Effects Of Faulty Design And Construction On Building Maintenance

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Abstract: The study examined the effects of faulty design and construction on the maintenance of building. A survey of randomly selected samples of 35 builders and 20 architects were conducted. Questionnaires were used to collect data from Architects and Builders. The survey included 4 groups of defects and sub defects in each groups. The predominant severity effects of each defects was assessed and ranked based on the severity index as ranked by both the Builders and the Architects. The results shows that 16 defects were rated as most severe, 19 as moderately severe and 12 defects as slightly severe defects, however according to the builders 15 defects were rated as most severe defects, 28 defects as moderately severe and 3 defects as slightly severe defects. The results also show that increase in maintenance work is the most predominant effects on building maintenance among other factors of defect with an index value of 100.00 as perceived by both the rank of the Architects and that of the builders. The research however includes a hypothesis that Architects and Builders generally agree on the ranking of the severity defects which was tested and proven to be true. The study concluded that there should be a design review before finally approving the design for construction; maintenance expert should not be overlooked in the planning stage of the project and most importantly the employment of professionals for any building projects.

Keywords: Faulty Design, Faulty construction, Building Maintenance.

1 INTRODUCTION

THE relationship between design, construction and maintenance is closely related but not easily distinguished. Hardy and lammers (1996: cited in maisarah 2012) explained the vital role of design in the early stage of project management. They stated that a functional design can promote skill; economy, conveniences, and comforts while a non-functional design can impeded activities of all types of detract from quality of care, and raise cost to intolerable levels. A typical saying by Vonnegut (1922-2007)' every body want to build and no body want to do maintenance. In Nigeria building design are copied from other countries without considering the conditions that lead to such design, hence maintenance experts are seldom included to advice on maintenance efficiency of such design. In a related development iyagba (2005) reveal that there are substantial numbers of people who do not know the meaning of maintenance. The mistakes most designer made is believing that a building that is design with the best aesthetics materials requires little or no maintenance, but such notion or argument are wrong because The maintenance of a building begins after the construction is completed (Haniff, 2007). Eizzatul 'Ain (2012) observed that the maintainability aspect at the design stage is often ignored and this has contributed to future problems when implementing maintenance work. He further explained that this happens when the aesthetics value has become more important in the design of asset, besides the design factor, site selection, apparatus, tools or facilities to maintain the asset are hard to obtain or very costly. According to Rozita (2006) the effectiveness of the building is not dependent on its aesthetic value but on the ability to perform maintenance works on the building in the future. Just like the military slogan that if you fail to plan, and then you are planning to fail. That is, if a building is design and constructed without any plan for maintenance the building is hovering towards failure. According Norhaniza etal(2007) if the designer failed to plan well the entire plan would also fail. Every decision made during the building design and construction has its own impact, too often the professionals that constructs and design don't worry whether the building they design and build will work properly, their major concern is just to complete the project and move to the next job while the consequence is left for the client to handle. The effect of faulty building design and construction has become one of the major issues in maintaining building in Nigeria. United nation (1992) mentioned that the world as pass a demographic milestone i.e. for the first time in the history of mankind. World Bank suggested that urbanization and resulting housing problems are the most dominant phenomenon in all developing countries. But a fact indicated that urban population forms an overwhelming majority in all developed countries, (World Bank, 1990). Nigeria has a population estimated to be around 150 million which has the largest black populace in the world and as such new building are being built daily to accommodate the demands of the teeming population, this has lead to the desperation of every single individual to have a building of his own , the consequence is that an inexperience designer is given a contract to design and same to another to construct in a short period of time which will result in many defects especially during the design and construction stage and this will inevitably result in high maintenance cost. Abdulmohsen and sadi, (1997) stated that the increase in maintenance cost is attributed to the failure of the building design. If we compare the production of as cars, for example a car is designed and then built; it is tested exhaustively, fault identified and then rectified. If we relate this to building work, we need to construct a building, test if overtime and then demolish and rebuild, removing all problem in the next design. Faulty construction also accounts for many building failure, if a new copied design has not been specified or built previously(most especially designed copied from abroad) the builder will have no experience of this design and may build it incorrectly resulting in high cost of maintenance with inherent defects. It is therefore sacrosanct for both the designer and the builder to consider the importance of maintenance at the onset of the design because decision made at the planning stage have a large effect on the maintenance of the building and the cost. It is most times worry some that most building expert that suppose to educate the public on the importance of building maintenance will say age building result in high cost of maintenance. It is most time correct but we should also know that there are some new building with numerous defect as a result of faulty design and construction which previous research work estimated to

surpass the cost of maintaining the age building. Dauda and muyiwa (2010) found out that defects within new building are area of non compliance with the building code of practice older buildings or building out of warranty period may not comply with theses standards but must be judged against the standard at the time of construction or refurbishment.

