Journal of Engineering, Project, and Production Management
2021, 11(3), 181-195

Predicting Cost Performance of Construction Projects from Projects Procurement Procedure

Samuel I. Egwunatum[1], Andrew I. Awo-Osagie[2], Imoleayo A. Awodele[3], and Emmanuel C. Eze[4]
[1]Department of Quantity surveying, Federal University of Technology, Owerri, Imo State, Nigeria. Email: samuelegwunatum1@gmail.com (corresponding author).
[2]Department of Quantity surveying, Delta State Polytechnic, Ozoro, Nigeria. Email: aawoosagie@yahoo.com
[3]Department of Quantity surveying, Federal University of Technology, Owerri, Imo State, Nigeria. Email: a.imole@yahoo.com
[4]Department of Quantity surveying, Federal University of Technology, Owerri, Imo State, Nigeria. Email: emmanuel.eze@futo.edu.ng

Project Management
Received September 26, 2020; revised November 19, 2020; December 4, 2020; accepted December 7, 2020
Available online December 27, 2020

Abstract: The purpose of this paper is to show by multivariate regression model if a defective procurement procedure leading to a contract award affects the smooth execution of a project in terms of its cost performance on the strength of the significance of the model. This investigation was conducted with a quantitative method of research by administering questionnaires to key industry players (clients, consultants, and contractors) engaged in construction projects (both civil and building works) in assessing contract award procedures, conditions for contract award after tender evaluation and criteria for contractors' prequalification. Data from their field survey was analysed with mean item score to show hierarchal importance of factors and critical evaluation using multivariate analysis of variance. Findings showed that a poor and inappropriate contract award procedure has divergence from efficient project cost management based on the corollary of mean score values of contract award procedures, conditions for the award and prequalification test. The practical implication of this, is that an unbiased contract award procedure will apparently lead to a lesser strenuous project management effort towards mitigating cost spills and overruns for a lesser project abandonment if the right contractor with the right capabilities is awarded the contract. These implications stem from the originality of the investigation arising from F-value statistics (7.406), t-value statistics (3.046), and p-value of 0.003.

Keywords: Cost performance, procurement, construction project, contract award, bid evaluation, prequalification.

DOI 10.2478/jeppm-2021-0018

1. Introduction

The construction industry is burdened with problems of projects cost performance failures often leading to cost overruns (Egwunatum and Akpokodje, 2015). Arguments in favour of contract award procedure as the remote cause is prevalent in construction journals and learned societies' proceedings. The problem of the high cost of construction, low quality work and project time and cost overruns in developing nations have become a subject of concern to both the practitioners within the industry as well as researchers in recent years. Failure to deliver a project within targeted time, budgeted cost and desired quality presents us with various unexpected negative effects on project performance (Oguonu, 2005; Kanoglu and Gulen 2013; Alzahrani and Emsley, 2012).

Wahab (2005) agreed that noncompliance with contractual procedures is one of the factors responsible for project failure in Nigeria. Contractual procedures that involve identification of project objectives, project scope, location, preliminary design/estimate, detailed project documentation, fund arrangement and procurement processes, etc. are de-emphasized as contracts have been let (Assaf and Al-Hejji, 2006). Such a contract is void of the necessary framework for proper monitoring and control of resources, that will result into on time project delivery, at targeted cost and time (Molla and Asa, 2015, Russell, 1996).

Selection of the most appropriate contractor is a fundamentally important part of the procurement process and a rudimentary challenge for clients in need of successful project outcomes (Fong and Choi, 2000). According to Russell and Zhai (1996) contractors' evaluation is a critical step in successfully completing a project if the rigors of prequalification and conditions of the award are as a routine, religiously followed. What was missing in that study was a predictive response model that narrowly examines the cost performance of a construction project in defective contract award situations. Contract award system and administration are fraught with irregularities arising from noncompliance with statutory conditions of contract viz-a-viz the JCT, Procurement Act of 2007 as amended in 2011 and Institution of Civil Engineers (ICE). From the foregoing and noting the negative effects non-prequalification has on construction project cost performance, a call for a critical look at the procedure for selecting contractors is expedient. For effective analysis of this study, the following hypotheses is proposed

H_0: Contract award procedures have no effect on the cost performance of the construction project.

2. Literature Review

There have been a number of researches in this area but mainly in Europe and the United States of America based on referred literature in this study. These include the pioneering work of Russel and Skibniewski (1988) which investigated the practice and procedures for prequalification of contractors for award of construction projects in the United States of America. The study conclusively identified five selection criteria for contract award as i) financial stability, ii) technical expertise, iii) project specific objectives, iv) reputation and past performances, and v) status of the current work program. Russel and Skibriewski (1990) further developed a contractor prequalification model which was termed "qualifier." This model was achieved by inserting in the program, decision parameter based on the result of these earlier works on prequalification criteria in 1998. Similarly, in Ng (1992) as reported by Ng and Skitmore (2001) carried out an empirical study in the United Kingdom on the importance of prequalification decision criteria to the contractor by examining the difference in perception between contractors and clients on the importance of each criterion. Other examples are the studies of Jarkas and Younes (2014), Hwang et al. (2013), and Iyer and Jha (2005). A model on contractor selection based on multicriteria utility theory was developed by Hatush and Skitmore (1998). This model which is capable of considering multiple criteria for contractors' selection was also based on scores of prequalification criteria with the model using utility curves to associating specific capability of a contractor and its value in risk terms (Aje, et al., 2009; Eriksson, 2017; Assaf and Al-Hejji, 2006; Ioannou and Awwad, 2010.

Furthermore, Odusami (1998) in Nigeria, investigated the procedures involved in contractors selection and the documents and criteria required for the exercise and the conclusion of this research shows that the final list of contractors should be related to the size of the job and to the quality which the client wants and is prepared to pay for (Ogunsemi and Aje, 2006). Similarly, in the works of Aje (2008) investigation on the impact of contractor's prequalification and criteria of the award on construction projects performance in Lagos and Abuja was carried out. The study also conclusively identified the important criteria for contractors' prequalification as those pertaining to technical and financial capability, managerial ability and past performance (Aje, 2012). The author further developed a contractor prequalification model capable of predicting cost and time performance of building projects during tender evaluation as well as selecting the most viable contractor for building projects (Laryea, 2011).

Aje (2012) had taken a holistic investigation into the impact of contractors' prequalification on project delivery and reported that time and quality of 0.039 and 0.030, respectively. Such studies on time and quality impacts have their resonance in construction literature with insularity to cost impacts study from a defective pre-qualifying process.

According to Molla and Asa (2015), there have been stylized literature and historical development in the industry and academia regarding the investigation of methods and procedures of pre-qualifying contractors with respect to national, regional and continental methods. Validation of these methods also by Molla and Asa (2015) using the frequency of the methods count to show the popularity of usage were indicated by available literature visibility amongst reputable/integrable publishers specifically among others, science direct, the web of science, ASCE and google scholar.

According to the study, theoretical developments by historic indicator pertaining to the current state of the art practice on contractor selection methods are here reported on continental demarcation into North America, Dimensional weightings aggregation method (Russell and Skibniewski, 1990), Knowledge base system (Russell et al., 1990), Time/cost approach (Ellis and Herbsman, 1990), multiparameter bidding system (Herbsman and Ellis, 1992), Artificial neural networks (Taha, 1994), Scoring system (Transportation Research Board, 1994), MAGNET System/simulated annealing (Collins et al., 1999), Hybrid multicriteria method (Seydel and Olson, 2001), and Rational approach (Elyamany, 2010).

In Europe, the contribution to the knowledge of contractor selection methods was recurring around, PERT models for contractor prequalification (Hatush and Skitmore, 1997), Points scoring system (Hatush and Skitmore, 1997), Cluster analysis (Holts, 1998), Multi-attribute utility theory (Hatush and Skitmore, 1998), Artificial neural networks (Khosrowshahi, 1999), Hybrid model of the combination of AAP, neural networks, genetic algorithm (El-Sawalhi et al., 2007), Weighted criteria method (Department of Treasury and Finance, 1999), Analytic hierarchy process (Topcu, 2004), Integer programming method (Missbauer and Hauber, 2006), Multi-attribute utility theory (Lambropoulos, 2007), Average bid criteria method (Conti and Naldi, 2008).

