Tackling Time and Cost Overrun in Infrastructure Projects:

A case study of selected projects in Lagos and Environs

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Abstract

The construction industry is one of the fastest growing industries in Nigeria and it contributes a lot to the country's economy. But majority of construction projects are hampered by the twin effects of time and cost overruns. The success of a construction project depends on many factors with time and cost factors being the most crucial, because project success largely depends on its timely completion and within specified budget. If time and cost are properly managed on a construction project, it will achieve its objectives and success. This research work has identified the factors that influence time and cost overruns from the literature review and using these factors a questionnaire was prepared containing 37 factors which cause delays and cost overruns on construction projects. A desk study of 20 completed infrastructure projects in Lagos and environs was carried out. The questionnaire was distributed to the industry's major stakeholders in consultant, contractor and client organizations. Of the 80 questionnaires distributed, 72 were returned. The respondents were asked to rate the factors on the basis of occurrence and severity of their impact on time and cost. Data obtained from the returned questionnaires was analyzed using statistical technique. The aim of this research is to identify the most critical factors responsible for time and cost overruns on construction projects and to find ways of tackling them to avert future occurrence. Responses received from the projects reviewed revealed that all projects suffered time and cost overruns in varying proportions. Time overruns ranged from 15.26% to 222% of contract time, while cost overruns ranged from -20% to 54.69% of the contract price. The research found that the most significant causes of time overrun are: *design and scope change, inadequate availability of skilled resources, and ineffective procurement planning*. And the most significant causes of cost overrun are: *price escalation of materials, escalation of labour costs, and scope change*. This research was limited in scope to only infrastructure projects, and covered infrastructure projects in Lagos and environs. Notwithstanding, this study provides a basis for pragmatic solutions that could enhance the chances of infrastructure project success, and contributes to the ongoing debate on the causes of project delays and cost overruns in the construction sector, especially from a developing country's perspective.

Keywords: infrastructure projects, time overrun, cost overrun, construction industry, infrastructure project, construction project, project success

1. INTRODUCTION

In general, the implementation of construction projects undertaken by government and its agencies are prone to time and cost overruns; more so for infrastructure projects. The construction industry plays a significant role in the socio-economic development of any nation. The interrelationship between the construction industry and the broader economy emanates from three of the industry's characteristics namely: the public sector client as its major client, its large market size which affords it the ability to provide investment or capital goods that contribute significantly to the nation's GDP, and as a major source of direct or indirect employment with multiplier effects.

Construction industry in Nigeria, like in most countries, faces lots of challenges occasioned by the increasing uncertainties in technology, budgets and development processes around the world. Consequently, time and cost overruns are very common occurrences in construction projects these days. This is heightened on infrastructure projects because of the time, scope and cost required to execute them. This puts more pressure on consultant, contractor and client organizations to deliver assigned projects in time and within the estimated budget. Different research works have shown that delays and cost overruns in the construction industry are a global phenomenon. In Nigeria, studies have found that the performance of projects in the construction industry in terms of time and cost performance is abysmal. A study conducted by Odeyinka and Yusif (1997) found that seven out of ten projects surveyed in Nigeria suffered time and cost overruns. Chan and Kumaraswamy (2008) in their study of project delays in Hong Kong construction industry concluded that timely delivery of projects within budget and to client's specified quality serves as an index of project success. This suggests that failure to meet targeted time, budgeted cost and specified quality could lead to unexpected negative consequences. When projects are delayed, the project time is either extended or the project pace accelerated, and therefore incur additional cost to complete. Most contracts allow a certain percentage of the project cost as a contingency allowance, often based on judgment, in the contract price to cushion the effects of

overruns. For small overruns, such allowances may be adequate to address the problem. But in most cases these provisions have proven to be grossly inadequate in tackling the effects of time and cost overruns owing to the peculiar circumstances of each project and the excessive overruns involved.

2. LITERATURE REVIEW

Generally, time and cost overruns impact the pace of projects and lead to loss of productivity, late completion of projects, increased time-related costs, and third party claims and eventual termination of contracts. Even with the present sophisticated equipment, advanced software, improved project management techniques, construction projects still grapple with time and cost overruns. Although opinions vary on what determines a project success, one thing rings loud and clear, 'cost performance' and 'time performance' are critical issues to be considered when assessing the success or failure of a project. Factors that cause overruns on construction projects differ from country to country because the economic, political and geological factors impact the projects differently. The quality of human resources also impacts projects.

