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Impact of Characteristics of Design-Bid-Build Delivery System on Construction Project Performance in Nigeria

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Abstract:

The study examined the impact of characteristics of Design-Bid-Build (DBB) delivery system on construction industry with a view to enhancing project delivery. A total of 13 DBB distinguishing attributes were obtained via literature review. Primary data were used for this study. Structured questionnaire was administered to consultants and contractors' personnel in Lagos State, Nigeria. A total of 200 copies of questionnaires were administered and 148 copies which represent a combined response rate of 74 per cent were retrieved. Data were analysed using frequency distribution, percentages and spearman's rank order correlation. The findings indicated that Construction cost is fixed at contract award (until Change Orders), Design is complete prior to construction award, Relative ease of implementation, Low bid cost and maximum competition, Owner at risk to contractor for design errors and Design and construction are sequential have positive direct effect on cost overrun. This study concluded that characteristics of Design-Bid-Build (DBB) delivery system had significant impact on the expected performance of construction project and recommended that stakeholders should have clear knowledge of unique characteristics of DBB delivery system for successful project execution.

Keywords: Delivery System, Design-Bid-Build, Project planning, Project Performance

Introduction

In construction industry projects, conflicts are essentially unavoidable due to the in-built complexity of constructing an infrastructure project, the diversity of organisations and individuals involved, and the significant financial requirements associated with projects (Federal Facilities Council (FFC, 2007). Stipanowich, (1998) observed that 10–30% of construction projects experience serious conflicts and disputes, usually one in four disputes, claims are ultimately filed. Arguably, costs associated with resolving disputes and claims are estimated to be between #4 and #20 billion per year (FFC, 2007), eventually consuming public funding. The cost of dispute resolution includes lawyers' fees, employees' salaries and overhead; and as well as long-term hostile relationships that may prevent repeat business. In fact, conflicts that result in claims can become very expensive and ultimately led to poor project performance. Also, the absence of project disputes is often seen as an indicator of success alongside other metrics, such as absence of cost increases, schedule delays, and quality defects (Pocock *et al.* 1996).

Studies have been conducted to advance strategies for alleviating the negative impacts of conflict and disputes, in order to improve the performance of construction projects (Chong *et al.*, 2013; Song *et al.*, 2014, and Barry and Leite 2015). There is consensus in the literature that conflicts can be avoided by enhanced understanding, finding common ground between stakeholders (owner, consultant and contractor), and establishing a cooperative project environment (Leicht *et al.*, 2014, Gad *et al.*, 2016; Zhang *et al.*, 2016). Yu *et al.* (2016) and Bo *et al.* (2016) observed that the level

of understanding, common ground between parties and cooperative project environment depends on deeper understanding and familiarisation with the characteristics of the chosen PDS (by stakeholders) is a key factor for more effective project success. More specifically, during the planning stage, parties can determine and agreed on project risk allocation based on the delivery method selected and establish a collaborative team approach by selecting the appropriate procurement method and contract type. During the construction phase, on the other hand, stakeholders can minimize adversarial relationships by encouraging communication and open information sharing, paying invoices on time and empowering project personnel to solve unexpected issues at the lowest level before escalation. Hence the need to study the impact of characteristics of (DBB) delivery systems on project performance in Nigeria construction industry in order to avoid the pit falls or benefit from the advantages.

Project Definition

Project Definition (PD) is a process in which all aspects of a proposed project are explored to examine the relationship between activities, events, durations and costs. Areas of uncertainty or conflict are identified, and possible alternatives or trade-offs are developed to strike a satisfactory balance. Therefore, (PD) is crucial for successful construction projects. It affects design quality, project communication between stakeholders, and final project performance in terms of cost, schedule, and quality. (PD) occurs at the first stage of a construction project. This involves the determination of what the owner needs and wants, translation of these needs and wants into design criteria, and generation of a design concept (Ballard and Zabelle, 2000). Project provides strategic information for owners to address project risks, maximize the chance of project success, and develop project implementation solutions (Construction Industry Institute, 1995). On the other hand, inadequate clarity of project goals, scope and expected outcome is a common source of problems in construction work (Fageha and Aibinu, 2013) and significantly increases the risk of an unsatisfactory outcome for the owner (Quatman and Dhar, 2003; Yu *et al.,* 2006; Wang Sand Ko, 2012). Hence, a clear PD is widely believed to be a key factor for project success (Chritamara *et al.,* 2001; Chan *et al.,* 2001and Cano and Lidon 2011).

