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The Impact of Contractor's Technical Competence on Cost and Time Performance of Construction Projects in North-Central Nigeria

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ABSTRACT

Existing literature indicates that contractor's technical competence is driven by an array of variables. These variables were deployed in this study to assess the impact of contractor's technical competence on cost and time performance of state government-funded projects in North-Central Nigeria. 177 out of 225 questionnaire administered to contractors, consultants and clients across the six states of the study area were adjudged suitable for data analysis. Reliability analysis returned Cronbach's alphas of 0.814 and 0.456 for subscales for cost- and time performance respectively. In descending order, contractor's experience and ability (1st), quality of plant and equipment (2nd), quality of personnel (3rd), and sophistication in construction technology (4th) were found to exert significantly high impact on cost performance ($p < 0.05$). Although ranked in the first position, the high impact of contractor's experience and ability on time performance was not significant. On the other hand, the quality of personnel (2nd), sophistication in construction technology (3rd), and the quality of plant and equipment (4th) were found to exert significantly moderate impact on time performance ($p < 0.05$). Contractor's technical competence was generally found to have a significantly high impact on cost performance of projects ($p < 0.05$), contrary to time performance for which the moderate impact of contractor's technical competence was not significant ($p > 0.05$). These results imply that contractor pre-qualification team for government-funded projects in North-Central Nigeria would have to rely on the specific variables of contractor's technical competence in the quest to meet cost and time performance benchmarks.

Keywords: Cost performance, Time performance, Contractor, Technical competence, Construction projects, North-Central Nigeria

INTRODUCTION

Background and problem statement

Clients of construction projects in Nigeria have become cautious of delay in project implementation and its corresponding consequences on cost overrun (Aibinu & Jagboro, 2002; Obodoh & Obodoh, 2016). This phenomenon had motivated the dynamism of contractor pre-qualification, financial management, and time control in construction projects.

All stakeholders in the construction industry are somehow involved in construction management, which encompasses the establishment of benchmarks for project implementation. Hence, irrespective of whether a stakeholder represents the contracting, consulting or client organization, the need to establish benchmarks for project planning and implementation cannot be overemphasized. Among the measureable benchmarks that have attracted the attention of these stakeholders include cost and time performance. While cost performance entails an evaluation of the relationship between estimated cost and actual cost of a project, time performance measures the rate of time per activity that would eventually engender project completion within the stipulated time frame. Studies have attributed the success or failure of construction projects to these two measures of performance (Memon et al., 2012). Furthermore, these performance measures have been linked to the technical competence of the contractor (Hatush & Skitmore, 1997; Odusami, 2002). Within the context of the construction industry, technical competence can be defined as the exhibition of skills that are aimed at managing and integrating a continuum of technologies capable of achieving successful project implementation.

Inference drawn from the analysis of the drivers of cost and time performance of projects indicates that project management- and contract administration skills are key competence areas for contractors (Memon et al., 2012). Beyond this inference is the need to further assess the impact of technical competence on cost and time performance of projects. Technical competence was identified among the drivers of contractor pre-qualification (Al-Otaibi & Price, 2010; Plebankiewicz, 2010; Rahman et al., 2013). Furthermore, this driver is characterized by subscales namely contractor's experience and ability; quality of personnel; sophistication in construction technology; and quality of plant and equipment (Hatush & Skitmore, 1997; Holt, 1998). Therefore, the overarching question is put forward: What is the level of impact that contractor's technical competence exerts on cost and time performance of construction projects in the North-Central Nigeria? Within the context of public-sector financed construction projects in the North-

Central Nigeria, this study deployed the subscales of contractor's technical competence as impact assessment tools for cost and time performance of projects.

Aim and Objectives of Study

This study aims to assess the impact of the indicators of contractors' technical competence on cost and time performance of construction projects in North-Central Nigeria. Specific objectives put forward to achieve this aim include:

1. to identify the indicators of technical competence that affects cost performance of projects;
2. to identify the indicators of technical competence that affects time performance of projects; and
3. to assess the relative impacts of contractors' technical competence on cost and time performance of projects.

Significance of Study

With particular emphasis on construction projects spanning across housing and infrastructure development in the North-Central Nigeria, there has been a dearth of studies that unraveled significant indicators of contractor's technical competence that may likely exert impact on cost and time performance. Notwithstanding that some state governments have commenced the use of variants of public-private partnerships (PPP) to finance construction projects (Nwangwu, 2016), there are still some projects that may require sustained funding using state budgets. This development requires an assessment of contractors' technical competence and how this phenomenon might likely exert impact on cost and time performance of projects that are financed using taxes and other sources of government revenue. The value/originality of this study hinges on the need for contractor pre-qualification team across public-sector client organizations to scientifically appreciate the level of impact which contractor's technical competence exert on cost and time performance of projects. Beneficiaries of this study include consultants within the construction industry, financial institutions, and client organizations comprising government ministries, departments and agencies (MDAs) across the North-Central states of Nigeria. Other beneficiaries include interested researchers, directorates of physical planning in higher education institutions, state bureau for public procurement, and state bureau for public-private partnerships respectively.

