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Impact of Risk on Performance of Design and Build Projects in Lagos State, Nigeria

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Abstract: "Design and Build" procurement method has been in use in Nigeria and this method has been latent with a lot of risks. This study intends to identify the risk inherent in "Design and Build" and also to evaluate the impact of the identified risks on project performance. A descriptive research survey is undertaken for this study. Snowballing sampling technique was used via the use of questionnaires. Population of the study includes contracting organizations, consultants and clients' organizations that are recently involved in "Design and Build" projects. A total of 39 questionnaires were distributed and 27 were returned and used for the analysis. Statistical Package for Social Sciences was used for analyzing the data collected. Descriptive statistical tool of mean item score was employed for the analysis. The results show that the most prominent risk is change in quantity/scope of work in terms of cost related risk while in terms of time related risks the most prominent risk is design changes. Errors and omissions during construction are the risks prominent in terms of quality. In conclusion, "Design and Build" procurement has a lot of inherent, unresolved and undefined cost, time and quality related factors that can trigger off risks that will affect performance of DB project. Implications of this study to practitioners in the construction is such that the findings of this study can create awareness for stakeholders and construction practitioners of the prominent risks that affect DB projects and this can help in better management of future DB projects in Nigeria and other developing countries. Design and Build procurement in spite of these plethora of risks is still strongly recommended for clients, stakeholders and other practitioners in the construction industry for use in their future projects. This procurement method delivers project faster, within cost and offers good quality of workmanship and product to users of this method.

Key words: Risk, design and build, procurement, impact, building projects.

1. Introduction

"Design and Build" is a method of project delivery in which one entity (designer and builder) undertakes a single contract with the owner to provide for architectural/engineering design services and construction services [1]. The procurement method has gained increased market share in the last few years [2–6]. It facilitates innovative and flexible approaches such as phased construction, improves the ability to manage risk because there is a single point of responsibility, allows managers to take advantage of new materials and new technologies, and encourages the development of innovative practices that support energy, efficiency and sustainability, shortened project delivery time and reduce project costs [3]. Construction industry is plagued of risks and it has led to poor performance such as inability of completing projects within time, cost and quality standard. Risk is a variable in the process of construction whose occurrence results in measurable uncertainty as to the final performance of the construction project. The high level of risk and uncertainty in the industry compounds the characteristics of the industry [7–9]. Construction project is a high risk activity, but the ability to identify potential risks and steps to be taken to avoid them are important aspects of project management [10]. According to Dada et al. [6], contractors in developing countries have insufficient experience and knowledge

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to manage risk effectively but financial mark-ups are used by contractors to cover the risk associated with construction projects. However, margins are tighter and so contractors must increase their awareness of risks and adopt proactive strategies in order to assess, model, analyse and mitigate risks. Most contractors are not familiar with these risk factors and are inexperienced in managing them effectively and so it could lead to failure of the project as opposed by Baloi et al. [11] and Wagner [12] that effective risk management leads to success of a project .Therefore, risks need to be shared between the parties involved, identified, registered and controlled throughout the project. Risk can be transferred, accepted, managed, minimized or shared but cannot be ignored [13]. "Design and Build" projects also involve risk which can be shared between the parties involved in the project. Oztas and Okmen [14] stressed that "Design and Build" provides various advantages though entailing the contractor carrying out the responsibility of constructing and designing the project. However, this is a risky form of procurement for both owners and contractors unless the risks are identified, analysed and managed throughout the project. They also opined that common construction project risks increase their intensity under "Design and Build" system in developing countries. It therefore becomes necessary that risk analysis and management should be important tools for successful performance of "Design and Build" projects. The purpose of this study is to identify the risk inherent in "Design and Build" projects and assess the impact of these risks on project performance in terms of time, cost and quality standard.