Project Planning

Project Planning is the most important project management function. Naoum, Fong and Walker (2004) described project planning as one of the tools used by stakeholders to ensure that construction projects are successful. Hore *et al.* (1997) and Faniran *et al.* (2000) described project planning as the systematic arrangement of project resources in the optimal manner so as to achieve the project objectives. Project planning can be described as the process of defining project objectives, determining the framework, methods, strategies, tactics, targets and deadlines to achieve the objectives and communicating them to the project stakeholders. Naoum *et al.* (2004) observed further that project planning process requires that the client's expectations or requirements and available resources be defined and matched to a set of project objectives. Then the available options are identified and evaluated, and the most appropriate frameworks, strategies and tactics to achieve the objectives are selected. The process involves the preparation of numerous project documents, each representing defined strategies to achieve the defined project objective(s). Project planning and project performance are two complementary activities in project management and the basis of project success or failure is defined in project planning. Faniran, Oluwoye and Lenard (1998) posted that the objective of project planning is to complete a project within a fixed amount of time, at a previously estimated cost and standards of quality. This assertion implies that the effectiveness of project planning is measured by project performance.

Naoum (1991), Ling and Chan (2002) and Thomas *et al.* (2002) also regarded project performance as the basis for evaluating the effectiveness of project planning. Dvir *et al.* (2003) identified three levels of project planning:

i) project conception planning also known as the end-user level, in which planning focuses mainly on the functional characteristics of the project end-product;
ii) project design planning which focuses on the technical specifications of the project deliverables required to support the functional requirements also called project design planning;
iii) construction planning otherwise regarded as the project management level, which focuses on planning the activities and processes required to ensure that the technical work proceeds effectively.

Project Performance

A project is acknowledged as successful, when it is completed on time, within budget, profitability to contractors, absence of legal claims and court proceeding and fitness for purpose for occupiers (Koushki *et al.,* 2005). Quantifying project success is challenging because the definition of success often varies by stakeholder. A contractor may consider construction speed and profitability to be the most important measures of success, whereas an owner may emphasize budget completion or construction quality. These conflicting views of success can result in poor overall project performance if expectations are not communicated. Performance is the degree of meeting or exceeding stakeholders' needs and expectations from a project and involves placing consideration on three major project elements time, cost and quality (Project Management Institute, 2004). This definition of performance by Project Management Institute (2004) encompasses the main characteristics of a construction project. In the literature and in practice, the outcomes most frequently used to define project success are cost, time, and quality known as the iron triangle (Atkinson 1999). In order to study dispute in this context, one needs specific metrics to assess and compare the performance of different construction projects. Diekmann and Girard (1995) defined two key components of dispute assessment:

i) Dispute frequency: number of disputes that occur in a construction project.
ii) Dispute severity: the time and cost associated with solving a dispute.

By analyzing a large database of construction projects, Diekmann and Girard (1995) used a logistic regression model to predict the likelihood of dispute occurrence based on several variables:

i) People criteria (e.g. experience and competency of owner, consultant and contractor etc.),
ii) Project criteria (e.g. size and complexity of the project, site limitations, etc.), and
iii) Process criteria (e.g. scope definition, adequacy of technical plans and specifications).
iv) In conclusion, they stated that while people, project, and process factors all plays a role in determining the likelihood of disputes, the impact of people factors are most significant.

Since Diekmann and Girard's approach for measuring project dispute performance has been frequently adopted by other researchers (Molenaar *et al.* 2000). We decided to use similar metrics to assess performance in this study.

