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## Design Error: A Source of Cost and Time Overrun in Construction Projects

John J. Anumah<sup>1</sup>, Lesado Anumah<sup>2</sup>, Emmamoge Orewere<sup>3</sup>, Alice A. Daniel<sup>1</sup>, Gyang D. Samson<sup>1</sup>

<sup>1</sup>Department of Architecture, University of Jos, Nigeria

<sup>2</sup>Archshel Development Ltd, Jos, Nigeria

<sup>3</sup>Department of Horticulture and Landscape Technology, Federal College of Forestry, Jos, Nigeria

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**Abstract** The study investigated the impact of design error on cost and time overrun of construction in Nigeria. Descriptive research design of the survey type was used. The opinion of Consultants, Contractors and Clients were sought through Questionnaires and interviews. The research studies reveal that design error affects the final cost of a construction project causing cost and time overrun. Additionally, the research revealed that the issue of cost and time impacts on project construction could be managed by using construction recognized and accepted methodologies which identifies and quantifies the overall impact to the project. It concludes that unclear scope of work or change in scope of projects in work; time and inexperience of the Architect and inaccuracy of the design documents are the major causes of design error in construction projects in Nigeria. Based on these findings, the researchers recommended adequate design review, proper planning and inspection of projects, clear scope of work and adequate time be given to produce clear and error free designs and specifications.

**Keywords** Clients, Consultants, Contractors, Design Error

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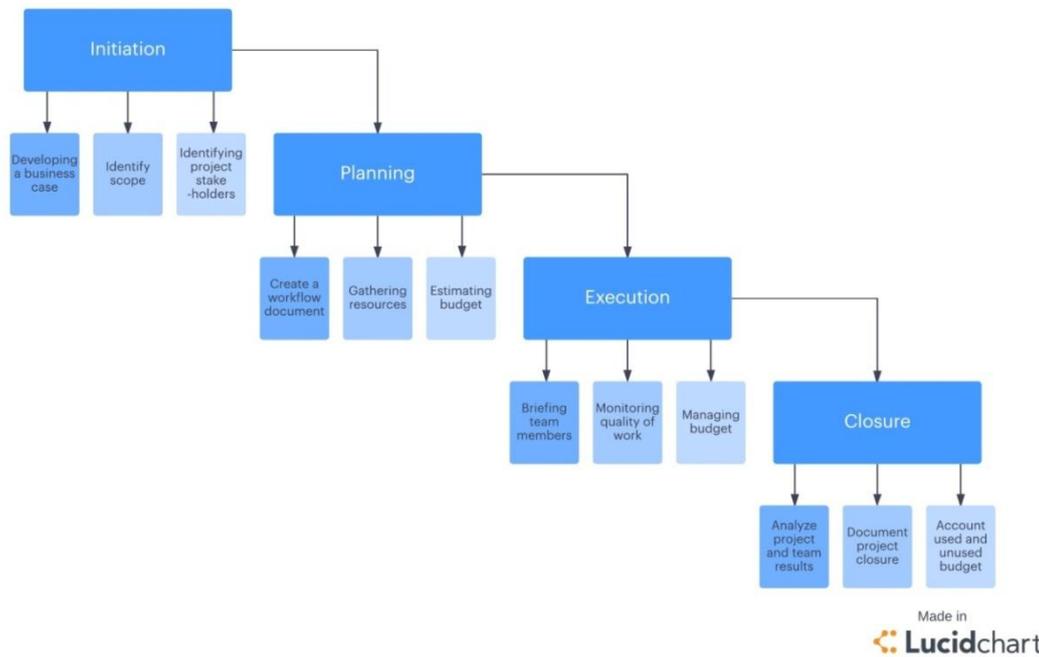
### Introduction

Building is as old as humanity whose product it is; and has evolved through centuries of activities from dwelling in caves to skyscrapers and recently to intelligent structures that can smartly respond to stimuli in its environment. Mbamali I, Okotie A. J. [1] observed that building practice has also undergone a great deal of metamorphosis in response to the dynamic nature of human need and development. However, building design and construction are processes which traditionally involve several professionals collaborating for relatively short periods to develop a facility. Aghahowa Enouma [2] defined it as the processes involved in the assembling and erection of structure primarily those used to provide shelter. The building process may be grouped into four major phases: the initiation phase, planning phase, execution phase and the closeout phase [3]. The initiation and planning phases which can be referred to as the conception and design phase is when most of the decisions that influence the output and performance of the building are made.

