The Effect of Construction Techniques on Cost of Building Maintenance in Enugu Metropolis, Enugu State

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Abstract
This study sought to investigate the effect of building techniques on cost of building maintenance in Enugu Metropolis. The specific objectives of the study are; to evaluate frame construction technique, in-situ concrete placing technique and strip foundation construction technique as affecting cost of building maintenance. Data was purposively collected from architects, builders, civil engineer and quantity Surveyors. The sample size of the study consists of 43 architects, 52 builders, 35 civil engineer and 30 quantity Surveyors. However, 40 architects, 46 builders, 34 civil engineer and 28 quantity Surveyors returned their questionnaire. The data collected was analysed using the Descriptive statistical tools such as means, percentages, standard deviation, frequency counts, tables and Friedman Test (SPSS) was used to present and discuss the response for the research questions. The study revealed that frame construction technique affect defective maintenance and regular maintenance in terms of cost. It also revealed that In-situ concrete placing technique does not make routine maintenance cheaper but can affect defective maintenance. And respondents differed on Strip foundation construction technique making routine and defective maintenance cheaper. Based on the findings, it is recommended that professionals involved in building construction use frame construction technique in other to reduce cost in terms of routine and defective maintenance.

Keywords: *Construction Techniques, Building maintenance, Cost.*

Introduction

It is not rocket science to recognize the increasing rate of reconstruction, dilapidation and deterioration of building structures within the contemporary Nigerian urban metropolis, which has been necessitated by the increasing needs for housing for various groups in country. According to World Bank (2013) as cited by Iwedi and Onuegbu (2014) Nigeria housing deficit is estimated around 16 million units and it requires more than ₦56 trillion to provide the 16 million housing units to bridge the housing deficit at a conservation cost of ₦3.5 million per unit in the country. For sustainable construct of buildings, the construction method and techniques has been highlighted as key.

Construction methods have been described by scholars to include procedures and techniques used in construction. Okpala and Aniekwu (1988) rightly divides the construction process of a building into project conception, project design, and project construction and asserts that the construction stage is the final phase of the three part process creating the physical form that satisfies the conception and permits the realization of the design. At every stage of building construction process great care must be taken to get it right so as to avoid unnecessary and unwarranted building maintenance cost in the future.

Recently there has been a lot of research emergence on new and improved construction methods and techniques. However, in this study the concept of building construction technique is limited to; frame construction technique, in-situ and precast construction technique and strip foundation techniques.

Techniques of constructing and the proper effecting of such technique can affect the future cost of maintaining such building, be it scheduled maintenance or defective maintenance. According to Hunt and Siddiqi (2015) Construction covers many aspects of the methods and practices involved in the construction process and providing the proper training for the trades and the efforts to achieve the desired results can be a challenge. They went further to assert that construction practices without proper work force training have the potential for defective workmanship. Defective construction work by trades can lead to costly construction, costly mitigation and long term cost impacts on scheduled and reoccurring facility maintenance.

Amobi (2006) defines maintenance in engineering terminology as the continuous upkeep, in good condition of a system(s) to achieve operational reliability with maximum designed output result, endurance and stability. This definition has been adapted for building maintenance by other authors as work undertaken to keep or restore every facility, part of a site, building and contents to an acceptable standard which may be continuous or one-time as to include some degree of improvement over the life of the building as acceptable comfort and amenity standards rise thereof. Consequently, in the causes of high maintenance cost is investigated as well as to what extent.

