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Comparing Performance Quality of Design-Bid-Build (DBB) and Design-Build (DB) Project Delivery Methods in Nigeria

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ABSTRACT

Design-bid-build (DBB) and design-build (DB) are two prevalent construction project delivery methods widely used in various countries of the world. Researches have generally compared these methods in terms of project quality, neglecting a very important quality dimension; performance quality. This paper aims at comparing the perception of construction professionals on performance quality of DBB and DB. It is based on a set of primary data from manually distributed research questionnaire to professionals in the built-environment, comprising of architects, builders, engineers and quantity surveyors. Using the sampling table, a sample size of 350 was computed. A total of 140 questionnaires (were drawn from professionals who were employed in clients' organizations (N52), contracting firms (N47), and consultancy firms (N41). Frequency counts of their responses were obtained and computed, from which the mean item score for each performance quality criterion was computed to obtain their Relative Importance Indexes, RII. Inferential statistical test was computed for responses of each of the groups and for the overall groups combined about performance quality criterion for DBB and DB. According to the professionals, DB outperforms DBB in terms of performance quality in Nigerian construction industry. Design & build method should therefore be promoted by public and private client alike. Public clients are encouraged to adopt Design & Build method in the delivery of their building construction projects, although not well supported by the subsisting public procurement laws in Nigeria. Performance Quality should be clearly defined at the early stages of building construction projects in Nigeria.

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1.1 INTRODUCTION

The choice of construction project delivery method is an important decisions that has a critical effect on project performance and construction quality (Al Khalil, 2002; Park, Lee, Kim, & Kim, 2015). Numerous studies (Yasamis, Arditi, & Mohammadi, 2002; Alzahrani & Emsley, 2013; Chang, 2016; Jelodar, Yiu, & Wilkinson, 2016; Sullivan, Asmar, Chalhoub, & Obeid, 2017) have been conducted on enhancing the optimization in the selection process of design-bid-build (DBB) and design-build (DB) by simple comparison. The design-bid-build and design-build, have been compared largely in terms of project quality (Idiake, Shittu, Anunobi, & Akanmu, 2015; Pandit & Yadav, 2014), but an important quality dimension; performance quality (Watermeyer, 2010), has generally been neglected in previous studies.

1.2 Concept of Design and Build and Design-Bid-Build

Under the design and build, the contractors typically make decisions and carry out the works based on co-operation and coordination (Ramus, Birchall, & Griffiths, 2006). DB and DBB methods exhibit varying characteristics

and consequently have different advantages and disadvantages. Therefore, the project participants may undertake unique quality dimensions with relevant strategies based on different delivery methods (Morledge & Smith, 2013).

