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Assessment of the Effect of Plan Shapes on Cost of Institutional Buildings in Nigeria

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Abstract:- This research analyzed the effect of plan shapes on cost of multi-storey Institutional buildings in Nigeria. Data were collected from drawings and priced bill of quantities for 28 projects of existing institutional buildings in Kwara State. In order to determine the plan shape with the most effect, a descriptive method of analysis (bar chart) was used. It was found out that, in all the plan types ("A" Circular-shaped, "B" U-shaped, "C" L-shaped, and "D" Rectangular shaped building) observed for each of the building elements (Substructure, Frame work, Block work, Roof work, Services, Finishes) including the overall building cost, plan shape Type "A" (circular shaped buildings) were the most expensive with an average total cost of N225,959,924.75 Plan shape type "D"(the Rectangular shaped buildings) have the lowest average total cost of ₦ 87,76I,791.27.It was concluded that plan Type "A" (circular shaped buildings) were the most expensive with highest average cost, plan Type "B" and "C" (U and L shaped) were at the average while building Type "D" (Rectangular shaped building) has the lowest average cost. The study recommends that clients that might be considering embarking on the multi-storey institutional building development should bear in mind the cost effectiveness of each plan shape in order to avoid adverse cost consequences on the project.

Keywords:- Plan shape, Building cost, Institutional building, Multi-storey building

I. INTRODUCTION

The building design process is a complex interaction of knowledge, skills, information, judgment, and decisions in order to meet the client's requirement. While designing Architects is known to take aesthetic requirements more important than economics. However, client's ultimate satisfaction is obtained when the best design solution has been achieved within the constraints imposed by the implication of project variables such as: plan shape, size, perimeter floor area, circulation space, storey height and the total height of the building (Ashworth, 2004).

A client is always much more concerned with quality, cost, and time and requires that the building is soundly constructed while the budget limit is not exceeded (Shittu, Adamu and Shehu, 2013)

However, when designing a building, the decision of a particular Architectural solution greatly affects its construction cost (Ferry and Brandon, 1999). Generally, the more complex the shape of the horizontal projection of a project, the greater the amount to be expended on such project because, the shape of the building has great impact on some building construction elements such as foundations, floor, walls, ceilings and roof (Ashworth, 2004).

According to Ibrahim (2007), the plan shape of a building layout has a spatial attribute that defines the outline of the building. The shape affects the areas, perimeters and sizes of vertical components of the building. These include; the internal and external walls as well as their associated finishes, windows and doors, frame structure, fascia, and the eaves of roofs.

However, the conclusions of previous findings on the cost effects of building shape have been based on the knowledge of building morphological and geometrical characteristics, and have lacked empirical authentication. Ibrahim (2003), concludes that perimeter/floor ratio, unit cost and total project cost are influenced by variation in plan shapes, narrowness as well as plan shape complexity.

Over the years, research interests in addressing the problems of plan shapes and construction cost has resulted in large number of publications. Previous studies concentrated on the cost of residential bungalow and storey buildings (Ibrahim, 2003; Ibrahim, 2007; Seeley, 1997; and Ferry and Brandon, 1999). Nonetheless, these studies fail to effectively address the problems of institutional plan shapes and elemental costs of construction. Moreover, despite the great practical effect of plan shapes on building construction cost, little research has been conducted to find out the relationship between plan shapes and building elements construction costs.

In this regard, this research intends to study the effect of plan shapes on the elemental construction cost of multi-storey institutional buildings in Kwara State, Nigeria. The result of this research will assist construction professionals, especially the cost consultants, in making more objective design decisions and solutions as well as

giving cost advice related to plan layout for the benefits of their client. In this way, building costs are now examined more closely with greater skill and accuracy thereby achieving value for client's money.

The buildings were broken down into elements which include; Sub-structural work, Frame structure, Block wall, Roof work, Services, and Finishes. Four different plan shapes were selected (within average gross floor area (AGFA) 2582to 2658m^2) because completed buildings with the same floor area were not easily accessible.

The shapes include; Plan Type "A" (Circular-shape buildings, AGFA 2, 657.86m^2), Plan Type "B" (U-shape buildings AGFA 2623.57 m^2), Plan Type "C" (L-shape buildings, AGFA 2,596.86 m^2) and plan Type "D" (Rectangular shaped buildings, AGFA 2,581.71 m^2).

The paper assumes that all site conditions imposed by its location are the same; there is no variation or fluctuation in the execution of the project; pricing of all bill of quantities irrespective of the project location are the same; all methods of procurement, construction as well as material specifications are the same; all terms and conditions of the project as well as clients requirement are the same. The variable, such as quality, location, and time, are kept constant.

II. PLAN SHAPE

The shape of a building has a significant effect on cost Seeley (1997). The complex the shape of a building the more expensive its unit cost will be. Moreover, buildings with complicated or irregular outlines lead to an increased perimeter/ floor area ratio which in turn results to a higher unit cost. A Building with complex outline will also result to an increased cost due to the fact that setting-out, ground work, and drainage work may be more complicated and uneconomical. The block work and roof work will also be expensive as a result of the complex nature of the building outlined (Seeley, 1997).