Project Delivery System

Project Delivery System (PDS) is the process by which designers, contractors and various consultants provide service for design and construction to deliver a complete project to the owner (Molenaar *et al.,* 2010). Furthermore, Oyetunji and Anderson (2006) defined PDSs as the roles and responsibilities of the parties involved in a project and also form an execution framework in terms of the sequencing of design, procurement, and construction. Also, a PDS can be described as various processes required in materialising the goals and objective of a client into a project through

integrated project team efforts (Chen *et al.*, 2011). Masterman (1994) classified project procurement systems into several categories based on the relationship and critical interaction between design and construction responsibilities. In Nigeria, several studies have confirmed the use of various types of (PDS). Studies like Ogunsanmi *et al.* (2003); Ojo *et al.* (2006) and Dada (2012) all confirmed the use of Design-Bid-Build (DBB), Design- Build (DB), Project Management (PM), Construction Management (CM), Labour-only (LO) contract, Direct Labour (DL) contract and other types of (PDS) such as Alliancing, Partnering and Joint Venture in the Nigerian construction industry. However, Amade (2012) and Idoro (2012) viewed DBB and DB as the most commonly used systems applied by both private and public sectors in construction industry in Nigeria. The focus of this study is only on the DBB delivery systems.

Design-Bid-Build (DBB) Delivery System

The (DBB) delivery system is the traditional and most commonly used method to complete a construction project where the owner contracts separately with the design team (Architects, Engineers and contractors) to design and construct the facility (Ibbs *et al.*, 2003). Also, Ojo *et al.* (2000) stated that the most frequently used delivery method in Nigeria is the traditional contract method. When using (DBB) delivery system, a sequential process begins with the design team, to furnish complete design services, and then advertising and awarding a separate construction contract based on the completed construction documents. In Nigeria, most government contract and their parastatals, private organisations and individual's contracts are done using (DBB) delivery system.

In a DBB) project delivery system, the owner has separate contracts with the design team and contractor. This is illustrated in Figure 1. (DBB) according to Thomsen (2006), the designing team hired by client to design, prepare construction documents and the specifications. The construction documents and specifications provide instruction for construction and state what will be required by the contractor invited to tender. The successful contractor (the construction firm with the lowest bid) is awarded to carry out the construction of the project. Then, the client signs a contract with the construction company to deliver the project.

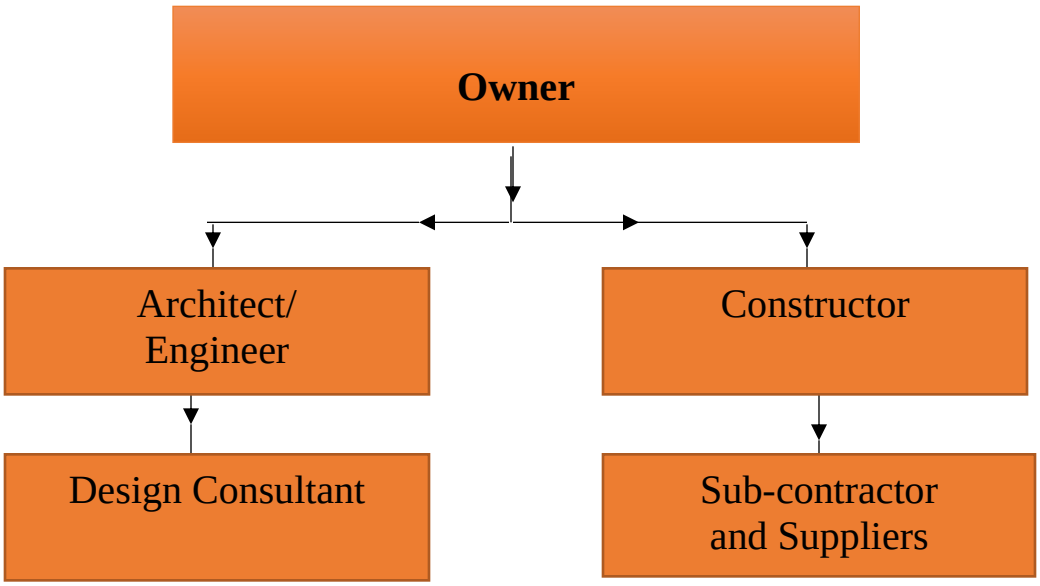

Figure 1: DBB Delivery System
Source: WSDOT, 2015

In the (DBB) Delivery System, the use of standard forms of contract (agreed upon and signed between the client and the contractor), standard methods of measurement and coordinated projects information are all essential to the smooth functioning of the system (Bennett and Grice, 1990). The standard form of contract defines in a clear term what is to be built, the roles of the various parties concerned and the terms of the bargain between them. It also specifies the client requirements, stipulates the measures to be taken to ensure compliance and states the remedies available to each party in the event of default (Rwelimila *et al.*, 2000).

