Factors Critical to Industrialised Building System Performance of Nigerian Mass Housing Projects

Edo O. Ojoko [1,2], Mohd H. Osman[1], Rahman A. B. Ahmad[1], and Nahisham Bakhary[1*]

[1] Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
[2] School of Environmental Studies, Federal Polytechnic Nasarawa, PMB 001, Nasarawa State, Nigeria
*norhisham@utm.my

Abstract: *Adopting Industrialised building system (IBS) for project delivery, World over, has been recognized as a remedy for poor project performance. However, in most developing nations, especially Nigeria, its adoption for mass housing delivery has been confronted with a myriad of factors culminating in poor performance and low uptake. Therefore, this study is focused on identifying and evaluating those factors inhibiting IBS performance. Of the 64 sixty-four (64) factors identified from the literature and structured interview, experts' opinion (Delphi method) considered forty-seven (47) as critical to IBS project performance. Applying purposive approach for this pilot exercise in Abuja, 300 questionnaires based on a Likert scale of I-5, (1-least significant to 5-Most Significant) were administered to multidisciplinary construction stakeholders. 210 (70%) responded within four weeks and both the descriptive and inferential statistics were employed in the data analysis. Although, the stakeholders considered all the 47 factors to be critical, however, forty (40) factors were perceived to be of high influence, and seven (7) factors of moderate influence on IBS performance. The five (5) leading critical success factors (CSFs) are; Clear and precise goals, knowledge & skills, planning & control top management support, and transportation. Knowledge of CSFs will assist Stakeholders in effective decision-making.*

Keyword— Industrialised Building System, Critical Success Factors, Project Performance, Mass Housing Projects, Nigerian Construction Industry

1 INTRODUCTION

The construction industry, through the provision of infrastructure and shelter, plays a pivotal role in the socio-economic development and employment generation goals of any nation (Oladinrin et al., 2012). Although, studies attest to the industry's successful performance in enhancing the GDP and employment status of various nations (Oluwakiyesi, 2011; Ekong & Onye, 2013), however these are largely in developed countries (DCs) while those in the less developed countries (LDCs) for decades have been besieged with poor performances manifesting in project delays, cost overruns, poor quality, unprecedented abandonment and incessant building collapse (UN-Habitat, 2006). For instance, in Nigeria in the last three decades, this myriad of failure, especially in the sector is reflected in its minuscule contribution to the nation's GDP and employment generation (Oluwakiyesi, 2011).

In the building sector, a subset of the construction industry, the failure attributes of the projects are mostly associated with the prevalent high cost and slow delivery rate of the conventional construction method which is predicated on massive on-site activities and unskilled labour (Aladeloba et al., 2015). Unfortunately, since independence in 1960, the conventional method accounts for over 90% of building projects in Nigeria (Jiboye, 2011), and by exetension, largely responsible for the current 17milion housing deficit (Federal Ministry Lands, Housing and Urban development, FMLHUD, 2013). To provide the requisite solution, as evidenced by various studies (Latham; 1994; Egan et al., 1998; Thanoon et al., 2003; Blismass and Wakefield, 2009), the Nigerian Government in 2011 embraced a paradigm shift from the conventional method of construction to the Industrialized Building System (IBS) (FMLHUD, 2013). The adopted four (4) IBS types are; i). America Light Gauge Steel ii). Plassmolite/Plasswall iii) Interlocking Masonry blocks, and iv). Burnt bricks for a Pilot Housing Project in Kuje, FCT, Abuja (FMLHUD, 2013). However, in spite of the recorded favourable performances in DCs and in even the pilot housing projects in FCT, Abuja that encouraged its embrace in other geo-political zones (FMLHUD, 2013) empirical observation and recent studies revealed poor performance and a low IBS take up in the Nigerian building industry (Kolo et al., 2014; Pour Fahiniam et al, 2017).

So far, list of contextual factors responsible for the poor performance are limited. Most of the factors presented by the few pioneer studies on IBS performance in the Nigeria building industry, are based on general construction projects from anecdotal sources (Kolo et al., 2014; Aladeloba, 2015). While the studies of Kolo et al., (2014) and Aladeloba (2015) outlined the likely causative factors based on literature review, that of Pour-Fahimian et al., (2017) only suggested a broad framework on general construction projects. The absence of context-specific approach in the studies makes the recommendations unlikely appropriate to resolving the challenges of IBS adoption in Nigerian housing projects (MHPs). The aim of this study, therefore, is to bridge this research gap by identifying and evaluating the factors critical to IBS performance in the MHPs delivery as perceived by key stakeholders in the Nigerian building industry.