Square shaped buildings are said to be the simplest plan shape which is less expensive to build, although it is not always a realistic proposition as there may be a difficulty in planning the internal layout of large square building (Seeley, 1997)

Ferry and Brandon (1991) provided several analytical plan shape indices, which Chau (1999) criticized as being only a function of the plan geometry without reference to empirical data. He therefore proposed a cost model (Box-Cox) which involves empirical estimation. Ibrahim (2004) used regression analysis to develop such predictive models for assessing the effect of variation in building plan shape on unit construction cost.

Moreover, Ibrahim (2007) opined that perimeter-to-floor ratio, unit construction cost and overall project cost are affected by variation in plan shape complexity or irregularity. According to seeley (1997), the simpler (or more complicated) the plan shape, the lower (or higher) the unit construction cost will be. This is due to the fact that the shape of the building influences significantly by number of building elements such as foundations, walls, ceilings, floors or the roof (Ashworth, 2004).

2.1 Regular and irregular Shapes

As comprehensively documented by Seeley (1997) the simplest plan shape, that is a square building will be the most economical to construct. Square shaped buildings would not always be a practicable proposition, since in dwellings, smaller offices, schools and hospitals buildings a great importance is attached to the desirability of securing adequate natural day lighting to most part of the building.

A complex (irregular) structure would contain areas in the center of the building which would lack adequate natural lighting. Also there may be a difficulty in the planning and internal layout of the building. In the case of circular buildings, the enclosing floor area for the smallest perimeter is uneconomical and results in a major internal planning problems (Seeley, 1999)

Seeley (1997) compared two buildings of rectangular and irregular shapes, each of which have the same floor area. Irregular shaped building where there is 6% more external walls to enclose the same floor area, setting out are increased by about 50% excavation cost about 20% and drainage cost by approximately 25%. The additional cost do not finish there as brick work and roofing will also be more costly due to the work being more complicated.

2.2 Effects of Plan Shapes on Total Cost of a Building.

The shape of a building has an important effect on construction cost of a building. Variation in plan shapes have a direct effect on the horizontal and vertical components of the building, example, walls portions, beams and columns with their associated finishing and decorations skoyles (1985).

Irregular shapes will also have effect on the construction cost in the aspect of services, therefore the number of subsidiary items which could be affected by a change in the shape of the building includes;

1. Longer services and waste pipes to supply sanitary appliances depending on the plan shape.
2. Possibility of high roof cost due to increased number of corners which causes material wastage.

3. The Possibility of additional cost in applying finishing and decoration.

The running cost of the completed building may also be affected by such factors as higher heat losses (windows and walls), window cleaning and painting.

A junior organization of Royal institute of Chartered surveyors (RICS) in (1970) set up a research team to consider the effect of height and shape on building construction costs. This team studied a number of buildings with different shapes and height but the buildings all had a gross floor area of $95m^2$. The conclusions of the study of the research team were two in fold;

1. The total construction cost increases with increase in the perimeter wall length in relation to the floor area.
2. The increased cost becomes well pronounced when the height of the building is being increased with additional floors without altering the total floor area.

2.3 Effect of Plan Shape on Cost of Substructure

The nature of the soil determines the strength of the soil. Mark and Halliburton (1972) emphasized that the strength of soil-lime mixture is dependent on many variables such as soil types, lime content, curing time, water content, method of compaction and cost. Mark and Halliburton (1972) discovered that increase in temperature on curing lime soil lead to increase strength. If the soil is swampy there will be increase in cost because of the type of foundation will be changed from strip foundation to deep strip foundation which will increase the cost of substructure. If the soil is a rocky area, it depends on the depth to which the rock is located, if the rock is located at the surface, that calls for little explosion before construction commence. If otherwise then there will not be increase in cost of explosion.

Building research establishment (1970) has reported that foundation as a proportion of total building cost can vary from 8 to 18% and tend to decrease with increases in the number of storeys. Adequate information on subsoil condition is vital before a decision can be made as to the most economical type of foundation. Seeley (1997) illustrates that soil condition can cause quite different foundation cost for otherwise similar building.

2.4 Effect of Plan Shape on Cost of Superstructure

The costs of superstructure vary considerably depending on block designs, and this element result to an additional construction cost of multi-storey projects over a traditional housing Seeley (1997). The need for fire-protecting walls, ceiling, floors and staircases in multi-storey buildings also leads to an increased construction costs. As described earlier, increased circulation ratios with multi-storey blocks will also produce higher unit usable floor space costs.

Seeley (1997), in his investigation into flat costs, indicated some rather surprising cost patterns related to blocks of flat with varying numbers of storey. In general three-storey flats were about 30% more expensive that two-storey houses, with costs related to a specific unit of floor area such as the square meter. Increasing the heights of blocks of flats from 3-5 storey raised cost by about 12% (6% per storey). This trend continued when the total height was further increased to 6-8 storeys, with a further rise in costs of about 17%. The rate of increase in costs appeared surprisingly to flatten above eight storeys in height to about a 2% addition per floor.

2.5 Effects of Plan Shape on Cost of Block work

The significance of blocks in housing and construction in general cannot be over emphasized, as it is the most accepted walling unit by the public because of its peculiar resistance to fluctuating weather condition (Ezetah 1999). As reported by (Etuka 1989) that apart from availability and cheapness of building materials, quality of such materials are measured in line with durability, size, shape and strength.

