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# Critical success factors (CSFs) influencing the implementation of industrialized building Systems (IBS) in Nigeria

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**Abstract.** Conventional method of construction hinders the actualization of triple success project objectives of time, cost and quality delivery of construction projects while IBS method is used for closing these negative effects. Hence, this study aimed at examining critical success factors (CSFs) influencing the implementation of industrialized building systems (IBS) in Nigeria. Adopting a cross-sectional survey design, a close-ended questionnaire was purposively administered online to construction professionals who have distinct knowledge and experience on projects where IBS has been implemented. The data was subjected to descriptive and inferential statistics using IBM SPSS v. 21. The study findings showed that good working relationship, training of skilled workforce, effective communication route and financial capacity are the CSFs furthering the implementation of IBS in a developing country like Nigeria. The implication for practice is for construction stakeholders to develop these competencies to maximally improve the implementation of IBS projects. The study developed a framework that the project stakeholders can implement for an efficient industrialized building system on construction projects.

**Keywords:** Construction Industry, Conventional Construction, Critical Success Factors, Descriptive statistics, inferential statistics, Industrialized Building system

## 1. Introduction

The construction industry provides the necessary residential, commercial and infrastructural facilities needed for social-economic development of a nation. These facilities are developed either through on-site or off-site construction methods. Evidence have shown that on-site construction technique also called traditional/conventional construction plays a dominant role in construction project delivery processes [1 – 3]. However, traditional construction method is marred with inefficiencies such as time and cost overrun and poor-quality performance [4]. These factors have detrimental effects on built environment, economy and construction industry at large. In addition, Zhang *et al.* [5] corroborated factors such as low site productivity, unreliable quality, high resource and energy consumption, frequent safety accidents, and



environmental pollution as problems related to conventional construction method. Thus, the adoption of reliable, speedy and conservative construction alternative is of great importance for prolonged growth and enduring future in construction sector.

IBS has been advanced by built environment practitioners and researchers in promoting sustainable environment, improving construction process, productivity and waste reduction. For instance, the study of Zhu *et al.* [6] on life cycle energy performance of prefabricated buildings in China, revealed energy reduction in prefabricated buildings during the occupied phase. Similarly, simulated Energyplus analysis study of Abbood *et al.* [7] in Iraq shows a reduced annual energy consumption of prefabricated residential building of about 37.32% for heating and 65.36% for cooling respectively. Also, in China, prefabrication employed in T30 Tower hotel was recorded to be completed in 15 days with magnitude 9-earthquake resistance, low construction cost, high thermal efficiency and less construction waste generation [8].

In another dimension, the utilization of prefabricated components shows a decline in the use of materials such as cement, sand, timber, steel and formwork due to lower amount of framing and foundation works [9]. Additionally, smart and innovative construction techniques have been linked to IBS model of construction delivery [6]. The ability to implement this method of construction strategies aimed at promoting built environment sustainability will create a balance in construction.

Notwithstanding the uptake of IBS in various climes, the adoption of IBS has shown some drawbacks. Chiang, Chan and Lok [10] attributed the limitations of IBS to cost arising from setting up of fabrication yards and transportation, vertical transportation on site, labour training, and jointing problems. The cost factor is further reinforced by Ogunde *et al.* [11] by identifying initial construction cost as the main impediments in achieving IBS in Nigeria. Low incorporation of innovation such as automation, standardization and modularization in construction industry is observed by Xue *et al.* [12]. Other challenging factors such as lack of awareness, negative perception among designers and customers and jointing issues were [13].