Following the development and deployment of these methods to contractor selection on the basis of their bid in North America and Europe, a similar academic campaign was instigated in Asia with resounding models for selection. The accompanying methods are currently in use therein: performance-based modeling (Kumaraswamy, 1996), Artificial neural networks (Lam et al., 2000), Case-based reasoning (Ng, 2001), Fuzzy logic system method (Zhang, 2009), Fuzzy-analytic hierarchy process-SMART (Padhi and Mohapatra, 2009), Two envelopes tendering system (Minister of Finance, 2012), Multi-attribute analysis (Lai et al., 2004), Unit-price based method (Wang et al., 2006).

In Australia, what is prevalent are methods such as weighted criteria and best value of money method (Department of Public Works, 2011), Fuzzy-analytic hierarchy process (Deng, 1999), Fuzzy set prequalification method (Nguyen, 1985) and outliers and goodness-of-fit method (Skitmore, 2002).

Further, the selection method currently in practice in Arabia or the Middle East are those, such as the Analytical hierarchy process (Munaif, 1995; Mahdi et al., 2002), following the inter-continental comparisons offered above, a general pattern of methods scheme on the basis of factors for selection are deduced from logical patterns, algorithms and statistical proofs is presented in summary hereunder not on the basis of relational or row mapping to one another (Table 1).

Table 1. Summary of modeling factors and methods

S/N	Modeling Factors	Modeling Method
1.	Historical non-performance	Multiparameter bidding systems Multi-attribute analysis (MAA)
2.	Quality assurance policy	Artificial Neural Network (ANN)
3.	Safety performance policy organization culture	Analytical hierarchy process (AHP)
4.	Organizational culture and management	Performance-based scoring (PERT)
5.	State of the art technology	Fuzzy set combined APH-SMART Dimensional weighting aggregation (DWA)
6.	Financial Muscle	Time-cost index
7.	Technical Might.	Knowledge-based systems. Scoring systems
8.	Bid price	Cluster analysis
9.	Risk bearing profile	Multiagent contract negotiation (MAGNET)
10.	Quality of previous work	AHP-Hybrid models Simulated annealing
11.	Site resources	Case-based reasoning
12.	Workload pressure response	Outliers and goodness-of-fit model
13.	Environmental and local knowledge	Unit price methods
14.	Goodwill and reputation	Simple multi-attribute ranking technique (SMART)
15.	Mark-up ratio/Greed intersection	Integer programming
16.	Construction/Project delivery time	Unit-price methods. Ration approaches.
17.	Hi-Tech offered	Weighting criteria Best-value approach

Following the research efforts of Molla and Asa (2015), using the Pareto analysis filtration process, the vital few presented 18 major and 15 minor factors from the 163 general factors where-in, using the Mann-Whitney ranking procedure presented the top 10 pre-qualifying factors from wide literature search (see Table 2). However, later studies by Ajayi et al. (2016) using the instrument of factor analysis presented us with six general contractor prequalification criteria, which were; 1) Personal capability, 2) Financial status of the contractor, 3) Health and safety practices, 4) Level of technology, 5) Bond administration and 6) Work experience and capability.

The paper reported that criterion (1), (4) and (5) are key contractor prequalification criteria with the potency to impact time performance of the project, but Opawole et al. (2018) opted for concessionaire form of project delivery with BoT means of transferring inherent risks associated with Time-cost of projects to contractors to decimate the time-consuming pre-qualifying to the selection process.

On the whole, the Molla and Asa (2015) study contributed majorly to exposing the literature progression and historical development in the industry with systemic and organized reviews towards identifying the competent, successful, qualified and quality contractor selection. Time performance impact studies are replete amongst these studies, which, as a consequence, this paper offers cost performance addition to industry literature.

Packaging, invitation, prequalification, shortlisting and bid evaluation are the five main process elements containing several steps, common across all contract awards (Hatush and Skitmore, 1997). Contractors' prequalification, the choice of eligible bidder among pre-qualified contractors and the construction and administration. The criteria used at the prequalification and evaluation of contractors revealed at the literature review and current practices were refined through the opinion of experts in construction procurement (Aje, 2012). The major aim of the client is to achieve satisfaction by getting high project performance in terms of cost, time and quality; therefore, the model in Fig. 1 depicted attempts to relate the criteria for contractors' prequalification, selection and construction and administration to these three dimensions. In the ensuing survey of literature mentioned above, it is pertinent to mention that a project that does not resort to requiring more money from the client in other for it to be complete or that completes without further obligatory claims are termed as rightly cost performed project. It becomes exigent to know from the outset since literature has shown that an assessment or evaluation of contractors is a requisite to knowing a premeditated smooth executable contract before it is let with a cost-performance model. Addressing this to a decision-maker requires that such a decision-maker examines the contractors understanding of knowing if the contractor has a grasp of the client's requirements, availability of project team, conduction of feasibility study, availability of bid documents, advertising, calling and pre-qualifying contractors, assessing bid preparation capability by the bidder, evaluating bids submitted by bidders and finalization/award criteria. A client armed with these variables transformed scores of these qualitative factors from a diligent and unbiased evaluation from a consultant can as a matter of fact, predict the cost performance of the project. Moreover, the main concern of the client is how the performance of the tenderer could be predicted prior to awarding the contract. This is shown in Fig. 2.

Network (2004) defined a construction procurement system as the overall methods used by a client to arrive at a tender figure and other operation towards the selection of a competent contractor to deliver a project at an agreed time and other conditions. Furthermore, procurement is a process that must be planned, and the time required to carry it out should not be underestimated (Lee, 2008).