2. Risk Associated with "Design and Build" Projects

Boehm and Port [15] opined that risks and events can cause a project to fail to meet its goals. They range in impact from trivial to fatal and in likelihood from certain to improbable. Since risk considerations dictate the path a development must take, it is important that those risks be catalogued candidly and completely. Every building procurement method has basic characteristics that define its framework. When a particular method is selected for a specific project, the characteristics dictate the risk and level of uncertainties involved. Irrespective of the procurement method, it is important to identify and assess the inherent risks so as to structure the risk management techniques to be adopted [6]. "Design and Build" has been a popular contract system in recent years [14] because it has been discovered to be most effective in meeting most project objectives when compared with DBB (design-bid-build) and CM (construction management) which are the other forms of procurement of project [3, 14, 16–18]. "Design and Build" is a system where one person, company or organization provides comprehensive service from the design to construction of the project with all the human resources secured in house [19]. Other researchers definitions of "Design and Build" entails a contract in which the "Design and Build" of the project is taken by a single entity [13, 20]. Because it involves a single entity, it thus enables some part of construction work to begin before the final design is completed. It results to shorten project duration and reduction of administration and inspection cost. It also reduces variation and claims. There are various variants of "Design and Build". It includes develop and construct, enhanced "Design and Build", traditional "Design and Build" and EPC (Engineering-Procurement-Construction). However, "Design and Build" is a risky system of project delivery for both owners and contractors expect if the risk is identified, analysed and managed throughout the project [14] and determine how the risk should be shared among parties. Therefore, risk analysis and management is an important tool for the success of "Design and Build project. Risk management involves risk identification, risk estimation, risk evaluation, risk response and risk monitoring [21].

Professional liability underwriters have perceived "Design and Build" procurement as the most hazardous

construction-related professional liability exposure due to the combination of design activity, on-site supervisory presence and active participation in the actual construction and the degree of control on the entire construction project [22] and so the contractor bears all the risks in a "Design and Build" project. The impact of risk on "Design and Build" project therefore result to cost overrun, time overrun and unsatisfactory quality standard [3].

3. Research Method

The population of the study consists of construction professionals involved in the building construction of DB (Design and Build) projects as well as some organizations that are involved in DB projects. The population therefore comprises of client, consultant and contractors who are into the practice of DB procurement and are based in Lagos metropolis in Nigeria. The construction professionals in these organizations are mainly quantity surveyors, architects, engineers and contractors. The study is a survey research that used cross-sectional and explanatory research designs for capturing the data for the study. Construction experts who are professionals already mentioned above were used to collate information required through the use of questionnaire/interview and archival sources. The identify risks affecting the performance of DB projects was achieved through literature and field survey while the effect of the identified risks on the performance indicators (cost, time and quality) was achieved through field survey in form of questionnaires. This study employed snowballing technique for selecting the sample as the sampling size cannot be formulated because there is no registered organisation that coordinates DB procurement practitioners. An opinion—based questionnaires were used for the study. Descriptive statistical tool of mean item score (*MIS*) was used to analyse the data using this formula:

$$MIS = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5(n_5 + n_4 + n_3 + n_2 + n_1)}$$

where,

n_5 = number of respondents with very high impact;
n_4 = number of respondents with high impact;
n_3 = number of respondents with average impact;
n_2 = number of respondents with low impact;
n_1 = number of respondents with no impact.

4. Analysis and Results

4.1 Background Information

Table 1 shows that 31% of the respondents are quantity surveyors, 27% are architects, 19% are civil Engineers, 12% are builders, 8% are mechanical/ Electrical engineers and 3% are accountants. It shows that majority of the respondents are quantity surveyors and architects. From the Table 1, 31% of the respondents are members of NIA (Nigerian Institute of Architects), 27% are members of NSE (Nigerian Society of Engineers), 23% are members of NIQS (Nigerian Institute of Quantity Surveying), 4% are NIOB (Nigerian Institute of Building) members and 15% do not belong to any professional body. It shows that 85% are members of particular professional bodies and so are able to provide vital information on the objectives of this research. 58% of the respondents have been in the construction industry for less than 11 years, 23% between 11–20 years, 12% are between 21–30 years and 8% have spent more than 30 years in the construction industry. Also from Table 1, 54% of the respondents are consultants in "Design and Build" project, 42% are contractors and 4% are clients. 50% of the projects are residential building, 31% are commercial/offices, 15% are industrial and 4% are institutional buildings. It shows that "Design and Build" projects are used for various types of projects. 39% of the clients who own the projects are private individuals 31% are corporate bodies, 15% are manufacturing companies and 4% are international organizations, religious body, private sector organizations and educational organizations.

Table 1 Background information.