1.1 NEED FOR THE STUDY

Previous research has shown that the cost of maintaining a building usually involve large amount of expenditure which most times surpass the cost of building the structure itself. Therefore, design and construction play a vital role in deciding if defect will transpire later in the building. Hence, by getting it right from the onset of the building can go a long way in minimizing mistakes and error that might occur during construction. The way public facilities deteriorate in Nigeria has give room for extra cost to the management of those facilities due to the failure of getting things right when planning the project right from the design and the construction stage. To avoid future negligence among designers and contractors, extensive research work on eliminating the issue of faulty design and construction need to be carried out to improve the design and construction process. The need for maintenance was not given much relevance in the past, in spite of expenses upon expenses incurred doing maintenance after large amount of money has been spent on building a house. Hence, the study aims at identifying the defect caused by faulty design and construction on maintenance and assessing the effect of those defects on maintenance.

1.2 STATEMENT OF PROBLEM

Most public buildings in Nigeria are in a state of derelict conditions of structural and aesthetic disrepair and if corrective measures are not properly carried out, it could results in a total breakdown of structural component. Despite the various strategies being adopted by the government for the maintenance of those facilities, the buildings remain a home for defects that should have been avoided if proper feasibility planning on maintenance has been given cognizance right from the design and construction stage of the project. This has led to unnecessary expenditure from the various authorities in carrying out remedial work to curb the effects. Brennan (2000) opined that the main purpose of maintenance of property is essentially to retain it values for investment, aesthetics, safety and durability with a view to ensuring that the property is continually used for habitation and to satisfaction of the owner. It was even observed that majority of the new construction were being built up with defects which later transpire into substantial expenses on maintenance.

1.3 AIM OF STUDY

The aim of this study is to gain an understanding if the Effects of faulty design and construction on Building maintenance Objectives of the study

1. To identify the building defects caused by faulty design and construction on building maintenance
2. To assess the effects of the building defects caused by faulty design and construction on maintenance

3.0 RESEARCH METHODOLOGY

This research work was carried out using two methods; the first methods involve a literature search and an interview. This stage identifies 49 defects caused by faulty design and construction, and also 8 effects of the defects on building maintenance. In the second method a questionnaire was developed using the defects identified as a parameters and a survey was conducted to assess the effect of these defects on maintenance. The population of the respondents consists of 20 Architects and 35 Builders respectively, hence 55 questionnaires were returned while 25 questionnaires were not completed.

3.1 DATA ANALYSIS

3.2 SEVERITY INDEX

The data collected were analyzed using inferential statistics. To measure the data obtained from the respondents, the questionnaire data was analyzed using the severity index formula. The severity index formula is to determine the ranking parameters for each answer to the question and check the weight of each item. For every question there are four (4) parameters that should be used by the respondent as options to answer the questionnaire. The four options given are Does not affects, strongly affects, moderately affects and slightly affects. Each factor has a severity index which can be calculated as follows (Assaf, 1995). A four scale point was used in solving the question provided. The important index could be obtained for each factor as follows (Assaf 1995)

$$\text{Severity index (IS)} = \frac{\Sigma (a_1 x_1) \times 100\%}{3 \sum x_1} \quad (1)$$

Where ai = constant expressing the weight given in ith response, I = 1,2,3,4 where a1= 0 is equivalent to Does not affect response, a2= 1 is equivalent to slightly affects response, a3= 2 is equivalent to moderately affects response, a4= 3 is equivalent to strongly affects response, Xi = the variable expressing the degree of importance, x_1 = the frequency of does not affects response, x_2 = the frequency of moderately affects response, x_3 = the frequency of slightly affects response, x_4 = the frequency of strongly affect.

3.3 SPEARMAN RANK CORRELATION

Spearman rank correlation will be used to establish whether there is any form of significant relationships in agreement between the professionals which include architect and builder. The following formula will be used to check the degree of agreement

Spearman rank correlation coefficient (Rs)

$$\text{Rho } (p) = \frac{1 - 6\Sigma d^2}{N (n^2-1)} \quad (2)$$

Where D = difference between the ranks given by one party and the ranks given by another party for an individual defects,

N = number of defects or group

3.4 PRESENTATION OF RESULTS

Table 5 Response to questionnaire administered

Questionnaire	No	Percent
Total administered	80	80
Total returned	55	55
Not returned	25	25
Used for the study	55	55

The results from the table 5 show the percentage of the questionnaire administered and the percentage returned and completed

Table 6 Qualification of respondent

Freq	Percentage
OND -	-
HND 12	21.82
BSc 15	27.27
MSc 28	50.91
PhD -	-
Total 55	100.00