2. CRITICAL SUCCESS FACTORS (CSFS) AND IBS PERFORMANCE

IBS, a term adopted from the manufacturing industry, is variously defined by construction stakeholders. In general, IBS designates a method of mass production of components/buildings. It is also

variously perceived as either a system and/or a process. Junid, (1986) defines IBS as an industrialized process by which components of a building are conceived, planned, fabricated, transported and erected on site. To Trikha (1999), it is "a system in which concrete components prefabricated at sites of factories are assembled to form structures under strict quality control and minimum in situ construction activity. In this study, IBS represents a process utilized for mass housing project delivery. While mass housing is considered as residential buildings, proposed and developed in standard multiple units on a substantial scale entirely by a government or in synergy with private concerns.

In comparison to the conventional method, although, adopting IBS offer higher benefits, however, evidence of its low performance is on ascendance (Kolo et al., 2014). In the UK, among many causative factors, Pan et al. (2007) attributed the leading issues to high initial capital cost, complex interfacing of components and systems. Lack of manufacturing capacity, a risk-averse culture, the fragmented nature of the industry, and government planning system are also contending factors. A related study in Australia, adjusting to processing change, high capital outlay, supply chain restrictions, lack of skills and requisite knowledge are the leading constraints to IBS uptake (Blismas and Wakefield, 2009).

In Hong Kong, Jaillon and Poon (2008) agreed that conflict with the design and construction processes and practices, unskilled labour, lack of motivation, and lack of client support are the leading factors cconstraining IBS performance. In addition to the foregoing factors, Arif et al (2012) in the Indian construction industry, highlighted high initial capital cost, few codes/standard, lack of guidance and information, low access to finance, industry fragmented nature, manufacturing low capacity, inexperience, legal issues and restrictive regulations as prime constraints to IBS adoption. In addition to the aforementioned, issues of Information Technology and procurement variability are topical in IBS projects of Malaysia (Lou and Kamar, 2014).

Although IBS adoption in Nigeria is still in its embryonic stage, Kolo et al. (2014) through literature review and empirical observations disclose that reluctance to innovate, lack of codes and standards, lack of supply chain integration and requisite skill are the leading constraints. Aladeloba et al (2015) itemized issues of high costs, lack of requisite skill and knowledge, supply chain, perception, motivation, communication and integration as core constraints to overcoming the challenges of poor IBS uptake in the Nigerian construction industry. To this, Ojoko et al., (2016) identified resistance to cultural change as the foremost constraint. This view shares some bearing with the findings of Pour Fahimian et al., (2017) that identified negative perception as a leading factor of IBS poor uptake in Nigeria. Other factors emphasized are lack of supporting infrastructure, wild fluctuation in housing demand, and low manufacturing capacity.

The foregoing revealed that the causative factors to IBS poor performance are not only numerous and multifaceted, but differ between projects types and locations. Therefore, to arrive at a comprehensive list of factors, this study combines multiple approaches in CSFs identification and evaluation.

3.0 RESEARCH METHOD

The study employed a deliberate and extensive approach of causative CSFs identification through literature review, discussions/structured interview before justification by experts' opinion. This ensures a comprehensive list of CSFs from a variety of perspectives (Blismas & Wakefield, 2009). First, from literature sources a list of factors was obtained. Then discussion/structured interview on IBS issues relative to; organization, experience, awareness, material type, equipment, ease of usage, region of application, benefits and barriers was held with 12 randomly chosen IBS stakeholders (Registered with FMLHUD, Abuja). The response obtained was evaluated using simple frequency, and the factors with values above 50% were accepted (Blismas and Wakefield, 2004). In all, a list of six-four (64) contextualised factors was obtained.