As outlined by Seeley (1997) walls and partition with associated windows and doors constitute a major item of expenditure of a building. In municipal housing, these components can accounts for about one quarter of the total cost of brick four-storey maisonnettees and about one third of total cost of brick two- storey houses. For low rise buildings, cavity walls are generally, the lowest long term cost solution, provided satisfactory detailing and workmanship are secured. Stone facings are very expensive and care is needed to select a stone which is suitable for the particular environment.

2.6 Effect of Plan Shape on Cost of Frame Structure

According to seeley (1997), a frame may not be necessary in low-rise building, but generally costs tend to rise rapidly over the first few storey as the frame takes the loads imposed by a succession of upper floors. As for the foundation, the total frame cost will change at rates determined by two separate factors, that is, the vertical and horizontal loading.

1. The addition of upper floors requiring supporting beams will vary at the rate of change in the ratio of upper floor area to total floor area:

Table 1: Rate of change in the ratio of upper floor area to total floor area.

Number of Storey	Quantity Factor
1	----
2	0.5
3	0.66
4	0.75
5	0.80
6	0.83
7	0.86
8	0.88
9	0.89
10	0.90

Source: Seeley (1997).

The additional loading on the columns will require strengthening of columns or reducing bay sizes as the number of floors carried increase. If the total floor area remains constant, then the smaller building on plan will create more perimeter frame conditions and this will add a further cost factor.

Moreover, on an irregularly shaped design, it may be easier to design a frame using steel in order to accept the disadvantages of irregularly sized columns and beam casings. Such design would also be possible in concrete, but the irregularity may also result in high costs for the framework.

2.7 Effect of Plan Shape on Cost of Roof work

A cost study of low flats found that flat roofs were consistently higher than comparable pitched roofs, the extra cost amounting on average to about thirty percent. With pitched roofs irregular shaped blocks resulted in considerably increased cost. For a multi-storey building design (where the total roof cost is shared by a larger number of dwellings), a reduction in the roof construction cost per dwelling unit is to be expected. In the case of 3-4 storey building, the roof is often of similar construction to that used for 2-storey buildings (Newberry and Eaton, 1976).

Roofing costs of traditional brick two-storey houses ranged from fourteen to eighteen percent of total cost (the minimum being for a low pitched roof with low quality covering, and the maximum for a high pitched roof with high quality covering).

2.8 Effect of Plan Shape on Cost of Services

The major factors that normally have effect on human comfort include; rain, wind, temperature, humidity, radiation, air volume and movement, air purity and ionization (Shittu *et al*, 2013). Shittu *et al.* (2013) described how buildings and their environmental services have become more complex and the range of choices continues to increase. In particular, environmental requirements are often considered far too late in the design process for them to make a positive contribution to the final design. This is uneconomical when viewed against the high cost of services installations which may amount to as much as 25% of the total costs on a modern housing scheme and 50% on a hospital project. Therefore, there is a vital need for integrated design solution with all specialists contributing at each stage of the design process.

Moreover, it is important to note that service costs will increase with a jump at three or four storey when it becomes necessary to install a lift, although the effect will lessen as additional storey are added provided the area per floor is economically served. Also, buildings with more complex shapes require an additional arrangement for acoustics, lightning and ventilation, most especially a multi-storey building (Shittu *et al.*,2013)

2.9 Effects of Plan Shape on Cost of Finishes

Seeley (1997) highlighted the effect of finishing on the cost of buildings in traditional brick two storey houses, floors, stair and finishes account for about 8-11% of the total cost. With flats and maisonettes, floor finishes on average account for about 6% of total costs. Floor finishes also vary considerably in unit cost and the thickness of flooring can influence structural cost as a thick finish.

The Economic specification of building prepared by Construction Section of Nigerian building and Road Research Institute (NABRRI, 1989) revealed that 10%-15% cost is saved by plastering with improved method using triangular trowel and corner finishing gadgets, cement, paint, or distemper on walls, steel and timber with indigenously made paint.

III. RESEARCH METHODOLOGY

The study covered multi-storey institutional buildings in Kwara State, Nigeria. Data for the research were obtained from contract drawings and priced Bill of Quantities of previously executed projects handled by reputable construction firms, consultancy firms, government establishment/ ministries.

Data on 28 Bills of Quantities and their drawings were obtained for type "A" (7 number Circular shaped buildings), type "B" (7 number U-shaped buildings), type "C" (7 number L-shaped buildings), and type "D"(7 number rectangular shaped buildings) using a purposive sampling method.

The total gross floor areas (TGFA) were averaged to give a guide as to the overall plan shape.

For the purpose of comparism of the different plan shapes, the average total gross floor area of the seven selected projects for each plan shapes were computed as follows, Type A 2,657.86 m^2, Type B 2,623.57 m^2, Type C 2,596.86 m^2 and Type D 2,581.71 m^2. Though they have almost the same floor areas but with a difference of $\pm$ 3 %. This forms the basis for comparing the cost of the different plan shapes for the multistory institutional buildings since it was difficult to get completed projects of different plan shapes with the same gross floor areas. The building elements considered for the study are: Substructure, Frame work, Block work, Roof work, Service and finishes. The total contract sum for each project under a particular plan shape type (A, B, C, and D) are added and divided by the number of the projects to determine the average contract sum at each category. In order to determine the plan shape with the most effect, a descriptive method of analysis (bar chart) was plotted for each plan shape type and the average cost of the building elements considered. The analysis was done using Microsoft office Excel.