The construction phase represents the actualization stage where the greatest portion of the capital costs is incurred. The operation or use phase account for the greatest proportion of time period of building life (usually in the range of 60 – 100 years) as against the few weeks, months or years usually used for the first two phases. It is at the design stage that most decisions affecting the construction are made [4]. The functionality of a building aims to optimize the value of the building to its end users for as long as the building life span serves its purpose. Design errors are omissions and ambiguities from drawing or specification [5]. The seriousness of this error must be considered to determine its consequences on the overall outcome of the project. Cost and time overruns can be controlled by the reduction of design errors [6]. The client, architect and contractor all have different



interests and responsibilities in the design of a facility. But what they do have in common is the commitment to complete the project safely and within a stipulated cost and time. Major design quality problems become evident during construction as a result of errors, omissions and ambiguities in plans and specifications [7].



This statement implies that the inadequacies in the plans and specifications are the major causes of changes to the project which can lead to errors. There have been extreme examples of design errors such as numerous building collapses in Nigeria; projects that have wrought disaster after the construction are completed and while construction is ongoing [8]. These are examples of design errors that escaped the close scrutiny of all parties. The projects that really suffer are those with many small errors (design, rework or change of scope) which when finally added up causes major impacts on the final cost and schedule growth. Davis and Ledbetter [7] stated that "accuracy of the design documents" was the most critical criteria used in the initial evaluation of design effectiveness. This was due to the fact that the drawings and specifications are the most "readily identifiable outputs of the design process." It is even more important that the quality control of designs be addressed during the planning phase and closely monitored during the construction phase.

Factors that account for design errors include:

- Poorly defined or unclear Scope of work
- Changes in the scope of works
- Designers lack of construction knowledge and experience; this hampers the designers ability to envisage correctly the completed building
- Insufficient funds and time to create and review quality documents
- Lack of coordination amongst allied professionals
- Human error; computation error in time and cost

These errors can be corrected with only initial cost considerations and little effect on the final cost and time schedule. Design errors of a project have been misconstrued in the country leading to tardy and unsatisfactory approach.

### Methodology

The research design adopted for this work is cross –sectional survey and descriptive analysis on a randomly selected sample of the different categories of construction industry operators (clients, consultants, contractors). Data was drawn from primary and secondary sources. The secondary data involves the use of information already in existence and this was sourced largely through literature review.



Primary data used was acquired through field survey, questionnaire survey and interview methods. A random sample method of data collection was employed with one hundred and twenty questionnaires distributed thus; forty five to clients, thirty five to consultants and forty to contractors. They were randomly selected using stratified random sampling technique as a type of probability sampling in order to give everyone that falls into any of these identified target groups equal and independent chance of being included in the sample.

### Results and Findings

Though 120 questionnaires were administered (Forty five to clients, thirty five to consultants and forty to contractors), only 100 were received, representing 83.33% effective response rate.

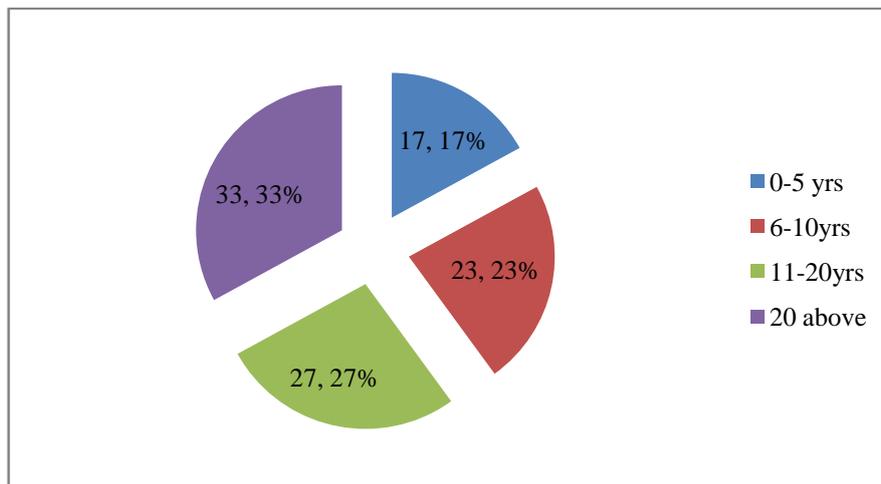


Figure 1: Years of Experience of respondents

Figure 1 above shows that eighty three percent (83%) of the respondents have been involved in the construction industry for at least six (6) years, hence; their opinion is valuable and can be depended on.