The stages of work in (DBB) delivery systems are usually conducted in linear sequence method in which the client allows the professionals to play their full part in the correct order (American Institute of Architects and Associated General Contractors of America [AIA-AGC], 2011). By this arrangement, the contractor is expected to bid for a building project based on a completed contract drawings because contractors are not involved in the design process of the project (Ojo, 2008). This process is advantageous because (although the design period may be longer than other procurement methods) it allows the client to make necessary changes during design, which are less costly than changes during construction (Molenaar and Songer, 1998). Although, Ojo (2008) submitted that, for a project that adopts the (DBB) delivery system, the contractor should be highly qualified to be responsible (that is having deeper understanding and familiarisation with the characteristics of (DBB) for project planning, procurement, and construction as the contractor is expected to mobilize to site within few weeks and at times with very little knowledge or understanding of the building he is to construct. This method offers the contractor the lowest chance to be integrated because of the normal split between design and construction which often result into adversarial relationship between the Architect and the Contractor. The outcome of the adversarial relationship to project is delay, distrust (claims) and with resultant cost and time overrun (Gordon, 1994). Molenaar and Songer, (1998) noted that (DBB) Delivery System encourages quality work as a result of checks and balances created by separating the design teams' and the contractors' responsibilities.

Characteristics of Design-Bid-Build (DBB) Delivery System

The characteristics of (DBB) Delivery System are the unique attributes that differentiate it from other available project Delivery Systems. The effectiveness and successful management of characteristics of (DBB) Delivery System have a considerable impact on the success or failure of a project. Therefore, having clearer understanding and being familiar with the attributes of the (DBB) delivery system is considered to be the most important competency of owners, designers, constructors and various consultants (Bo *et al.*, 2016), and is to be treated as a fundamental aspect of project management (Atkinson *et al.*, 2006). Hence, the degree of success that will be achieved in the execution of any (DBB) construction project is totally dependent on the depth of a good knowledge and successful management of characteristics of (DBB) Delivery System adopted by the professionals involved. Previous studies on project success have concentrated primarily on project performance from the following aspects: projects owners; consultants and contractor characteristics. Although, various studies have been conducted to determine the key characteristics of (DBB) Delivery System. However, studies on the impact of characteristics of (DBB) Delivery System considered by professionals in monitoring and ensuring project success before choosing (DBB) to undertake construction projects appear not to have been considered. Therefore, these include:

Quite a lot of unique characteristics are responsible for monitoring and ensuring project success. AIA-AGC (2011) identified some attributes vital to DBB delivery system. These include owner controls design and construction, design changes easily accommodated prior to start of construction, design is complete prior to construction award, construction cost is fixed at contract award (until Change Orders), low bid cost and maximum competition, relative ease of implementation and owner at risk to contractor for design errors. Obviously, the degree of success that will be achieved in the

execution of any construction project is totally dependent on the depth a good knowledge and successful management of characteristics of project delivery system adopted by the professional involved. Also, characteristics most significant to DBB delivery system according to ACI-NA, ACC and AGC (2012) were owner controls design/construction quality, requires significant owner expertise and resources, and shared responsibility for project delivery. Also the DBB delivery system attributes unique for checking and guaranteeing project success according to Washington State Department of Transportation's (WSDOT, 2015) include design and construction are sequential, typically resulting in longer schedules, construction costs unknown until contract award, and no contractor input in design, planning, or value engineering (VE).Bo *et al.* (2016), Fageha and Aibinu, (2013), Bearup *et al.* (2007) and Yu *et al.* (2006) agreed that design and construction are sequential, typically resulting in longer schedules, construction costs unknown until contract award, and no contractor input in design, planning, or value engineering were highly significant characteristics of DBB delivery system. Hence, the summary of the results of these studies are presented Table 1.