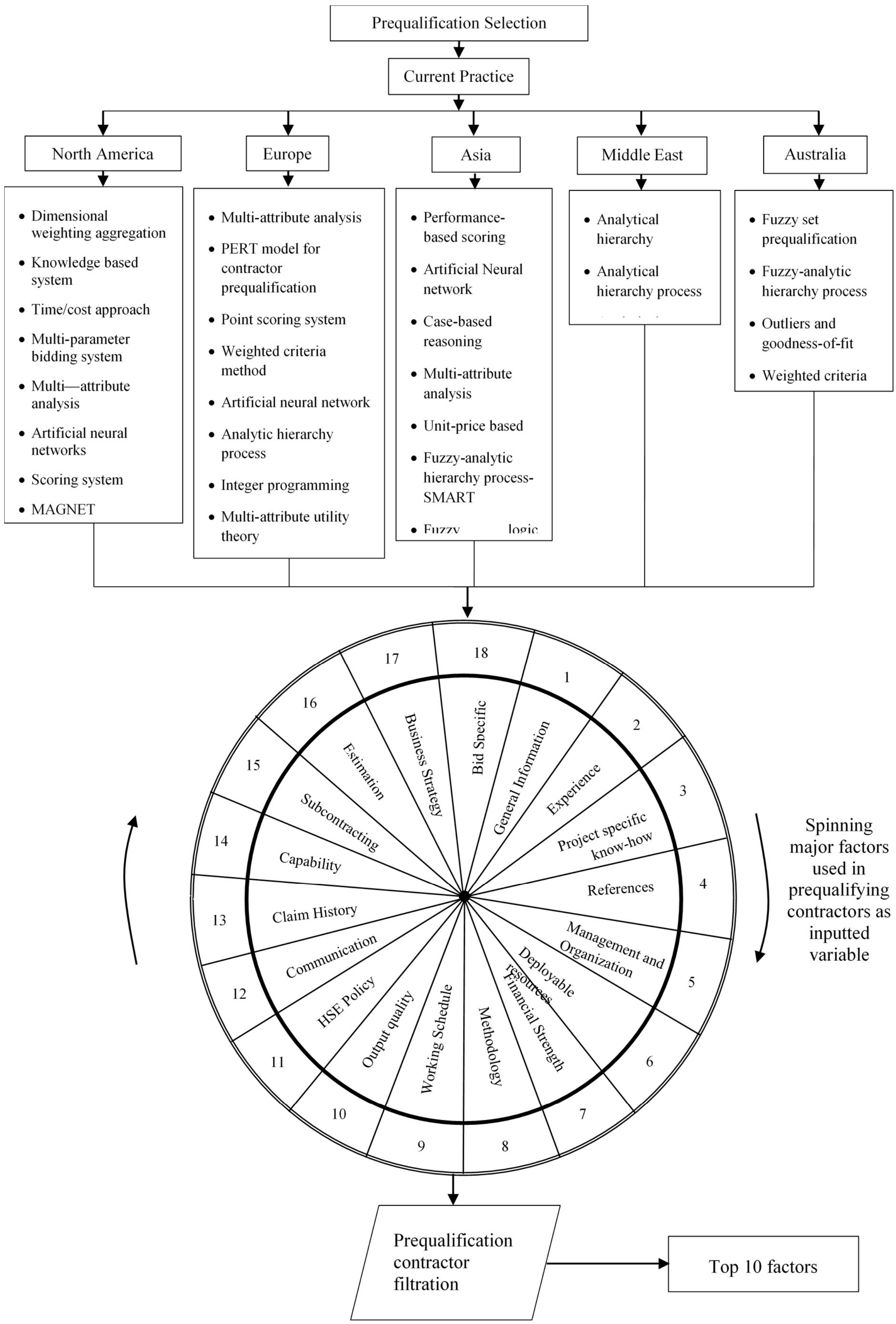

Fig. 1. Prequalification selection method

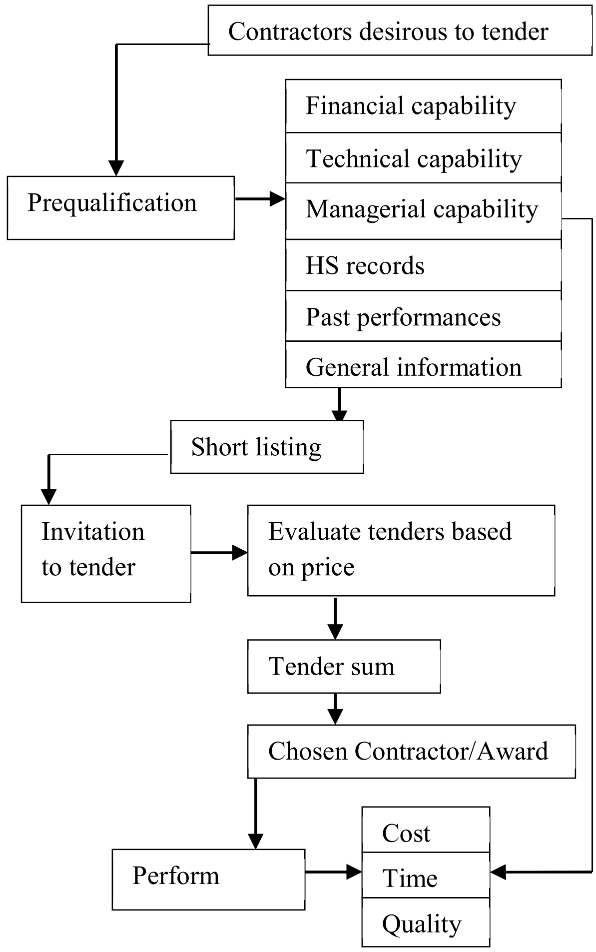

Fig. 2. Contract procedure framework (Aje, 2008)

Project procurement method and process

According to Network (2004), there are numerous procurement methods used today in the construction industry. The type adopted depends on the nature and size of the project being envisaged. Among these methods are the traditional method, turnkey system, management contracting, construction management, build–own–operate and transfer (BOOT), build–own–operate (BOT) and fast track system (Eriksson, 2017).

Oforeh and Alufohai (2001) posit that the construction industry is principally organised and operates essentially about a quadrangular framework involving the construction organisations, the different professional organisations, and the employers otherwise known as its operators. These parties are bounded and functions under some form of legal system. According to Bowen et al. (2012), the procurement process of a project begins typical with a project brief by the employer to the design team, this is followed by tender of bid documents production, and following the selection of the suitable contractor, the bidding process ends. The selected contractor is executing project and the supervision to completion is done by the employer's team and the contractors. The main drive of the procurement process is to guarantee efficiency in the utilisation of scarce resources for the individual construction projects at the micro economic level. The procedure is as illustrated in Fig. 3.

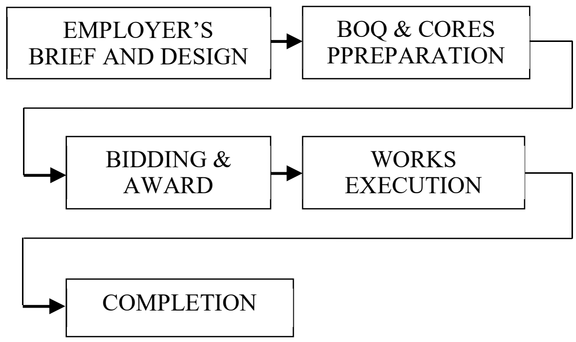

Fig. 3. Project procurement process (Oforeh and Alufohai, 2001)

Identification of client's requirements

Construction projects are responses to "business needs" identified by clients. They tend to have one-off characteristics with a clear purpose, constraints within which they have to be executed and clear beginning and end in the eyes of the client. At this stage, the project will be defined by the client and all the factors influencing the project identified, with the project requirements analyzed.

Table 2. Top 10 pre-qualifying factors

S/N	Factors	Count Freq	Rank	Remark
1.	Health and Safety Performance and plan	26	1	Most vital factor
2.	Quality management control and assurance system	24	2	2nd Most vital factor
3.	Financial stability and soundness	22	3	3rd most vital factor
4.	Management and technical skills and capability	18	4	
5.	Key managerial, supervisory and operational personnel experience and availability	18	4	4th tied most vital factor
6.	Equipment resources and availability	17	5	5th tied most vital factor
7.	Contractors failure to complete a project	17	5	
8.	Past and current performance	16	6	6th most vital factor
9.	Workforce resources and availability	13	7	7th tied most vital factor
10.	Claim history	13	7	
11.	Length of time in business	12	8	
12.	Contractor's organization and plan	12	8	8th tied most vital factor
13.	Current workload	12	8	
14.	Expertise in the project's geographic location	11	9	9th tied most vital factor
15.	Credit rating and history	10	10	10th tied most vital factor

Source: Molla and Asa (2015)

Identification of procedures, organizational structure and range of professionals

Project procurement is a team-based activity. Selecting the right procedure and project team is likely to be a single activity that can potentially reduce most clients' risk. An effective team and structure can collaborate in the client's interest to ensure the delivery of the right project at the right price, time and quality. An ineffective team can fail on all these criteria and involve clients in expensive disputes (Assaf and Hejji, 2006).

Feasibility study/project appraisal

After the client's requirement has been established, a feasibility study is carried out on such aspects as finance, users' requirements make an appraisal and provide recommendation so that the client can determine the form of the projects.

Preparation of production information documents for tender purposes

The tender documents will constitute of project drawings; un-priced bill of quantities; form of the tender; articles of agreement; contract condition, preferably standard form; method of measurement, preferably based on standard method should be clearly stated; the analysis/breakdown should include preliminaries, unit rates, advance payment and relevant breakdown.

Advertisement, prequalification, and issuance of bidding documents

Advertisement will be placed in at least two local newspapers with a national spread requesting interested firms to pre-qualify and tender for the project. For complex and specialized projects where the expertise may not be readily available locally, the advertisement will be placed in both local and international Journals and newspapers (Aje, 2012). The following information is required: name and status of the firm; details of turnover together with three years audited accounts; letter of reference from two reputable banks as to financial status; names of banks or insurance company who will produce bonds (performance and advance payment); detail of similar projects already completed in the last five years; letter of reference from at least two previous employers; list of plant and equipment; list of staff and their academic qualifications; any other information the firm may consider of value (Iyer and Jha, 2005).

Bid preparation by bidding tenderers and return of tender

The bids were prepared by bidding tenderers and returned. This returned tender should be opened within 24 hours of receipt. Attendance at the opening of tenders should be encouraged because it encourages transparency (Bowen et al., 2010). Usually, what appears as the lowest tender at the opening may be fraught with omission and arithmetic errors. These errors may eventually make the tender less competitive. The late tender should be returned to the tenderers unopened.

Evaluation, reviewing and recommendation of potential contractors' bid

The purpose of the examination is to detect arithmetical errors; establish the completeness of the tender; detect high unit rates which may lead to large early payments; detect the loading of a particular section of the priced bill and other anomalies. The needs for negotiation interview for the "actual lowest three contractors" after all the points stated above have been examined (Kumaraswamy, 1996). The followings are the points for the interview: errors (if any); the attached qualification to the tender; completion period; the need for phasing of the project if required and the effect on preliminaries etc.; programmes of work; details of specialist work and need to appoint sub-contractors; adequacy of tender documents and clarifications of specifications; discounts and any other relevant matter (Kumaraswamy, 1996).