Early research by Jahren and Ashe (1990) found a strong correlation between project size and project overruns and established the point that the larger the size of a project the higher the delays and cost overrun occurring on it. Later research by Shrestha *et al* (2013) covering 363 construction projects supported the argument that projects of bigger size give rise to more substantial time and cost overruns. Cantarelli *et al* (2010) found that inaccurate estimates and improper planning based on faulty assumptions from feasibility studies culminate in embarking on the implementation of inferior projects that are fraught with unmitigated risks. This leads to project failure arising from delays and cost overruns, among other things, which all exert additional burden on the nation's GDP. Perhaps, this explains why despite the injection of US$36.4bn on infrastructure in 2014, the Nigerian government has yet to achieve commensurate impact in infrastructure development (Atorough 2016; This Is Africa 2015).

Unfortunately, the inability to complete infrastructure projects on time and within budget has become a chronic global problem and is fast becoming the accepted norm rather than the exception (Ahmed *et al* 2002). This development has given rise to debates among professionals working in client, contractor and consultant organizations. Debate is also ongoing among policymakers in the construction industry on the best approach to eliminate time and cost overruns on construction projects. Most are optimistic that projects can be delivered in time and within budget but that that would require a good starting estimate, project management discipline and a general awareness of the factors that can lead to delays and cost overruns. This research was anchored on this optimism.

3. RESEARCH METHODOLOGY

The strategy adopted for this research is both quantitative and qualitative; for analyzing data collected from the questionnaires and interviews respectively. The perception of the respondents have been carefully scrutinized and analyzed. The samples for the research were randomly selected from the three main organizations of contractors, clients and consultants. Creative Research System (2001) was used to determine the sample size of the unlimited population, using the formula:

$$SS = \frac{Z^2 \times P \times (1-P)}{C^2} \quad \text{.....Equation No.1}$$

Where; SS = sample size

Z = Z value (e.g. 1.96 for 95% confidence level)

P = Percentage picking a choice, expressed as decimal (0.50 used for sample size needed)

C = Margin of error (say 11%)

$$\text{Therefore, } SS = \frac{(1.96)^2 \times 0.5 \times (1 - 0.5)}{(0.11)^2} = \frac{3.8416 \times 0.5 \times 0.5}{0.0121} = \frac{0.9604}{0.0121}$$

= 79.37 ~ 80

This is how the author arrived at a sample size of 80 questionnaires for distribution, using a confidence level of 95% and 11% margin of error.

4. DATA COLLECTION

80 respondents who participated in 20 selected projects were randomly selected from the rank of project managers, resident engineers/quantity surveyors, site engineers/quantity surveyors, and office engineers/quantity surveyors or their equivalents; and 72 responded. They were categorized according to their organizations in Table I and according to their designations and experience in Table II below:

Table I: Respondents Organization

Respondents Designation		
Organization	Number of Respondents	Percentage
Contractor	38	53
Client	19	26
Consultant	15	21
Total	72	100

Table II: Respondents Designation and Experience

Number of Respondents		
Designation	Number of Respondents	Percentage
Project Managers/Resident Engineers and Q/Surveyors	46	64
Site Engineers and Quantity Surveyors	16	22
Office Engineers and Quantity Surveyors	10	14
Total	72	100
Respondents Work Experience		
Experience (yrs)	Number of Respondents	Percentage
0-4	2	3
4-8	8	11
8-12	25	35
>12	37	51
Total	72	100

The questionnaire listed several factors designed from the literature review of construction projects and structured on the basis of significance of these factors, in order of priority scaling beginning with the *'least significant'* =1 to the *'extremely significant'* = 5. See table III below:

Table III: Scales that show chances of occurrence

Chances of occurrence	Not Significant	Slightly significant	Moderately significant	Very significant	Extremely significant
Scale	1	2	3	4	5

The analysis of the obtained data includes the checking of reliability of data to ascertain whether the data is acceptable or not. Hypotheses testing method was used for this, and for ascertaining whether agreement exists or not in the views expressed by the various respondents on the causes of time and cost overruns on the in projects investigated.

