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## Cost Implications of Architectural Design Variables in Building Industry (A Case Study of 10 Houses in Enugu State)

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**Abstract** The study was carried out to assess the cost implication of design variables so that they can make more objective design decisions and offer more objective cost advice for the benefits of their clients. Over the years, it has been proved that the selection of the correct design, coupled with the correct choice of materials and systems, have long-term effects on the performance of a building. Usually the quantity surveyor evaluates the cost of the various viable designs to assist the client in decision making. Various architectural design variables such as building size, shape, story height, height, circulation area, level of specification are factors affecting design cost such as technical requirement, user requirement and aesthetic requirement. The data used to carry out this study is the primary and secondary sources which comprise the direct observations made by the researcher and document from the bill of quantities of the sampled buildings. Analysis was carried out using product moment correlation coefficient ( $r$ ) to investigate the effects of design variables on total costs, and the results so obtained showed that there is an appreciable impact of these design variables on total building cost. The study will assist construction professionals, especially the cost consultants, in making more objective design decisions and in giving cost advice related to different architectural designs for the benefits of their clients.

**Keywords** Cost Implication, Architectural Design Variables, Building Industry, Enugu State.

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### Introduction

According to Hornby [1] design is the creation of a plan or convention for the construction of an object, system or measurable human interaction. Design is can also be defined as a specification of an object, manifested by an agent, intended to accomplish goals, in a particular environment, using a set of primitive components, satisfying a set of requirements. Specification in this term is defined as a detailed description of how something is, or should be designed or made. The design of buildings is a multi-disciplinary function that involve team work. A prime objective in building design is to secure an attractive building in terms of time, cost, aesthetics, functionality which will satisfy the clients need.

Cost on the other hand is defined by the Oxford Advance Learners Dictionary as the price to be paid or the amount of money needed for something. Building cost can be estimated or analyzed based on the price charged for the finished building or parts thereof, or it can still be estimated based on the cost of the materials required to achieve them. Thus, the builder's price is the client's cost. In the building industry, clients tend to shoulder a lot of cost due to design variables. Design variables are those variables from which a client can choose in the course of design; they include plan shape, total building height, storey height, circulation area, material specifications, etc. Therefore, for any building production to commence and be accomplished, it is important to know the uses of the building and the required design that will be considered as this will show the total cost commitment for the building production. The client has a wide range/varieties of design variables to choose from, but, since the society is made up of people from different walks of life with little or no knowledge of construction, it is advisable that a construction/building cost expert is consulted so as to obtain a more economic project. Consequently, designers should take adequate care in the design and specification of materials of which an unrelated design decisions such as uneconomic design, incorrect assessment of loads, inadequate appreciation of conditions of use, inadequate assessment of exposures, inadequate assessment of size of the units of materials and components to be used in order to minimize cutting, inadequate check on standard specifications are bound



to affect quality, functionality, materials in terms of waste and most especially cost, thus, the cost implications of design variables.

However, the initial cost of a building is worth considering before construction, as well as the cost in-use of the building; as this plays a very crucial role in ascertaining the cost of a building component. This is true due to the fact that components have initial cheaper cost with resultant higher repair and maintenance costs in the long-run. Some have higher initial cost with little or no running costs over the lifespan of the building. Thus, it is upon this fact that the client should choose a group of components or specifications that suits his purpose. Purpose differs, in that some would want to cost to a design while some would design to a cost. It will be better to carefully put chosen design into consideration to know the financial involvement before any commitment. This is very important in our economy as many projects have been abandoned or half-done due to little or no knowledge of cost implications of different design variables by individuals and governments

In past years, series of abandoned project has littered all the nook and crannies of Nigeria just because of improper appraisal and evaluation of design variables before commencing a project. Many government and private building projects which was contracted for the sole purpose of arresting the increasing demand of shelter by the increasing population of the nation had been put to a halt because of the inappropriate choice of design. This ugly situation does not only affect the demand for shelter by the society but also the national economy in general since the money spent on the abandoned project cannot be gotten back in any form, thereby resulting to a great wastage of resources to the nation.

The question is "why do we still witness such problems in Nigeria while there are a lot of professional in the building industry who can offer solid service and advice on a particular design for its use and optimum money value to the developer. The problem is that Nigerians take things into granted or should it be said that it is due to our ignorance of the existence of those professionals that would have offered such service or that we are afraid of their professional fees for services rendered. However, there is need to educate the public on the need for such professional services and the people involved. And this forms part of the reason for the researcher going into the study to point out those factors that contribute to the cost of the building design variables as it affect cost of buildings which if adopted and put into practice will go a long way in providing more economical building which can be carried out and be accomplished without difficulties, hence, assure prompt availability of buildings for the increasing population wellbeing.