3.1 Delphi Method

The preliminary list of sixty-four (64) factors was presented to a panel of 30 experts, out of which 27 (90%) responded in a two-phase Delphi technique. The experts are of diverse disciplines, consisting of six (6) Academia, seven (7) Contracting, ten (10) Consulting, and four (4) from client organization, with all having an average of 17 years experience. The list of the experts was sourced from the supervisory ministry, FMLHUD, Abuja. The first phase, besides item name moderation, required the experts to rate the causative factors on a five-point Likert scale (1- highly insignificant, to 5-highly significant). A total of forty-seven (47) success variables were selected based on a mean score of three (3). For the second phase, based on the same scale, the average score of the first exercise was provided to the experts and asked to further rate the factors indicating agreement or otherwise. The reassessed scores were used to calculate a final average score for all the CSFs. Any factor with a mean score of three and above (≥ 3) is considered to have a reasonable influence on project performance and thus accepted, while those with values below 3 are rejected (Chan et al., 2004). Table 1 shows the 47 factors that ranked above the threshold of 3 and thus accepted.

3.2 Design and Administration of the Questionnaire

In construction management research, questionnaire provides less biased results (Enshassi et al., 2010). A two-section questionnaire was developed with the first segment elucidating information on the respondents' background, while the second part investigated the influence of each factor on IBS performance. This pilot exercise was conducted within the FCT, Abuja being the nation's capital, it has a high presence of ongoing IBS projects. To eliminate ambiguity and ensure easy interpretation of result, with appropriate measurement of data on the ordinal scale, the Likert five-point scale was employed, where 1-represents-least significant and 5-most significant (Yang et al., 2012).

Based on purposive technique, 300 questionnaires were administered on the stakeholders (Client, Consultant, and Contractors, Project manager, Manufacturers and Suppliers) being the main players involved in Nigerian mass housing project (MHP). 210

(70%) stakeholders made up of various professionals responded within the four weeks of October 2015. This response rate in construction management field meets the threshold of 20-30 % (Akintoye, 2000).

Table 1: List of Accepted Success Factors

No	Factor	No	Factor
1	Level of automation	25	Project size &Value
2	Team integration	26	Socio-Cultural
3	Training of Personnel	27	Weather/Act of God
4	Clear and Precise Goals	28	Economics
5	Supply chain collabotion	29	Waste Disposal
6	Monitoring & Feedback	30	Risk management
7	Knowledge & Skills	31	Power (electricity)
8	Component Reuse.	32	Motivation
9	Buildability/Constructability	33	Personnel Commitment
10	Planning & Control	34	Authority/Responsibility
11	Transportation	35	Permit/ Regulations
12	Top Management Support	36	Product & Service Cert.
13	Component repeatability	37	Locations
14	Components interfacing	38	Strategic Value Chain
15	Equipment	39	Conflict Resolution
16	Raw Material		Water
17	Technology Transfer	41	Budget date
18	Communication	42	Procurement mgt
19	Warrant /Insurance Coverage	43	Vested Interest
20	Innovation	44	Schedule Updates
21	Standardisation	45	Storage
22	Stakeholder Management	46	Manufacturing capability
23	Modularisation	47	Sewage
24	Code & Standard		

3.3 Data Analysis and Results

The Statistical Package for Social Sciences (SPSS Version 20) software aided the data analysis and the internal consistency test was determined using the Cronbach coefficient alpha (Zhai et al., 2014). The analysis of the 47 factors signposts an internal consistency with a Cronbach's alpha value of 0.843 which exceeds the minimum threshold of 0.7 (Pallant, 2007). Civil engineers constitute the highest (33.5%) professionals of all respondents and are present to varying degrees in all the firms. Almost 70% of the respondents are within the 31-50years age bracket; an active age range considered of optimum performance in the construction industry. More than 65% of the respondents have over 11years experience in the construction industry and not less than 5years in IBS. Over 50% of the respondents work in the consulting and project management firms.These further add validity to this study since the firms were the domain of experts in project performance evaluation and management.

In order to determine if the 47 CSFs (Table 1) were similarly perceived by the respondents, Kendall's concordance coefficient was employed. If Kendall's coefficient equals one (1), then CSFs were identically ranked, but otherwise, if Kendall's coefficient equals zero (0) (Yeung et al, 2007). The ranked 47CSFs have Kendall's coefficient value of 0.115 which is statistically significant at 1% level. This suggests a general consensus among the 210 respondents. To establish the general similarity of the respondents' rankings between the respondents; Spearman's rank correlation test was employed. At 5% level, the least Spearman's rank correlation coefficient (r) for the different pairs is 0.621 (Client-Contractor). Therefore, statistically, there is a general consensus among the stakeholders.