REVIEW OF LITERATURE

Technical Competence of a Contractor

The selection of contractor for construction projects is anchored on the ability of the contractor to exhibit a set of skills. Holt (1998) refers to these set of skills as measurable attributes of the contractor. It is the evaluation process that tend to unveil the competence or otherwise of a contractor. Odusami (2002) defines skill as an ability that an individual can develop and can further be manifested in the performance of a task. Within the context of this study, technical competence is defined as the capacity to manage and integrate progressive technological changes with solutions geared towards actualizing a successful project. In other words, a technically competent contractor is the one who can manage and integrate a continuum of construction technologies capable of achieving successful project delivery.

Hatush and Skitmore (1997) reiterated that the technical assessment of a contractor entails an evaluation of the commitment of project resources (labour and plant), the ability of the contractor to supervise the work on site irrespective of the project type and scope without compromising quality of work on site. Other specific studies identifying the technical competence of contractors vis-á-vis other indicators of contractor selection include Hatush and Skitmore (1997); Russell and Skibniewski (1998); El-Sawalhi *et al.,* (2007). A consensus among these studies is that contractor competence is a function of an array of indicators.

Notwithstanding that Hatush and Skitmore (1997) outlined an array of indicators of contractors' technical competence, the following list of indicators derived from existing literature have been deployed given their compact scope in terms of the set of skills that competent contractors are expected to exhibit. These include Contractor's experience and ability (Ajayi et al., 2010; Al-Otaibi & Price, 2010; El-Sawalhi et al., 2007; Hatush & Skitmore, 1997; Huang, 2011); Quality of plant and equipment; and Quality of personnel (Al-Otaibi & Price, 2010; Hatush & Skitmore, 1997; Huang, 2011); and Sophistication in construction technology/Construction method adopted (Ajayi et al., 2010; Meeampol & Ogunlana, 2006). It is against these variables that the impact of contractor's technical competence on cost and time performance of projects shall be evaluated.

Measures of Cost and Time Performance of Projects

The essence of cost performance of project is to evaluate the degree to which budgeted cost of a project can absorb the actual cost of implementing the project. In view of this, Ali and Kamaruzzaman (2010) identified the indicators for measuring cost performance of building projects to include total budgeted cost (TBC), cumulative budgeted cost (CBC), cumulative actual cost (CAC), and cumulative earned value (CEV). These measures have been used over the years by construction cost experts to monitor the progress of work on site vis-á-vis the disbursement of funds for construction projects.

Time performance of construction projects is principally viewed from the perspective of the possibility of completing a project within the time schedule. In other words, extension of the completion date for specific tasks within the project plan shall pose a risk to the proposed completion and handover date especially when such task is on the critical path. Some projects may lag behind the completion date by a few days while others may lag beyond a year (Alaghbari *et al.*, 2007). Consequences of a project that has failed time performance test include delayed completion or abandonment, which may vary according to the type and scope of the project.

Time-Cost Correlation

Love et al. (2005) conducted a study to examine the relationship between cost and time of construction projects. Using a sample of 161 projects in Australia, and conducting an array of regression analysis, it was found that the rate of construction work is directly (inversely) proportional to the gross floor area of a building (the number of floor levels). Secondly, they found that cost is a poor predictor of project time since the knowledge of construction cost prior to project completion date is uncertain.

In a related study aimed at calibrating and developing an appropriate time-cost model for the performance of construction projects in Bangladesh, Mizanur et al. (2014) deployed a questionnaire design to harness data on construction delay and cost overrun with recourse to completed building projects. Among the tools of analysis were five regression models comprising the logarithmic model, quadratic model, cubic model, exponential model, and the Bromilow's time-cost (BTC) model. They found that the BTC models indicated a good measure of fit for determining the relationship between time-cost performance of building projects in Bangladesh but warned that it might not be the best fit regression model. Notwithstanding, the exponential regression model exhibited the highest coefficient of determination compared to the other five models. Like any other study involving regression models, a critical look at this study indicates that the calibration of time-cost models of construction project performance may exhibit unstable coefficients and regression diagnostics over time. Hence, it might only be appropriate to separately examine cost and time performance indicators as identified in existing literature with a view to informing experts and contractors on the areas where caution should be exercised from time-to-time when the objective of averting delays and cost overruns becomes paramount.

Factors Determining Cost and Time Performance of Projects

In a study conducted in Malaysia, Alaghbari *et al.,* (2007) identified the principal delay factors attributable to the contractor to include financial problems, inadequate construction materials on site, poor site management, mistakes in construction, delayed delivery of materials and construction logistics to the site and poor coordination with other stakeholders in the project delivery. Ranked least in the category of factors is the shortage of equipment and tools on site. Conclusion can be drawn that the competence and capability of the contractor accounts for half of the top ten factors affecting time performance of construction project, which is in consonance with a similar study conducted by Ogunlana and Promkuntong (1996).

González *et al.,* (2013) set up two indicators comprising reasons for noncompliance (RNC) and a delay index (DI), while analyzing the causes of delay and time performance of construction projects. Deploying a combination of case study, qualitative and quantitative tools, it was found that RNCs at the planning and subcontract phases constitute the most frequent causes of project delays and hence exert higher impact on time performance.