Objectives of the study

The broad objective of the study is to investigate the effect of construction techniques on cost of building maintenance in Enugu metropolis, Enugu State. The specific objectives of the study are;

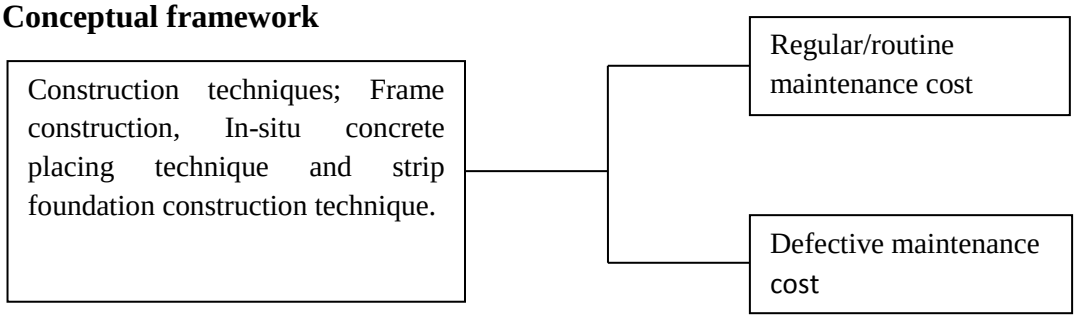
1. To evaluate frame construction technique as affecting cost of building maintenance.
2. To assess in-situ concrete placing technique as affecting cost of building maintenance.
3. To determine strip foundation construction technique as affecting the cost of building maintenance.

Research questions

1. Does frame construction technique affect cost of maintenance of buildings?
2. Does in-situ concrete placing technique affect cost of maintenance of buildings?
3. Has strip foundation construction technique affected cost of maintenance of buildings?

Review of related literature

Conceptual framework



Frame Construction Technique

According to the online civil engineering dictionary, frame construction can be described as Frame structures having the combination of beam, column and slab to resist the lateral and gravity loads. These structures are usually used to overcome the large moments developing due to the applied loading. Frames structures can be differentiated into: rigid frame structure and brace frame structure.

In-Situ and Precast Construction Technique

In-situ technique does not rely on the assembly of factory components (a kit of parts). Instead of being system-built, it involves innovatory approaches to wall construction, using in situ poured concrete.

The complete house is cast on site, using specially designed "house-sized" formwork or re-useable formwork moulds, examples of which are referred to as No-Fines house. 'No-Fines' refers to the type of concrete used - a mix of cement and coarse aggregate, without any sand (fines). The walls are load-bearing and the concrete is full of air holes - giving a slightly better insulation value. The claim to prefabrication lies in the manufacture of large reusable shuttering - the "moulds" into which the concrete is poured. This type of construction enabled the house to be quickly erected using non-skilled labour. This made it particularly suitable to meet the demand for large scale social housing estates built during the 1950s and 1960s. The rendered finish of these types of houses hides the fact that they are constructed from No-Fines concrete. Block HCPM.101 (Retrieved in February 2017)

The precast construction technique is a structural system of precast concrete frames, containing steel reinforcement to strengthen the concrete. This provides the load bearing "skeleton", onto which a variety of different types of cladding is attached. This technique is affected by corrosion of the steel resulting in buildings having some of the worst structural problems as a result of carbonation, chloride and cover, often referred to as the three Cs.Block HCPM.101 (Retrieved in February 2017)

Strip Foundation Technique.

The purpose of a foundation is to transfer the imposed load of a building or structure onto a suitable substratum. Strip foundation technique is the construction of foundations as a continuous concrete section supporting load bearing walls. If they are in plain concrete they must be at least 150 mm thick to prevent shear.

Strip foundations are used where the soil is of good bearing capacity, although where the soil have reduced bearing capacity - places like states in south-south Nigeria - with marshy grounds or water-laden soils, it is very important to strengthen the strip foundation with steel reinforcement. Another alternative to this would be pile or raft foundations but they have their cost implications.

The key sizes of a strip foundation for concrete cavity wall construction and timber frame cavity wall construction are similar. The size and position of the strip is directly related to the overall width of the wall. The principle design features of a strip foundation are based on the fact that the load is transmitted at 45 degrees from the base of the wall to the soil. The depth of a strip foundation must be equal to or greater than the overall width of the wall.

However noble the intent of the builder, architect or civil engineer, if the application of these techniques are faulty, it causes defects in the structural stability of the building and eventually increasing maintenance cost. According to Okuntade (2014), faulty construction is one of the problems most public building is facing in Nigeria and this can be attributed to inexperience and inconsistency in the training of artisan, who are the workmen to execute construction.