Table 6.0 shows that 21.28% are HND holders, 27.27% BSC holders, 50.91% MSC holders. This show that MSC holders are the highest respondents

Table 7.0 Demography of respondent

Profession	frequency	percentage
Architect	20	36.38
Builder	35	63.64
Total	55	100.00

Table 7.0 show that 36.36% are Architects while 63.54% are builders. This show that the builders are the highest respondents

Table 8.0 Working experience

Working	frequency	percentage
1-5 years	15	27.27
6-10 years	12	21.82
Above 10 years	28	50.91
Total	55	100.00

Table 8.0 above show that 72.72% of the respondents have experience between 1-5 years, 21.82% has between 6-10 years and 50.91% above 10 years. This shoe that the respondents will have enough experience about the research problem

Table 9.0 results of Architects and Builders on the defects identified through previous wok and survey

	Defects	Builders	Rank	Architects	Rank
	Faulty design defects				
1.	Inadequate provision for movement due to thermal Effects	73.33	10	73.34	15
2.	Ignoring changing environmental weather condition	66.67	12	57.14	26
3.	Inadequate concrete cover for reinforcement	86.67	5	74.29	14
4.	Overlooking the changes in soil conditions	90.00	4	57.15	26
5.	Poor structural design	93.33	3	70.49	17
6.	Inaccurate dimensions on drawing	75.00	9	80.95	
7.	Improper design of construction joints between finished	75.00	9	73.34	15
8.	Wrong detailing of production information i.e. schedule	43.33	22	80.95	9
9.	Not considering the effects of wind on structure	66.67	12	65.71	21
10.	Ignoring the impacts of load on the building stability	60.00	16	91.43	3
11.	Not considering the effects of climate on materials	50.00	19	49.51	28
12.	Not considering the maintainability and buildabilty during	80.00	7	78.10	10
	Faulty construction defects				
13.	Premature formwork removal	86.67	5	95.24	2
14.	Painting in unsuitable working environment	95.00	2	84.77	6
15.	Inadequate curing procedures	73.33	10	71.43	16
16.	Damaged formwork	73.33	10	68.53	18
17.	Poor soil compaction	56.67	17	84.76	7
18.	Insufficient concrete cover	100.00	1	100.00	1
19.	Movement of formwork	65.00	13	62.86	22
20.	Improper construction of joints	50.00	19	77.14	12
21.	Inadequate concrete vibration	56.67	17	78.09	11
22.	Non conformity with waterproofing specification	65.00	13	74.29	14
23.	Uneven mixture of aggregate	55.00	18	86.67	16
24.	Non compliance with specification	66.67	12	71.43	16
25.	Wrong use of equipment for construction	56.67	17	62.86	22
26.	Using unwashed aggregate for construction	65.00	13	62.85	23
27.	Poor bonding	83.33	6	66.67	19
28.	Inaccurate measurement	83.33	6	69.52	18
	Contractors administration and staff				
29.	Poor communication with the design firm	71.67	11	60.00	25
30.	Incompetent workforce	40.00	24	38.10	29
31.	Lack of proper supervision	40.00	24	38.09	30
32.	Non compliance with specifications	86.67	5	57.14	26
33.	Inability to interpret drawing	66.67	12	71.43	16
34.	Hiring incompetent supervision	66.67	12	66.66	19
35.	Speedy completion of work	90.00	4	76.19	13
36.	Inexperience workmen and lack of motivation	90.00	4	83.81	8
37.	Bad workmanship	40.00	24	67.63	20
38.	Non challant attitude towards building regulations	31.67	26	56.19	27
39.	Poor technical background	41.67	23	60.00	25
	Consultant administration and staff				
40.	The technical ability of the designer	38.33	25	87.62	4
41.	Designer field experience	63.33	14	71.43	16
42.	Hiring inexperienced designer	43.33	22	74.29	14
43.	Designer ignorance of materials properties	50.00	19	79.19	9
44.	Poor technical updating of staff	90.00	4	57.14	26
45.	Misjudgment of climatic conditions	78.33	8	74.29	14
46.	Failure of consultant to their jobs	65.00	13	74.29	14
47.	Making frequent changes	46.67	21	61.90	24
48.	Incomplete implementation	61.67	15	86.67	5
49.	Misjudgment of intended use of facility	48.83	20	61.90	24