To enhance decision making, it is recommended for the conversion of any ubiquitous scale (Likert scale to three scale point). This "levels of mean Value Distribution" for a Likert scale five -point has 1.0-2.33 as Low; 2.38-3.67 as moderate and 3.68-5 as high (Jacoby and Matell, 1971). The mean scores for the 47 CSFs range from 3.986 to 3.252. Hence, the influence of all the factors lie above the low mean value of 2.33. This implies that each of the 47 factors can noticeably influence IBS performance. However, while forty (40) factors have high influence (above 3.68) on project performance, seven (7) factors exercise moderate influence (between; 2.34-3.67) on IBS performance. Table 2 shows the five factors with the highest influence on IBS performance.

Table 2: Five Factors with High influence on Performance

No	FACTOR	MS	SD	RANK
4	Clear & Precise Goals	3.986	0.904	1
7	Knowledge & Skills	3.976	0.935	2
10	Planning & Control	3.948	0.919	3
12	Top Management Support	3.938	0.479	4
11	Transportation	3.924	0.909	5

4.0 FINDING AND DISCUSSION

The mean scores for the 47 CSFs range from 3.986 to 3.252, implying that all the factors are above the low mean value of 2.33 (Jacoby and Matell, 1971). Although, this implies that each of the 47 factors can noticeably influence IBS performance but while forty (40) factors generate high influence (above 3.68) on IBS project performance the remaining seven (7) exercise moderate influence (between; 2.34-3.67).

Based on Pareto rule, the highest factor ranked factor has the greatest influence (Ogwueleka, 2011). Thus, for this study, the lack of clear and precise goals (3.986) has the most impact on IBS project performance. Like in most other nations, the Nigerian government is the initiator and foremost consumer of construction products. Although the government embraced IBS since 2011, till date, there are no defined underpinning measures (policy statements or study) targeted at making IBS implementation a viable option. Also, this finding buttresses the claim of about 67% of the respondents in the discussion/structured interview that lack of clear and goals was a major barrier to IBS uptake in Nigeria. For IBS success, the vision of all stakeholders must be anchored on clear and precise goals. Countries, with a good measure of success in IBS implementation (Sweden; UK) have clear and precise goals with IBS policies incorporated into their construction development plans and backed with regulatory institutions (Steinhardt and Manley, 2016).

Lack of requisite knowledge and skills (3.976) was the second highest factor influencing IBS performance. This finding is in consonance with the studies of Amade et al., (2015) and Pour Rahimian et al., (2017). The stakeholders' perception also agrees with the 63% rating accorded the same factor by the respondents interviewed.

Aribigbola (2008), argued that to attain the goal of adequate housing for all, requisite knowledge and skills must be enhanced. Unfortuately with regards to innovative construction method, the curriculum of most Nigerian tertiary institutions are limited in depth. Lack of sufficient planning and control attracted a mean score value of (3.948) rated third.This factor is intrinsically tied to the two earlier factors. Without a requisite knowledge and skills, it is impossible to evolve a clear plan, and by extension attain set objectives.

5.0 CONCLUSION

It is eveident from this prelimary study embracing the IBS to overcome the huge housing deficit in Nigeriain building industry is a step in the right direction. The 47 CSFs considered contextual out of the initial 64 factors by stakeholders are sufficient in resolving issues of IBS poor performance and low uptake in Nigeria. However, to improve on IBS performance, the gap in between stakeholders' CSFs perception homogeneity need future clarification and management.

The CSFs observed in this study is limited to MHPs' micro viewpoint, and could significantly differ from those of the macro viewpoint in same locality. Also, the influence of the interrelationship of the factors on IBS performance is yet to be conducted. Since this study is ongoing, the author shall engage Factor Analysis to investigate the influence of these inter-relationships among the identified CSFs. It is envisaged that the findings of this study would assist the stakeholders in establishing a more reliable reference in the drive towards improving the performance of IBS projects in both the region and regions with similar constraints.