Also, Okuntade (2014) while citing Assaf et al (1995) established that faulty construction is one of the causes of early deterioration in building. The resultant faults will reduce the service life of the structure as a result of reinforcement rusting after the concrete has become strong and the cost of maintenance can be substantial

Methodology

Data was purposively collected from architects, builders, civil engineer and quantity Surveyors. The sample size of the study consists of 43 architects, 52 builders, 35 civil engineer and 30 quantity Surveyors. Questionnaire items were distributed in other to collect information, however, it was divided into two sections; section A to collect background information of the respondents while section B was to collect information bordering on techniques and how it affects cost of maintenance of buildings.

Data analysis

The data collected was analysed using the Descriptive statistical tools such as means, percentages, standard deviation, frequency counts, tables and Friedman Test (SPSS) was used to present and discuss the response for the research questions.

Discussions

Table 1

Questionnaire	No	Percent
Total administered	160	100
Total returned	148	92.5
Not returned	12	7.5

The result from table1 show that 92% of questionnaire administered were returned and 7.5% were not returned.

Table 2 Demography of respondents

Professions	Frequency	Percent	Cumulative
Architects	40	27.0	27.0
Civil Engineers	34	22.9	49.9
Builders	46	31.1	81.1
Quantity Surveyors	28	18.9	100
Total	148	100	

Source: Field survey 2017

Table 2 shows that 26.9% are architects, 21.9% are civil engineer, 32.5% are builders and 18.8% are quantity Surveyors.

Frame structure building technique as affecting cost of maintenance of buildings

Table 3 Responses of Frame structure building technique as affecting cost of maintenance of buildings.

S/n	Techniques as affecting cost of maintenance	Architects					Civil Engineers					Builders					Qty Surveyors				
		SA	A	UD	D	SD	SA	A	UD	D	SD	SA	A	UD	D	SD	SA	A	UD	D	SD
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	Frame structure building technique affects routine	56	78	11	1	2	53	77	15	3	0	0	23	73	42	10	7	28	54	43	16
		3	5	7	0	1	3	5	1	2	0	0	1	4	2	6	4	1	3	2	1

	maintenance	7.8	2.7	.4	.7	.4	5.8	2	0.1	.0			5.5	9.3	8.4	.8	.7	8.9	6.5	9.1	0.8
2	Frame structure building technique affects defective maintenance	61	77	7	1	2	62	73	10	3	0	11	29	61	37	10	18	35	44	37	14
		41.2	52	4.7	0.7	1.4	41.9	49.3	6.8	2	0	7.4	19.6	41.2	25	6.8	12.2	23.6	29.7	25	9.5

Source: Field survey 2017

Research responses from various respondents indicated that, 37.8% of respondents strongly agree that frame structure building technique affects cost of routine maintenance of buildings, 52.7% agree, 7.4% undecided, 0.7% disagree and 1.4% strongly disagree. Concerning civil engineers, 35.8% of respondents strongly agree that frame structure building technique affects cost of routine maintenance of buildings, 52% agree, 10.1% undecided, 2% disagree and 0% strongly disagree. Among builders, 0% of respondents strongly agree that frame structure building technique affects cost of routine maintenance of buildings, 15.5% agree, 49.3% undecided, 28.4% disagree and 6.8% strongly disagree. Concerning quantity surveyors, 4.7% of respondents strongly agree that frame structure building technique affects cost of routine maintenance of buildings, 18.9% agree, 36.5% undecided, 29.1% disagree and 10.8% strongly disagree.

41.2% of respondents strongly agree that frame structure building technique affects cost of defective maintenance of buildings, 52% agree, 4.7% undecided, 0.7% disagree and 1.4% strongly disagree. Concerning civil engineers, 41.9% of respondents strongly agree that frame structure building technique affects cost of defective maintenance of buildings, 49.3% agree, 6.8% undecided, 2% disagree and 0% strongly disagree. Among builders, 7.4% of respondents strongly agree that frame structure building technique affects cost of defective maintenance of buildings, 19.6% agree, 41.2% undecided, 25% disagree and 6.8% strongly disagree. Concerning quantity surveyors, 12.2% of respondents strongly agree that frame structure building technique affects cost of defective maintenance of buildings, 23.6% agree, 29.7% undecided, 25% disagree and 9.5% strongly disagree.