Background information	Frequency	Percentage (%)
Professional		
Architect	7	27
Mechanical/electrical engineer	2	8
Builder	3	12
Civil engineer	5	19
Quantity surveyor	8	31
Accountant	1	3
Total	26	100
Professional affiliation		
NIA	8	31
NIQS	6	23
NSE	7	27
NIOB	1	4
NONE	4	15
Total	26	100
Grade of membership		
None	4	15
Full member NIA	4	15
Associate member NIQS	3	12
Associate member NSE	5	19
Corporate member NSE	2	8
Graduate NIA	2	8
Graduate NIQS	2	8
APMP, qualified	1	4
Associate member NIA	2	8
Associate member NIOB	1	4
Total	26	100
Years of experience		
Under 11 years	15	58
11-20 years	6	23
21-30 years	3	12
Above 30 years	2	8
Total	26	100
Types of respondent		
Client	1	4
Contractor	11	42
Consultant	14	54
Total	26	100
Types of project		
Residential	13	50
Commercial/offices	8	31
Industrial	4	15
Institutional	1	4
Total	26	100
Category of client		
Private individual	10	38
Manufacturing company	4	15
Corporate body	8	31
International organization	1	4
Religious body	1	4
Private sector organization	1	4
Educational institution	1	4
Total	26	100

4.2 Cost Related Risk Factors and Impact on Design and Build Performance

Table 2 shows that 11% of the cost related risk factors in "Design and Build" projects pertain to changes in quantity/scope of work, 19% of the risks relate to inflation, 8% of the risks are in exchange rate, while 2% of the risks emanate from safety and accidents and 1% are from financial failure and catastrophes. In testing the level of impact of cost related factors on "Design and Build", mean item score was calculated and ranked. It is realized that changes in quantity/scope of work ranks highest, followed by inflation, exchange rate fluctuation, owner and contractor experience, quality control and assurance and the least rank is catastrophes.

4.3 Time Related Risk Factors and Impact on Design and Build Project

Permits and approvals and changes in scope of work both have 8% of the time related risk factors in "Design and Build" projects, 7% of the identified risk relate to owner and contractor experience as shown in Table 2. Site access, design changes, government acts and regulations, contract and award method have 6% of time related risk. 2% emanate from exceptional inclement weather and 1% from catstrophes. In terms of level of impact as show in Table 3, changes in quantity/scope of work ranks highest, followed by permit and approval and differing site condition and the least is catastrophes.

4.4 Quality Related Risk Factors Identification and Level of Impact on Design and Build Projects

Table 4 indicates that quality control and assurance has 18% of the quality related risk factors in "Design and Build" projects, 14% relate to owner and contractor experience, and warranty of facility performance, 11% of the risks emanate from errors or omissions revealed during construction and construction defects, 10% result from contract and award method while 2% of the risks emanate from

Table 2 Cost related risk factors and impact.

Cost related	Frequency	Percentage (%)	Mean item score	Rank
1. Changes in quantity/scope of work	23	11	0.70	1
2. Inflation	19	9	0.64	2
3. Owner and contractor experience	16	8	0.58	4
4. Exchange rate fluctuation/devaluation	15	7	0.64	2
5. Quality control and assurance	15	7	0.52	7
6. Difficulties/delays in availability of materials, Equipment and labour	14	7	0.45	15
7. Contract and award method	14	7	0.55	5
8. Warranty of facility performance	14	7	0.47	12
9. Errors or omissions revealed during construction	12	6	0.50	10
10. Differing site conditions (unforeseen site conditions)	11	5	0.53	6
11. Owner delays (lack of payments/delayed progress payment)	11	5	0.52	7
12. Bureaucratic problems	9	4	0.45	15
13. Construction defect (inadepuate quality of work and need for correction)	9	4	0.41	17
14. Inadequate specifications	8	4	0.47	12
15. Government acts and regulations	8	4	0.48	11
16. Constructability of design	7	3	0.52	7
17. Safety and Accidents	4	2	0.35	18
18. Financial failure-any party	2	1	0.47	12
19. Catastrophes (earthquake and fire)	2	1	0.35	18
Total	213	100		

Table 3 Time related risk factors.

Time related risk factors	Frequency	Percentage (%)	Mean item score	Rank
1. Permit and approval	18	8	0.64	2
2. Changes in quantity/scope of work	18	8	0.70	1
3. Owner and contractor experience	16	7	0.53	9
4. Site access/right of ways	14	6	0.58	4
5. Design changes	13	6	0.49	15
6. Governemt acts and regulations	13	6	0.49	15
7. Contract and award method	13	6	0.50	13
8. Difficulties/delays in availability of materials, equipment and labour	12	5	0.55	6
9. Errors of omissions revealed during construction	12	5	0.45	20
10. Owner delays (lack of payments/delayed progress payment)	11	5	0.56	5
11. Third party delay and default	10	5	0.46	16
12. Financial failure-any party	10	5	0.46	16
13. Differing site conditions (unforeseen site conditions)	9	4	0.59	3
14. Constructability of design	9	4	0.51	11
15. Bureaucratic problems	8	4	0.46	16
16. Construction defect (inadequate quality of work and need for correction)	8	4	0.54	8
17. Safety and accidents	7	3	0.46	16
18. Inadequate specification	7	3	0.50	13
19. Delay in design/redesign if over budget	6	3	0.52	10
20. Exceptionally inclement weather	5	2	0.51	11
21. Catastrophes (earthquake, fire etc.)	3	1	0.39	21
Total	222	100		

Table 4 Quality related risk factors and their level of impact.

