Strategies for Reduction of Design-Related Rework in the Nigerian Construction Industry [1]

Comfort Salihu and Sunday Ajiboye Babarinde[2]

Dollahills Research Lab, Dollasoft Technologies,
Lagos, Nigeria

ABSTRACT

Rework remains a major basis of concern in the construction industry due to its attendant cost implication on construction projects. Eliminating occurrence of reworks on projects has proven to be a herculean task, professionals are hence concerned with taking giant strides in bringing its probability of occurrence to the barest minimum. In forestalling reworks on construction projects, the design stage holds a vital position. This research study was aimed at evaluating how reductions in design related rework can be achieved. A well-structured questionnaire was administered to seek out primary data, while secondary data was sourced through reviewed literature. Information obtained from these sources was collated, analysed and presented using descriptive method of statistics (tables and chats), relative important index (RII) and correlation analysis. The findings of this study expounded that design related rework had the highest frequency of occurrence with an RII of 0.74 based on the respondents' perception among other nature of rework. Majority of construction firms resorted to an improved use of computer aided design/engineering technologies as a means of achieving reductions in rework construction projects. This study hence recommends the implementation of a multidisciplinary design team provided with a detailed client brief during the design stage to ensure reductions in the rate of errors, omission and ambiguity. Construction clients should be properly enlightened and advised on the cost implications of frequented changes in construction scope and details which habitually results in rework.

Keywords: Rework, Design Error, Reduction

INTRODUCTION

The occurrence of rework has been noted to have recorded increased level of occurrence in recent times, this is believed to have resulted to acute reduction in the quality of project performance. Construction Industry Institute (CII, 2001), defined rework as an activity that has to be carried out more than once or activities that involves removal of previously completed that has been previously fitted as part of a project work and redoing such. Also, this denotes unjustified labour

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[2] Corresponding author - ajiboye196@gmail.com

engaged in repeating such an element of work, process and activity that wasn't well carried out the first time (Love and Li, 2000). Towards achieving improvements in project's cost and schedule performance, several companies have adopted the speed up approach, where there is an overlap of both the design and the construction phase (Pena-mora and Li, 2001). This overlap in stages enables the contractor to commence the construction phase with a possibly flawed or defected plans laden with undiscovered errors. Non-detection of the possibility of a rework occurrence that remains undetected during the design stage can result to substantial rework occurrence during the construction stage. In the annihilation of reworks on construction projects, architects are saddled with a vital role in the design process towards the elimination of deficiency or errors in the inception phase which might eventually lead to an abnormality during the construction phase (Oyedele and Tham, 2007).

Love *et al* (2010), argued that the longer an error stays undetected the more the possibility of a rework occurrence which might have significant adverse effects on the project's cost and schedules. They also postulated that quiet a number of circumstances that triggers error provoking activities takes place downstream during the construction stage. Furthermore, Love (2002a), discovered that the obscure cost of rework might be as much as five times the cost of rectification. In order to achieve improvements in projects' performance and productivity level, urgent action is essential on the reduction of rework occurrence and its consequential additional cost (Love, 2002).

Design error represents deviations from drawings or specifications, this also covers omissions and ambiguities. Mryyan and Tzortzopoulos (2013), harangued about the origin of design errors and gave their classification as errors attributed to: client's actions, non-adherence to building regulations and building codes, inadequacy of details in drawing and/or mis-interpretation of drawings. Love and Li (2000), has been noted to make substantial out that rework can make a large input to increased project cost.

THE NIGERIAN CONSTRUCTION INDUSTRY

Major upsurge in demand for real estate housing and infrastructural amenities and support for the increasing population size can be attributed as the cause of the rapid growth of the Nigerian construction industry. The key actors in the industry includes the architects, engineers, quantity surveyors, management consultant, general contractors, heavy engineering contractors, subcontractors, construction personnel together with the owners, workers and clients of the constructed facilities.