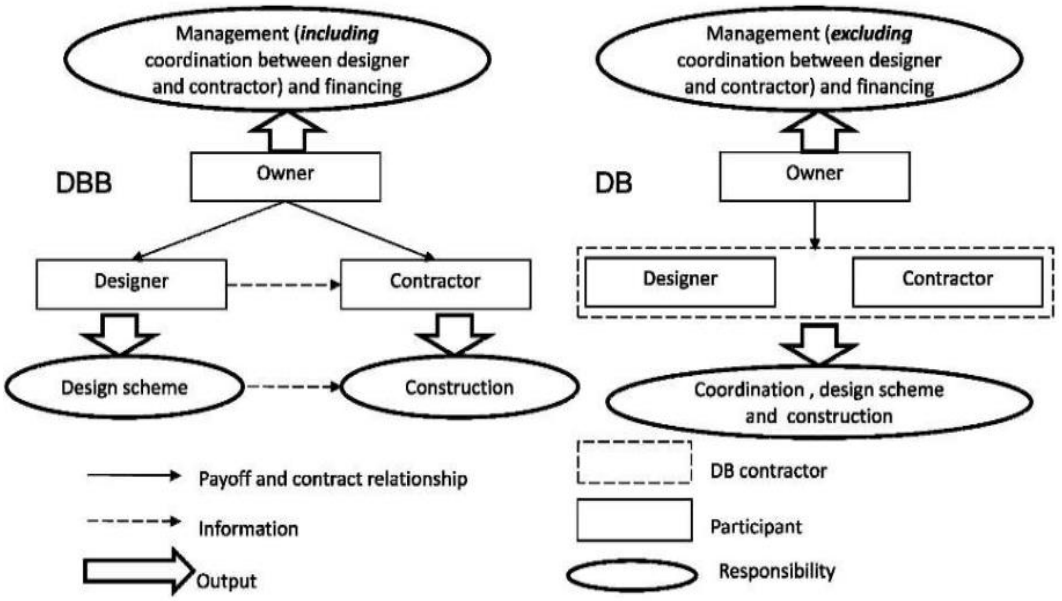

Figure 1: *Conceptual model for DBB and DB* *Source: Ashworth & Perera (2015)*

In DBB, the project owner divides project tasks into two parts (i.e., the design component and the construction component) and separately awards them to two entities (i.e., a designer and a contractor). Figure 1 simplifies the DBB and the DB delivery methods, with their unique attributes. As shown, no contractual relationship exists between the designer and the contractor; the two parties typically make decisions and complete their work independently. However, in the DB method, the owner contracts the entire project to only one entity (a DB contractor) that undertakes all the design and construction tasks of the project (Group, Mahdi, Riley, Fereig, & Alex, 2002).

Table 1 *Comparison between the DB and DBB Delivery Method (Chen, Zhu, & Zhang, 2009)*

Dimension	DB	DBB
1. Mode of payment	The owner pays the DB contractor	The owner pays the designer and the contractor, respectively
2. Degree of cooperation between the designer and the contractor	High	Low
3. Responsibility and involvement of the owner	Low	High
4. Responsibility and involvement of the designer and the contractor	High	Low
5. Risks for the owner	Low	High
6. Risks for the designer and the contractor	High	Low
7. Design/construction costs for the designer and the contractor	Uncertain	Uncertain
8. Coordination/communication costs for the designer and the contractor	High	Low
9. Management costs for the owner	Low	High

1.2.1 Design-Bid-Build (Traditional Method)

Design-bid-build (DBB) remains the predominant delivery method for construction services in the United Kingdom as well as many parts of the world (Morledge & Smith, 2013), with low-bid procurement being the predominant method for selecting construction firms (Sullivan & Guo, 2009; El Asmar et al. 2010; Ballesteros-pérez, Skitmore, Pellicer, & Gonzalez-Cruz, 2015; Schöttle & Arroyo, 2017; Nguyen, Lines, & Tran, 2018). However, increasing numbers of owners are inclined to adopting alternative contracting methods, such as design-build (DB) and construction manager at risk (CMAR), for better project performance (El Asmar et al. 2016; Carpenter & Bausman 2016; Sullivan et al.2017). Because procuring a qualified contractor greatly affects the performance of the project (El-Wardani, Messner, & Horman, 2006; Carpenter & Bausman, 2016), from early nineteenth century until about the 1950s, the ways by which building projects were promoted and carried out in the UK conformed to straightforward and well-tried procedures.

If the project was small, the building owner (or 'Employer', as he is often called) employed a building contractor to design and construct the building for him. Because buildings generally conformed to a well-defined pattern, contractors had within their organizations the full range of expertise and skills normally required. In the case of larger projects, the Employer appointed an architect to design the building, and he then produced drawings and a specification. If the architect considered it necessary (and the Employer approved), he then appointed a quantity surveyor to prepare a bill of quantities. Then, on the basis of either the specification and drawings or the bill, contractors were invited to tender in competition to carry out the work. Usually the lowest tenderer was awarded the contract. Since the mid-1940s, the architect's nomination and/or appointment of the quantity surveyor has been gradually superseded by appointment by the Employer, sometimes before the selection of the architect and, in some cases, the latter's selection is made on the recommendation of the quantity surveyor.