6.0 REFERENCES

[1] Akintoye, A. (2000) Analysis of factors influencing project cost estimating practice. *Construction Management & Economics*, *18*(1), 77–89.

[2] Aladeloba, E. A., Okesoto, J. O. And Olawale, S. O. (2015) Prospects of Industrialized Materials in Building Production in Nigeria International Journal if Development Research, 5 (01), pp. 3143-3148

[3] Blismas, N and Wakefield, R. (2009) "Drivers, constraints and the future of offsite manufacture in Australia," *Construction Innovation*, vol. 9, no. 1, pp. 72–83Goodier, C and Gibb, A. (2007)"Future opportunities for offsite in the UK," *Construction Management and Economics*, vol. 25, no. 6, pp. 585–595

[4] Chan, A. P. C. & Chan, D. W. M. (2004) Developing a benchmark model for project construction time performance in Hong Kong, Building and Environment, 39: pp.339–349.

[5] Egan, J. (1998) "Rethinking construction, Construction Task Force report", Department of the Environment, Transport and the Regions HMSO, London.

[6] Enshassi, A., Mohamed, S., & Abushaban, S. (2010) Factors affecting the performance of construction projects in the Gaza strip. Journal of Civil Engineering and Management, 15(3), 269–280

[7] Goulding J S, Rahimian F P, Arif M, and Sharp M (2012) "Off-Site Construction: Strategic Priorities for Shaping the Future Research Agenda", Architectoni.ca, Canadian Centre of Academic Art and Science (CCAAS), 1(1), 62-73

[8] Hamid, A. K. (2009) Barriers to Industrialized Building System (IBS): The Case of Malaysia; the Problem Statement Research Methodology. A preliminary PhD study on Industrialised Building System. Built and Human Environment 9th International Postgraduate Research Conference, pp.1–16.

[9] Jacoby, J. and Matell, M. (1971) Three-Point Likert Scales Are Good Enough. Journal of Marketing Research. 8(4), 495-500

[10] Jiboye, A. D. (2011) Urbanization challenges and housing delivery in Nigeria: The need for an effective Policy framework for Sustainable Development. International Review of Social Sciences and Humanities, 2(1), 176–185.

[11] Jaillon, L. and Poon, C.S. (2008) Sustainable construction aspects of using prefabrication in dense urban environment: a Hong Kong case study. Construction Management and Economics, 26(9), 953–66.

[12] Junid, S. M S. (1986) Industrialized Building System. In Proceedings of UNESCO/FEISEAP Regional workshop, UPM serdang.

[13] Kolo, S. J, Rahimian, F. P., & Goulding, J. S. (2014) Offsite Manufacturing Construction: a big opportunity for housing delivery in Nigeria. Procedia Engineering, 85, 319–327.

[14] Ojoko, E.O., Osman, M.H., Rahman, A.B.A., Omar, W.S.W and Ojoko, O. (2016). Critical Success Factors of Industrialised Building System Implementation in Nigerian Mass Housing Projects. Proceedings of the 2nd Int. Conf. on Sc., Engr. & Soc. Sci. (ICSESS 2016) 29th May- 1st June 254-255

[15] Ogwueleka, A. (2011). The critical success factors influencing project performance in Nigeria. International Journal of Management Science and Engineering Management, 6(5), 343–349.

[16] Pan, W., Gibb, A. and Dainty, A. (2007) Perspectives of UK housebuilders on the use of offsite modern methods of construction. Construction Management and Economics, 25(2), 183–94.

[17] Pour Rahimian, F. and Goulding, J. and Akintoye, A. and Kolo, S. (2017). Review of motivations, success factors, and barriers to the adoption of offsite manufacturing in Nigeria. Procedia Engineering, 196. pp. 512-519.

[18] **Trikha, D.N. (1999)** Industrialised building systems: Prospects in Malaysia, ProceedingsWorld Engineering Congress, Malaysia

[19] **UN-Habitat-Agenda (2006).** Available at The-Habitat-Agenda-Istanbul-Declaration-on-Human-Settlements-2006.pdf

[20] Yang, J., Zhu, X. F., & Zhang, H. (2012**).** Group model exploration of housing industrialization. Construction Technology, 364(41), 95e98. In Chinese.