IV. RESULTS AND DISCUSSION

The figures below present the results of the relationship between the plan shapes and the building elements considered for the study

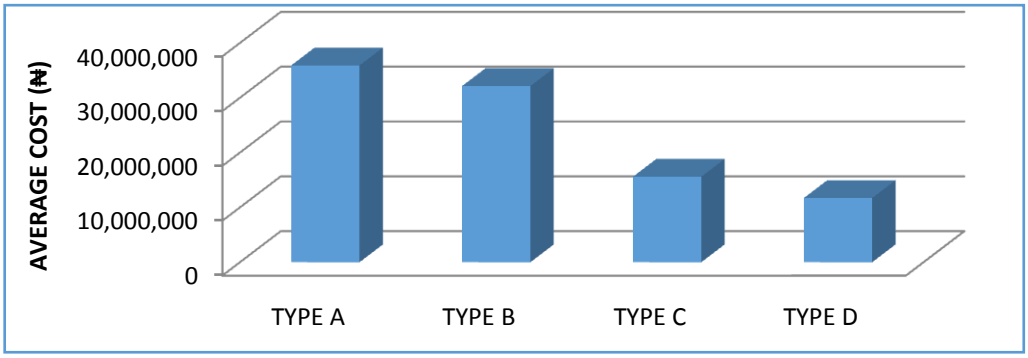

Fig. 4.1: Average Substructure cost of the research sample.

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average cost of Substructure at (₦35, 901,083), while the lowest plan type was the Rectangular shaped building at the average substructure cost at (₦16, 532,130). Therefore, variations in the average cost of Substructure for the various plan shapes under study were ₦19, 368,953.

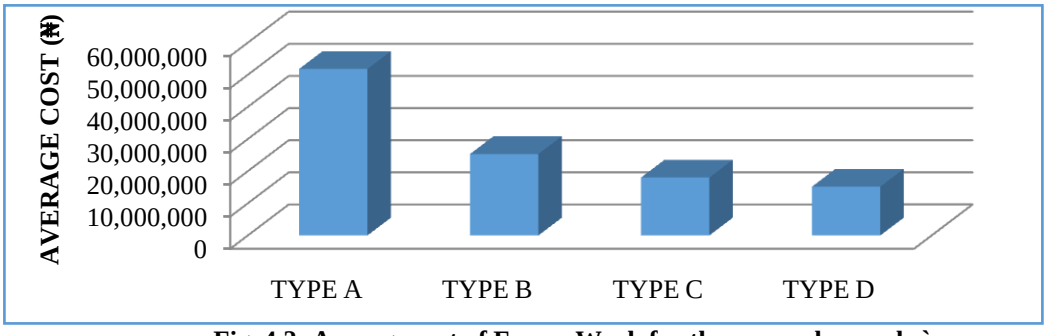

Fig. 4.2: Average cost of Frame Work for the research sample.`

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average cost of Frame work at (₦51, 824,949), while the lowest plan type was the Rectangular shaped building at the average cost of (₦17, 865,980). Therefore, variations in the average cost of Frame work for the various plan shapes under study was ₦33, 958, 969

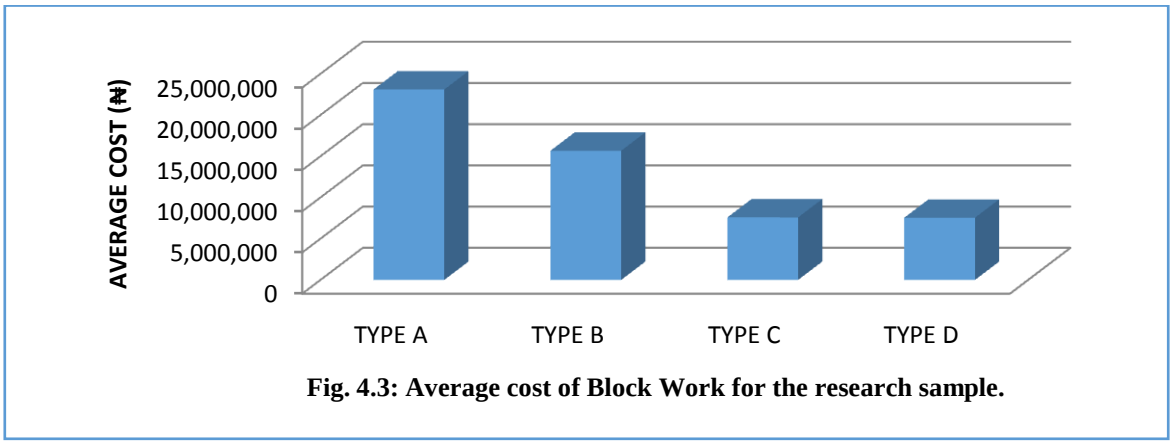

Fig. 4.3: Average cost of Block Work for the research sample.