1.2.2 Design and Build

Design and build projects aim to overcome the problem of having separate design and construction processes by providing for them within a single organization (Morledge & Smith, 2013). The single firm is generally the building contractor, who may employ the designers in-house or be responsible for employing consultants directly under their control. The major difference is that instead of approaching the designer for a building, the employer briefs the contractor directly. The employer may choose to retain the services of an architect or quantity surveyor to assess the contractor's design or to monitor the work on site. The prudent employer will always want some form of independent advice. The design evolved by the contractor is more likely to be suited to the needs of the contractor's organization and construction methodology, and this should save construction time and construction costs. Some argue that the design will be more attuned to the contractor's construction capabilities, rather than the design requirements of the employer. The final building should result in lower production costs on site and an overall shorter design and construction period, both of which should provide price savings to the employer (Arslan, Kivrak, Birgonul, & Dikmen, 2008; Lines & Kakarappalli, 2018). There should also be some supposed savings on the design fees, even after taking into account the necessary costs of any independent architectural advice. A further advantage to the employer is in the implied warranty of suitability, because the contractor

has provided the design as a part of the all-in service (Ramus et al., 2006).

Design-bid-build (DBB) and design-build (DB) are two prevalent delivery methods widely used in various countries such as China, Singapore, United Kingdom, and United States (Chen et al., 2009). The choice of delivery method is one of the most important decisions that can determine the quality of construction projects. Two basic delivery methods, design-bid-build and design-build, have been compared in terms of project quality; however, an important quality dimension, performance quality, has generally been ignored in previous studies (Warsame, Borg, & Lind, 2013; Sullivan et al., 2017; Tao, Geoffrey, & Qian, 2019).

The construction industry in China has experienced rapid growth because of unprecedented urbanization processes. During this period, DBB and DB were the most commonly adopted procurement route to deliver construction projects (Chen, Xia, Jin, Wu, & Hu, 2016). In America, DBB dominated the construction industry for a long time because the Federal Acquisition Regulations had strict constraints on the utilization of other delivery methods before 1996 (Hale, Shrestha, Gibson, & Migliaccio, 2009). Presently, DB has become an important alternative for American practitioners because of its favorable delivery speed (Minchin, Li, Issa, & Vargas, 2013). In terms of application, these two delivery methods have been successfully used to develop highway and bridge projects in America (Minchin et al. 2013). The study conducted by (Park et al., 2015) indicates that DBB and DB can be effectively utilized to develop public housing projects such as in the case of South Korea. In summary, DBB and DB have been widely used and accepted by practitioners from all over the world. In a project, the delivery method can significantly affect the risk allocation, the incentive mechanism for performance improvement, the scope of work, and the efficiency of cooperation among different participants (Bausman, Chowdhury, & Tupper, 2014).

In Konchar & Sanvido (1998), defined project quality as "the degree to which a facility meets expected requirement." This definition of quality placed emphasis on the conformance to quality requirements and ignored the importance of performance quality. In some related studies, *client's satisfaction* on DBB and DB projects was a major consideration. But key performance quality indicators such as *fitness for purpose* and *functions* were generally ignored. In this paper, DBB and DB methods are compared in terms of their performance quality. The study will be useful in client organizations in the development of informed strategies for the procurement of construction projects in Nigeria by exposing the perception of professionals in the construction industries on quality performance of design bid build and design and build procurement routes based on identified set of measurable criteria. The perception of the Architects, quantity surveyors, builders and engineers employed in public organizations, contracting organizations and consulting firms were engaged.

2.1 METHODOLOGY

Architecture and Engineering professionals were drawn randomly from a list of the financially up-to-date registered members of their various professional associations, where a sample size of 450 was obtained using Krejcie & Morgan's (1970) formula. A sample of 160 (above the minimum of 30%) of the sample size was computed. 160 responses were obtained through a self-administered questionnaire, on which 140 valid responses were analyzed using inferential and descriptive statistics. The perception of the professionals about the performance quality of design-bid-build and design-build delivery method was evaluated using relative importance index after which statistical tests were conducted.

3.1 RESULT AND DISCUSSION

A. The Relative Importance Index, RII

The Relative Importance Index, RII is used to compute the mean score of project success criteria in relation to the overall responses on a criterion.

$$\text{Relative Importance Index} = \frac{5n_5+4n_4+3n_3+2n_2+1n_1}{5N} \quad \text{Equation 1}$$

From Equation 1, n_1 = number of respondents for not important; n_2 =number of respondents for somewhat important; n_3= number of respondents for important, n_4= number of respondents for very important, n_5 = number of respondents for extremely important, N = Total number of responses. The highest possible value of the computed index is + 1.0 when the rankings are in perfect agreement (Creswell, 2012, 2014). The strength of an agreement is seen in performance criteria with corresponding values of near or equal +1.0. The responses were grouped into employer organizations (clients, consultants and contractors). The distribution of respondents' professional background is shown in table 2. The highest number was quantity surveyors (19%), civil engineers (17%), estate surveyors and architects (13%) each, mechanical engineers (11%); and (9%) were electrical engineers. 35% of the respondents work in contractor organizations, 27% work in Client organizations, 29% work in consultancy organizations and 7% work in organizations other than the other three categories.