Policies and initiatives have emanated in promoting IBS in many countries. Rashidi and Ibrahim [14] assert that from 1962-2015 various advanced and developing countries have initiated polices and departments that drives the implementation of IBS in their respective regions. In Asia, Malaysia has the highest strategy in form of IBS Strategic Plan 1999, IBS Roadmap 2003–2010, Construction Industry Master Plan 2006–2015, IBS Roadmap 2011–2015 and Construction Industry Transformation Program 2016–2020, 2015. This action is followed by Singapore promoting Construction 21 and Reinventing Construction, 1999 while Japan is with Future Directions of the Construction Industry, 1999. UK is leading in Europe with programmes like Greater Integration of the Design and Construction Process, 1962; Constructing the team (Latham report) 1994, Construction task force (rethinking construction), 1998, Construction client group CCG, 2004 and Build offsite, 2006 initiatives. Finland is pursuing Reengineering the construction process using ICT, 2002 and Ireland has Building our future together, 1997. Australia has embarked on Building for growth initiative, 1999 while USA hinged on National Construction Goals, 1994. In Africa, South Africa formulated Creating an enabling environment for Reconstruction growth and development in the construction industry, 1997 to attain IBS. Irrespective of these initiatives and projects developed with IBS technique across climes, researchers are of the view that the adoption has not been commensurate with traditional method of construction. This situates the need to investigate the critical success factors that promise effective implementation of IBS in Nigeria.

Issues that are deemed critical for effectiveness of IBS have been investigated in past studies [15 – 18]. However, there have been little studies undertaken to offer insight into problems of CSFs for application in IBS projects in developing countries such as in Nigeria. Omotayo and Keraminiyage [19] compared the knowledge gap in lean and offsite construction techniques in Nigeria and UK. The prospect of IBS construction method in building production in Nigeria was qualitatively reviewed by [20]. Ogunde *et al.*

[11] evaluated challenges and factors influencing the use of prefabrication in Nigeria while Ojoko *et al.* [21] qualitatively identified and evaluated the factors hindering the IBS performance in the Nigerian mass housing projects. Also, a mixed study of Zakari, *et al.* [3] explored the perceptions of construction personnel in Nigeria on the use of IBS. This study therefore draws on Ojoko [22] by examining the CSFs influencing the implementation of industrialized building systems (IBS) in Nigeria. The study objectives are to identify and evaluate the critical success factors that further the implementation of IBS projects in Nigeria. The study provides up-to-date literature on CSFs for implementation of IBS projects and also adds to IBS CSFs literature. The study also gives awareness to construction professionals, public and government on major factors responsible for effective implementation of IBS project.

## 2. Literature Review

### 2.1 Overview of Industrialized Building Techniques

Industrialized building has been seen as the implementation of manufacturing process into construction and has been gaining popularity as new method of construction. Kolo, Pour Rahimian and Goulding [23] traced the existence of IBS to 1850 while noting that the technique came into prominence after world war one and two when renewed efforts were made towards developing infrastructures that meet the social, economic and technological needs of the time. Also, the lack of speed and efficiency in traditional construction process in the late 50s' called for an innovative process of integrating off-site controlled and factory produced components into buildings construction process. Ever since then improved practices of IBS has been witnessed in countries such as USA, UK, Australia, Malaysia, New Zealand, Sweden, Japan, India, China, Honk Kong etc. In Nigeria, the use of prefabrication gains its entrance in 1970s' as posit by Kolo, *et al.* [24] while over 500 residential and commercial housing units including civil engineering projects have been commissioned utilizing prefabrication [11]. In the same vein, Zakari *et al.* [3] assert that the application of IBS is majorly seen in bridges, high rise and housing estate construction in Nigeria. Furthermore, Ojoko [22] identified prominent areas of IBS applications in Nigerian mass housing development to include light gauge steel, pllasswall/pllassmolite, interlocking and burnt clay bricks.

Several studies have used varied terms in denoting IBS construction as no single term has specifically been used in defining the concept. Compilation of terminologies by Rashidi and Ibrahim [14] revealed seven key terms used in addressing IBS. Such terms include: pre-assembly, prefabrication, off-site manufacturing (OSM), off-site production (OSP), and off-site construction and modern method of construction (MMC). Earlier studies of Steinhardt and Manley [1], Abbood *et al.* [7] and Kolo *et al.* [24] included dry construction, modularization and tunnel-form construction as terms in achieving IBS. It is evident that a thin line of different exist between the associated terms. This study adopts industrialized building system (IBS) because of its inclusiveness in addressing all processes of moving some aspect of construction activities to a coordinated setting or factory.