Quality related risk factors	Frequency	Percentage (%)	Mean item score	Rank
1. Quality control and assurance	18	18	0.62	1
2. Owner and contract experience	14	14	0.56	3
3. Warranty of facility performance	14	14	0.48	7
4. Errors or omissions revealed during construction	11	11	0.43	9
5. Construction defect (inadequate quality of work and need For correction)	11	11	0.56	3
6. Contract and award method	10	10	0.51	5
7. Constructability of design	8	8	0.59	2
8. Inadequate specifications	7	7	0.51	5
9. Differing site condition (unforeseen ground conditions)	6	6	0.46	8
10. Catastrophes (earthquake, fire)	2	2	0.40	10
Total	101	100		

catastrophes. In terms of level of impact, quality control and assurance ranks first, followed by constructability of design, construction defects and owner and contractor experience, inadequate specifications and warranty of facility performance while the least ranked factor is catastrophes.

5. Discussion of Findings

Traditional construction contracts have been tested for nearly 150 years in the crucible of the twentieth century whereas “Design and Build” contracts have received little attention as a result the risks involved. The method is less understood and contractual provisions for resolving them are less well settled [10]. Although in all procurement methods, there is transference of risk due to apportionment of risk. Based on this, the following findings emanate from this study:

(1) Changes in quantity/scope of work,inflation,owner and contractor experience, contract and award method, error or omission revealed during construction and owner delays (lack of payments/delayed progress payment) are the prominent cost risk factors affecting the performance of “Design and Build” projects, while exchange rate fluctuation, quality control and assurance, delays in availability of materials, equipment and labour, warranty of facility performance and differing site condition are not the prominent cost risk factors affecting the performance of “Design and Build” projects;

(2) Design changes, delays in availability of material, equipment and labour, error or omission revealed during construction and owners delay are the prominent time related risk factors affecting the performance of “Design and Build” projects;

(3) Errors or omission revealed during construction is the most prominent quality risk factors affecting the performance of “Design and Build” projects;

(4) Changes in quantity/scope of work permit and approvals, differing site condition, quality control and assurance among others have an impact on the cost, time and quality performance of “Design and Build” projects.

6. Conclusions

This study has critically examined and evaluated the issues surrounding the effect of risk on performance of “Design and Build” projects in Lagos state, Nigeria. The results of the study can be seen as another contribution to the fact that risk is involved in every construction project irrespective of the framework adopted in its actualization. This is due to the fact that every procurement method has its own peculiar risks. According to Ashcraft et al. [23], “Design and Build” entails a lot of risks but a clear understanding of the risks with risk management undertaken can significantly reduce their impacts on performance of Design and Build projects.

Thus the following conclusions are drawn on this study:

(1) “Design and Build” has a lot of inherent, unresolved and undefined cost related factors that result into risk which will affect the procurement;

(2) “Design and Build” is encumbered with unsettled issues and inadequate preparation before proceeding to construction phase which result into risks that are triggered-off by time related risk factors that will affect the procurement;

(3) “Design and Build” acquires additional works/issues which are not preempted at the initial stage for adequate incorporation into the design factors hence it result into quality related risk factors that will affect procurement;

(4) Cost performance of “Design and Build” is dependent on changes in quantity/scope of work cost related factor;

(5) “Design and Build” absorbs time related risk factors thus preventing its impact on the time performance;

(6) Quality related risk factors have impact on “Design and Build” due to inability of the owner to exercise control over design and build.

Findings of this study can create awareness for stakeholders and construction practitioners of the prominent risks that affect DB projects and this can help in better management of future DB projects in Nigeria and other developing countries. Design and Build procurement in spite of these plethora of risks is still strongly recommended for clients, stakeholders and other practitioners in the construction industry for use in their future projects. This procurement method delivers project faster, within cost and offers good quality of workmanship and product to users of this method.

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