Table 2 shows the details of the representation of the professionals. Overall, the professionals were employed in clients' organizations (*N*47) representing 33.6% of the sample, consultancy organization, *N*41 (29.29%), and contracting organizations, *N*52 (about 37%). Out of the 20 responses drawn from quantity surveyors, 40% worked for client organizations, 35% worked for consultant organization and twenty five, 25% were engaged in contracting organization. One-quarter of the architects were engaged in clients' organizations, 40% in consultancy services, and 35% were employed in contracting organizations. 40% of the builders are working with contractors and consultants each, while 20% were working in clients' organizations. Forty five percent (45%) of the civil engineers were working for clients' organizations, while 15% were working as consultants and other 40% were working for contractors. Thirty-five percent of the mechanical engineers were working for client organizations; 25% were working for consultant organizations, while contracting firms engaged 40%. Half of the electrical engineers, 50% were engaged in consultancy firms, with 30% and 20% for client and consultancy firms respectively.

Table 2: *Representation of professionals*

	Client		Consultants		Contractor		
Professionals	**Professional**	**Percentage**	**Professional**	**Percentage**	**Professional**	**Percentage**	**Total**
Quantity Surveyors	8	40%	7	35%	5	25%	20
Architects	5	25%	8	40%	7	35%	20
Builders	4	20%	8	40%	8	40%	20
Civil Engineers	9	45%	3	15%	8	40%	20
Mechanical Engineers	7	35%	5	25%	8	40%	20
Electricals Engineer	6	30%	4	20%	10	50%	20
Estate Surveyors	8	40%	6	30%	6	30%	20
Total	47	33.6%	41	29.29%	52	37.14%	140

Source: *Field survey*

3.1.1 Statistical test

Table 4 shows the overall perception of the groups both for DBB and DB for all the professionals. Statistical tests were carried out on the ranking of the performance quality of DBB and DB.

T-test was used to confirm for or otherwise the agreement in the perception of the professionals in the construction industry on performance quality criteria. Rs = Spearman's rank correlation coefficient, t-cal = t-calculated, t-tab = t-tabulated, Ho = null hypothesis; and *p*-value = probability that rejects null hypothesis wrongly.

3.2 Discussion

Table 4 reveals that Durability ranked first in both DBB and DB according to the professionals in the Nigerian construction industry. While, fair introduction of Change was ranked second. On the remaining performance criteria, the DBB and DB according to the professionals vary significantly. Table 3 shows the Spearman's rank correlation and the *t*-values for the importance of performance quality criteria as perceived by the professionals in the industry. It can be observed that the *t*-cal 3.442, 6.128, and 5.104 are greater than the *t*-tab of 1.645 at *p*= 0.05 significant levels. A comparison of responses for both DBB and DB shows that there is no general agreement between the professionals; clients and consultants, clients and contractors, as well as consultants and contractors, with respect to their ranking of the importance of performance quality in DBB and DB. Comparison of the professionals' response reveals significant disagreement. This study differed from previous studies in measuring project performance quality. In Park et al. (2015), project quality was assessed from two dimensions; design quality and construction quality, using only eight indicators to measure the dimensions. Konchar & Sanvido (1998) applied "the degree to which the facility met expected requirements" (including seven indicators) to assess project quality of DBB and DB projects. Some scholars like Aina, & Yakeen (2011) opine that the DB achieves higher performance quality than DBB in terms of; (1) improved cooperation and teamwork between designer and contractor, (2) fewer incidences of misunderstanding and conflicts as a result of improved communication, and (3) earlier involvement of the contractor at the project design stage (Xia, Chan, Zuo, & Molenaar, 2013; Stanford & Molenaar, 2018). Other scholars (Ratnasabapathy & Rameezdeen, 2006; Balson, Gray, & Xia, 2012; Safa, Yee, Rayside, & Haas, 2016) argue that DBB is superior to DB.