Contract finalization and appointment of contractor

The technical, commercial and financial evaluation will be drawn together, and a final decision made. Selection of tenderers and evaluation of submitted tenders may seem to be a long, laborious process, but the choice of contractor will generally be a critical decision in the successful completion of a contract

3. Research Design

In order to ensure that adequate and reliable data to investigate the research problem were generated, it was necessary to have a sample which is homogeneous and representative. It is important that such a population gives a true representation of Nigeria construction industry. Hence the target population for this study is the major actors in the construction industry i.e., clients, construction professionals and contractors. It is required of respondents to examine some important aspects of contract award procedures which are significant to achieving a properly cost performance project. This, however, borders on contract award procedures, conditions for contract award after tender evaluation, criteria for contractor's prequalification and selection and relevant documents required from the contractor for selection. The client here comprises of the in-house professionals of the Niger Delta Development Commission (NDDC) which includes Architects, Engineers, Quantity Surveyors and Builders. The list of practicing construction professionals within the study area registered with Niger Delta Development Commission (NDDC) and their professional bodies was obtained, while the names and addresses of construction companies (contractors) were sourced from the list of contractors registered with Niger Delta Development Commission (NDDC). Therefore, for the purpose of this project, the population is referred to as the in-house professionals employed by Niger Delta Development Commission (NDDC) and all the registered consultants and contractors registered with the Niger Delta Development Commission (NDDC) in Edo, Delta, Ondo, Cross River and the Rivers States respectively and their professional bodies (see Table 3).

Table 3. Population of respondents

Respondents	Edo	Delta	Ondo	Cross River	Rivers	Total
Architect	34	39	45	36	66	220
Engineers	69	74	63	52	78	336
Quantity surveyors	35	26	28	18	39	146
Contractors	125	114	107	99	166	611
Builders	24	30	19	17	33	123
Client Representative	6	51	5	4	7	73
Total population	**293**	**334**	**267**	**226**	**389**	**1509**

Source: Niger Delta Development Commission (NDDC), 2017; news bulletin

3.1. Sampling Frame

The adequacy of a sample is assessed by how well it represents the whole population of participants from which the sample is drawn (Aje, 2008). In order to achieve this, a list of relevant in-house professionals employed by the Niger Delta Development Commission (NDDC), were obtained. A list of all practicing professionals within the study area registered with Niger Delta Development Commission (NDDC) as consultants and their professional bodies were obtained, namely Nigerian Institute of Architect (NIA), Nigerian Society of Engineers (NSE), Nigerian Institute of Quantity Surveyors (NIQS) and Nigerian Institute of Builders (NIOB). Furthermore, a list of contractors registered with the Niger Delta Development Commission (NDDC) in the five states mentioned above were also obtained. Table 4 shows a list of all professionals and contractors who are financial members as of June 2017 based on the five states, as earlier mentioned.

Table 4. Sampling frame of respondents

Ref No	Respondents	Population
A	Architect	220
B	Engineers	336
C	Quantity surveyors	146
D	Contractors	611
E	Builders	123
F	Client Representative	73
	Total population	**1509**

Source: Niger Delta Development Commission (NDDC)

Sample Size: The sample size for this study was obtained using the formula from Krejcie and Morgan (1970) at 95% confidence level, and it is 306 as shown below:

$$s = \frac{X^2NP(1-P)}{d^2(N-1)+X^2P(1-P)} \quad (1)$$

where;

s = finite population sample size

X = based on confidence level 1.96 for 95% confidence was used for this study

d = Precision desired, expressed as a decimal (i.e. 0.05 for 5% used for this study

P = Estimated variance in Population as a decimal (i.e. 0.5 for this study)

N = sample population, 1509

$$s = \frac{1.96^2\times 1509\times 0.5\times(1-0.5)}{\left(0.05^2\times(1509-1)+1.96^2\times 0.5\times(1-0.5)\right)}$$

$$s = 306$$

3.2 Method of Data Analysis

3.2.1 Mean score

To establish the importance of each criterion for contractor's selection, the mean score for each of the significant factors, i.e., clients, consultants and contractors, as well as for the overall were calculated. The following attributes/criteria in ensuring a successful contractor selection on the project performance were requested of respondents to assess (Table 5).

Mean score involves assigning numerical values to respondents' rating of factors e.g., extremely significant 5 point, very significant 4 point etc. in the case of contract award procedure the procedures were identified, and the respondents were asked to rate the level of importance attached (LIA) to each criterion on 5-point Likert scale. This method of analysis has been employed by many construction management researchers (Kululanga et al., 2001; Wong and Holt, 2003; Ling et al., 2000; and Akintoye, 2000). The mean score for each criterion is determined as follows in Eq. (2):

$$Mean\ Score = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{n_5 + n_4 + n_3 + n_2 + n_1 + n_0} \quad (2)$$

Where n_0 = the number of respondents who answered "no occurrence" or "no impact," n_1 = the number of respondents who answered "very low occurrence" or "little impact," n_2 = *the* number of respondents who answered "low occurrence" or "fairly critical impact," n_3 = *the* number of respondents who answered "medium occurrence" or "critical impact," n_4 = the number of respondents who answered "high occurrence" or "very critical impact," n_5 = number of respondents who answered "very high occurrence" or extremely critical impact." In testing of concord ranking of the criteria between the three significant actors, Spearman analysis for any two groups was also determined. The Spearman rank correlation coefficient is commonly used to measure the correlation between two sets of rankings (Mendenhall et al., 1993).

3.2.2 Multivariate analysis of variance (MANOVA)

This paper also resorted to the use of MANOVA to tests for the difference in two or more vectors of means. Testing the multiple dependent variables was accomplished by creating new dependent variables that maximize group differences. These artificial dependent variables are linear combinations of the estimated regression or response variables. The paper resorted to MANOVA following its usefulness in validation situations with inherent risk factors associated with the selection. Under this test, the following assumptions were assessed: Normality, Linearity, Homogeneity of Variances, Homoscedasticity, and Homogeneity of Variances and Covariances. The computation procedure adopted the French et al. (2019) MANOVA highlighted hereunder in terms of statistic checks. The procedure requires that first, the total sum-of-squares is nested into between and within groups.

Table 5. Components of prequalification assessment of contractors

Attributes	Variables
Financial Soundness	• Contractors financial stability • Contractor bank arrangement and bonding • Contactors credit rating (from subcontractors and suppliers) • Contractors financial status
Technical ability	• Contractors past experiences • Availability of experienced personnel employed by the contractor • Availability and adequacy of construction equipment
Management capability	• Contractors past performance and quality achieved • Contractors management personnel • Contractors planning tools and management knowledge • Contractors experience • Contractors relationship with subcontractors • Contractors possession of quality assurance certificate
Health and Safety (HS)	• Contractors safety performance • Contractors management of safety accountability • Accident claims made by contractors • Safety policy, provision of health and safety information to employees • Level of adherence to HS regulations • Frequency with which accidents cases are being reported • Compilation of above accidents record by foremen • Review and distribution of accident reports • Occupation safety and housing
Reputation	• Contractors failure in past projects • Contractors length of time in business • Level of responsibility in keeping commitment • Proximity of contractor's home office to job site • Percentage of sublets contract • Relationship with statutory undertakes • Relationship with employees • Local knowledge of contractors • Contractors relationship with others (subcontractors & suppliers) • The extent to which the contractor responds to issues relating to quality
Others and general information	• Political inclination of the contractor • Evidence of local contents • Emphasis on community social responsibilities • Directors' integrity • Firms' membership of trade association • Cooperative outlook • Familiarity of the contractor with locality of the people

$$SS_t = SS_b + SS_w \quad (3)$$

Taking the form of:

$$\Sigma_i \Sigma_j \left(Y_{ij}\text{-}GM\right)^2 = n\,\Sigma\left(\overline{Y}_{ij}\text{-}GM\right)^2 + \Sigma_i \Sigma_j \left(Y_{ij}\text{-}Y_{ij}\right)^2 \quad (4)$$

The SS_b is then nested into variance for each IV with the associated interactions between them.