Cost overrun is an indisputable source of frustration for project sponsors and their implementation team. With recourse to road construction projects in Zambia, Kaliba *et al.*, (2009) attempted an identification of the causes and effects of cost escalation and schedule delays. They utilized a combination of questionnaire survey, disproportionate stratified sampling technique, and weighted average score and found bad weather to be a major cause of cost escalation. Ranked second and third among the causes of cost escalation are changes in project scope, and environmental protection and mitigation costs. Furthermore, delayed payments ranked first among the drivers of schedule delays. Among other factors include lengthy financial processes and contract modification. With recourse to this study, the lessons for the Nigerian building industry is that force majeure may tend to exhibit adverse impact on timely completion of projects let alone posing a daunting implication for cost overruns. It can be inferred that irrespective of the type of project executed, the construction team comprising the contractor, client, and consultant should assess the scope of the project, take cognizance of costs of mitigating environmental challenges, and ensure that all funds required for the construction process are sourced on time to avert incidences of temporary disruption of construction work on site. All these proactive measures are anchored on the competence of the contractor.

In a similar study aimed at ranking the various causes of cost overruns in construction projects, Ali and Kamaruzzaman (2010) found the underestimation of construction cost to be the major cause of cost overruns. Others include poor project planning, inexperience of contractors, (deliberate) inflation of project costs, high cost of machineries, and fluctuations in the price of construction materials. Ranked least among the causes of cost overrun is mistake in design. However, mistake in design constitute a caveat for the design team and consultants. Nonetheless, Ali and Kamaruzzaman (2010) underscored the importance of cost estimation, and the matching of project financing with cost control.

In another related study aimed at assessing time and cost performance of construction projects, Memon et al. (2012) deployed a combination of questionnaire design, quantitative and qualitative methods leading to the construction of a 5-point likert scale, the calculation of relative Importance index (RII), and correlation analysis. They found that 48 out of 140 respondents reported 10% - 15% time overrun in construction projects. Although the level of cost overrun varied from project to project, the study further found cost overrun to be a common phenomenon among these projects. Furthermore, Memon *et al.,* (2012) identified the four main drivers of time and cost performance of construction projects to include project design and documentation, strength of financial management, skills in project management and contract administration, contractor's site management, and the use of information and communications technology

(ICT). A significant finding in their study is that good (bad) quality design exerts positive (negative) impact on the ability of the contractor to manage construction activities and deliver the project in compliance with the terms of the contract. Secondly, the ability of the contractor to manage activities within a modern construction site depends on his/her deployment of ICT-enabled communication facilities. This study indicates that competence factors of project management and contract administration are among the drivers of time and cost performance of projects.

With recourse to 35 common factors of cost overrun identified from literature, Rahman et al. (2013) deployed questionnaire survey to unravel the factors that determine improvement of cost performance of construction projects. Data analysis using relative importance index (RII) indicates the top three significant determinants of cost overrun to include variation in prices of building materials, difficulty of contractors to handle cash flow and financial issues, and poor site management and supervision. A cursory examination of these three factors indicates that while the first factor is beyond the control of the contractor, the second and third factors are products of contractor's financial- and technical competence respectively.

In a related study, Meeampol and Ogunlana (2006) utilized questionnaire survey, sample *t*-test and discriminant analysis to identify the critical factors that determine cost- and time performance of construction projects. Six factors found to exert significant impacts on cost performance of construction projects include management of construction resources, management of budget, method of construction, management of project schedule, communication and report, and management of human resources. On the other hand, the drivers for time performance of construction projects were identified in their study to include method of construction, management of construction resources, management of project schedule, management of human resources, supervision and control, management of budget, human resources management, involvement of project owners, nature of construction team relationship, and the nature of communication and report.

With recourse to a review of literature, Kiran (2017) identified 42 factors causing time and cost overruns. On the basis of ranking of relative importance indices, Kiran (2017) identified the critical factors influencing time and cost overrun to include effects of subsurface conditions, shortage of labour, poor coordination and communication among parties, contractors' poor site management and supervision, and errors arising from cost estimation.

For the purpose of this study, emphasis has been placed on the significance of the impact of variables of contractors' technical competence on cost and time performance of projects. These variables have been identified to include contractor's experience and ability; Quality of personnel; Sophistication in construction technology; and Quality of plant and equipment (Hatush & Skitmore, 1997; Holt, 1998). Notwithstanding that Alaghbari et al. (2007), Ali and Kamaruzzaman (2010), González et al. (2013), Kiran (2017), Le-Hoai *et al.*, (2008), Meeampol and Ogunlana (2006), Memon et al. (2012), Mizanur *et al.,* (2014), and Ogunlana and Promkuntong (1996) were able to identify these array of variables of contractors' technical competence (being prima facie, a driver for contractor pre-qualification), the gap which this study intends to address is the question of identifying those variables that exert impact on cost and time performance of construction projects.

METHODOLOGY

Case Study Research Design

Case study design is most appropriate for researches aimed at discovering facts surrounding the behavioural trait of a social unit (Singh, 2006), which in this particular study are contractors. Yin (2003) affirmed that explanatory and exploratory approaches to case study designs can be deployed in a research depending on the research problem. With particular emphasis on this study, the explanatory case study approach was principally deployed to unravel specific indices of contractors' technical competence that are significant to cost and time performance of construction projects in North-Central Nigeria.

Description of the Study Area

The North-Central Nigeria (excluding the Federal Capital Territory - FCT) indicated in Fig. 1 occupies an area of about 137,758 km^2 and comprises Benue-, Kogi-, Kwara-, Nasarawa-, Niger-, and Plateau states. The Federal Capital Territory (FCT) was excluded with a view to exclusively capture the perception of respondents pertaining to matters that are unique to these federating units.