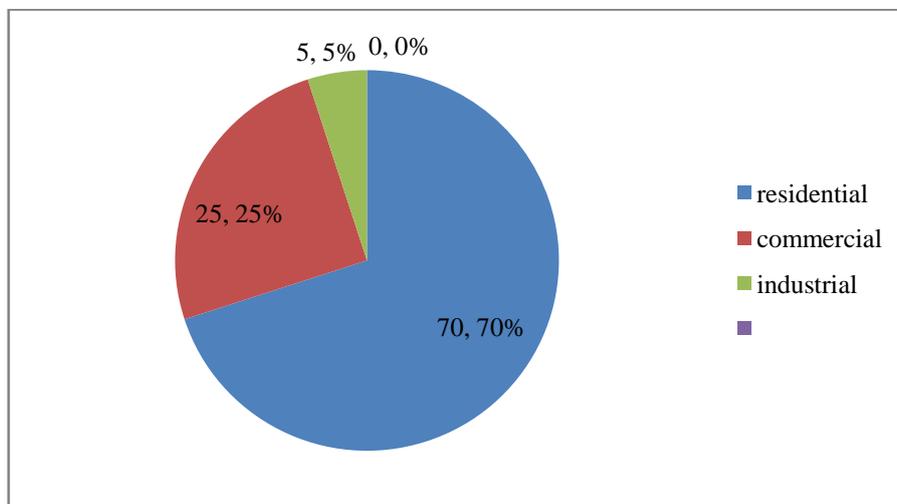


Figure 2: Types of buildings investigated

Figure 2 shows that the survey cut across different categories of buildings; residential, commercial and industrial. It shows that no just one building type is considered. Hence, the result of the survey can be applicable to all building types.