Wherein two cases of IV1 and IV2, takes the form of:

$$nk_m\Sigma_k\Sigma_m\left(\frac{IV_1}{IV_{1_{km}}}\text{-}GM\right)^2 = nk_m\Sigma_k(IV_{1_k}\text{-}GM)^2 + n_m\Sigma_m(IV_{1_m}\text{-}GM)^2 + [nk_m\Sigma_k\Sigma_m\left(\frac{IV_1}{IV_{2_{km}}}\text{-}GM\right)^2 \text{-}\, n_k\Sigma_k(IV_{1_k}\text{-}GM)^2 \text{-}\, n_m\Sigma_m(IV_{2_m}\text{-}GM)^2] \quad (5)$$

Taking the loop summations of nested functions for each SS_b with the corresponding independent variable, the comprehensive equation with the group mean indicator becomes:

$$nk_m\Sigma_k\Sigma_m\left(\frac{IV_1}{IV_{2_{km}}}\text{-}GM\right)^2 = nk_m\Sigma_k(IV1_k\text{-}GM)^2 + n_m\Sigma_m(IV_{2_m}\text{-}GM)^2 + [nk_m\Sigma_k\Sigma_m\left(\frac{IV_1}{IV_{2_{km}}}\text{-}GM\right)^2 \text{-}\, n_k\Sigma_k(IV_{1_k}\text{-}GM)^2 \text{-}\, n_m\Sigma_m\left(IV_{2_m}\text{-}GM\right)^2] + \quad (6)$$

$$\Sigma_i\Sigma_k\Sigma_m \left(\text{Y}_{ikm}\text{-} \frac{IV1}{IV2_{km}}\right)^2$$

The computation process requires that multiple DV_s are subjected to vector matrices (column matrices) form for each DV to enable test statistics. For two DVs (*u* and *v*) with *n* values, a corresponding matrix equation of the form exists;

$$Y_{i...n}= \begin{bmatrix}u_1\\v_1\end{bmatrix}\begin{bmatrix}u_2\\v_2\end{bmatrix}\begin{bmatrix}u_3\\v_3\end{bmatrix}\cdots\begin{bmatrix}u_n\\v_n\end{bmatrix} \quad (7)$$

There are also column matrices for IVs. Each matrix of IVs for each level of iterative statistics is composed of means for every DV. For "*n*" DVs and "*m*" levels of each IV, the following corresponding matrices are true:

$$IVA_1= \begin{bmatrix}\overline{DV}_1\\ \vdots \\ \overline{DV}_n\end{bmatrix} IVA_2= \begin{bmatrix}\overline{DV}_1\\ \vdots \\ \overline{DV}_n\end{bmatrix} \ldots IVA_n= \begin{bmatrix}\overline{DV}_1\\ \vdots \\ \overline{DV}_n\end{bmatrix} \quad (8)$$

Iterating to obtain a single matrix for a grand means is computed with an identity value for each DV and subsequently averaged by decomposition across all DV in additional matrices for each cell.

$$\text{G}M= \begin{bmatrix}\overline{DV}_1\\ \vdots \\ \overline{DV}_n\end{bmatrix} \quad (9)$$

The decomposition process often results in differences by subtracting the same dimension matrices from one another to precipitate newer matrices from which error term of the iterative process is obtained by the differencing of the Grand Mean (GM) value from each individual DV score.

$$(Y_{ikm}\text{-}\ GM)$$

Next, each column matrix is multiplied by each row matrix:

$$(Y_{\text{ikm}}\text{-}\ GM)(Y_{\text{ikm}}\text{-}\ GM)$$

The decomposition process optimally sums up matrices over rows and groups to production S-matrix (sum of squares and cross product). Referring to any two independent and dependent variables we have:

$$\Sigma_i\Sigma_k\Sigma_m(Y_{ikm}\text{-}\ GM)(Y_{ikm}\text{-}\ GM)= n_k\Sigma_k\ (IV1_k\text{-}GM)(IV1_k\text{-}GM)+ n_m\Sigma_m(IV2_m\text{-}GM)(IV2_{m}\text{-}GM)+[n_{km}\Sigma_k\Sigma_m(IV_1/IV_2\ \text{-}GM)(IV_1/IV2_m\text{-}GM)\text{-}\ n_k\Sigma_k(IV1_k\text{-}GM)(IV1_k\text{-}GM)\text{-}n_m\Sigma_m(IV2_m\text{-}GM)(IV2_m\text{-}GM)+\ ]+\Sigma_i\Sigma_k\Sigma_m(Y_{ikm}\text{-}\ IV_1/IV2_m)(Y_{ikm}\text{-}\ IV_1I/IV2_m) \quad (10)$$

$$S_t= S_1V_1 + S_2V_2 + S_{interaction} + S_{wgerror}$$

Properties of the investigated hypothesis significance and estimation criterion are derived from the determinant of the S-matrices by administering appropriate test statistics found in the computation of F-statistics described hereunder for MANOVA analysis

$$F_{approximate}(df_1,\ df_2)= \left(\frac{t\text{-}y}{y}\right)\left(\frac{df_1}{df_2}\right) \quad (11)$$

Where,

$$df_1=p\left(df_{effect}\right)^{dh}=s\left[\left(df_{error}\right)\text{-}\ \frac{p\text{-}df_{affect}{}^{+1}}{2}\right]\text{-}\left[\frac{p\text{-}df_{affect}{}^{-2}}{2}\right]s=\sqrt{\frac{p^2\left(df_{affect}\right)^{2\text{-}4}}{p^{2+}\left(df_{affect}\right)^{2\text{-}5}}} \quad (12)$$

$$y= \wedge^{\frac{1}{2}}p\text{=No. of }DVs\,df_{affect}\text{=}(IV_1\text{-}1)(IV_2\text{-}1)\ldots(IV_n\text{-}1)df_{error}\text{=}\ nl_1\times nl_2\ (n_{DV}\text{-}1) \quad (13)$$

Summarily we return to measuring the strength of the associating by introducing the Wilk's (λ) to compensate for the variance not observed by the combined DV_s with (1-λ) as the variance observed for the best linear combination of DV_s.

$$\eta^2\text{=}1\text{-}\ \wedge \quad (14)$$

Taking the loop across all DVs, it can be greater than one and therefore:

$$\eta^2\text{=}1\text{-}\ \wedge^{1/3} \quad (15)$$

Narration to the robust estimation of MANOVA statistics squared heavily on some alternate generic tests like Wilk's (λ) test that parametrically assess ratios of the error to effects variances for exact F-statistic measure were deployed.

Ditto the Hotelling's trace test expressed as $T = \sum_{i-1}^{s}\lambda_i$ for understanding the polled effects to error variances, Pillai-Barlett Criterion estimated from $V = \sum_{i-1}^{s}\frac{\lambda_i}{1+\lambda}$ for a conservative F-statistic and the Roy's Largest Root test for the determination of optimal Eigen value for the upper bound F-statistic.

4. Result and Discussion

Table 6 shows the mean scores of the respondents' level of agreement with the listed factors as procedures for contract award, and this ranges between 3.74 and 3.34. This indicates that they are the necessary procedure for contractor's selection and contract award in achieving construction project performance. The table shows the top three key procedures. These are the identification of client's requirements (3.74), preparation of client's strategic brief and identification of procedure, organizational structures and range of consultants (3.66) and preparation of outline proposal, assessment of economic constraints, cost studies of design, cost plan, an estimate of cost and review of procurement route (3.57), amongst practitioners in Nigeria construction industry.

From the client's perspective, it is evident that the identification of the client's requirement was identified as the first step of project procurement with a mean score of 3.90. This is closely followed by the commencement of development of strategic brief by preparing the outline proposal which includes the assessment of economic constraints, cost studies of designs, cost plan, an estimate of cost and review of procurement route, while preparation of strategic brief of the client and identification of procedures, organizational structure and range of consultants and others to be engaged for the project and further cost studies were rated third and fourth respectively.

On the other hand, consultants identified the client`s requirements as the first step in the contract procurement exercise. Preparation of the strategic brief of the client and identification of procedures, organizational structure and range of consultants and others to be engaged for the project and further cost studies, commence development of strategic brief by preparing the outline proposal which includes an assessment of economic constraints, cost studies of designs cost plan, an estimate of cost and review of procurement route and further cost studies, cost checking and preparation of production information document for tender purposes were ranked second, third and fourth respectively. Again, the views of the contractor' agree with that of the consultants.

In summary, Table 6 shows the mean score and ranking of the procedures of project procurement in construction projects as perceived by the client and consultant. Identification of clients' requirements was ranked highest by both the client and consultants. However, it is very obvious from the two categories of respondents that preparation of clients strategic brief and identification of procedures and organizational structure ranked (third for a client, second for consultants); Preparation of outline which includes the assessment of economic constraints and cost studies of design ranked (second for clients and third for consultants); Further cost studies and preparation of production information documents for tender purposes (ranked fourth by all); Advertisement, prequalification and issuance of bidding documents ranked (fifth by clients, sixth by consultants); Evaluation, reviewing and recommendation of the potential contractor (ranked sixth by the client and fifth by consultants and contractors); While contract finalization and appointment of the contractor (ranked seventh by all).