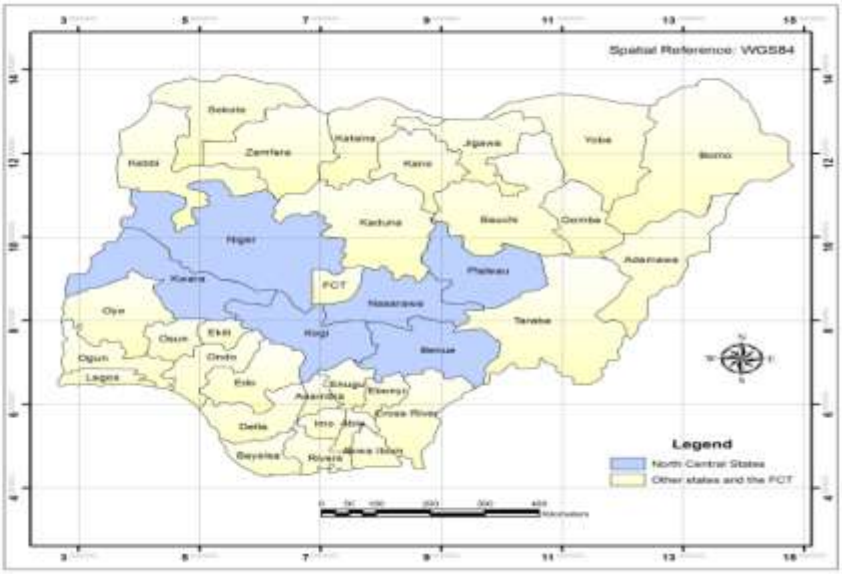

Fig. 1: Map indicating the constituent states of North-Central

The physical characteristics of this region include tropical climate with dry grassland savanna, mean monthly rainfall of about 103.96mm, mean annual relative humidity of around 50%, and mean annual temperatures ranging from a minimum of 22.55±0.42^{o}C to a maximum of 33.54±0.23^{o}C (Olayemi et al., 2014*)*.

Found in each state are the state branches/chapters of professional associations for construction and built environment comprising the Nigerian Institute of Architects, Nigerian Institute of Builders, Nigerian Institute of Quantity Surveyors, and the Nigerian Society of Engineers among others. Project management practitioners in the study area are affiliate to the Northern Nigeria branch of the Project Management Institute (PMI) Nigeria, located at Abuja, the Federal Capital Territory by virtue of its geographical contiguity. Further supporting the process of bidding and tendering for public- and private sector-led construction projects in the region is the collaboration among the various stakeholders of the construction industry comprising clients, the aforementioned professionals, and building/civil engineering contractors. Explored in this study therefore, is the experience and perception of these major stakeholders.

Questionnaire design

Structured questionnaire was administered to elicit data from respondents. The preamble contained instructions on how to complete the questionnaire.

The questionnaire was structured in two major sections. Section one comprises questions eliciting background data of respondents, while section two contain questions eliciting the evaluation of the impact of contractors technical competence on cost and time performance of projects respectively. Respondents were asked a combination of questions demanding open-ended and closed-ended responses. Specifically, nominal scale of measurement was applied to five questions in section one of the study questionnaire, while interval scale of measurement was applied to the checkboxes representing answer options to the remaining three questions. Furthermore, section two contains four indices of contractors' technical competence comprising Contractor's experience and ability (CEA); Quality of plant and equipment (QPE); Sophistication in construction technology (SCT); and Quality of personnel (QOP). Ordinal score was assigned to answer options for the questions in section two. Just as in a similar study on contractor prequalification (Bubshalt & Al-Gobail, 1996), the system of ordinal score in this study entailed a 5-point Likert scale comprising 5 = very high impact; 4 = high impact; 3 = moderate impact; 2 = low impact; and 1 = no impact. Respondents were expected to select answer options that represent their perception of how these factors exert impacts on cost and time performance of projects. The questionnaire was administered on the basis of the sample size for the three strata of respondents comprising the contractors, consultants, and clients in the study area.

Sampling and Sample Size

The disproportionate stratified random sampling technique was used to determine the sample sizes of contractors and consultants in the study area, while a combination of census count and stratified random sampling was used to determine the sample size of clients.

If it is assumed that each category of respondent have an equal chance of being drawn from their sample frames and that the proportion of population elements belonging to that category of respondent is put at 50%, then the Cochran's equation for determining the stratified random sample of each class (Cochran, 1977) is generally expressed as:

$$n = \frac{n_0}{1 + (n_0 / N)} = \left\{ \frac{N\{p(1-p)\}^2}{Ne^2 + \{p(1-p)\}^2} \right\} \quad (1)$$

on the condition that the approximate representation of sample size, $n_0 = s^2/e^2$ and the maximum standard deviation from estimated proportion of the study population, $s = p(1 - p)$, and N = Total number of respondents in each strata. Assuming that standard error of sampling distribution, e = 0.05, and the standard deviation of population elements, s = 0.25, the stratified random sample size is reduced to:

$$n = \left\{ \frac{0.0625N}{0.0025N + 0.0625} \right\} \quad (2)$$

For each category of respondent, the total number of respondents in a stratum, N was deployed in Equation 2 to determine the sample size for the stratum in question.