The public sector is the major source of project finance, resulting in major boosts in the development and growth in the construction industry in Nigeria. Construction Industry as common with most developing nations around the world is still clogged with a lot of innate challenges ranging from poor technical and managerial experience to deficient financial, material and equipment capital base (Ofori, 2001). Nevertheless, the industry has other diverse inherent capabilities such as its independence in cement manufacturing which has made the construction material relatively affordable and available in the material sector (International Council for Building (CIB), 2004; Oluwakiyesi, 2011). The use of sophisticated machinery, plants and

software has substituted the high rate of dependence on manual labour and tools this has increased the efficiency and effectiveness of the industry and has aid quick completion and delivery of projects within the stipulated contract period.

CONSTRUCTION INDUSTRY AND REWORK

Rework occurs due to so many factors such as errors in design, construction failure and change order, poor coordination, ineffective and inefficient communication amongst participants of the project (Oyewobi *et al*. 2011). It is found changes made by clients and design error/omission seems to be the main cause of rework having a relatively higher cost consequence than the other factors aforementioned (Hwang *et al*., 2009). Wasfy (2010) recorded that other causes of rework in construction projects includes; unexperienced supervision, deficient supervision, poor workmanship, inappropriate subcontractor selection, poor work security and inappropriate work arrangement.

Cost and time overruns are effects directly associated with rework on construction projects. This consist of; the additional time taken to carry out rework, additional cost incurred in the rectification of the defect, increments in the volume of materials occasioned by rework occurrence, wastages, increase in labour cost for making good defects (Palaneeswaran et al. 2005). In comparison with civil works, building works has a higher rate of occurrence of reworks on projects. Reworks in building works occurs more frequently due to numerous reasons including: differences in interface related issues i.e. deficiencies in organizational line between main building contractors and building services contractors, poor flow of information between design team and construction team (Palaneeswaran, 2006). The time limit of cost tracking includes the duration of time rework is known, the time needed to make good the rework and the time needed to continue and complete the original scope of work (Fayek *et al.*, 2003). Early discovery and correction of reworks that may arise due to design error, flaws, non-conformance are essential for regulating the negative effect of rework on cost and project duration (Palaneeswaran, 2006). The principal causes of rework can be grouped into different classifications these are; factors associated to clients, factors that are associated with designs and factors related to contractors together with site management and contractor factors (Love and Edwards, 2004).

DESIGN ERRORS

Tuker and Edmonson (2002), opined that design error refers to the execution of a job that is either needless or wrongly done. Design error represents major deviances from drawings or specifications, this are inclusive of omissions and ambiguities. Failure in accurate project delivery is often synonymized with error, nevertheless there is represents a major differential between expected and observed performance. (Ayininuola and Olalusi, 2004).

Sources of Design Error

Mryyan and Tzortzopoulos (2013), identified the sources of design errors had their categorization under the following headings as follows:

A. Errors Attributed to the Client

i. As a result of lack of experience of the client about construction processes and techniques errors springs up.

ii. Little or no knowledge in describing with precision the project aims and objectives

iii. Inability of the client to present his requirement in written form.

iv. Uncertainty of allocation of space.

v. Inability of the client to provide schematic sketches about the potential design.

vi. Unavailability of funds at hand for the design process and construction to progress

vii. Elaborate clients' requirements most time exceeds potential budget.

viii. Interruption and lack of commitment to fees payment.

ix. Client changing or selecting new finishing materials than the one initially specified.

x. Errors due to budget and plot size not satisfying client requirements.

B. Errors attributed to failure to implement regulations and building codes

i. Errors in calculating the vertical dimension of the building.

ii. Errors due to violation in clearance between adjacent buildings.

iii. Errors in identifying the correct dimension of the plot and plot boundaries.

C. Errors attributed to lack of details in drawing and/or mis-interpretation of drawings.

i. Inability to correctly link the street level with building level.

ii. Mistakes in establishing the ground floor level.

iii. Errors in linking stair case with the floor level.

iv. Adopting existing design and specification of other projects for the new project.

v. Due to importation of details from other projects to the new project, errors arises in architectural details.

vi. Errors due to inadequate internal details on the architectural drawing which leads to incorrect allocation of electrical works and outlets.

vii. Errors due to orientation and direction especially that of electrical and plumbing works and outlets.

viii. Using different sets of drawings i.e. one for approval or work permit and the other for the actual construction.

ix. Change of professionals working on the project most especially the architect, due to either them leaving the company or going on a vacation.

x. Client selecting materials without first consulting the architect.

xi. Errors due to misinterpreting or ignoring building codes.

xii. Lack of specification or missing details for steel, wood, and aluminium work.