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average cost of Block work at (₦23, 097,057), while the lowest plan (type D) was the Rectangular shaped building at the average cost of (₦7, 868, 403). Therefore, variations in the average cost of Block work for the various plan shapes under study were ₦15, 228,654.

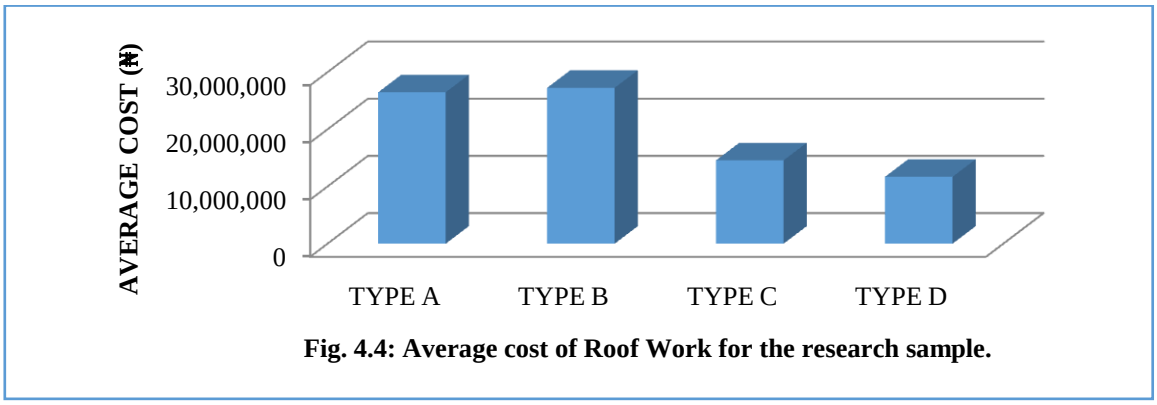

Fig. 4.4: Average cost of Roof Work for the research sample.

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average cost of Roof work at (₦26, 487,552), while the lowest plan type was the Rectangular shaped building at the average cost of (₦11, 034,503). Therefore, a variation in the average cost of Roof work for the various plan shapes under study was ₦15, 453,049.

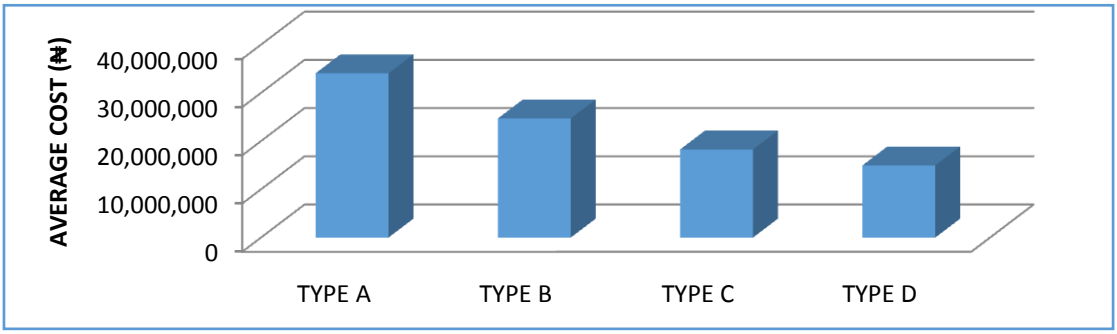

Fig. 4.5: Average cost of Services for the research sample.

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average cost of Services at (₦34, 081,673), while the lowest plan type was the Rectangular shaped building at the average cost of (₦16, 553,417). Therefore, a variation in the average cost of Services for the various plan shapes under study was ₦17, 528,256.

Figure 6: The relationship between plan shapes (Type A, B, C, and D) and average cost of finishes

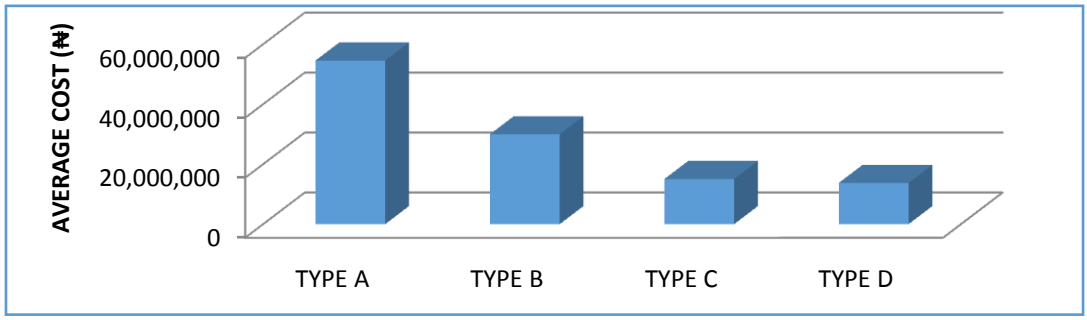

Fig. 4.6: Average cost of Finishes for the research sample.

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average cost of Finishes at (₦54, 567,612), while the lowest plan type was the Rectangular shaped building at the average cost of (₦17, 222,359). Therefore, a variation in the average cost of Finishes for the various plan shapes under study was ₦37, 3451,253.