The Federation of Construction Industry - FOCI is an organized trade organization for contractors in Nigeria. Construction Review Online (2013) published an interview report indicating that the FOCI had about 125 registered members nationwide as at August 2013.

Table 1: Population and sample size of contractors

States	No. of registered contractors	Sample size
Benue	19	11
Kogi	25	13
Kwara	17	10
Nassarawa	13	9
Niger	30	14
Plateau	11	8
Total	115	65

The sample frame of contractors per state in North-Central Nigeria was determined through a census count of existing contractors that were duly registered members of the FOCI and were handling construction contracts within these states indicated in Fig. 1. A visit to the web page of the FOCI (http://www.foci.org.ng/members-directory/) facilitated the confirmation of membership statuses of these contractors. The disproportionate stratified sampling was adopted in Table 1 due to geographical diversification of some contractors across some states as observed in the sampling survey. Following the application of Equation 2 to each stratum (state), the total sample size of contractors was put at 65 (Table 1).

Consultants drawn into the sample comprises Architects, Builders, Engineers, Quantity Surveyors, and Project Managers.

Table 2: Population and sample size of consultants

Consultants	Professional bodies	Population	Sample size
Architects	NIA	79	19
Builders	NIOB	65	18
Project Managers	PMI	56	17
Quantity Surveyors	NIQS	14	9
Consulting Engineers	NSE	93	20
Total		307	83

As at the time the field work was commenced in November 2011, the population of practicing and financially up-to-date consultants within the study area was obtained from the state branches and chapters of the respective professional bodies across North-Central Nigeria.

Table 3: State-by-state allocation of sample size of consultants

State	Professionals and their respective professional organizations (abbreviated)										
	Architects [NIA] $P_s \approx 24\%$		Builders [NIOB] $P_s \approx 28\%$		Project Manager [PMI] $P_s \approx 30\%$		Quantity Surveyors [NIQS] $P_s \approx 64\%$		Consulting Engineers [NSE] $P_s \approx 22\%$		Total Sample
	N_1	n_1	N_2	n_2	N_3	n_3	N_4	n_4	N_5	n_5	n_T
Benue	15	4	8	2	5	2	2	1	19	4	13
Kogi	9	2	9	3	4	1	2	1	14	3	10
Kwara	13	3	10	3	9	3	2	2	13	3	14
Nassarawa	10	2	11	3	11	3	2	1	15	3	12
Niger	20	5	16	4	17	5	4	3	22	5	22
Plateau	12	3	11	3	10	3	2	1	10	2	12
Total	79	(19)	65	(18)	56	(17)	14	(9)	93	(20)	(83)

Note: P_s = sample proportion, N_i = Population of each stratum, n_i = stratified sample, and n_T = Total sample size

Abbreviations

NIA: Nigerian Institute of Architects

PMIN - Project Management Institute, Nigeria

NIOB - Nigerian Institute of Builders

NIQS - Nigerian Institute of Quantity Surveyors

NSE - Nigerian Society of Engineers

Following the application of Equation 2 to each stratum, the total sample size of consultants was put at 83 (Table 2). The state-by-state allocation of sample size for individual groups of professionals in each strata was calculated as a proportion of the sample size (P_s) as indicated in Table 3.

Across the six states, the sample size of public-sector clients comprises a census count of six ministries of works and housing, six state housing corporations/property companies, and the sample size arising from the application of Equation 2 to the sample frame of Local government works departments. With recourse to Table 4, this amounted to a total of 77 public-sector clients.

Table 4: Population and sample size of public-sector clients

States	LGA Works dept.	Sample of LGA Works dept.	State Ministry of Works and Housing	State Housing Corp./Property Company	Total sample size
Benue	23	12	1	1	14
Kogi	21	11	1	1	13
Kwara	16	10	1	1	12
Nassarawa	13	9	1	1	11
Niger	25	13	1	1	15
Plateau	17	10	1	1	12
Total	115	65	6	6	77

Data Collection

Table 5 was used to guide the process of questionnaire administration across the six states identified in Fig. 1. Niger state received the highest allocation of about 22.7% -, while Plateau state received the least allocation of about 14.2% of the total of 225 questionnaire administered across contractors, consultants and clients respectively. Across each state of North-Central Nigeria, the actual number of project managers that completed the study questionnaire was specifically reached through snowballing.

Table 5: Administration of study questionnaire according to sample size

State	Sample of respondents in categories			
	Contractors	Consultants	Clients	State-by-state total
Benue	11	13	14	38
Kogi	13	10	13	36
Kwara	10	14	12	36
Nassarawa	9	12	11	32
Niger	14	22	15	51
Plateau	8	12	12	32
Total	65	83	77	225

Out of the 225 questionnaires administered, 192 were returned, while 33 could not be successfully retrieved (Table 6). In the course of sorting and arranging the questionnaires, 15 out of the 192 questionnaires were found to be improperly completed thereby bringing the total number of effective questionnaires to 177, which implies about 78.6% success rate for the administered questionnaire (See Table 6 for details).

Table 6: Effective number of questionnaire analyzed

Group of respondent	Status of study questionnaire				
	Administered	**Not returned**	**Returned**	**Improperly completed**	**Properly completed**
Contractors	65	7	58	3	55
Consultants	83	19	64	8	56
Clients	77	7	70	4	66
Total	225	33	192	15	177

Reliability of Data Collection Instrument

With recourse to the indices of contractor's' technical competence as subscales, Version 21.0 of the SPSS was used to evaluate the Cronbach's alpha for the two major scales in this study, namely the cost performance- and time performance of construction projects. This test was aimed at evaluating the stability and consistency of elicited data.