REWORKS REDUCTION

Reductions in occurrence of reworks can be achieved given that adequate attention is paid to project planning and coordination of resources for projects. Nevertheless, efficiency in design management and procurement can be adopted as strategies used in diminishing occurrence of client-initiated changes, design repetitions and errors but their successful implementation is hinged on the level of efficiency in its deployment technique.

It is thus vital to re-examine the work practices and procedures used to deliver projects if rework occurrence is to be cut down. Love (2002), established that the adoption of a multidisciplinary team approach during the production and management of contract documentation could reduce errors and the prospect for client-initiated variations (Love, 2002). Rather than working in a successive manner to design in producing the project's design and contract documentation, identification of materials and equipment required for production, project participants should work together in a concurrent manner and, therefore, increase their understanding, coordination, and information flow with one another.

With the intention of decreasing owner-initiated alterations, encouraging the adoption of value management (VM), and refining the making and management of contract documentation via the use of information technology. A substitute procurement models that has emphasis on rework reduction is seen in the figure above. Here, each member of the team is presumed to have a direct interaction with the client as the different stages of the design and production process is being carried out so that they can be guided about the choice of alternative design solutions/construction sequencing and informed about the cost implications of initiating changes. The procurement structure has been formed to encourage teamwork, as this is considered a serious characteristic for the effective organization of information in projects. In fact, when the team members have a portion in the progress of the project they tend to perform better, and as a result have a positive effect on limiting design repetitions, deviations, and sacrifices in quality (Nesan and Holt, 1999).

RESEARCH METHODOLOGY

For data collection purposes, well-structured questionnaires were developed and administered to source for primary data, while secondary data was sourced through reviewed literature. There was also collation of secondary data from books, past works of eminent scholars related to the topic under investigation. The population for the study is comprised of the construction companies registered with Abuja's business directory which is 244 as at March 2017. Considering the population size identified, the sampling frame was limited to Abuja, questionnaires was distributed to registered construction companies with Abuja business directory. The sample size for the study from the study's population (244) will be 71 based on Yamane, 1967 formula as given below using 10% level of accuracy, 95% certainty level, 50% level of inconstancy and a purposive sampling. From the entire population of this study which was 244, sixty-four (64) questionnaires were retrieved accounting for 90% of the limit set for the questionnaire which was seventy – one (71) questionnaires. Archival data of ten institutional building projects in Abuja was retrieved, sorted and analysed.

RESEARCH RESULTS

Table 7.1: Causes of Design Related Rework on Institutional Buildings

Causes	1	2	3	4	5	RII	Rank
Insufficient information from the client in other to prepare detailed contract document	0	3	10	29	22	0.73	1st
Limited time for preparation of contract document	0	7	16	33	8	0.65	2nd
Quality management practices are not being utilized effectively	0	4	27	27	6	0.63	3rd
Different design team members being poorly coordinated	0	7	29	23	5	0.61	4th
Time boxing/fixed time for a task	0	8	33	22	1	0.58	5th
Information technology not being utilized effectively	1	13	28	18	4	0.56	6th
Resignation/reallocation of design team to other projects	3	19	22	13	7	0.54	7th
Inadequate planning of workload	0	19	31	11	3	0.53	8th
Unavailability of skilled workforce to complete the required task	6	19	28	9	2	0.48	9th

Source: Researcher's Analysis (2017)

Table 7.1 shows, the causes of design related rework on projects executed by the respondents. Insufficient information from the client in other to prepare detailed contract document came 1st with RII of 0.73 Limited time for preparation of contract document followed 2nd with RII of 0.65, Quality management practices are not being utilized effectively, Different design team members being poorly coordinated, Time boxing/fixed time for a task, Information technology not being utilized effectively, Resignation/reallocation of design team to other projects, Inadequate planning of

workload and Unavailability of skilled workforce to complete the required task came 3rd, 4th, 5th, 6th, 7th, 8th and 9th with RII of 0.63, 0.61, 0.58, 0.56, 0.54, 0.53 and 0.48 respectively. This shows that all the design related causes of rework are quite significant.