The analysis of results adopted a procedure which helped to establish the mean scores (MS) of the various factors responsible for project time and cost overruns. The score for the factors was determined by adding up the scores assigned by the various respondents to ascertain the level of importance and mean score of each factor as provided by the different respondents, using the Formula:

$$MSi = \frac{\Sigma (F \times S)}{N} \quad \text{.....Equation No.2}$$

Where, S = score given to each cause of overrun by the respondent
F = frequency of responses to each score for each cause of overrun
N = total number of responses received in the respective cause of overrun

And the weighted averages were calculated using the formula below, before ranking them.

$$\text{Weighted Average} = w_a x_a + w_b x_b + w_c x_c \quad \text{.....Equation No.3}$$

Where, *w* = relative weight (%)
x = mean score
a, *b* & *c* represent contractor, consultant and client respectively.

The research then tested respondents' views for correlation using Spearman rank coefficients to see if there is significant difference in ranking between two groups of respondents such as contractor versus clients, contractors versus consultants, and client versus consultants, on the variables of time overrun and cost overrun, and their rate of occurrence. For any two groups of ranking, the Spearman (rho) rank correlation coefficient could be ascertained using the formula below:

$$\text{Rho } (\rho cal) = 1 - \frac{6 \times (\Sigma d_i^2)}{N \times (N^2 - 1)} \quad \text{.....Equation No.4}$$

Where, Rho (ρcal) = Spearman rank correlation coefficient
d_i = the difference in ranking between each pair of factors
N = number of factors (or variables)

5. ANALYSIS OF DATA

Below is a summary of analyses of data obtained from filled questionnaires and discussions with the different respondents surveyed in the construction industry.

A. Time overruns related factors

(i). Contractor view: Table IV shows mean scores and ranking for the factors causing time overruns. The contractor respondents ranked "design and scope change" highest with MS of 4.579. This supports the argument that design and scope change cause significant delays and elongate project completion time. Improper project planning and inadequate project scoping at project inception are major causes. "Delay in decision making" by client (and his technical team) ranked second with a score of 3.974. Decisions that are critical to smooth project take off, once delayed, will result in unnecessary delays that affect the sequence of events, program of work and timelines for deliveries of critical materials and services. In third place is "ineffective procurement planning" which concerns the shabby way contract agreements are prepared and entered into without regard for due process. It leads to conflicts and delays later during project implementation. In fourth place with mean score of 3.842 is "delay in taking possession of project site". This is critical to timely completion of projects because delay in handing over site to contractor delays timely project take off and impacts timelines and milestones. Ranked fifth by contractors is "inadequate availability of skilled resources" with a score of 3.789. This is obvious because using personnel with the wrong skill sets jeopardises job quality and encumbers smooth project management.