The weighted average of the mean scores of these factors in Table 6 was statistically carried out from the sample mean of mean and ranked to show agreement; this cross-analysis between client and consultants is a summary of the procedure for contract award and it revealed that these could be adopted as procedures for contract award. This can further be summarized as identification of client's requirements; preparation of client's strategic brief and identification of procedures, organizational structures and range of consultants; preparation of outline proposal, assessment of economic constraints, cost studies of design, cost plan, the estimate of cost and review of procurement route; preparation of production information documents for tender purposes; advertisement, prequalification and issuance of bidding documents; evaluation, reviewing and recommendation of potential contractor's bid and contract finalization and award.

Table 7 presents the mean scores and ranking of the most significant factors in respect of the condition for the award of contract for construction projects as perceived by clients. From the result, it is obvious that the lowest bidder after the tender was identified as the highest condition for contract award with a mean score of 3.81; this is often the situation in the Nigerian construction industry. This is closely followed by the highest rated contractor after the evaluation of commercial and technical bid with a mean score of 3.71, while the highest rated contractor after the completion time 3.60 and the average bid method in the contractor's entire bid with a mean score of 3.50 were ranked third and fourth respectively.

Table 6. Assessment of the procedures for contractor's selection and contract award

Procurement procedure	**Client**		**Consultant**		**Contractor**		**Overall**	
	Mean	**Rank**	**Mean**	**Rank**	**Rank**	**mean**	**mean**	
Identification of client`s requirements.	3.90	1st	3.60	1st	3.60	1st	3.74	1st
Preparation of client's strategic brief and identification of procedures, organizational structure and range of consultants and others to be engaged for the project.	3.88	3rd	3.46	2nd	3.46	2nd	3.66	2nd
Development of client's strategic brief by preparing the outline proposals, which includes assessment of economic constraints, cost studies of designs, cost plan, estimate of cost and review of procurement route.	3.89	2nd	3.41	3rd	3.41	3rd	3.57	3rd
Further cost studies, cost checking and preparation of production information document for tender purpose.	3.87	4th	3.40	4th	3.40	4th	3.56	4th
Advertisement, prequalification and issuance of bidding documents.	3.74	5th	3.32	7th	3.32	7th	3.46	5th
Bid preparation by bidding contractors.	3.65	6th	3.33	6th	3.33	6th	3.44	7th
Evaluation, reviewing and recommendation of potential contractors bid.	3.56	7th	3.39	5th	3.39	5th	3.45	6th
Contract finalization and appointment of the contractor.	3.43	8th	3.25	8th	3.25	8th	3.34	8th

Table 7. Assessment of the conditions of the award of contract after tender evaluation

Conditions for contract award	Client		Consultant		Contractor		Overall	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
The lowest evaluated responsive tender that falls within -10% to +10% of the consultant estimated figure.	3.49	4th	4.01	2nd	3.25	4th	3.58	1st
The highest rated contractor after the evaluation of commercial and technical bid.	3.71	2nd	3.68	3rd	3.32	2nd	3.57	2nd
The lowest bidder after tender.	3.81	1st	3.43	4th	3.36	1st	3.53	3rd
The lowest bidder during prequalification.	3.21	5th	4.04	1st	3.24	5th	3.5	4th
The highest rated contractor after the evaluation of bid figures and the consultant estimated figure.	3.6	3rd	3.33	5th	3.28	3rd	3.4	5th

Table 8. Analysis on the effects of procedures leading to contract award on cost performance of construction projects

(Variables in equation)	Cost performance Model		
	B	t-value	p-value
Constant	2.869	*** 3.046	0.003
Identification of client's requirements	0.103	2.4	0.031
Appointment of project team	.204**	0.319	0.022
Feasibility study/project appraisal	0.04	0.401	0.69
Preparation of bidding document	0.029	0.173	0.243
Advertising and pre-qualification	0.002	0.532	0.985
Bid preparation by bidder	0.129	1.407	0.682
Evaluation and reviewing of bids	.270**	2.726	0.289
Contract finalization/Award	0.094	1.082	0.001
df	6.214		
F-value	7.406***		
Sig.	0		
R	0.745		
R^2	0.63		
Adj. R^2	0.624		

Predictors: Constant, Identification of client's requirements (IDC), Appointment of the project team (APT), Feasibility study (FS), Preparation of bidding document (PBD), Advertisement and prequalification (AP), Bid preparation by bidder (BPB), Evaluation of bids (EB), Contract finalization/award (CFA).

On the other hand, consultants identified the lowest bidder during prequalification as the highest condition for contract award with a mean score of 4.04, closely followed by the lowest evaluated responsive tender that falls within – 10% to +10% of the consultant estimated figure with a mean score of 4.01, while the highest rated contractor after evaluation of technical and financial bid 3.68 and the highest bidder after tender been third and fourth respectively. Again, the lowest bidder after tender with a mean score of 3.36 tops the list of contractor's responses.

Cost performance (CP) = 2.879 + 0.103*IDC* + 0.204*APT* + 0.040*FS* + 0.029*PBD* + 0.002*AP* + 0.129*BPB* + 0.270*EB* + 0.094*CFA*

(R= 0.745, R^2 = 63.0%, Adjusted R^2 = 62.4%)

Where CP is Cost Performance, IDC = Identification of client's requirements, APT = Appointment of project team, FS = Feasibility study, PBD Preparation of bidding document, AP = Advertisement and prequalification, BPB = Bid preparation by bidder, EB = Evaluation of bids, CFA Contract finalization/award.

From the above regression model, it is suggestive of validating contractors' capability in a contest situation by transforming the scores of the variables in the model earned by the contractor at the tender reporting stage from a qualitative scale into real numerals and operated upon by the coefficients to give predictive ratings of individual's contractor's cost performance. The coefficient of correlation (R), which, according to Xiano and Proverbs (2005), measures the strength of a linear association, is 0.745. This shows that there is 74.5% relationship between the dependent variables and the independent variables. The coefficient of determination (R^2) is 63% while the adjusted R^2 value is 62% indicating a high degree or fitness of the multiple regression model (MRM). The R^2 value of 63% also shows that only 27% of the residual variations in the dependent variable is not included in the model. The variable in the model were further subjected to a multi-collinearity test by constructing the correlation matrix of the variable, as shown in the appendix. The result shows that there are no multiple correlations among the variables and thus confirming the level of significance of the cost performance model. The F statistic (F=7.406, P=0.000) shows great significance of $P<0.01$, signifying that the variation explained by the model is not due to change.

From Table 8, the observed value of F statistic is 7.406 while the p-value is 0.000. The result shows that the effect of contract award procedure on cost performance of construction project is absolutely significant and positively correlated at $p < 0.05$, since the p-value is less than 0.05. Therefore, there is significant positive effect between the variables of contract award procedures and cost performance.

Hypothesis testing

Effects of procedures leading to contract award on cost performance of construction projects

Hypothesis H_0 was put forward in order to assess the influence of the variables of the procedures leading to contract award on cost performance of the project. This hypothesis H_0 states that: procedures leading to contract award have no effect on cost performance of construction projects. From Table 5 and in the appendix below, the observed value of F statistic is 7.406 while the p-value is 0.000. The result shows that the effect of contract award procedure on cost performance of construction project is absolutely significant and positively correlated at $p < 0.05$, since the p-value is less than 0.05. Therefore, there is a significant positive effect between the variables of contract award procedures and cost performance. Hence there is substantial evidence to reject the null hypothesis H_0 and accept the alternate hypothesis H_1. This cost performance concordance to procurement procedure, fans the amber of deviation from previous investigations by Aje et al. (2009) and generalized project delivery by Aje (2012) that provided contractor selection impact on time and project delivery studies.

Summary of findings

Based on the analysis carried out in this study, observable findings of the study showed that there is symmetry between procurement routes, contract awards and cost performance of any construction projects within the Nigerian practice. A properly evaluated procurement route and contractor's assessment will often result in good project cost performance as against inadvertent prevalent practice in Nigeria. Further, the necessary procedures for contractor's selection and contract award and projects efficient cost performance are specifically tied to identification of the client's requirements. Also, preparation of client's strategic brief and identification of procedures, organizational structures and range of consultants; preparation of outline proposal, assessment of economic constraints, cost studies of design, cost plan, an estimate of cost and review of procurement route; preparation of production information documents for tender purposes are considered as a prerequisite factor in the Nigerian construction industry. In other words, advertisement, prequalification and issuance of bidding documents; evaluation, reviewing and recommendation of potential contractor's bid and contract finalization and award are necessary but sufficient condition for the due diligent procedure for contract award.