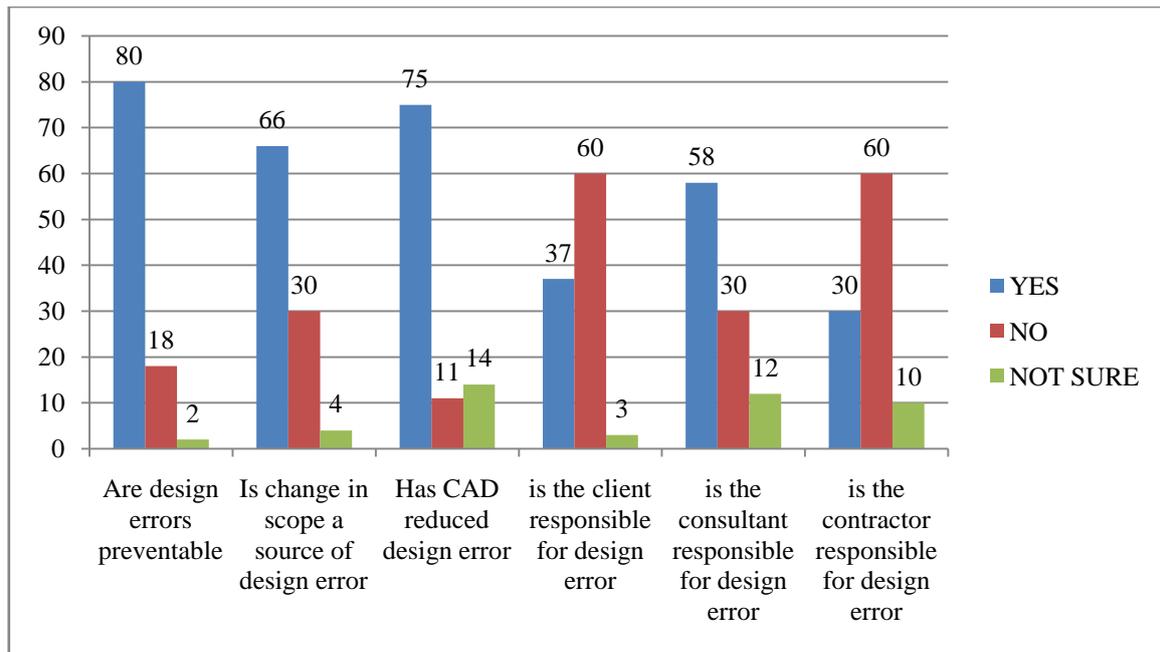


Figure 3: Sources of design error

Figure 3 above shows the results of the survey conducted amongst Clients, Consultants and Contractors. From the survey, it is generally agreed that design errors are preventable. It also shows that change of scope of works is a source of design error. Computer Aided Design (CAD) has reduced design errors mostly due to computation of dimensions as this is automated. CAD also enhances the updating of design as inputs are made. It can also be seen from the figure that the responsibility of design errors rests heavily on the shoulders of the consultant. As a result of this, the consultant(s) must do all in their power to ensure an efficient coordination of the project mostly coordinating the clients brief to a desirable outcome. At the design stage, the consultants should not be tired of updating the drawings as inputs are made so that all changes are made on paper and once construction commences, there will be no need for changes which is a source of design error.

From interviews conducted amongst clients', consultants' and contractors', the top five (5) causes of design errors which cause cost and time overrun are as summarized in Table 1.

Table 1: Factors perceived as causes of design errors

Rank	Client's perception	Consultant's perception	Contractor's perception
1	Improper interpretation of design brief	Client inability to coordinate his brief properly	Mistakes in dimensioning in drawings
2	Consultants design and bills not flexible enough to accommodate changes	Changes in the clients brief	Discrepancies between drawings and bills of quantities
3	Inexperienced consultants and poor supervision	Inadequate time to assimilate the brief and come up with a comprehensive design	Incomplete comprehensive and detailed drawings
4	Poor communication between consultant and contractor	contractor during the bidding process should call the attention of consultant where discrepancies are noticed	Consultants should ensure they do a double check on their drawings to avoid discrepancies
5	Improper interpretation of drawings by contractors	Unclear scope of works and changes in the scope of works	Unclear scope of works

From table 1 above more of the responsibility of design error rest on the shoulders of the client and consultant. The contractor has little or nothing to do with design as he is only involved in construction after the design has been completed and ready for actualization (construction). The evolution of computer aided design (CAD) has

lessened or even eliminated design errors arising from mistakes in dimensioning. The computer is still only a design tool; adequate care must be taken to ensure that the dimension seen is the one actually required.

### Conclusion and Recommendations

It was the consensus of the respondents that design errors affect the final cost of a project and are avoidable. Obviously, the client is accountable for additional cost and time overrun caused by additional works. Yet, additional works are not the only sources of cost and time overrun. Every personnel in the construction industry must won up to their responsibilities and take preventive steps to ensure that this (design error) is a thing of the past. The following conclusions and recommendations were drawn up from the research:

1. Design error affects final cost of a construction project which results in cost and time overrun of a project. A lot of factors were found to be responsible for design error in construction projects which includes unclear scope of work and/or change in scope of work, time and inexperience of the designer and inaccuracy of the design documents. This finding concurs with the research of Olawale, Y., and Sun M. [9] which determined that accuracy of the design documents was critical in the initial evaluation of cost and time overrun.
2. Design errors causes cost overrun in a building construction which creates negative impact on a project. This agreed with the findings of P.A. Bowen, K.A. Hall, P.J. Edwards, R.G. Pearl, and K.S. Cattell [10]. Also, M.V. Raju, S.S. Asadi, M. Satish Kumar & Hepsibah Palivela [11], identified reasons for project cost overruns: frequent design changes, poor project management, inappropriate contractors, unskilled manpower, inaccuracy of material estimate, lack of appropriate software, complexity of works.
3. Among the three categories of personnel involved in construction; the clients, consultants (designer) and contractors, the consultants' and contractor are responsible for the design error where the consultant is not able to digest comprehensively the clients' brief and where the design is not properly interpreted by the contractor. This will lead to reworks which will inadvertently lead to cost overrun. The client on the other hand has a role to play. Changes made during the construction phase especially where it leads to reworks will also lead to cost and time overrun.
4. Finally, clients should come out with a clear scope of work and reasonable amount of time should be given to the designer (consultants) in order to produce a clear and error free designs and specification.

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