Table IV: Mean Scores and ranking for time overrun

	RESPONDENTS' VIEWS OF FACTORS INFLUENCING TIME OVERRUNS	Contractor		Client		Consultant		Weighted Average	
S/N	Factors	MSi	Rank	MSi	Rank	MSi	Rank	MSi	Rank
	Causes of delay at Pre-Execution phase								
a.	Land/Site handover	3.842	4	3.053	12	3.333	9	*3.280*	*11*
b.	Delay in obtaining regulatory approval	3.632	8	3.316	8	3.600	8	*3.516*	*7*
c.	Lack of R&R policies	3.447	11	2.947	13	3.333	9	*3.219*	*13*
d.	Relationship with other projects	2.921	15	2.579	18	2.600	19	*2.685*	*19*
e.	Inflexible country planning	3.316	12	3.105	11	3.267	13	*3.234*	*12*
f.	Delay in decision making	3.974	2	3.474	6	3.800	4	*3.666*	*6*
g.	Ineffective procurement planning	3.947	3	3.579	5	4.267	1	*3.778*	*3*
	Causes of delay at Execution/Closing phase								
a.	Design and scope change	4.579	1	4.211	1	4.133	2	*4.264*	*1*
b.	Inadequate availability of skilled resources	3.789	5	3.842	2	3.800	4	*3.803*	*2*
c.	Contractual disputes	2.711	19	2.684	17	2.800	16	*2.730*	*17*
d.	Industrial relations and law issues	2.737	18	2.474	20	3.067	14	*2.725*	*18*
e.	Inadequate topographical surveys and field investigation (geological challenges)	3.026	14	2.947	13	2.467	20	*2.766*	*15*
f.	Pre-commissioning teething challenges	2.816	17	2.789	16	2.667	18	*2.755*	*16*
g.	Coordination problems with project team and vendors	3.553	10	3.158	9	3.333	9	*3.355*	*9*
h.	Geographical challenges and cultural differences	2.474	20	2.526	19	2.933	15	*2.620*	*20*
i.	Delay in obtaining regulatory approvals at commissioning stage	2.921	15	2.842	15	2.733	17	*2.828*	*14*
j.	Ineffective project/program management	3.632	8	3.632	4	3.800	4	*3.674*	*5*
k.	Ineffective project monitoring	3.711	6	3.737	3	3.800	4	*3.744*	*4*
l.	Lack of awareness of modern technology	3.289	13	3.474	6	3.333	9	*3.343*	*10*
m.	Inadequate availability of funds	3.711	6	3.158	9	4.067	3	*3.494*	*8*

(ii) Consultant view: Consultant respondents ranked "ineffective procurement planning" in first position with a mean score of 4.267 which they adduced to faulty start and poor contract packaging. They ranked "design and scope change" in second place with a mean score of 4.133 in support of the argument that scope and design change impacts the project negatively and delays timely completion. In third place is "inadequate availability of funds" for the project. Without adequate funds set aside for the project, progress and productivity will slow down in the course of implementation. Four factors were tied in fourth place in the ranking of consultant respondents. These factors are "inadequate availability of skilled resources", "delay in decision making", "ineffective project monitoring", and 'ineffective project/program management". In the opinion of these respondents, each of these factors delay projects in equal measure.

(iii) Client view: The client respondents, like the contractor's, ranked "design and scope change" in first place with a mean score of 4.211, for the same reasons earlier adduced. This buttresses the argument of its impact on project time. They ranked "inadequate availability of skilled resources" in second place with a mean score of 3.842, to advance the argument that availability of skilled resources will not only enhance smooth project management but will ensure the timely delivery of quality projects. Ranked in third place was "ineffective project monitoring" with a mean score of 3.737, closely followed in fourth place by "ineffective project/program management" which scored 3.632. Both are a function of skilled resources required for effective project/program monitoring and management. "Ineffective procurement

planning" scored 3.579 in fifth place, and in sixth place with a score of 3.474 was, "delay in decision making". Both factors are a drag on project progress as they cause delays. This is evident in the fact that consultant respondents had earlier ranked "ineffective procurement planning" in first position and "delay in decision making" in second place.

B. Cost overruns related factors

Table V: Mean Scores and ranking for cost overrun

	RESPONDENTS' VIEWS OF FACTORS INFLUENCING COST OVERRUNS	Contractor		Client		Consultant		Weighted Average	
S/N	Factors	MSi	Rank	MSi	Rank	MSi	Rank	MSi	Rank
	Causes of cost overruns at Pre-Execution phase								
a.	Scope change	4.289	4	3.947	4	4.333	3	*4.177*	*3*
b.	Inadequate DPR, original estimate and budgeting of project	4.053	6	3.684	6	4.333	3	*3.961*	*6*
c.	Acquisition of land at market price	2.895	16	2.474	16	2.133	17	*2.493*	*16*
d.	High cost of environmental safeguards	2.921	15	2.632	15	2.867	13	*2.804*	*14*
e.	Poor choice of consultant	3.579	9	3.158	11	2.867	13	*3.158*	*11*
f.	Lack of strong R&R policies	3.263	11	2.842	12	3.400	10	*3.151*	*12*
g.	Inflexible country plan	3.105	14	2.684	14	2.533	15	*2.768*	*15*
	Causes of cost overruns at Execution/Closing phase								
a.	Price escalations of materials beyond earlier projections	4.632	1	4.158	1	4.733	1	*4.508*	*1*
b.	Escalation of labor costs/ineffective use of labour	4.158	5	4.053	2	4.533	2	*4.218*	*2*
c.	Design changes	4.421	2	4.000	3	4.000	6	*4.077*	*5*
d.	Increasing costs of project financing such as costs of borrowing, volatility of foreign exchange, etc.	4.395	3	3.842	5	4.267	5	*4.133*	*4*
e.	Location and connectivity of project site	2.684	17	1.947	17	2.467	16	*2.364*	*17*
f.	Insufficient availability of skilled resources	3.921	7	3.474	7	3.800	7	*3.732*	*7*
g.	Weak contract administration and management of claims	3.658	8	3.263	8	3.533	9	*3.487*	*8*
h.	Weak procurement planning	3.526	10	3.211	10	3.600	8	*3.435*	*9*
i.	Contractual disputes due to poor packaging of contract document	3.132	13	2.737	13	3.400	10	*3.064*	*13*
j.	Poor choice of technology/equipment	3.237	12	3.263	8	3.333	12	*3.280*	*10*