5. Conclusion

This paper investigated key players in the construction industry ranging from clients, contractors and consultants actively involved in project procurement management and delivery on contract award procedure and its effect on projects cost performance. Data from the field survey were subjected to descriptive and inferential statistics to make a description of the population outcome. The paper mirrored in its literature, basic industry documents (conditions of contract and procurement act) to validate actual procurement requirements and procedure while using it as a necessary control experiment in this investigation to determine if an otherwise contract procedure is not followed, what will be its impact on a project cost performance. Four Nigerian states were investigated with a questionnaire served on the principal actors mentioned above by appropriate sampling from the population of the study. Inferences and predictions from a generalized linear model were extracted from the test statistics. The model will serve as a cost-performance metrics for contractors by tabulating their quantitative values from their bid evaluations in terms of the variables in the model and worked out by the coefficient of the variables. In addition to strict compliance with the procurement process, the quality of the procurement and response documents could impact scope creep and costs performance.

6. Recommendations

Based on the findings of this research, the following policy recommendations are proposed: The procedures leading to contract award should be adhered to, through the documentation and approval of procurement management plan, before any contract is let out, as it has become obvious from the construction sector that contracts fail cost performance because of a defective procedure for the award which as a result of the subjective judgment, corrupt practices and absence of universal approach that trails the procurement exercise. The use of the lowest bidder as automatic selection for award of contract, currently being done under the due process policy, is risky and cannot guarantee efficient project performance in terms of cost, time and quality. A more refined method of awarding the contract to the optimum tenderer whose tender figure is realistic enough and falls within -10% to +10% of the consultant's figure is recommended. This will further improve the effectiveness of construction project delivery in terms of time and quality performance.

References

Aje, I. (2012). The impact of contractors' prequalification on construction project delivery in Nigeria. *Engineering, Construction and Architectural Management*, 19(2), 159-172.

Aje, I. O. (2008). *The impact of contractor prequalification and criteria of award on construction project performance in Lagos and Abuja, Nigeria*. An unpublished PhD Thesis Submitted to Department of Quantity Surveying, Federal University of Technology, Akure, Nigeria.

Aje, I. O., Odusami, K. T., and Ogunsemi, D. R. (2009). The impact of contractors' management capability on cost and time performance of construction projects in Nigeria. *Journal of financial Management of Property and Construction*, 14(2), 171-187.

Akintoye, A. (2000). Analysis of factors influencing project cost estimating practice. *Construction Management and Economics*, 18(1), 77-89.

Alzahrani, J. I. and Emsley, M. W. (2012). The impact of contractors' attributes on construction project success: A post construction evaluation. *International Journal of Project Management*, 31(2), 313-322.

Assaf, S. A. and Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, 1(24), 349-357.

Bowen, P. A., Edwards, P. J., and Cattell, K. (2012). Corruption in the South African construction industry: A thematic analysis of verbation comments from survey participants. *Construction Management and Economics*, 30(10), 885-901.

Collins, J., Sundareswara, E., Tsvetovat, M., and Gini, M. (1999). *Search strategies for bid selection in multiagent contracting*. Unpublished manuscript, Department of Computer Science and Engineering, University of Minnesota, Minneapolis, Minnesota.

Conti, P. L. and Naldi, M. (2008). Detection of anomalous bids in procurement auctions. *Decision Support Systems*, 46(1), 420-428.

Deng, H. (1999). Multicriteria analysis with fuzzy pairwise comparison. *International Journal of Approximate Reasoning*, 21(3), 215-231.

Department of Public Works. (2011). *Contractor PQC Tendering and Selection Process*. Brisbane, Queensland, Australia.

Department of Treasury and Finance. (1999). *Guidelines on Tender Evaluation Using Weighted Criteria for Building Works and Services*. Hobart, Tasmania.

Egwunatum, I. S. and Akpokodje, I. O. (2015). Iterating a stationary cause of cost overruns in construction projects. *International Journal of Construction Engineering and Management*, 4(2), 52-59.

Ellis, R. D. and Herbsman, Z. J. (1990). Cost-time bidding concept: An innovative approach. *Transportation Research Record*, 1282, 89-94.

El-Sawalhi, N., Eaton, D., and Rustom, R. (2007). Contractor prequalification model: State-of-the-are. *International Journal of Project Management*, 25(5), 465-474.

Elyamany, A. (2010). *Developing a rational approach for contractor selection based on history of construction quality and long-term performance*. Ph.D. thesis, North Dakota State University, Fargo, North Dakota.

Eriksson, P. E. (2017). Procurement strategies for enhancing exploration and exploitation in construction projects. *Journal of Financial Management of Property and Construction*, 22(2), 211-230.

Fong, P. S. and Choi, S. K. (2000). Final contractor selection using the analytical hierarchy process. *Construction Management and Economics*, 18(5), 547-557.

French, A., Marcelo, M., Poulsen J., Watson, T., and Yu, A. (2010). Multivariate Analysis of Variance (MANOVA). Retrieved from http://ibgwww.colorado.edu/~carey/p7291dir/handouts/manova1.pdf

Hatush, Z. and Skitmore, M. (1997). Criteria for contractor selection. *Construction Management & Economics*, 15(1), 19-38.

Hatush, Z. and Skitmore, M. (1998). Contractor selection using multicriteria utility theory: an additive model. *Building and environment*, 33(2), 105-115.

Hatush, Z. and Skitmore, R. M. (1997). Evaluating contractors prequalification data: selection criteria and project success factors. *Construction Management and Economics*, 15(2), 129-147.

Hatush, Z. and Skitmore, R. M. (1998). Contractor selection using multivariate utility theory: an additive model. *Building and Environment*, 33 (2-3), 105-115.

Herbsman, Z. and Ellis, R. (1992). Multiparameter bidding system-innovation in contract administration. *Journal of Construction Engineering and Management*, 118(1), 142-150.

Holt, G. D. (1998). Which contractor selection methodology?. *International Journal of project management*, 16(3), 153-164.

Holt, G. D., Olomolaiye, P. O., and Harris, F. C. (1994). Evaluating prequalification criteria in contractor selection. *Building and Environment*, 29(4), 437-448.

Hwang, B. G., Zhao, X., and Ng, S. Y. (2013). Identifying the critical factors affecting schedule performance of public housing projects. *Habitat International*, 38, 214-221.

Ioannou, P. G. and Awwad, R. E. (2010). Below-average bidding method. *Journal of Construction Engineering and Management*, 136(9), 936-946.

Iyer, K. C. and Jha, K. N. (2005). Factors affecting cost performance: evidence from Indian construction projects. *International Journal of Project Management*, 23(4), 283-295.

Jarkas, A. M. and Younes, J. H. (2014). Principal factors contributing to construction delays in the State of Qatar. *International Journal of Construction Project Management*, 6(1), 39-62.

Kanoglu, A. and Gulen, S. (2013). Model for managing the contractual risks of construction firms imposed by the procurement system. *International Journal of Architecture, Engineering and Construction*, 2(1), 43-54.

Khosrowshahi, F. (1999). Neural network model for contractors' prequalification for local authority projects. *Engineering Construction and Architectural Management*, 6(3), 315-328.

Krejcie, R. V. and Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30(3), 607-610

Kululanga, G. K., Kuotcha W., McCaffer, R., and Edum-Fotwe, F. (2001). Construction contractor's claim process framework. *Journal of Construction Engineering and Management*, 127(4), 303-314.

Kumaraswamy, M. M. (1996). Contractor evaluation and selection: A Hong Kong perspective. *Building and Environment*, 31(3), 273-282.

Lai, K., Liu, S., and Wang, S. (2004). A method used for evaluating bids in the Chinese construction industry. *International Journal of Project Management*, 22(3), 193-201.

Lam, K., Thomas, N. G. S., Hu, T., Skitmore, M., and Cheung, S. (2000). Decision support system for contractor prequalification artificial neural network model. *Engineering construction and Architectural Management*, 7(3), 251-266.

Lambropoulos, S. (2007). The use of time and cost utility for construction contract award under European Union Legislation. *Building and Environment*, 42(1), 452-463.

Laryea, S. (2011). Quality of tender documents: case studies form the UK. *Construction Management and Economics*, 29(3), 275-286.

Lee, J. K. (2008). Cost overrun and cause in Korean social overhead capital projects: road, rail, airports and ports. *Journal of Urban Planning and Development*. 134(2), 59-62.

Ling, Y. Y., Khee, H. Y., and Lim, K. S. G. (2000). The reasons why clients prefer to procure more project based on design-bid-build than design-build. *Journal of Construction Procurement*, 6(2), 135-146.