### Research design and methodology

#### Area of study (location of the study area).

This study covers the issue of cost implications of architectural design variable and other factors that affect the cost of a building in Enugu States using buildings located at different places in the area.

#### Method of Data Collection

The study used both primary and secondary data. The primary data were obtained using field surveys, In-depth Interview, Focus Group Discussion and Questionnaire administered to the stakeholders (Client, Contractor, Consultant, Materials, Equipment, Labor, External factors) in the construction sector. The questionnaires were structured to elicit much information as possible on the cost implications of Architectural design variables in building construction industry in Enugu State. Ten (10) building projects in Enugu State were selected for this study, the selection was based on logistics and easy communication links

#### Primary Data

Direct observation accorded the researcher the opportunity of taking direct measurement of the perimeter round the selected buildings and their floor areas and other relevant building elements in the area of study. The relevant building elements in this case include plain wall without opening such that the relationship between the height of the wall and costs in measured in the correlation analysis. The researcher also conducted market survey on the current prices of building materials as at the time of this research. The market survey was conducted on the prices of materials and labour required for the erection of one-metre length of wall, complete with rendering such that the variable factor is the difference in height

**Table 1:** Extract of the market survey conducted at building Projects in Enugu State.

Description	Unit	Price (N)	Town
<b>Materials</b>			
225mm thick hollow sand-crete Blocks	Piece	120	Enugu
Cement	Bag	1850	Enugu
Sand (6m <sup>3</sup> , sharp sand)	Trip	15,000	Enugu
<b>Labour</b>			
Unloading cement	Per bag	20	Enugu
Gang labour	Hour	500	Enugu
Skilled labour	Day	3000	Enugu
Unskilled labour	Day	1500	Enugu



**Secondary Data**

These include extracts from the Bills of Quantities of the ten (10) selected buildings project in Enugu State.

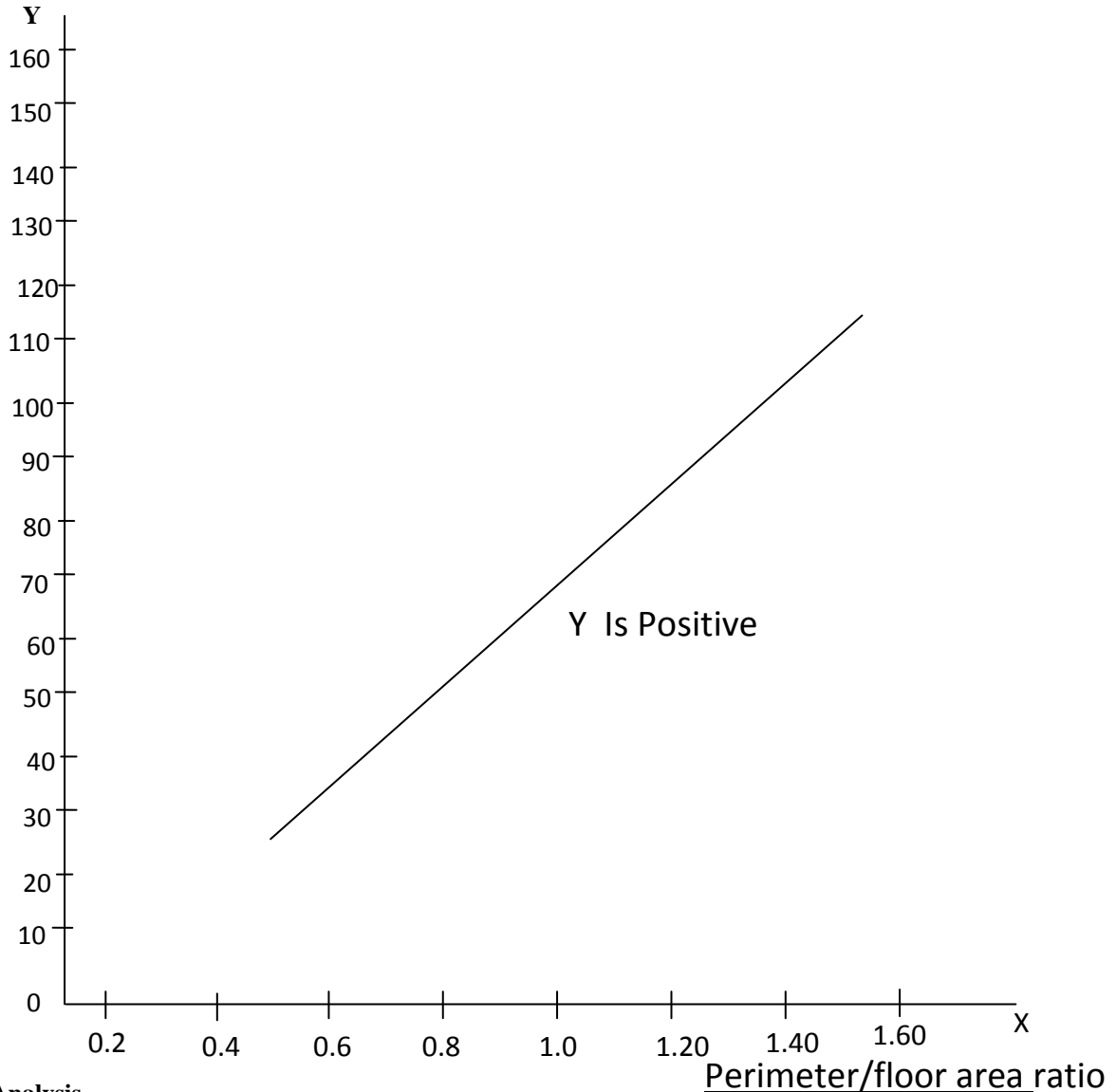
**Method of Data Presentation/Analysis**