(i) Contractor, Client and Consultant views: Table V shows all three categories of respondents i.e. contractors, client and consultants in agreement with the ranking of "price escalations of materials " in the first position as the chief cause of cost overruns with mean scores of 4.632, 4.158 and 4.733 respectively. In second place is the ranking by client and consultant of "escalation of labour costs " with mean scores of 4.053 and 4.533 respectively. This same factor is ranked fifth by contractor respondents but with a strong mean score of 4.158. This all points to the fact that price escalations of materials and labour are very strong causes of cost overruns. This is understandably so, because Nigeria's construction market is prone to erratic price fluctuations of materials, equipment and labour, occasioned by price instability in the foreign exchange market and the oil and gas sector; with serious impact on construction activities."Design change" was ranked second with score of 4.421 by contractor respondents because it

leads to scope change which may require more time to execute and additional costs, of course. Ranked in third place by contractor's was "increasing cost of project financing" with a mean score of 4.395. The Nigerian foreign exchange market is erratic due to the weakening local currency (Naira) against foreign currencies such as the US Dollar. Nigeria's overdependence on imported construction materials and equipment has only heightened this problem. Client and consultant respondents, however, ranked it in fifth place with mean scores of 3.842 and 4.267 respectively. This further confirms its impact on cost overruns in projects.

Tests for Agreement on causes of Time and Cost overruns

The main thrust of this research is to investigate and ascertain whether there is agreement or not in the views expressed by the various respondents on the causes of time and cost overruns in infrastructure projects. This section tests respondents views for correlation using Spearman rank coefficients to see if there is significant difference in ranking between the groups of respondents on variables of time overrun and cost overrun, and their rate of occurrence.

The major purpose of the hypotheses test is to be sure that the outcome is not a chance occurrence. It helps the author evaluate whether there is consensus of opinions among the different groups of respondents. Hence;

Null Hypothesis (H_0) - There is no agreement in the ranking of causes of time and cost overruns between respondents.

Alternate Hypothesis (H_A) - There is agreement in the ranking of causes of time and cost overruns between respondents.

Table VI: Summary of correlation test on ranking of the causes of time overrun.

Respondents	Rho (ρcal) = $1 - \frac{6 \times (\Sigma D_i^2)}{N - (N^2-1)}$	Critical value of ρ (Appendix B)	Significance for P < 0.05
Contractor vs Client	0.8481	0.3783	Significant, reject
Client vs Consultant	0.8414	0.3783	Significant, reject
Consultant vs Client	0.8549	0.3783	Significant, reject

With a significance level of 95% (P = 0.05), the calculated values of ρ for 20 pairs of data in all three group cases given in Table VI are all greater than the critical value of ρ = 0.3783, which indicates a very significant correlation between two sets of data in each case. Consequently, the Null hypothesis (H_0) which says there is no significant agreement between the respondents is rejected. The Alternative hypothesis (H_A) which says there is agreement in the ranking of causes of time overrun between the respondents is accepted as most respondents have same perception about the causes of time overrun.

Table VII: Summary of correlation test on ranking of the causes of cost overrun.