### 2.2 Critical Success Factors Influencing IBS Projects

The relevance of CSFs in IBS projects has been documented in various studies [14, 16,17,18,25]. The concept as stated by Ogunsanmi [26] was first applied in information and project management studies before it was later used in construction management research. Kamar *et al.* [25] linked the theory of CSFs to Bullen and Rockhart [27] and Rockhart and Crescenzi [28] who theorized CSFs as means of identifying and measuring organization performance. Kamar *et al.* [25] defined CSFs as few identified areas that promote the effective competitive performance of IBS projects. Similarly, Olaniyan [29] as cited by Ogunsanmi [26] views CSFs as those important features of interest in which favorable outcomes are completely required for particular personnel to attain his or her purpose. These definitions of CSFs are drawn with the conceptualization of CSFs in the present study as those factors essential for effective application of IBS projects in Nigeria are investigated.

In reviewing the CSFs in IBS, Kamar *et al.* [25] highlighted and discussed eleven CSFs that called for debate and input from construction players in Malaysia. The addressed eleven CSFs are training and education, leadership and organization structure, cost management, supply chain and procurement,

information technology, site management, change management, optimization, design integration, capital expenditure planning and risk assessment. The study of Nawi *et al.* [16] examined the factors considered critical for successful integrated design delivery towards IBS in Malaysia. Their study qualitatively benchmarked nine CSFs that involve personal working attitude, team base, accountability, team organization, management of leadership, transparent communication process, policy, procurement and contract, operational, and appropriate technology. Also, Kamar *et al.* [17] measured eighteen CSFs by surveying G7 contractors in Malaysia. The surveyed and measured factors include: Top- down vision & commitment, early decision to use IBS, early assemble of project team, effective communication, site logistic & machineries, business & finance, process coordination, competent workforce, planning & scheduling, design process, management of supply chain, continues improvement and alliance, demand and volume, organization knowledge, information technology (IT), training and education technology & capability.

Likewise, Yunus *et al.* [18] considered thirty-one CSFs in lean thinking. These are: leadership, collaboration of organization, financial funding, readiness of organization, time management customer focus, teamwork, barriers in lean thinking implementation, trust among participants better coordination, effective information transfer, appropriate tools, effective communication, employees' mindset, organizational culture change, ability to compromise, effective planning, financial capabilities, on-the-spot decision, adaptability, clear direction and motivation, education, skills and expertise, optimizing material used, root cause corrective measure, information exchange, continuous improvement, efficient logistics, operational improvement, operate in diverse environment, top management commitment, lean management system, stability contract, modify environment, lean knowledge, product development, commitment reliability, lean community, self-interest, documentation, production planning ,cost management , application of lean house, customer focus transportation, employee involvement, effective management practice, learn from failure , employee behavior.

Furthermore, Rashidi and Ibrahim [14] enumerated, CSFs such as good working collaboration, effective communication channel, continues improvement and learning coordination of design, manufacture and Construction, key decisions on strategy, application, design, logistic, and detail unit should be made as early as possible between all parties involved, team members involved during the design stage, experienced workforce and technical capable information and communication technology (ICT), close relationship with suppliers, extensive planning and scheduling factors in attaining IBS. Ojoko *et al.* [22] on the other hand identified and examined six categories of CSF such as project, stakeholders, interactive, supply chain and eternal success factors responsible for IBS successes in Nigeria. The result revealed that project success factors and interactive success factors are the dominating factors critical for IBS implementation in Nigeria built environment. This study adapted twenty CSFs from Malaysian studies [14,18,23].