Table 7: Reliability analysis of data

Scale label	Elements of contractors' technical competence	Cronbach's alpha (α)
Cost performance of projects	4	0.814
Time performance of projects	4	0.456

Subscales for cost performance of projects all had high reliabilities, all Cronbach's α = 0.814. However, subscales for time performance of construction projects all had relatively low reliability, Cronbach's α = 0.456 (Table 7). Scholars have acknowledged the higher degree of reliability of data collection instrument that return Cronbach's alpha approximate to unity (Meeampol & Ogunlana, 2006; Rahman et al., 2013). As indicated in Table 7, subscales for cost performance of construction projects are more reliable compared to the subscales for time performance that returned Cronbach's alpha of less than 0.5. Scholars, however agreed that such low level of Cronbach's alpha should be expected in social science researches (Field, 2009; Kline, 1999), which in this case deals with assessment of stakeholders' perception of factors that might likely exert impact on time performance. Subscales for time performance were further analyzed in spite of the low level of its Cronbach's alpha.

Data Analysis Techniques

Microsoft Excel was used to prepare a transcript of data harnessed from the valid questionnaires. Subsequently, frequency distribution table was created in the Excel worksheet after which functions comprising frequency count and percentiles were instantiated for nominal and ordinal data respectively. The formula audit ribbon of Excel was used to calculate the arithmetic mean ± standard deviation of the respondents' years of experience in the construction sector. The mean, $\overline{X}$ and the standard deviation, s of the grouped data were determined using the following equations:

$$\overline{X} = \frac{\sum fx'}{n} \tag{3}$$

$$s = \sqrt{\left(\sum fx^2 - \frac{\left(\sum fx\right)^2}{n}\right)\frac{1}{n-1}} \tag{4}$$

Microsoft Excel was further used to produce histogram for class interval data pertaining to the value in contract sum of construction projects for which respondents have been involved in about 2 years prior to the administration of the study questionnaire. Embedded with this histogram was the calculation of mean and standard deviation of the cost of the project.

Unlike the impact index that Bubshalt and Al-Gobail (1996) used in a related research, this study adopted a variant of the impact index by retaining only the sum of frequencies as the quotient to arrive at the weighted mean impact for a 5-point Likert scale. The formula for the weighted mean impact, $W_{\overline{X}}$ is expressed as:

$$W_{\overline{X}} = \frac{\sum f_i w_i}{\sum f_i} = \frac{5(f_5) + 4(f_4) + 3(f_3) + 2(f_2) + 1(f_1)}{f_5 + f_4 + f_3 + f_2 + f_1} \tag{5}$$

Where f_5 = frequency of respondents that answered "Very high impact", f_4 = "High impact", f_3 = "moderate impact", f_2 = "Low impact", and f_1 = "No impact" and the individual weights for the ordered responses, w_i include 5, 4, 3, 2, and 1 respectively.

Table 8: Range of calculated weighted mean impact and their interpretation

Range of weighted mean impact	Interpretation
$4.50 \le W_{\bar{X}} \le 5.00$	Very high impact
$3.50 \le W_{\bar{X}} \le 4.49$	High impact
$2.50 \le W_{\bar{X}} \le 3.49$	Moderate impact
$1.50 \le W_{\bar{X}} \le 2.49$	Low impact
$1.00 \le W_{\bar{X}} \le 1.49$	No impact

On the basis of the 5-point Likert scale, the criteria for the interpretation of the weighted mean impact of the indicators of contractors' technical competence on cost and time performance of projects was proposed in Table 8. At the subscale level, the calculation of the weighted mean impact, $W_{\bar{X}}$ of the indicators of contractors' technical competence was complemented with an analysis of the group weighted mean impact, $GW_{\bar{X}}$ across the three categories of respondents, ranking of the indicators of contractors' technical competence in descending order, and a one-way ANOVA test (F-ratio and *p*-value) with a view to identify those significant indicators that account for a variation of cost and time performance of construction projects.

RESULTS AND DISCUSSION

Characteristics of Sample

Demographic characteristics of respondents in Table 9 have been arranged under five themes. comprising their highest academic qualification, profession, cadre of professional membership, type of organization, and years of experience in the construction sector. Results indicate that at least 58% of the respondents have obtained Higher National Diploma (HND) or its equivalent, while at least 42% of the valid respondents have obtained a first degree, thereby affirming that they have attained a reasonable level of proficiency for the purpose of completing the study questionnaire.

Ranked next to Engineers who constituted the highest number of respondents (20.9%) within the construction trade are Architects (19.8%). However, professionals outside the purview of the construction industry constituted the highest number of respondents on the overall scale (23.7%). Respondents were found to have amassed an average of 17.3±9.5 years of experience in the construction industry (Table 9). Irrespective of the profession of respondents, Table 9 further revealed that more than half (55.4%) are professionally qualified as Fellows, Members, and Associates respectively. This information implies that data had been elicited mainly from professionals with reasonable level of experience, competency, and proficiency irrespective of their affiliations with either contracting-, consulting-, or client organizations.