Respondents	Rho (ρcal) = $1 - \frac{6 \times (\Sigma D_i^2)}{N \times (N^2-1)}$	Critical value of ρ (Appendix A)	Significance for P < 0.05
Contractor vs Client	0.9571	0.4124	Significant, reject
Client vs Consultant	0.9216	0.4124	Significant, reject

Consultant vs Client	0.9056	0.4124	Significant, reject

Similarly, Table VII shows that the calculated values of ρ for 20 pairs of data in all three group cases are greater than the critical value of ρ = 0.4124, which indicates a very significant correlation between two sets of data in each case. Consequently, the Null hypothesis (H_0) which says there is no significant agreement between the respondents is rejected. The Alternative hypothesis (H_A) which says there is agreement in the ranking of causes of cost overrun between the respondents is accepted as most respondents have same perception about the causes of cost overrun.

From the analysis of data, it was concluded that there was agreement in the perception of contractor, client and consultant on the factors influencing time and cost overruns.

6. CONCLUSIONS

This research set out to identify the major causes of time and cost overruns on infrastructure projects, with selected projects in Lagos and environs as case study. Of the 37 causes established from literature review, the most common causes of time and cost overruns on infrastructure projects were identified by the research. The most common causes of time overruns are design and scope change, inadequate availability of skilled resources, and ineffective procurement planning. And for time overruns, the research identified price escalations of materials, escalation of labour costs and scope change.

A major limitation of this research is its limited scope to infrastructure projects executed in Lagos and environs. Although Lagos is home to about 60% of the country's infrastructure projects, the author believes that if the scope had covered the entire country, it would have showcased a wider variety of projects that could have enriched the research work. Secondly, the research was limited to infrastructure projects. Perhaps, a wider scope that embraced construction projects in general may have broadened the scope of knowledge and influenced the final outcome. Notwithstanding, it is hoped that future research work would consider widening the scope and broadening the research space to ascertain if the work produces richer findings that add to knowledge.

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Appendix A

Critical Values for Spearman's Rank Correlation Coefficient

Use this table to determine the significance of your result for this test. For example, if you had 20 pairs of data and a value of 0.53, then there would be a probability of between 0.01 and 0.005 that it had occurred by chance. In other words, you might expect to get this result occurring by chance once every 100-200 times. This, therefore indicates a very significant correlation between the two sets of data.

n (number of pairs)	**0.1**	**0.05**	**0.025**	**0.01**	**0.005**
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7000	0.9000	0.9000	1.0000	1.0000
6	0.6571	0.7714	0.8286	0.9429	0.9429
7	0.5714	0.6786	0.7857	0.8571	0.8929
8	0.5476	0.6429	0.7381	0.8095	0.8571
9	0.4833	0.6000	0.6833	0.7667	0.8167
10	0.4424	0.5636	0.6485	0.7333	0.7818
11	0.4182	0.5273	0.6091	0.7000	0.7545
12	0.3986	0.5035	0.5874	0.6713	0.7273
13	0.3791	0.4780	0.5604	0.6484	0.6978
14	0.3670	0.4593	0.5385	0.6220	0.6747
15	0.3500	0.4429	0.5179	0.6000	0.6536
16	0.3382	0.4265	0.5029	0.5824	0.6324
17	0.3271	0.4124	0.4821	0.5577	0.6055
18	0.3170	0.4000	0.4683	0.5425	0.5897
19	0.3077	0.3887	0.4555	0.5285	0.5751
20	0.2992	0.3783	0.4438	0.5155	0.5614
21	0.2914	0.3687	0.4329	0.5034	0.5487
22	0.2841	0.3598	0.4227	0.4921	0.5368
23	0.2774	0.3515	0.4132	0.4815	0.5256
24	0.2711	0.3438	0.4044	0.4716	0.5151
25	0.2653	0.3365	0.3961	0.4622	0.5052
26	0.2598	0.3297	0.3882	0.4534	0.4958
27	0.2546	0.3233	0.3809	0.4451	0.4869
28	0.2497	0.3172	0.3739	0.4372	0.4785
29	0.2451	0.3115	0.3673	0.4297	0.4705
30	0.2407	0.3061	0.3610	0.4226	0.4629