### **3. Research Methodology**

A combination of literature review and administration of online survey instrument was employed in this study. The review assisted in understanding the current issues and gaps that exit on the theme thereby furthering the identification of the CSFs variables used in the design of the survey instrument [30]. The study area Lagos, Nigeria is recognized for high construction activities and subsequent large number of construction professionals practicing in the state. The study population consists of construction professionals both in public and private sectors namely, architects, builders, civil engineers and quantity surveyors. These represent four out of seven built environment professionals responsible for design, production and estimation of construction projects in Nigeria. A cross-sectional survey design was employed to provide information with respect to perception of both knowledge and exposure of the respondents. A close ended survey instrument was designed using google form and purposively administered through a link to each professional body's state chapter's membership online WhatsApp group platform. The online google form platform collected responses for two calendar months. A total of one

hundred and five (105) questionnaires were received as the sample frame for the study after rigorous attempts. IBM SPSS v.21 was used in coding and analyzing the data obtained. Descriptive statistics tools of tables, mean score (MS) and standard deviation were used in calculating the independent variables while inferential statistical tool of one sample t-test was used in decision making. The survey instrument consists of two parts (A - B). Part A sought for information relating to respondent's background, role played in IBS construction and years of involvement in IBS. Section B sought for information on CSFs for implementation of IBS based on five Likert scale 1-5. 1 = not significant, 2 = slightly significant, 3 = moderately significant, 4 = significant and 5 = highly significant. The research instrument was externally validated by peer review while Cronbach's Alpha value of 0.744 was obtained through reliability test conducted. This shows a robust internal consistency of the scale used in the study of the factors [31].

## 4. Result and Discussion

### 4.1. Personal Data of Respondents

The demographic characteristics of the respondents and their roles in IBS implementation are presented in Table 1. In Table 1, higher percentage of the respondents (50.5%) have between 11-20 years of construction working experience. Considering the years of involvement in IBS in their careers, 1month-4years have 30.5% involvement. In respect to their academic qualifications, 28.6% held BSc/BTech degree while building profession background had the highest representation of 31.1%. In terms of roles played by respondents in IBS implementation, majority of the respondents functioned as site manager cum supervisor (58.1%). The findings show that the construction professionals' personal characteristics can give valuable information on CSFs for implementation of IBS in Nigeria context. These professionals were used in analyzing other sections in this study.

Presented in Table 2 are perceptions of the 84% of the total respondents who have involved in the implementation of IBS model. As shown in the table, the mean score (MS) for all the CSFs are greater than the average mean of 4.00 except for "close relationship with suppliers" (MS = 3.87) indicating that they are all critical for the actualization of total IBS in Nigeria. The uppermost five ranked CSFs of IBS process are "good working relationship" (MS = 4.60), "training of skilled workforce"/ "effective communication route" (MS = 4.54), "financial capability" (MS = 4.53) and "risk management strategy" (MS = 4.51). Good working relationship among project participant is fundamental to effective implementation of IBS in many climes and it is not astonishing that this factor ranked first in all prospect. The next ranked CSFs are "continuous improvement" (MS = 4.48), "team members involved in design" (MS = 4.47), key decision on strategy (MS = 4.44) and "coordination of design"/ "adaptability"/ "experience workforce" (MS = 4.42). The least ranked CSFs as indicated show "extensive planning and scheduling" (MS = 4.27), "strategy and business approach" (MS = 4.18), "design and standardization" (MS = 4.15), "demand and supply" (MS = 4.15), "top-down management" (MS = 4.12) and "close relationship with suppliers" (MS = 3.87). The results of this study are closely related to findings by Yunus *et al.* [18] on CSFs on lean thinking in the application of IBS in Malaysia. Their results revealed top ranked CSFs like "collaboration of organization" (MS = 4.53) and "financial funding" (MS = 4.51). Similarly, Ismail *et al.* (2012) ranked good working collaboration (MS = 4.67), effective communication channel (MS = 4.52) extensive planning and scheduling (MS = 4.42) amongst others as top management CSFs in IBS implementation in Malaysia. Also noted is the study of Kamar *et al.* [25] that evaluated "effective communication" (MS = 4.19) as top ranked CSF in driving IBS also in Malaysia. Consequently, the present study corroborated the findings of Ojoko *et al.* [22] that implementation of IBS is hinged on the commitment and participation of all project stakeholders.