Methods of Reducing Design-related Rework Occurrence

Table 7.2: Methods of Design-related Rework Occurrence

Strategies	1	2	3	4	5	RII	Rank
Increased use of computer aided design/engineering technologies	0	0	5	29	30	0.78	1st
Proper implementation of design management	0	0	33	28	3	0.63	2nd
Use of value management during the design stage	0	3	30	29	2	0.62	3rd
Introduction of multidisciplinary design team	0	7	38	14	5	0.58	4th
Proper implementation of procurement strategies at the design stage	1	11	34	12	6	0.56	5th

Source: Researcher's Analysis (2017)

Table 7.2 shows the ranking for ways of reducing design related rework that has been put to use by the respondents' firm. The increased use of computer aided design/engineering technologies with RII of 0.78 has the highest ranking, followed by proper implementation of design management with RII of 0.63. Use of value management during the design stage, introduction of multidisciplinary design team and proper implementation of procurement strategies at the design stage ranked 3rd, 4th and 5th with RII of 0.62, 0.58, and 0.56 respectively.

DISCUSSION OF RESULTS

Analysed data reveals that a majority of the construction firms engage in the increased use of computer aided design/engineering technologies ranked as the most effective means of achieving reductions in rework's occurrence with a RII of 0.78 based on the respondent's data. Proper implementation of design management with RII of 0.63 was acclaimed as the 2nd most effective means of rework control. Use of value management during the design stage with RII of 0.62, introduction of multidisciplinary design team with RII of 0.58 and proper implementation of procurement strategies at the design stage with RII of 0.56. this implies that a lot still need to be done in sensitizing professionals on the need to actually introduce the use of multidisciplinary design team approach to the crafting and management of contract documentation which according to love (2002) could reduce errors and the prospect for client initiated changes which was aforementioned to be the highest cause of design related rework.

CONCLUSION AND RECOMMENDATION

It is observed from the results that methods of reducing design related rework reduced have not really been adopted by most firms except for the increased use of computer aided design/engineering technologies. Other ways that have been identified from previous research to be very effective such as introduction of multidisciplinary design team and proper implementation of procurement strategies at the design stage have not been widely adopted. Design related rework reduction is very keen if the construction industry is to make headway and deliver quality projects to meet clients' satisfaction.

It is recommended that the introduction of multidisciplinary design team during the design stage should be adopted by both clients and professionals so as to reduce the rate of errors, omission and ambiguity. Furthermore, clients should be advised on the cost implications of frequent changes which usually lead to rework so as to get detailed client brief during the design stage before construction commences.

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About the Authors

Comfort Salihu
Federal University of Technology,
Minna, Niger State, Nigeria.

Comfort Salihu is a Facility Supervisor, Quantity Surveyor and Researcher. She graduated from the Federal University of Technology Minna with a Bachelor of Technology Degree in Quantity Surveying (First Class Honors) in 2017. She has also obtained professional certifications in Health Safety and Environment (HSE 123) and Project Management. She is passionate about construction cost optimization in the construction industry in Nigeria and Africa. She currently works at AGE Facility and Energy Management Services Limited as a facility Supervisor. Her research interests are in the area of Rework, Modular Construction, Construction Safety and Construction waste. Comfort Salihu can be contacted on salihucomfort@gmail.com

Sunday Ajiboye Babarinde

Federal University of Technology,
Minna, Niger State, Nigeria.

Sunday Ajiboye Babarinde is a resourceful Quantity surveyor and researcher. He attended Federal University of Technology, Minna where he studied Bachelor of Technology in Quantity surveying and graduated in 2017. He possesses certifications in Project Management and Facility Management from Global Institute of Project Management and also a certification in Quality Control and Assurance. He has great passion for the implementation of innovative technology towards advancing the Nigerian and African Construction Industry with a view at fostering quality and cost-efficient construction. He works with Brainsworth Nigeria Ltd. in the capacity of a quantity surveyor. His research interests are on building information modelling, risk management, lean construction, and IT applications to construction. Sunday can be contacted on spenpe196@gmail.com.