Table 9.0 above shows the severity index of the defects caused by faulty design and construction on maintenance of building. According to the Architects inadequate concrete cover (86.,67), overlooking the changes in soil

condition(90.00), poor structural design(93.33), inaccurate dimension on drawing(75.00), improper design of construction joints between finished faces (97.50), not considering the maintainability and buildability during design(80.00), premature formwork removal(86.67), painting in unsuitable working environment(95.00), insufficient concrete cover(100.00), poor bonding(83.33), inaccurate measurement(83.33), non compliance with specification(86.67), speedy completion of work(90.00), inexperienced workmen and lack of motivation(90.00), misjudgment of climatic conditions(90.00), failure of consultant to do their jobs(78.33) were rated the most severe defects. However, according to Builders inaccurate dimension on drawing (80.95), wrong detailing of construction information (80.95), ignoring the impacts of load on the building stability and strength (91.43), not considering the maintainability and buildability during design (78.10), premature formwork removal(95.24), painting in an unsuitable working environment(84.77), poor soil compaction(84.76), insufficient concrete cover(100.00), inadequate concrete vibration(77.14), improper construction of joints(78.09), uneven mixture of aggregate(86.67), speedy completion of work(76.19), inexperienced workmen and lack of motivation(83.81), the technical ability of the designer(87.62), poor updating of staff(79.19) and incomplete implementation(86.67) are the most severe defects acting negatively on building maintenance.

Table 10 below show the results of spearman correlation coefficient of the association of the effects of faulty design and construction on building maintenance between the Architects and the Builders

Variables	Rs	Df	T_{cal}	T_{tab}	Decision
Factors	0.79	1	8.834	1.960	Accept h_1

Note: Rs-spearman's rank correlation coefficient, t_{cal}-t-calculated, t_{tab}-t tabulated, Ho-null hypothesis,

Referring to table 7.0, the spearman rank correlation coefficient, rho (rs) is 0.794 which indicate a strong positive association between the two professional's perception of the effects of faulty design and construction on building maintenance. At 0.05 level of significant at 95% confident level t_{cal} is 8.834 and t_{tab} is 1.960 therefore accept alternative hypothesis this is an indication that both the Architect and the Builders agree on the ranking of severity index and have almost the same perception about the defects caused by faulty design and construction on maintenance.

Table 8.0 effects of defects on building maintenance

Defects	Architect	Rank	Builder	Rank
Increase in maintenance budget	56.67	3	95.24	2
Increase workforce	46.67	5	73.33	4
Increase in maintenance work	100.00	1	100.00	1
Increase in maintenance quality	43.33	6	59.05	7
Difficulties in maintenance planning	56.67	3	68.57	5
Increase maintenance frequency	48.33	4	68.57	5
Maintenance works become obsolete	60.00	2	78.09	3
Lower maintenance quality	43.33	6	59.05	6

Table 8.0 above show the effects of defects on building maintenance, the Architects and the Builders both rank increase in maintenance work (100.00) the most predominant effects among other factors

Variables	Rs	Df	T_{cal}	T_{tab}	Decision
Factors	1.000	1	15.69	1.895	Accept Hi

Referring to table 8.0, the spearman rank correlation coefficient rho (is) is 0.99 which indicates a strong positive association between the two professionals perception on the effects on the defects on building maintenance. At 0.05 level of significance t_{cal} is 15.69 and t_{tab} is 1.895 therefore accept alternative hypothesis. This is an indication that both the Architect and Builders agree on the ranking of the defects identified

4.0 DISCUSSION OF FINDINGS

From the perception of the Architect's poor structural design seem to be the most severe defects caused by faulty design while the Builders agreed on ignoring the impact of load on the building stability and strength as the most severe defects caused by faulty design on maintenance. Insufficient concrete covers were both agreed by the Architects and Builders to be the most severe defect caused by faulty construction on maintenance. Speedy completion of work, inexperience workmen and lack of motivation were both agreed to be caused by contractor administrations and staff by the Architects and Builders. The architects believes misjudgment of climatic condition is most severe defects caused by consultant administration and staff while the Builders rank incomplete implementation as the most severe defects caused by the consultant firm and administration staff. The factors highlighted were also confirmed in the study of Assaf, Abdul-mohsen Alhammad and mansoor Alshilah 1995).

5.0 CONCLUSION

From the findings, above the study concludes that the two professionals agreed that out of the total of 49 defects identified the top 7 most severe defects on building maintenance are:

1. Inaccurate dimension on drawings
2. Not considering the maintainability and Buildability during design
3. Premature formwork removal
4. Painting in unsuitable working environment
5. Insufficient concrete cover
6. Speedy completion of work
7. Inexperience workmen and lack of motivation

The study concludes that there is a positive association between the perception of the two professionals that is, both the architect and builders have similar idea of the defects caused by faulty design and construction and its effects on maintenance.

The following recommendations are made in view of the results of the study

1. There should be a design review before finally approving the design for construction
2. Maintenance expert should not be overlooked in the planning stage of the project
3. Selection of contractors should be based on competency and potentials for performance and quality not favourism
4. Registered professional should be employed to handled building projects

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