In-situ concrete placing technique as affecting cost of maintenance of buildings

Table 4 Responses on In-situ concrete placing technique as affecting cost of maintenance of buildings

S/n	Techniques as affecting cost of maintenance	Architects					Civil Engineers					Builders					Qty Surveyors				
		SA	A	UD	D	SD	SA	A	UD	D	SD	SA	A	UD	D	SD	SA	A	UD	D	SD
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	In-situ concrete placing technique is cheap to use in routine maintenance	6	17	14	79	32	66	71	11	0	0	10	73	41	0	24	10	22	46	47	23
		44.1	11.5	9.5	53.4	21.6	44.6	48	7.4	0	0	6.8	49.3	27.7	0	16.2	6.8	14.9	31.1	31.8	15.5
2	In-situ concrete placing technique is cheaper in defective	33	35	30	33	17	5	11	27	74	31	69	71	8	0	0	6	16	68	37	21
		2	2	2	2	1	3	7	1	5	2	4	4	5	0	0	4	1	4	2	1

	maintenance	2.3	3.6	0.3	2.3	1.5	.4	.4	8.2	0	0.9	6.6	8	.4			.1	0.8	5.9	5	4.2

Source: Field survey 2017

Research responses from various respondents indicated that, 4.1% of respondents strongly agree that In-situ concrete placing technique affects cost of routine maintenance of buildings, 11.5% agree, 9.5% undecided, 53.4% disagree and 21.6% strongly disagree. Concerning civil engineers, 44.6% of respondents strongly agree that In-situ concrete placing technique affects cost of routine maintenance of buildings, 48% agree, 7.4% undecided, 0% disagree and 0% strongly disagree. Among builders, 6.8% of respondents strongly agree that In-situ concrete placing technique affects cost of routine maintenance of buildings, 49.3% agree, 27.7% undecided, 0% disagree and 16.2% strongly disagree. Concerning quantity surveyors, 6.8% of respondents strongly agree that In-situ concrete placing technique affects cost of routine maintenance of buildings, 14.9% agree, 31.1% undecided, 31.8% disagree and 15.5% strongly disagree.

22.3% of respondents strongly agree that In-situ concrete placing technique affects cost of defective maintenance of buildings, 23.6% agree, 20.3% undecided, 22.3% disagree and 11.5% strongly disagree. Concerning civil engineers, 3.4% of respondents strongly agree that In-situ concrete placing technique affects cost of defective maintenance of buildings, 7.4% agree, 18.2% undecided, 50% disagree and 20.9% strongly disagree. Among builders, 46.6% of respondents strongly agree that In-situ concrete placing technique affects cost of defective maintenance of buildings, 48% agree, 5.4% undecided, 0% disagree and 0% strongly disagree. Concerning quantity surveyors, 4.1% of respondents strongly agree that In-situ concrete placing technique affects cost of defective maintenance of buildings, 10.8% agree, 45.9% undecided, 25% disagree and 14.2% strongly disagree.

Strip foundation construction technique as affecting cost of maintenance of buildings

Table 5 Responses on Strip foundation construction technique as affecting cost of maintenance of buildings

S/n	Techniques as affecting cost of maintenance	Architects					Civil Engineers					Builders					Qty Surveyors				
		SA	A	UD	D	SD	SA	A	UD	D	SD	SA	A	UD	D	SD	SA	A	UD	D	SD
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	Strip foundation construction technique is cheap to use in routine maintenance	0	5	19	74	50	36	42	40	21	9	6	17	67	33	25	19	22	46	42	19
		0	3.4	12.8	50	33.8	24.3	28.4	27	14.2	6.1	4.1	11.5	45.3	22.3	16.9	12.8	14.9	31.1	28.4	13.8
2	Strip foundation construction technique is cheaper in defective maintenance	42	47	28	22	9	6	13	48	46	35	38	43	38	20	9	13	18	58	37	22
		28.4	31.8	18.9	14.9	6.1	4.1	8.8	32.4	31.1	23.6	25.7	29.1	25.7	13.5	6.1	8.8	12.2	39.2	25	14.9