Table 1. Characteristics of Design-Bid-Build Delivery System

Distinguishing Characteristics	Authors
Owner controls design and construction	AIA-AGC (2011), WSDOT (2015), Chan, Ho and Tam, (2001), Yu *et al.*,(2006)
Design changes easily accommodated prior to start of construction	AIA-AGC (2011), ACI-NA, ACC and AGC (2012), Chan, Ho and Tam, (2001)
Design is complete prior to construction award	AIA-AGC (2011), ACI-NA, ACC and AGC (2012), Fageha and Aibinu, (2013), Bo *et al.,* (2016), Bearup *et al.,* (2007)
Construction cost is fixed at contract award (until Change Orders)	AIA-AGC (2011), WSDOT (2015), Chan, Ho and Tam, (2001), Bo *et al.,* (2016)
Low bid cost, maximum competition	AIA-AGC (2011), ACI-NA, ACC and AGC (2012), Yu *et al.*,(2006), Bo *et al.,* (2016), Walewski *et al* (2001)
Relative ease of implementation	AIA-AGC (2011), ACI-NA, ACC and AGC (2012), Chan, Ho and Tam, (2001), Walewski *et al* (2001)
Owner controls design/construction quality	ACI-NA, ACC and AGC (2012), WSDOT (2015), Chan, Ho and Tam, (2001) TCRP,(2002), Garvin, (2003), Irwin,(2003), Bearup *et al.,* (2007)
Requires significant owner expertise and resources	WSDOT (2015), ACI-NA, ACC and AGC (2012) Chan, Ho and Tam, (2001), Fageha and Aibinu, 2013), Walewski *et al (*2001)
Shared responsibility for project delivery	ACI-NA, ACC and AGC (2012), Chan, Ho and Tam, (2001), Fageha and Aibinu, 2013)
Owner at risk to contractor for design errors	AIA-AGC (2011), WSDOT (2015), Yu *et al.*,(2006), Bo *et al.,* (2016), Konchar and Sanvido, (1998)
Design and construction are sequential, typically resulting in longer schedules	ACI-NA, ACC and AGC (2012), WSDOT (2015), AIA-AGC (2011), Bo *et al.,* (2016)
Construction costs unknown until contract award	WSDOT (2015), AIA-AGC (2011), Chan, Ho and Tam, (2001), Yu *et al.*,(2006), Bearup *et al.,* (2007)
No contractor input in design, planning, or value engineering (VE)	WSDOT (2015), AIA-AGC (2011), ACI-NA, ACC and AGC (2012), Bo *et al.,* (2016)

Materials and Method

This study was carried out within Lagos State, the commercial nerve centre of Nigeria where a significant number of construction projects are being executed. Lagos State is still considered as booming business zone and economic centre of Nigeria despite the fact that Abuja is the administrative capital of Nigeria. Lagos State hosts over 90% of the construction companies' headquarters or branch offices (Adeyemi *et al.*, 2005).The basic requirement for this study was primary and secondary data. The primary data was collected from two main sources namely, the contractors (construction firms) and the consultants. These sources provide data on the characteristics and success factors affecting performance of (DBB) Delivery Systems. Secondary data were obtained from existing records of the construction firms and consultants as applicable for this study. The survey instrument used for the collection of data was structured questionnaire.The target population for this study comprised the registered construction firms and consultants in Lagos State, Nigeria. These are construction firms who either have their head offices in Lagos or have their branch offices there or are currently engaged in an on-going construction project in Lagos State. Large and medium sized construction firms who are the registered member of the Federation of Construction Industry (FOCI) were considered for the study. These firms were distinguished based on the assertion made by Inuwa *et al.* (2012) who noted that project with substantial cost categories of ₦10 million - ₦100 million, ₦101 million - ₦500 million and above are often executed by medium and large sized construction contractors respectively. The consultants group comprised of Architects, Builders, Quantity Surveyors and Engineer. These are the professionals usually employed by the clients to design, supervise and manage construction projects from its inception to completion.