Table 9: Respondents' demographics

Category	Classification	Frequency	Percentage (%)
Highest academic qualification	PhD	0	0.0
	M.Sc/MTech/M.Eng	38	21.5
	BSc/BTech/BEng	36	20.3
	Post Graduate Diploma	49	27.7
	HND	54	30.5
	Total	177	100.0
Profession of respondent	Architect	35	19.8
	Builder	23	13
	Engineer	37	20.9
	Quantity Surveyor	22	12.4
	Project Manager	18	10.2
	Others	42	23.7
	Total	177	100.0
Cadre of professional membership	Fellow	2	1.1
	Member	75	42.4
	Associate	21	11.9
	Graduate/Probationer	31	17.5
	No professional membership	48	27.1
	Total	177	100.0
Type of organization/firm	Contracting	55	31.1
	Consulting	56	31.6
	Client	66	37.3
	Total	177	100.0
Years of experience in the Construction sector	1 – 10	54	30.5
	11 – 20	48	27.1
	21 – 30	67	37.9
	31 – 40	6	3.4
	> 40	2	1.1
	Total	177	100.0
	Mean ± SD	17.3 ± 9.5years	

Total Contract Sum of Projects Executed

In Fig. 2, 11 respondents constituted the least number of persons involved in contracts valued from ₦80.5 Million to ₦100.5 million. Data elicited from respondents further indicates a modal class interval of contract sum valued in the range of ₦20.5 Million to ₦40.5 Million. However, there was a marginal difference in the frequency of respondents who had been involved in projects valued in the range of ₦0.5 Million to ₦20.5 Million; ₦40.5 Million to ₦60.5 Million; and ₦100.5 Million to ₦120.5 Million respectively.

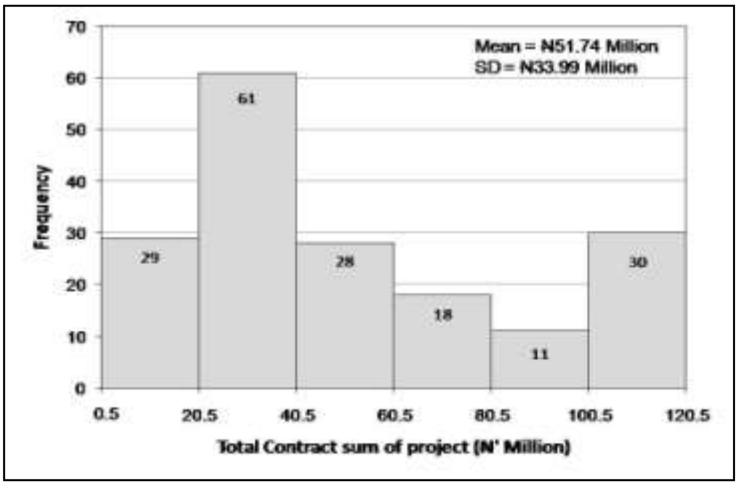

Fig. 2: Number of respondents by project cost

The mean contract sum across the states in North-Central Nigeria was put at (₦51.74 ± ₦33.99) Million, implying that the total contract sum of projects varied across the six states and among the respondents.

Impact of Variables of Technical Competence on Cost Performance of Projects

Table 10 indicates the weighted mean impact of the indices of contractors' technical competence on cost performance of projects, inclusive of the ranking, and statistical significance of each indicator.

Table 10: Impact of technical competence variable on cost performance of projects

Indicators	Weighted mean impact			Group mean $GW_{\overline{X}}$	Rank	F - ratio	*p*-value
	Contractor	Consultant	Client				
CEA	4.56	4.46	3.39	4.14	1	35.115	0.000***
QPE	3.73	4.07	3.59	3.80	2	4.696	0.010**
QOP	3.87	4.00	3.39	3.76	3	9.184	0.000***
SCT	3.47	3.71	3.20	3.46	4	6.992	0.001***

***Significant at $p < 0.01$
**Significant at $p < 0.05$

Ranked first is contractor's experience and ability ($GW_{\overline{X}}$ = 4.14), which exerts a high impact on the cost performance of projects in the study area. This aligns with results of similar studies where the experience and expertise of contractors constituted the major determinants for cost performance of construction projects (Ali & Kamaruzzaman, 2010; Kiran, 2017; Memon et al., 2012; Rahman *et al.*, 2013). Also exerting a high impact on cost performance are quality of plant and equipment ($GW_{\overline{X}}$ = 3.80; $p < 0.05$), and quality of personnel ($GW_{\overline{X}}$ = 3.76; $p < 0.01$) which were ranked in the second and third positions respectively. These have further consolidated similar studies where adequacy of logistics and construction materials (Alaghbari et al., 2007), and the competency of personnel (Ali & Kamaruzzaman, 2010; Meeampol & Ogunlana, 2006) were found to be strategic tools for averting cost overruns.

Construction methods might involve some level of sophistication depending on the use of nascent and cost-effective technologies. With respect to this study, sophistication in construction technology (ranked fourth) was found to exert moderate impact on cost performance of projects in the study area ($GW_{\overline{X}}$ = 3.46; $p < 0.01$). This result aligned with a similar study where construction methods exhibited significant correlation with cost performance of projects (Meeampol & Ogunlana, 2006). Impacts of all indices of contractors' technical competence on cost performance of projects in the study area were found to be statistically significant at $p < 0.05$ (Table 10); out of which contractor's experience and ability, quality of personnel, and sophistication in construction technology were specifically found to exert very significant impacts at $p < 0.01$.