Source: Field survey 2017

Research responses from various respondents indicated that no respondent strongly agree that Strip foundation construction technique affects cost of routine maintenance of buildings,

3.4% agree, 12.8% undecided, 50% disagree and 33.8% strongly disagree. Concerning civil engineers, 24.3% of respondents strongly agree that Strip foundation construction technique affects cost of routine maintenance of buildings, 28.4% agree, 27% undecided, 14.2% disagree and 6.1% strongly disagree. Among builders, 4.1% of respondents strongly agree that Strip foundation construction technique affects cost of routine maintenance of buildings, 11.5% agree, 45.3% undecided, 22.3% disagree and 16.9% strongly disagree. Concerning quantity surveyors, 12.8% of respondents strongly agree that Strip foundation construction technique affects cost of routine maintenance of buildings, 14.9% agree, 31.1% undecided, 28.4% disagree and 13.8% strongly disagree.

28.4% of respondents strongly agree that Strip foundation construction technique affects cost of defective maintenance of buildings, 31.8% agree, 18.9% undecided, 14.9% disagree and 6.1% strongly disagree. Concerning civil engineers, 4.1% of respondents strongly agree that Strip foundation construction technique affects cost of defective maintenance of buildings, 8.8% agree, 32.4% undecided, 31.1% disagree and 23.6% strongly disagree. Among builders, 25.7% of respondents strongly agree that Strip foundation construction technique affects cost of defective maintenance of buildings, 29.1% agree, 25.7% undecided, 13.5% disagree and 6.1% strongly disagree. Concerning quantity surveyors, 8%.8 of respondents strongly agree that Strip foundation construction technique affects cost of defective maintenance of buildings, 12.2% agree, 39.2% undecided, 25% disagree and 14.9% strongly disagree.

Table 6 Percentage Summary Of Strongly Agree And Agree Responses.

S/n	Techniques as affecting cost of maintenance	Architects	Builders	Civil Engineers	Qty Surveyors	mean	Std dev
1	Frame structure building technique affects routine maintenance	90.0	68.0	100.0	57.1	78.775	19.68
2	Frame structure building technique affects defective maintenance	92.5	58.6	100.0	64.0	78.775	20.53
3	In-situ concrete placing technique is cheap to use in routine maintenance	15.0	17.4	8.8	14.2	13.85	3.63
4	In-situ concrete placing technique is cheaper in defective maintenance	70.0	100.0	97.0	100.0	91.75	14.57
5	Strip foundation construction technique is cheap to use in routine maintenance	2.5	4.34	0	3.5	2.59	1.88
6	Strip foundation construction technique is cheaper in defective maintenance	52.5	58.6	55.8	67.8	58.68	6.57

Source: field Survey 2017

Table 6 show the percentage summary of respondents. With a mean response of above 50%, respondents (Architects, Builders, Civil Engineers and Quantity Surveyors) mostly agree that frame structure building technique affects routine and defective maintenance.

With a mean response of below 50%, respondents (Architects, Builders, Civil Engineers and Quantity Surveyors) mostly disagree that In-situ concrete placing technique can make routine maintenance cheaper. However, with a mean response of above 50%, they agree that In-situ concrete placing technique can make defective maintenance cheaper.

From table 6 above, with a mean response of 2.59, which is far below 50%, respondents (Architects, Builders, Civil Engineers and Quantity Surveyors) mostly disagree that strip foundation construction technique makes routine maintenance cheaper. With a mean response

of just around 50%, respondent barely agrees that strip foundation construction technique makes defective maintenance cheaper.