For the purpose of this study, total enumeration of the fifty three (53) registered construction firms with FOCI that served as study population for this study was used. Therefore, the sample size for the contractors is the fifty three (53) construction firms in Lagos State. Also, purposive sampling was used to identify and select two (2) of the contractor's personnel that possess sufficient experience to provide the required information. Thus, a total of one hundred and six (106) copies of questionnaire were administered to contractors' personnel. The consultants' population was sampled using snowballing technique. This was done by identifying the consultants that have been involved in the projects executed by selected contractors. The Architects, Quantity Surveyors and Engineers were targeted in this study. This is because Architects are usually involved in construction project from inception to the completion phases and also act as the client representative in most projects. The Quantity Surveyors are the best consultant to provide cost information as regards initial and completion cost of construction projects. The Structural and Services Engineers are also involved in project execution from planning and design phases and generally engaged in project inspection for specification compliance and quality assurance throughout the project construction stage. Therefore, through the snowballing technique, a total of ninety-four (94) copies of questionnaire were administered to the consultants. A total of two hundred copies of questionnaire were administered in the study.

Method of Data Analysis

Descriptive statistics such as frequency distribution and percentages were employed in analyzing the respondents' profile, number of projects handled using DBB Delivery System and types of project organisation involved. Cost, and time data of projects under review for the methods was obtained from existing documented records of past projects of the construction firms. Effects of the characteristics of Design-Bid-Build (DBB) Delivery Systems on the estimated time and cost of construction projects were determined by finding the percentage time and cost performance (i.e.

construction time and cost overrun) difference between the estimated and final values in each of the two variables as follows:

$$\text{Construction time overrun (t)} = \frac{t_2 - t_1}{t_1} \times 100\,\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$\text{Construction Cost overrun (C)} = \frac{C_2 - C_1}{C_1} \times 100\,\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where

t_1 is the estimated period of completion in months

t_2 is the final period of completion in months

C_1 is the estimated cost of completion

C_2 is the final cost of completion

Spearman's rank order correlation analysis of time and cost overruns with the identified characteristics of (DBB) Delivery Systems extensively used in the construction industry in Lagos state was carried out to determine impact of characteristics on construction projects performance.

Results and Discussion

Table 2 provides information on the questionnaire administration and the number of questionnaire that were appropriately filled and returned for the two groups of respondents. A total of 200 copies of questionnaire were administered on the contractors and consultants in the study area. From the 106 copies of questionnaire administered on the contractors' personnel, seventy-eight 78 copies (73.58 per cent response rate) were correctly filled and returned. Whereas, from the 94 copies of questionnaire administered on the consultants, 70 copies (78.04 per cent response rate) were correctly filled and returned. Table 2 shows a combined response rate of 74.02 per cent which is significantly high and very appropriate for this study.

Table 2. Response rate from questionnaire administration

Class of Respondent	Number Distributed	Number Received	Percentage (%)
Contractors	106	78	73.58
Consultants	94	70	74.46
Total	200	148	74.00

(Author's field work)

Profile of Respondents

The first section of the questionnaire solicited for personal information of the respondents and general information concerning their organisations. The information elicited were: profession, academic qualification, experience level and number of projects handle using DBB Delivery System (Table 3).Architects representing 13.5% of the total respondents, forty-four are Builders representing 29.7%, twelve of respondents were Electrical/Mechanical Engineer (8.1%). Fourteen responses were from Land Surveyor (9.5%), nineteen responses were from Quantity Surveyors (12.8%) and thirty-nine responses were from Structural/Civil Engineers (26.4%). This depicts a fair representation of professional group in the construction industry, thus guaranteeing impartial responses for the study. Respondents' highest academic qualification is second part of respondents' profile. Respondents with MSc. Holders were 40.5 per cent of the total. BSc/B.Tech holders (27.0

%), HND holders (20.3 %). OND holders (5.4 %), Ph.D. holders (4.1 %) and PGD holders (2.7 %). This shows that respondents possess the minimum education qualification required to understand the questionnaire and respond appropriately.