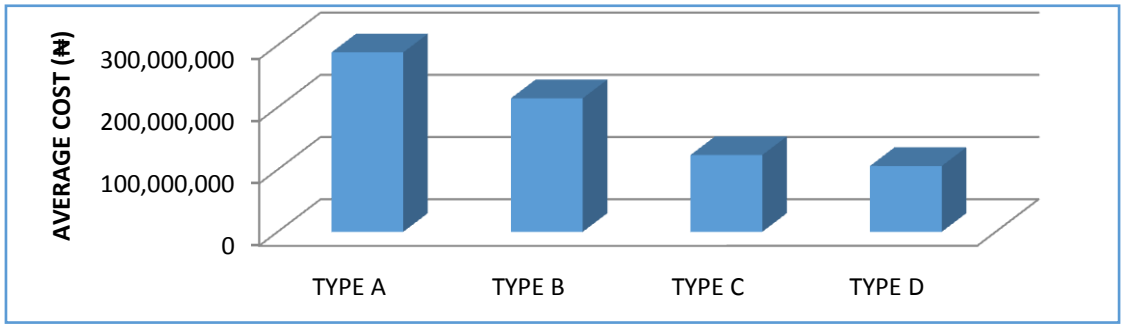

Fig. 4.7: Average Contract Sum for the research sample.

Source: Researcher's Analysis (2014).

The circular plan shape (plan type A) has the highest average Contract sum at (₦225, 959,925), while the lowest plan type was the Rectangular shaped building at the average cost of (₦87, 076,791). Therefore, a variation in the average Contract sum for the various plan shapes under study was ₦138, 883,134.

Table 1. Comparism of elemental average cost of different shapes

Building Shape	Cost of Substructure (₦)	Cost of Frame (₦)	Cost of Block wall (₦)	Cost of Roof work (₦)	Cost of Services (₦)	Cost of Finishes (₦)	Average Total Contract Sum (₦)	Average gross floor area (m^2)	Average Cost/GFA (₦/m^2)
TYPE A	35,901,082.54	51,824,948.86	23,097,057.00	26,487,551.71	34,081,673.07	54,567,611.57	225,959,924.75	2,657.86	85,015.74
% Difference	117.16%	190.08%	193.54%	140.04%	105.89%	216.84%	159.50%		
TYPE B	27,756,358.43	26,190,026.03	15,430,676.07	25,996,355.74	20,300,264.35	28,576,991.71	144,250,672.33	2,623.57	54,982.59

% Difference	67.89%	46.59%	96.11%	135.59%	22.63%	65.93%	65.66%		
TYPE C	17,662,125.86	17,919,067.14	8,150,677.00	18,652,727.18	17,016,626.51	17,624,239.00	97,025,462.69	2,596.86	37,362.61
% Difference	6.84%	0.30%	3.59%	69.04%	2.80%	2.33%	11.43%		
TYPE D	16,532,130.14	17,865,979.57	7,868,402.71	11,034,502.77	16,553,417.14	17,222,358.93	87,076,791.27	2,581.71	33,728.34

The result on the table 1 revealed the trend of the effects of average cost of elements on different building shapes. The range of the differences in average cost of the elements for the various building shapes were 6.80 to 117.16%, 0.30 to 190.08%, 3.59 to 193.54%, 69.04 to 140.04%, 2.80 to 105.89%, 2.33 to 216.84%, and 11.43 to 159.50% for the substructure , frame work, blockwork, roof work, services and finishes respectively.

Furthermore, the result shows that, the average total contract sum were ₦ 225,959,924.75, ₦ 144, 250, 672.33, ₦ 97,205, 462.69 and ₦ 87, 076, 791.27 for the building types A, B,C, and D respectively.

It also revealed that percentage difference of the average total contract sum for the four different building shapes were between 11.43 and 138.99%. While the average total contract sum per average gross floor area were ₦ 85, 015.74/m^2, ₦ 54, 982.59/ m^2 , ₦ 37, 362.61/ m^2 and ₦ 33, 728.34/ m^2 for the plan shapes Types A,B, C, and D respectively.

V. DISCUSSION OF RESULTS

In all the plan types (“A” Circular-shaped, “B” U-shaped, “C” L-shaped, and “D” Rectangular shaped building)observed for each of the building elements (Substructure, Frame work, Block work, Roof work, Services, Finishes) including the overall building cost, type “A” circular shaped buildings was the most expensive with highest average cost ((₦225, 959,924.75),while building Type “D” Rectangular shaped building has the lowest average cost (₦ 87, 076, 791.27). This is in line with the fact established in the literature, that the more complex the shape of a building the more expensive its construction cost will be (Seeley, 1997, Ibrahim, 2007, Ibrahim, 2003, Ibrahim 2004 and Ferry and Brandom, 1999).

The range of the differences and average cost of the elements for the various building shapes were 6.80 to 117.16%, 0.30 to 190.08%, 3.59 to 193.54%, 69.04 to 140.04%, 2.80 to 105.89%, 2.33 to 216.84%, for the substructure, frame work, block work, roof work, services and finishes.

The percentage difference of the average total contract sum for the four different building shapes were between 11.43 to 159.50%. While the average total contract sum per average gross floor area were ₦ 85, 015.74/m^2, ₦ 54, 982.59/ m^2 , ₦ 37, 362.61/ m^2 and ₦ 33, 728.34/ m^2 for the plan shapes Types A, B, C, and D respectively.