Analysis

Frame structure building technique as affecting cost of maintenance of buildings

Analysis of opinion of experts on frame structure building technique affecting cost of maintenance of building.

Friedman Test

Test Statistics[a]

N	4
Chi-Square	1.200
Df	3
Asymp. Sig.	.753

a. Friedman Test

Source: Researchers' computation 2017

The table above shows that there is no overall statistically significant difference between the mean ranks of opinion of architects, builders, civil engineers and quantity surveyors. Therefore, its observed that there is no statistical significant difference in the responses on frame structure building techniques on the cost of building maintenance, $\chi^2(3) = 1.200$, $p = 0.753$.

In-situ concrete placing technique as affecting cost of maintenance of buildings

Analysis of opinion of experts on In-situ concrete placing technique affecting cost of maintenance of building.

Friedman Test

Test Statistics[a]

N	5
Chi-Square	7.394
Df	4
Asymp. Sig.	.116

a. Friedman Test

Source: Researchers' computation 2017

From the table above, there was no statistically significant difference in perceived effect of in situ concrete placing technique on cost of building maintenance, $\chi^2(4) = 7.394$, $p = 0.116$.

Strip foundation construction technique as affecting cost of maintenance of buildings

Analysis of opinion of experts on strip foundation construction technique affecting cost of maintenance of building.

Friedman Test

Test Statistics[a]

N	5
Chi-Square	10.720
Df	4
Asymp. Sig.	.030

a. Friedman Test
Source: Researchers' computation 2017

From the table above, there was a statistically significant difference in perceived effect of strip foundation construction technique in affecting cost of building maintenance, $\chi^2(4) = 10.720$, $p = 0.030$.

Conclusion

This study sought to investigate the effect of building techniques on cost of building maintenance in Enugu Metropolis. The specific objectives of the study are; to evaluate frame construction technique, in-situ concrete placing technique and strip foundation construction technique as affecting cost of building maintenance.

Research analysis shows that, there is no statistical significant difference in the group responses on frame structure building technique on the cost of building maintenance, $\chi^2(3) = 1.200$, $p = 0.753$. Also haven observed that majority of the respondents across professional lines strongly agree and agree that frame construction technique affects cost of building maintenance. We conclude therefore, the frame construction technique affect defective maintenance and regular maintenance in terms of cost.

Research analysis shows that, there was no statistically significant difference in the group responses on the perceived effect of in situ concrete placing technique on cost of building maintenance, $\chi^2(4) = 7.394$, $p = 0.116$. Also haven observed that majority of respondents mostly disagree that In-situ concrete placing technique can make routine maintenance cheaper and majorly agree that In-situ concrete placing technique can make defective maintenance cheaper. We conclude therefore, that In-situ concrete placing technique does not make routine maintenance cheaper. However, can affect defective maintenance.

Research analysis shows that, there was a statistically significant difference in perceived effect of strip foundation construction technique in affecting cost of building maintenance, $\chi^2(4) = 10.720$, $p = 0.030$.

We therefore conclude that, statistically respondent's responses differed on if strip foundation construction technique makes routine and defective maintenance cheaper.

Meaning Strip foundation construction effect is dependent among other things, on the soil bearing capacity. A weaker soil may necessitate more reinforcements while a stronger soil requires less.

Recommendations

Based on the findings, professionals involved in building construction should use frame construction technique in other to reduce cost in terms of routine and defective maintenance. Also, In-situ concrete placing technique affects building maintenance; depending on the level of maintenance it could be costly. For medium rise building, cost of maintenance get higher because of the need for shoring and underpinning for some of the building parts. For low rise residential buildings, the cost differential may not be significant meaning it doesn't make cost of building maintenance any cheaper. Therefore it does affect defective maintenance in

comparison to precast technique but not regular maintenance and due diligence must be taken when considering this technique.

Consideration for further studies

Since the Friedman test was primary to analyze opinions in this work, we recommend for further studies a Post Hos Tests, to ascertain which particular variable made the most difference to cost of building maintenance.

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