The statistical tools used for the analysis of data collected for this project is the Pearson’s product moment correlation coefficient. Correlation measures the degree or extent of association or relation between Two variables. The correlation (Y) gives an idea of degree or extent of linear relationship between two variables.

**Results**

**Graphical representation of the result**

Cost/m<sup>2</sup>



**Data Analysis**

The product moment linear correlation coefficient (Y) will be used in the analysis.

$$Y = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

$$Y = \frac{10(546268.39) - 7.87(633400.88)}{\sqrt{[10(6.65) - (7.87)^2][10(50416193686.68) - (633400.88)^2]}}$$

$$Y = \frac{5462683.90 - 4984864.93}{\sqrt{[66.5 - 61.94][504161936866.80 - 401196674784.77]}}$$



$$Y = \frac{477818.97}{\sqrt{4.56 \times 1296526082.03}}$$

$$Y = \frac{477818.97}{685216.46}$$

$$Y = 0.697 \leq 0.70; 0.70 \times 100 = 70\%$$

$$Y = 70\%$$

**Test of Hypothesis 1**

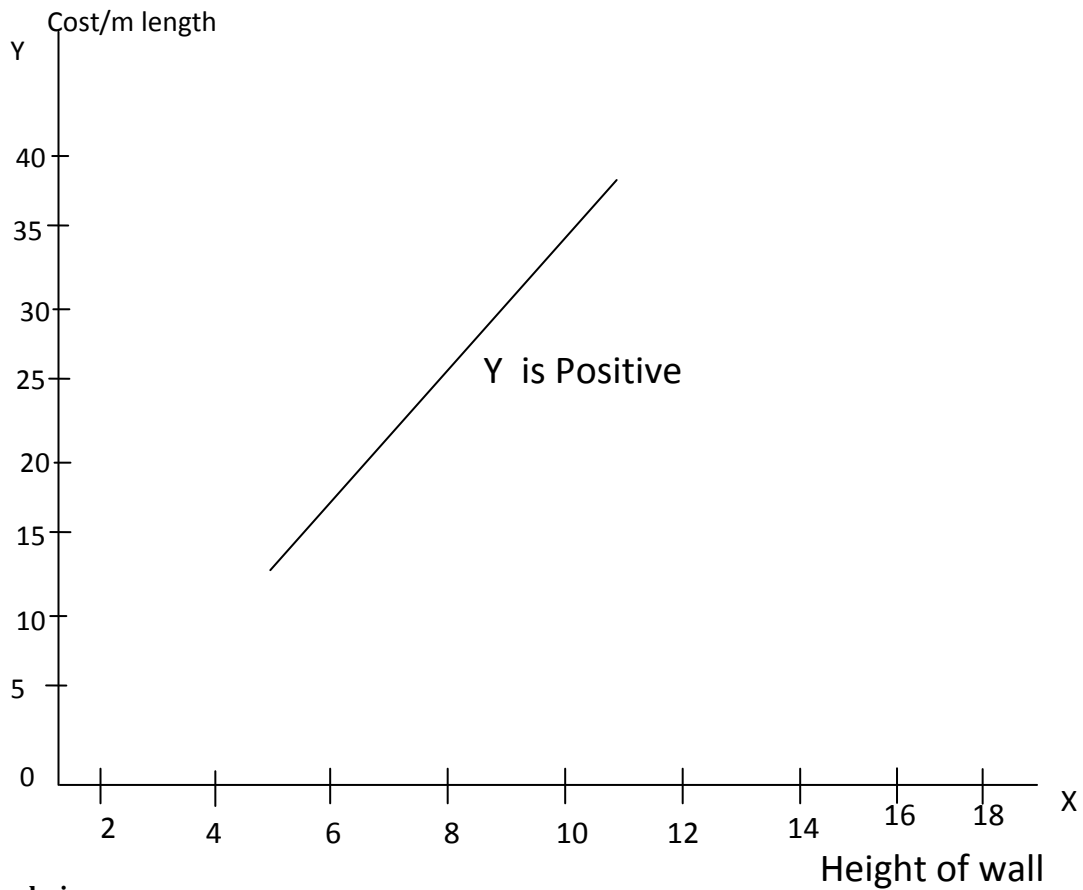
The product moment linear correlation coefficient (Y), reveals that relationship is positive and strong. Therefore, the perimeter/floor area ration have an appreciable impact on the cost of a building.