The distribution of the respondents as regards their experience level in the construction industry is also presented in Table 3. Respondents with over 10 years working experience in the Nigerian construction industry are 56.1% total respondents. This depicts a reasonably high level of experience of respondents necessary for this study. While the experience of respondents on total number of building projects executed using Design-Bid-Build (DBB) delivery systemis also presented in Table 3. Over 50% of respondents have executed more than 10 building projects using DBB Delivery System. This shows that respondents possess adequate practical experience in the execution of building projects using DBB Delivery System and that subsequently the information retrieved for this study can be considered reliable.

Table 3. Respondents' Profile

Respondents' back ground information	Frequency	Percentage (%)
Professional Group		
Architects	20	13.5
Builder	44	29.7
Electrical/Mechanical Engineer.	12	8.1
Land Surveyor	14	9.5
Quantity Surveyor	19	12.8
Structural/Civil Engineer	39	26.4
Total	148	100.0
Academic Qualification		
OND	8	5.4
HND	30	20.3
PGD	4	2.7
B. Sc. / B.Tech.	40	27.0
M. Sc.	60	40.5
Ph. D	6	4.1
Total	148	100.0
Year of Experience		
Less than 5years	22	14.9
5-10 years	43	29.1
11-15 years	57	38.5
16-20 years	19	12.8
More than 21 years	7	4.7
Total	148	100.0
Number of Building Project Handled using Design-Bid-Build (DDB) Delivery System		
Less than 5	6	4.1
5 to 10	54	36.5
11 to 15	66	44.6
16 to 20	13	8.8
More than 21	9	6.0
Total	148	100.0

(Author's field work)

Effects of Characteristics of Design Bid Build (DBB) Delivery Systems on Project Performance

Effect of characteristics of DBB delivery system on project was determined. This was to establish the impact of the characteristics of DBB Delivery Systems used on project performance in Lagos State in terms of mean time overruns and mean cost overruns.Cost and time data of two hundred and ninety-three projects initiated and completed by the construction firms surveyed were obtained from documented records of past projects procured.

Time and cost overrun were calculated using the equation 1&2. Table 4 shows the result of mean construction cost overrun. The result shows that the rate of cost overrun has significant of 0.028 for the DBB delivery systems. This could be attributed to project disruption by the owner's actions; project conditions change; and design problems occurrence. It may result to a change order and different degree of cost growth and affected the quality performance of DBB projects during construction phase. Chan and Chan (2004) corroborate this view by stating that cost is not only limited to the tender sum and that it is the overall cost that a project incurs from inception to completion, which includes any cost arising from variations, modifications during construction period.

Table 4. Mean construction cost overrun

Procurement method	Number of valid cases	Mean cost overrun %	Inference from test
Design-Bid-Build (DBB)	148	36.00	P= 0.028 (significant)

(Author's field work)

Table 5 shows the result of mean construction time overrun. Time overrun has significant of 0.003 for DBB Delivery System as shown in Table 5. This could mean that inexperience contractors are selected based on lowest bid; rigid contract period; and lack of communication among project team members. The implication of findings is that projects are not likely to be completed faster. This agrees with the findings of Ling and Liu (2004) that projects are likely to be completed faster if contractors are selected based on a combination of their bid price and their ability to deliver faster. Ling and Liu (2004) further asserted that projects that have variable contract period such as DB tend to be completed and delivered in a shorter time because of the flexibility given to contractors which allows them to be more creative in their project approach. Furthermore, Ling and Liu (2004) noted that, construction speed are higher when contractor gets on with the work without needing to consult with designers, as the contractor has single point of responsibility especially in DB project.

Table 5. Mean construction time overrun

Procurement method	Number of valid cases	Mean time overrun %	Inference from test
Design-Bid-Build (DBB)	148	26.30	P= 0.003 (significant)

(Author's field work)

Impact of Design Bid Build (DBB) system characteristics on project performance

The results of the Spearman's rank order correlation analysis (r) of time and cost overruns with the identified characteristics of DBB Delivery System extensively used in the construction industry in Lagos state are presented in Table 6. Chi-Square Test of Independence was used to determine the interdependence of variables (at @ = 0.05). The values of the test statistic (Chi-Square), the level of significance (p-value) and correlation coefficient (r) for all the measured variables. It shows that construction cost is fixed at contract award (until Change Orders), with p-value of 0.000 and

correlation coefficients value of 0.348 (p = 0.000; r = 0.348) and design is prepared prior to construction award, with (p = 0.000; r = 0.404) had a significant impact on cost overrun. Other DBB delivery system characteristics that had positive direct effect on cost overrun include relative ease of implementation (p = 0.000; r = 0.574), low bid cost and maximum competition (p = 0.000; r = 0.355), owner at risk to contractor for design errors (p = 0.001; r = 0.304); and design and construction are sequential (p = 0.002; r = 0.279).