Table 3: *Test of Agreement on Ranking of Criteria as Perceived by Different Groups*

				DBB			DB	
				Accept			Accept	
Group of Professionals	Rs	t-cal	t-tab	H_0	*p*-value	t-tab	H_0	*p*-value
Clients and Consultants	0.73	3.442	1.645	Yes	Sig.< 0.05	1.645	Yes	Sig.< 0.05
Consultants and Contractors	0.81	6.128	1.645	Yes	Sig.< 0.05	1.645	Yes	Sig.< 0.05
Clients and Contractors	0.88	5.104	1.645	Yes	Sig.< 0.05	1.645	Yes	Sig.< 0.05

Table 4: *Mean Score and Ranks for DBB and DB by Professionals and Overall Average Rank*

S/ No	Performance Quality Criteria	DBB Mean Score	DBB Rank	DB Mean Score	DB Rank	Average on DBB and DB Mean Score	Average on DBB and DB Overall Rank
1	Durability	4.23	1	4.33	1	0.9	1
2	Change are being fairly introduced	4.19	2	2.52	2	0.87	2
3	Client interaction being open and friendly	4.19	2	3.19	10	0.69	3
4	End user's satisfaction	4.19	2	4.24	4	0.76	4
5	Openness and friendliness in communication	4.18	3	2.98	5	0.75	5
6	Fitness for purpose	4.05	4	4.20	11	0.67	9
7	Meeting design, functional, technical, managerial and organizational goals	4.05	4	4.29	3	0.66	10
8	Quality compliance	4.00	5	3.86	16	0.42	23
9	Project schedule being detail	3.86	6	4.26	6	0.57	15
10	Perceived performance and functionality	3.86	6	4.29	7	0.82	3
11	Technical performance	3.86	6	4.38	13	0.71	6
12	Functionality	3.86	6	3.67	22	0.53	17
13	Contractor's satisfaction	3.81	7	4.33	24	0.62	13
14	Client's satisfaction	3.79	8	3.67	28	0.45	22
15	Project management team satisfaction	3.79	8	3.67	9	0.52	18
16	Health, safety and risk procedures being met with minimal accidents	3.79	8	4.30	27	0.68	8
17	Reduction in dispute	3.78	9	4.33	12	0.51	19
18	Perceived quality	3.76	10	4.02	15	0.46	21
19	Conformance to standard of environmental management	3.76	10	3.95	17	0.41	24
20	Project completed on time	3.71	11	4.33	29	0.35	45
21	Suppliers being able to meet deadline	3.71	11	4.10	18	0.28	29
22	Efficiency in project execution	3.66	12	1.69	14	0.62	17
23	Reliability	3.52	13	4.19	8	0.34	27
24	Project being paid for as agreed	3.48	14	3.86	19	0.61	19
25	Commitment of contractor to environmental management	3.43	15	4.24	20	0.35	25
26	Response to complain being quick and productive	3.24	16	4.05	25	0.29	28
27	Minimal injuries	3.24	16	4.05	23	0.56	16
28	Conformance to specification	3.21	17	4.57	26	0.59	14
29	Communication flow being consistent	3.04	18	4.02	21	0.50	20

Source: Field Survey

4.1 CONCLUSION AND RECOMMENDATION

In this study, performance quality attributes were sourced from literature. Built-environment professionals were asked to rate the performance quality criteria against their perception for design bid build (DBB) and design and build (DB) project delivery methods in Nigeria. This study shows that the professionals do not agree on the superiority of DB over DBB in terms of performance quality, but agree only on performance quality dimensions like; durability, fair introduction of changes and Open and friendly client interaction. Built-environment professionals do not have a consensus on the importance of Performance quality attributes for both DB and DBB project delivery methods. Therefore, clients adopting Design & Build procurement method for their projects should ensure that detailed and conclusive briefs herald their project development process. Similarly, quality performance should be reviewed at the early stages of project by clients through detailed analysis by ensuring that designs are also detailed to enhance performance quality in DB as well as DBB delivery method in building construction projects in Nigeria.

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