VI. CONCLUSIONS

The study concludes that in all the plan shape types (“A” Circular-shaped, “B” U-shaped, “C” L-shaped, and “D” Rectangular shaped building) observed for each of the building elements (Substructure, Frame work, Block work, Roof work, Services, Finishes) including the overall building cost, plan Type “A” (circular shaped buildings) were the most expensive with highest average cost, plan Type “B” and “C”(U and L shaped) were at the average while building Type “D” (Rectangular shaped building) has the lowest average cost.

VII. RECOMMENDATION

[1]. The study recommends, clients that might be considering embarking on the development of multi-storey institutional buildings should bear in mind the cost effectiveness of each plan shape in order to avoid adverse cost consequences on the project.

[2]. It recommended that further inferential research on this topic should be conducted with larger sample of projects to relate the result with the findings of this paper.

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Appendices

Data presentation

The data obtained from the field work on all the projects under study were presented in table 1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b respectively.

Table 1a: Shape Factors for Plan Type A (Circular-shaped Buildings).

S/N	Gross Floor Area(m^2)	Perimeter Length(m^2)	Number ofFloors (no)	g(m)	g^2 (m^2)	r(m^2)	16r(m^2)	Plan Shape Index
1	2405	716	3	238.7	56977.7	1066	17051.2	11.27
2	2708	579	3	193	37249	902.7	14443.2	8.19
3	3082	773	3	257.7	66306.3	1027	16436.8	19.7
4	2753	699	3	174.8	30555	873.8	13980	6.59
5	2686	808	3	269.3	72522.5	1073	17168	14.8
6	2854	1027	3	342.3	117169	1364	21824	19.4
7	2117	783	3	261	68121	1039	16624	14.31
Total GFA	18605	**Average = GFA**	2657.86					

Source: Author's Field Work (2014).

Table 1b: Total Contract sum and Cost of the selectedbuilding elements under study for Plan Type A (Circular-shaped Buildings).

S/N	Cost of Substructure (₦)	Cost ofFrame work (₦)	Cost ofBlock wall (₦)	Cost ofRoofWork(₦)	Cost ofServices(₦)	Cost ofFinishes(₦)	TotalContractSum(₦)
1	31,532,933	46,339,991	17,320,500	33,359,588	24,047,900	27,889,190	180, 490,102
2	26,711,200	60,320,055	24,016,200	4,296,340	38,650,644	52,298,380	206, 292, 819
3	35,335,225	50,302,500	25,355,440	8,015,920	25,678,405	43,054,500	187, 741, 990
4	42,138,210	66,211,218	21,218,995	9,611,300	65,156,250	108,248,421	312, 584, 394
5	35,710,900	40,664,300	16,315,940	49,186,640	14,159,500	33,157,650	189, 194, 930
6	43,701,259	56,213,348	32,810,174	42,396,919	32,028,937	72,339,240	279, 489, 878
7	36,177,850	42,723,230	24,642,150	38,546,155	38,850,075	44,985,900	225, 925, 360
Total	251,307,578	362,774,642	161,679,399	185,412,862	238,571,712	381,973,281	1,581, 719, 473
Average Total Cost	**35901082.54**	**51824948.86**	**23097057**	**26487551.71**	**34081673.07**	**54567611.57**	**225,959,924.80**

Source: Author's Field Work (2014)

Table 2a: Shape Factors for Plan Type B (U-shaped Buildings).

S/n	Gross Floor Area (m^2)	Perimeter Length(m^2)	Number of Floors	g (m)	g^2 (m^2)	r (m^2)	16r (m^2)	Plan Shape Index
1	2249	564	3	188	35344	749.7	11995.2	9.68
2	2172	384	3	128	16384	724	11584	3.36
3	2983	645	3	215	46225	994.3	15908.8	9.52
4	3142	788	3	262.7	69011.3	1047.3	16756.8	14.4
5	3216	675	3	225	50625	1072	17152	9.7
6	2421	807	3	269	72361	807	12912	20.37
7	2182	445	3	148.3	21992.9	727.3	11636.8	5.37
Total GFA	18365/7	**Ave. GFA=**	2623.57					
Source: Author's Field Work (2014).								

Table 2.b: Total Contract Sum and Cost of Building Elements under study for Plan Type B (U-Shaped Buildings)

S/N	Cost of Substructure(₦)	Cost of Framework (₦)	Cost of Block wall (₦)	Cost of Roof work (₦)	Cost of Services (₦)	Cost of Finishes (₦)	Total Contract sum (₦)
1	22,175,098	23,531,440	9,597,900	26,436,285	40,268,350	21,877,070	143, 886, 143
2	24,060,617	15,301,400	24,119,600	24,165,380	14,112,120	12,864,000	114, 623, 117
3	29,360,850	41,395,000	10,410,000	20,935,000	13,433,935	47,042,055	162, 576, 840
4	30,995,850	23,100,500	13,324,700	27,218,800	16,613,893	30,718,155	141, 971, 898
5	35,705,107	29,661,050	27,228,025	23,949,727	24,932,450	38,415,925	179, 892,284
6	23,879,580	29,373,240	12,284,190	32,758,600	15,654,105	21,229,270	135, 178, 95
7	28,117,407	20,967,552	11,050,317	26,510,698	17,086,997	27,892,467	131, 625, 439
Total	194,294,509	183,330,182	108,014,733	181,974,490	142,101,850	200,038,942	1,009, 754, 706

AVE. TOTAL COST	27756358	26190026	15430676	25996355	20300264	28576991	144, 250, 672
Source: Author's Field Work (2014).							