Impact of Variables of Technical Competence on Timely Completion of Projects

Table 11 summarizes the weighted mean impact of the indices of contractors' technical competence on time performance of projects, alongside the ranking, and statistical significance of each indicator for the study area.

Table 11: Impact of technical competence variable on time performance of projects

Indicators	Weighted mean impact			Group mean $GW_{\bar{X}}$	Rank	F - ratio	*p*-value
	Contractor	Consultant	Client				
CEA	3.45	3.66	3.39	3.50	1	1.757	0.176
QOP	3.69	3.55	3.20	3.48	2	7.237	0.001***
SCT	3.04	3.39	3.20	3.21	3	3.770	0.025**
QPE	2.75	2.77	3.59	3.03	4	19.228	0.000***

***Significant at $p < 0.01$
**Significant at $p < 0.05$

Ranked first in Table 11 is contractor's experience and ability ($GW_{\bar{X}}$ = 3.50), which exerts high impact on the time performance of projects. This aligns with similar studies which found contractor's experience and ability as constituting one of the determinants of time performance of construction projects (Alaghbari et al., 2007; Ogunlana & Promkuntong, 1996). Exhibiting moderate impacts on time performance of construction projects in the study area include quality of personnel ($GW_{\bar{X}}$ = 3.48; $p < 0.01$), sophistication in construction technology ($GW_{\bar{X}}$ = 3.21; $p < 0.05$), and the quality of plant and equipment ($GW_{\bar{X}}$ = 3.03; $p < 0.01$), which were ranked in the second, third, and fourth positions respectively. These results aligned with similar studies which found the quality of human resource management, construction methods (Meeampol & Ogunlana, 2006), and the adequacy of construction materials and logistics (Alaghbari et al., 2007), to be positively correlated with time performance of projects.

ANOVA test in Table 11 shows that the high impact of contractor's experience and ability (CEA) on time performance of projects in the study area is not significant ($p > 0.05$). Notwithstanding that the timely completion of projects might require ample experience and ability of the contractor, the ANOVA test could not affirm this claim for contractors in North-Central Nigeria. Howbeit, the moderate impacts of the quality of personnel (QOP), sophistication in construction technology (SCT), and quality of plant and equipment (QPE) were generally found to be significant at $p < 0.05$ (Table 11); out of which quality of personnel, and the quality of plant and equipment were significant at $p < 0.01$.

General Impact of Technical Competence on Cost- and Time Performance of Projects

Table 12 summarizes the weighted mean impact of the indices of contractors' technical competence on cost and time performance of projects, alongside the statistical significance of the general impact of these indicators on cost and time performance of projects.

Table 12: Impact of technical competence on cost- and time performance of projects

Project performance index	Mean item score			Group mean $GW_{\overline{X}}$	F - ratio	*p*-value
	Contractor	Consultant	Client			
Cost performance	3.91	4.06	3.39	3.79	40.680	0.000***
Time performance	3.23	3.34	3.34	3.31	1.393	0.249

***Significant at $p < 0.01$

On a general scale, indices of contractors' technical competence exerts a significantly high impact on the cost performance of projects ($GW_{\overline{X}}$ = 3.79; $p < 0.01$). This result might be attributed to the significant impact of the individual indicators of technical competence on cost performance of projects in the study area (Table 10).

On the other hand, Table 12 shows that the indices of contractors' technical competence exert insignificantly moderate impact on time performance of project ($GW_{\overline{X}}$ = 3.31; $p > 0.05$). The removal of data pertaining to contractor's experience and ability from the subscales did not improve the results of ANOVA (F-ratio = 0.915, $p = 0.401$) as the pool of the second, third, and fourth subscales in Table 11 still exert insignificantly moderate impact ($GW_{\overline{X}}$ = 3.24) on time performance of projects in the study area. This phenomenon might likely be attributed to the vagaries surrounding the range of time that is acceptable as benchmark for implementing construction projects.

CONCLUSION

Cost and time performance of construction projects is crucial to the financial viability and early completion of construction projects. The achievement of cost and time performance benchmarks demand that contractors deploy some measure of competence, which in the first place have been documented among the drivers for contractor pre-qualification in existing literature. In descending order, it was found that contractor's experience and ability (1st), quality of plant and equipment (2nd), quality of personnel (3rd), and sophistication in construction technology (4th) exert significantly high impact on the extent to which budgeted cost of a project can absorb the actual cost of the same project. Although contractor's experience and ability was ranked first on the basis of the high impact it exerts on time performance of projects, it was however not significant ($p > 0.05$). Howbeit, quality of personnel (2nd), sophistication in construction technology (3rd), and the quality of plant and equipment (4th) were found to exert significantly moderate impact on the possibility of completing construction projects within the time schedule. While these indices were generally found to have significantly high impact on cost performance of projects, the ANOVA could not establish statistical significance for the moderate impact of the same indices on time performance of projects. With respect to government-funded construction projects, it is recommended that the contractor pre-qualification team should attach importance to the significantly high impact of contractor's experience and ability on cost performance. Finally, public-sector clients with a major drive for time performance are expected to pre-qualify contractors on the basis of the quality of plant and equipment, quality of personnel, and the level of sophistication of construction technology, notwithstanding the scope of the project.

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