On the other hand, if the percentage is less than 60% it is said to be positive and weak, but if it is 60% and above, it is said to be positive and strong. In the light of this, the researcher rejects Ho if the percentage is less than and accept Hi if it is 60% and above; and in this case, 70% is above the constant percentage which is 600/0. Therefore Hi is accepted/upheld while Ho is rejected.

**Research Question 2**

Does total height of a building have any significant impact on the cost of building?

**Graphical Representation**



**Data Analysis**

Using the product moment linear correlation coefficient (Y)

$$Y = \frac{n\sum x y - \sum x \sum y}{\sqrt{(n\sum x^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)}}$$

$$Y = \frac{10(1291829.74) - 58.78(202791)}{\sqrt{(10(374.44) - 58.78)^2} \sqrt{(10(4456812568.50) - (202791)^2)}}$$

$$Y = \frac{12918297.40 - 11920054.98}{\sqrt{(3744.4 - 3455.09)} \sqrt{(4456812685 - 4112418968)}}$$



$$Y = \frac{477818.97}{\sqrt{4.56 \times 10296526082.03}}$$

$$Y = \frac{998242.42}{\sqrt{289.31 \times 34439396004}}$$

$$Y = \frac{998242.42}{\sqrt{996365125317.24}}$$

$$Y = \frac{998242.42}{998189.91}$$

$$Y = 1.000; 1.000 \times 100 = 100\%$$

$$Y = 100\%$$

### Discussion of Findings

The cost implications of architectural design of variables in ten (10) building projects in Enugu state revealed that the greater the perimeter/floor area ratio of buildings, the greater the contract sum, also the greater the total heights of the buildings, the greater the cost of the element, wall and its associated finishes, although the level of specification may cause this to differ. Other architectural design variables that are also observed on site are building shape. Size, number of storey and circulation space. One of the building project studied, showed that the shape of the building project is a major factor in considering the cost implication of the design of any project. This means that "L" shaped of building project had the highest contract sum which is in line with the study of Chan (1991) on shape, which conveys that the more irregular a building shape, the more expensive to construct the building as setting out costs is increased, cost of plumbing and drainage work and extra costs accompanying complicated designs. The other buildings with lower tender figure are of regular shapes, square and rectangle. The size of the building project also affected the cost of the architectural design of the building project.

The results revealed that building projects with higher wall/floor area ratios has the higher tender figures, although some buildings with a higher wall/floor area ratios has a lower tender figures. This is because the buildings were of different specifications and the award of the contract were not of the same base year. But comparing two buildings which were awarded the same base year; it was observed that building project with higher perimeter/floor area ratios of 0.95 and 1.01 respectively has the higher cost implication, while building project with lower perimeter/ floor area ratios had lower cost implications on the design. The study also revealed that the higher the total heights of the finishes and decorations the higher the cost of architectural design In the analysis carried out, it was shown that where buildings are of the same floor area, the greater the storey height, the greater the cost of walls and associated finishes. Likewise, the number of storeys, where the buildings that have an upper floor, costs more than the buildings that were bungalows.

However, the building projects with greater storey heights require nothing or relatively low amount of money in future as regards air conditioning, though this is dependent on the number of persons using the building, but the building with lower storey height may require a lot in procuring air conditioning systems to deal with air conditioning.

### Conclusion

In conclusion, Building clients whose interest are not protected professionally by the designers in terms of quality, cost functionality, standards and material control are bound not to have value for their money. Design vary from one individual to another, therefore, a proper appraisal should be done at the conceptual stage to ensure better designs and materials that suits the intended usage of a facility within the clients target cost. The architectural design variables of interest include plan shape, storey height, building size, number of storeys, circulation space, perimeter/floor area ratio and level of specification. The client should be able to combine these variables alongside other factors such as type of contract, choice of site, choice of consultants, and choice of contractor to be able to achieve a functionally sound facility at a justifiable cost.

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