencies from the perspectives of owner-occupier of public buildings in Enugu Metropolis.

4. Public building design managers should carry out regular conversation or interaction among building design managers, building owner-occupier, post-occupational maintenance managers to harmonize those building design deficiencies that rigger significant post-occupational maintenance costs for owner-occupiers of public buildings in Enugu.

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