Mahdi, I. M., Riley, M. J., Fereig, S. M., and Alex, A. P. (2002). A multicriteria approach to contractor selection.

Engineering Construction and Architectural Management, 9(1), 29-37.
Mendenhall, M., Reimuth, J. E., Beaver, R. J., and Beaver, R. J. (1993). *Statistics for Management and Economics* (7th Ed.). Belmont: Duxtury Press.
Minister of Finance. (2012). *Best practice guide for on procurement and bid evaluation*. Republic Democratic of Timor Leste.
Missbauer, H. and Hauber, W. (2006). Bid calculation for construction projects: Regulations and incentive effects of unit price contracts. *European Journal of Operational Research*, 171(3), 1005-1019.
Molla, M. M. and Asa, E. (2015). Factors influencing contractor prequalification process in developing countries. *International Journal of Architecture, Engineering and Construction*, 4(4), 232-245.
Munaif, M. A. (1995). *Multiple criteria decision making in contractor selection and evaluation of construction bids in Saudi Arabia*. Ph.D. thesis, University of Missouri-Rolla, Missouri.
Network. (2004). *Proposed for monitoring on resident due process teams*. Case Study of Owerri, Imo State, Nigeria.
Ng, S. (2001). Equal: a case based contractor pre-qualifier. *Automation in Construction*, 10(4), 443-457.
Ng, S. T. and Skitmore, R. M. (2001). Contractor selecting criteria: a benefit–cost analysis. *IEEE Transactions in Engineering Management*, 48(1), 96-106.
Nguyen, V. U. (1985). Tender evaluation by fuzzy sets. *Journal of Construction Engineering and Management*, 111(3), 231-243.
Odusami, K. T. (1998). Prequalification and selection of contractor. *Construction in Nigeria*, 13(1), 26-32.
Oforeh, B. C. and Alufohai, A. J. (2001). *Management Estimating and Budgeting for Electrical Installation*. Maryland Nigeria: Cosines.
Ogunsemi, D. R. and Aje, I. O. (2006). A model for contractors' selection in Nigeria. *Journal of Financial Management of Property and Construction,* 11(1), 33-44.
Oguonu, C. N. (2005). *Project performance in a changing public sector featuring articles*. Retrieved from http:/www.Hollerafrica.com/showArticle.php?catid=iartltd=248 on May 16th, 2011.
Padhi, S. S. and Mohapatra, P. K. J. (2009). Contractor selection in government procurement auctions: a case study. *European Journal of Industrial Engineering*, 3(2), 170-186.
Russell, J. S. (1996). *Constructor prequalification: Choosing the best constructor and avoiding construction failure*. ASCE Press, New York.
Russell, J. S. and Skibniewski, M. J. (1990). Qualifier-1: Contractor prequalification model. *Journal of Computing in Civil Engineering*, 4(1), 77 – 90.
Russell, J. S. and Skibniewski, M. J. (1988). Decision criteria in contractor prequalification. *Journal of Management in Engineering*, 4(2), 148-164.
Russell, J. S. and Zhai, H. (1996). Predicting contractors' failure using stochastic dynamics of economics and financial variables. *Journal of Construction Engineering and Management,* 122(2), 183-191.
Russell, J. S., Skibniewski, M. J., and Cozier, D. R. (1990). Qualifier-2: Knowledge-based system for contractor prequalification. *Journal of Construction Engineering and Management*, 116(1), 157-171.
Seydel, J. and Olson, D. (2001). Multicriteria support for construction bidding. *Mathematical and Computer Modelling*, 34(5), 677-701.
Skitmore, M. (2002). Identifying non-competitive bids in construction contract auctions. *Omega*, 30(6), 443-449.
Taha, M. A. E. (1994). *Applying distributed artificial intelligence to the prequalification of construction contractors*. Ph.D. thesis, The University of Wisconsin-Madison, Madison, Wisconsin.
Topcu, Y. I. (2004). A decision model proposal for construction contractor selection in Turkey. *Building and Environment*, 39(4), 469-481.
Transportation Research Board (1994). *Criteria for qualifying contractors for bidding purposes, a synthesis of highway practice*. National Research Council, Washington, D.C.
Wahab, K. A. (2005). Due process: The Construction industry and the Builders. *Proceedings of the 35th Annual General meeting and Conference of the Nigeria Institute of Building*, held on 10th August 2005, at Aba, Abia State. 63-75
Wang, W. C., Wang, H. H., Lai, Y., and Li, J. C. C. (2006). Unit-price-based model for evaluating competitive bids. *International Journal of Project Management*, 24(2), 156-166.
Wong, C. H. and Holt, G. D. (2003). Developing a contractor classification model using a multivariate discriminate. Analysis approach. *RICS foundation Research Paper Series*, 4(20), 1-23.
Xiano, H. and Proverbs, D. (2005). Factors influencing contractors performance: an international investigation. *Engineering Construction and Architectural Management*, 10(5), 322-332.
Zhang, X. (2009). Best value concessionaire selection through a fuzzy logic system. *Expert Systems with Applications*, 36(4), 7519-7527.

Samuel I. Egwunatum had his degrees in Quantity Surveying from the Federal University of Technology, Akure, Nigeria up till 2014 specializing in Construction Economics. He started his lecturing career with Delta State Polytechnic, Ozoro, Nigeria after a short stint in industry service where he conceptualized the use of labourers productivity outputs to build cost models for estimating unit rate costs of construction work items and facilitating the cost modelling research group. He is currently a lecturer with Federal University of Technology Owerri, Nigeria. He is a Corporate Member of The Nigerian Institute of Quantity Surveyors (NIQS), Association for the Advancement of cost engineering (AACE) and American Society of professional estimators (ASPE). He is a review editor to international journals and a consultant to the Delta State government of Nigeria on Hydraform Mass Housing Project. He has to his credit, published one textbook in Germany on (Lost Labour Claims in Construction Projects: Principles and Estimation, 2016) and a chapter contribution in the United Kingdom to the book Zero and Net Zero Buildings under the title: Economic Aspects of Zero Energy Buildings. He has over twenty-one published

Andrew I. Awo-Osagie in 2015 obtained his master's degree in Quantity Surveying from the Federal University of Technology, Akure. He specialized in Quantity Surveying practice. His career in the profession began in 1991 with Bight Engineering Limited, a construction company based in Benin City, Nigeria. He began his career after completing the compulsory paramilitary service (NYSC) to Nigeria in 1991 as well. He currently serves as a lecturer in the Delta State Polytechnic, Ozoro, Nigeria. He has published several journals and conference papers, among which are: Impact of Information and Communication Technology (ICT) on practitioners in Nigeria Construction Industry, Challenges Facing the Use of Information and Communication Technology (ICT) in Quantity Surveying Services in Nigeria and a lot more. He is a corporate member of the Nigerian Institute of Quantity Surveyors (NIQS). His research interest includes quantity Surveying, information and communication Technology, cost management, procurement and contract administration.

Imoleayo A. Awodele is a Lecturer in the Department of Quantity Surveying, School of Environmental Technology, Federal University of Technology, Owerri, Imo State, Nigeria. He holds B.Tech (Hons) in Quantity Surveying and MSc in Construction Management. Imoleayo has research interest in the general areas of Quantity Surveying and Construction Project Management with particular emphasis on Risk Management in oil and gas, Professional Practice and Procedure, Public-Private Partnerships, Commercial and construction marketing, and Heavy Engineering. He has over seven years' experience in the field of Civil/Heavy engineering and housing construction and property development and management. He is a cooperative member of the Nigerian Institute of Quantity Surveyors and also a Registered Quantity Surveyor with the Quantity Surveyors Registration Board of Nigeria.

Emmanuel C. Eze is a Lecturer in the Department of Quantity Surveying, School of Environmental Technology, Federal University of Technology, Owerri, Imo State, Nigeria. He holds a National Diploma (ND), Bachelor of Technology, (B.Tech), and Masters of Technology (M.Tech) all in Quantity Surveying. He has over seven years of field experience with a frontline International Construction Company in Abuja, Nigeria. He is a certified Project Management Professional, PMP. He is a Corporate Member of The Nigerian Institute of Quantity Surveyors (NIQS) and a Registered Quantity Surveyor and Consultant (RQS), having registered with Quantity Surveyors Registration Board of Nigeria (QSRBN). His research interests include Quantity surveying, Construction marketing, construction innovations and ICT application, Construction rework, sustainable construction, Project management with specific emphasis on Cost, Schedule, Risk and Quality, Procurement, and stakeholders' management.