Table 3a: Shape Factors for Plan Type C (L-shaped Buildings).

S/n	Gross floor Area(m^2)	Perimeter length(m^2)	Number of Floors	g(m)	$g(m^2)$	$r(m^2)$	$16r(m^2)$	Plan Shape Index
1	**2486**	**557**	**3**	**185.7**	**34484.5**	**802**	**12832**	**8.63**
2	**2576**	**646**	**4**	**161.5**	**26082.3**	**644**	**10304**	**8**
3	**2766**	**597**	**3**	**199**	**39601**	**922**	**14752**	**8.62**
4	**2381**	**572**	**3**	**190.7**	**36366.5**	**760.3**	**12164.8**	**9.86**
5	**2740**	**380**	**3**	**126.7**	**16052.9**	**571.3**	**9140.8**	**4.82**
6	**2567**	**514**	**3**	**171.3**	**29343.7**	**722.3**	**11556.8**	**8.03**
7	**2662**	**668**	**4**	**167**	**27889**	**655.5**	**10488**	**8.53**
Total GFA=		**18178**	**Ave. GFA**	**=2596.86**				

Source: Author's Field Work (2014)

Table 3b: Total Contract sum and Cost of some Building Elements under study for Plan Type C (L-shaped Buildings).

S/n	Cost of Substructure (₦)	Cost of frame work (₦)	Cost of block Wall (₦)	Cost of roof work(₦)	Cost of Services (₦)	Cost of finishes(₦)	Total Contract Sum(₦)
1	14,017,440	20,108,800	7,627,000	6,559,100	21,326,510	15,164,160	84,803,010
2	25,167,200	28,884,561	9,620,320	28,062,904	23,797,866	19,680,815	135,213,666
3	19,266,781	14,364,514	8,257,192	18,165,822.68	11,338,044.54	19,112,647	90,505,001
4	15,885,400	13,099,210	7,978,858	14,033,340	7,986,330	15,764,495	74,747,633
5	16,361,136	12,200,905	7,812,014	16,426,431.60	10,751,755	14,355,656	77,907,897
6	14,400,950	19,789,500	7,825,240	21,141,835	25,000,000	16,711,000	104,868,525
7	18,535,974	16,985,980	7,934,115	26,179,657	18,915,880	22,580,900	111,132,506
TOTAL	123,634,881	125,433,470	57,054,739	130,569,090	119,116,386	123,369,673	679,178,239
AVE. TOTAL COST	17662125	17919067	8150677	18652727	17016626	17624239	97, 025, 462

Source: Author's Field Work (2014).

Table 4a: Shape Factors for Plan Type D (Rectangular-shaped Buildings).

S/n	Gross floor area(m^2)	Perimeter Length (m^2)	Number of floors	g(m)	$g^2(m^2)$	r (m^2)	16r (m^2)	Plan Shape Index
1	2476	396	3	132	17424	658.7	10539.2	4.38
2	2862	467	3	155.7	24242.5	620.7	9931.2	7.63
3	2530	472	3	157.3	24743.3	649	10384	7.4
4	2450	515	3	171.7	29480.9	683.3	10932.8	8.67
5	2439	612	3	204	41616	813	13008	10.7
6	3029	712	4	178	31684	757.3	12116.8	8.34
7	2286	450	3	150	22500	661.3	10580.8	6.35

Total GFA =18072

Ave. GFA =2581.71

Source: Author's Field Work (2014).

Table 4b: Total Contract sum and Cost of some Building Elements under study for Plan Type D (Rectangular-shaped Buildings).

S/n	Cost of Substructure (₦)	Cost of Framework(₦)	Cost of Block Wall (₦)	Cost of Roof Work (₦)	Cost of Services (₦)	Cost of Finishes (₦)	Total Contract Sum (₦)
1	11,481,071	17,957,150	7,378,410	22,167,261.40	24,159,780	14,159,780	97, 303, 452
2	8,668,805	12,966,800	5,272,350	10,159,740	18,059,630	15,422,505	70, 549, 830
3	13,563,955	15,493,310	5,704,200	5,458,300	16,006,840	12,484,432.50	68, 711, 037
4	16,407,357	19,203,500	9,310,250	6,140,275	13,084,000	14,335,350	78, 480, 732
5	21,652,793	18,936,750	9,943,640	9,190,525	14,458,670	18,600,830	92, 783,208
6	29,729,875	21,140,077	11,762,814	16,211,400	20,355,000	24,577,550	123, 776, 716
7	14,221,055	19,364,270	5,707,155	7,914,018	9,750,000	20,976,065	77, 932, 563
Total	115,724,911	125,061,857	55,078,819	77,241,519	115,873,920	120,556,513	609, 537, 539
Average Total Cost	16532130	17865979	9154117	11034502	16553417	17222358	87, 076, 791

Source: Author's Field Work (2014).