Design is prepared prior to construction award, with (p = 0.000; r = 0.347); and low bid cost and maximum competition, with (p = 0.000; r = 0.318) had positive direct effect on cost growth. Also, owner at risk to contractor for design errors; and design and construction are sequential, resulting in longer schedules had a significant impact on cost overrun with (p = 0.009; r = 0.233 and p = 0.000; r = 0.401) respectively. The implication of this is that the success of any construction project depends greatly on the degree of clarity of parties involved in the project design, procurement and construction methodologies as enumerated by the characteristics of the chosen PDS (Liu *et al.*, 2016).

Table 6. DBB delivery system characteristics and performance

DBB Characteristics	Cost overrun			Time overrun		
	r	p-value	Remark	r	p-value	Remark
Construction cost is fixed at contract award (until Change Orders)	0.348	0.000	Significant	0.154	0.088	Not Significant
Design is complete prior to construction award	0.404	0.000	Significant	0.347	0.000	Significant
Relative ease of Implementation	0.574	0.000	Significant	-0.018	0.828	Not Significant
Design changes easily accommodated prior to start of construction	-0.121	0.147	Not Significant	0.170	0.140	Not Significant
Owner controls design and construction	-0.307	0.000	Not Significant	0.173	0.053	Not Significant
Low bid cost, maximum competition	0.355	0.000	Significant	0.318	0.000	Significant
Owner at risk to contractor for design errors	0.304	0.001	Significant	0.233	0.009	Significant
Design and construction are sequential, typically resulting in longer schedules	0.279	0.002	Significant	0.401	0.000	Significant

(Author's field work) Note r – Correlation coefficient

Therefore, it is imperative for both parties having good knowledge of this characteristic for effective and successful management of DBB Delivery construction projects. It is common on projects that the parties find disagreement because the nature of each disagreement will predictively affect each party different ways (Chen *et al.,* 2011). Moreover, if the disagreement is inadequately managed, it can also become the source of disputed issues between the owner and the contractor on projects.

This shows that deeper knowledge and clarity with the characteristics of DBB delivery system is a key to project success and an increased effort in understanding characteristics leads to improve project performance in terms of cost and time. This agrees with the findings of ACI-NA, ACC and AGC (2012), Fageha and Aibinu (2013) and Bo *el al*. (2016) that having a clear understanding with

the characteristics of chosen PDS is crucial for successful construction projects. It affects design quality, project communication between stakeholders, and final project performance in terms of cost, schedule, and quality. It could be deduced that successful completion of construction projects in Lagos may be greatly jeopardized without effective management of these significant DBB characteristics.

Conclusion

The study examined impact of characteristics of DBB Delivery Systems on project performance in Lagos State to enhance project delivery in Nigerian construction industry. The results of correlation analysis between cost overrun and DBB characteristics showed that relative ease of implementation, design is complete prior to construction award and construction cost is fixed at contract award (until Change Orders) respectively. Similarly, the correlation between time overrun and DBB characteristics that were significant at p = 0.000 were design and construction are sequential, typically resulting in longer schedules, design is complete prior to construction award and low bid cost, maximum competition.

Based on the findings and conclusion drawn from this study, the following recommendations were made:

i) Scope of work for DBB delivery project must be properly and completely defined in the contract before the approval is made for the commencement of construction project so that disagreements over scope changes can be minimized.
ii) Comprehensive design project data must be totally completed, be in tune with the changing needs of the owner and all necessary requirements incorporated for contractors to bid for the project to minimize changing order.
iii) The timeframe for delivery of a typical DBB delivery project can be upwards. This long duration requires project teams to be flexible as conditions/scope changes.

The study provides implications for effective execution and management of DBB delivery system characteristics.

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