**Table 1.** Personal data of respondents that participated in the study

Personal Data Characteristics	Frequency (N)	Percentage (%)
<i>Years of Working Experience</i>		
1 – 10	28	26.7
11– 20	53	50.5
21 – 30	10	9.5
31 –40	5	4.8
41- 50	5	4.8
>50	4	3.8
Total	105	100
<i>Years of involvement in IBS</i>		
1month - 4years	32	30.5
4 -7years	20	19.0
7-10years	9	8.6
Over 10years	28	26.7
None	16	15.2
Total	105	100
<i>Academic Qualification</i>		
HND	27	25.7
BSc/BTECH	30	28.6
PGD	12	11.4
MSc/M.TECH	28	26.7
PhD	8	7.6
Total	105	100
<i>Profession Background</i>		
Architecture	30	28.6
Building	39	37.1
Civil Engineering	19	18.1
Quantity Surveying	17	16.2
Total	105	100
<i>Role played in IBS</i>		
Contractor	12	11.4
Consultant	32	30.5
Site manager/supervisor	61	58.1
Total	105	100

**Table 2.** Ranking of CSFs influencing implementation of IBS projects

Critical Success Factors	Mean Score	Std. Deviation	Remark
Good working relationship	4.60	0.64	Very Critical
Training of skilled workforce	4.54	0.60	Very Critical
Effective communication route	4.54	0.60	Very Critical
Financial capability	4.53	0.66	Very Critical
Risk management strategy	4.51	0.64	Very Critical
Continuous improvement	4.48	0.57	Critical
Team members involved in design	4.47	0.68	Critical
Key decision on strategy	4.44	0.54	Critical
Coordination of design	4.42	0.75	Critical
Adaptability	4.42	0.60	Critical
Experience workforce	4.42	0.72	Critical
Management of supply chain	4.32	0.70	Critical
Information and communication Technology	4.30	0.71	Critical
Improvement in procurement strategy	4.27	0.72	Critical
Extensive planning and scheduling	4.27	0.69	Critical
Strategy and business approach	4.18	0.78	Critical
Design standardization	4.15	0.78	Critical
Demand and supply	4.15	0.79	Critical
Top-down management	4.12	0.77	Critical
Close relationship with supplier	3.87	0.68	Moderate

For inferential decision to be supported on the evaluation of the CSFs for IBS implementation, one sample t-test of the CSFs are undertaken and the results are summarized in Table 3. From the results in Table 3 it is shown that for Good working relationship, Training of skilled workforce, Effective communication route, Financial capability, Risk management strategy, Continuous improvement, Strategy and business approach, Design standardization, Demand and supply, Top-down management and Close relationship with supplier, the t statistics (t-value = 3.65, 2.96, 2.96, 2.55, 2.29, 2.22, -2.07, -2.48, -2.43, -2.79, -6.75) are at significance level less than 0.05 ( $P < 0.05$ ). Hence, the alternative hypothesis that there is significant difference among the CSFs in the implementation of IBS is accepted. This infers that Good working relationship, Training of skilled workforce, Effective communication route, Financial capability, Risk management strategy, Continuous improvement, Strategy and business approach, Design standardization, Demand and supply, Top-down management and Close relationship with supplier are the critical success factors furthering the implementation of IBS in Nigeria. It implies that for effective implementation of IBS technique in construction projects there must be dedicated training programme for both management and technical staff that will implement the desired goal of IBS initiatives.

This method of construction involves higher level of mechanization on and off-site requiring education and training than conventional construction. Also, effective communication channel among the project stakeholders is considered vital. The use of innovative technology in construction (drone technology, cloud computing and internet of things) have maximize communication in all human endeavour. IBS technique are beset with a lot of risk from design to commissioning and other external sources thereby requiring efficient risk management strategy for execution of IBS. Strong financial capacity by the contractor is necessitous in order to avert delay and ultimately abandonment of IBS project. The capital nature of IBS components sometimes compels contractors to seek for bond from financial institutions as a guarantee to be deposited with IBS manufacturers. Continuous improvement in managerial and technological personnel



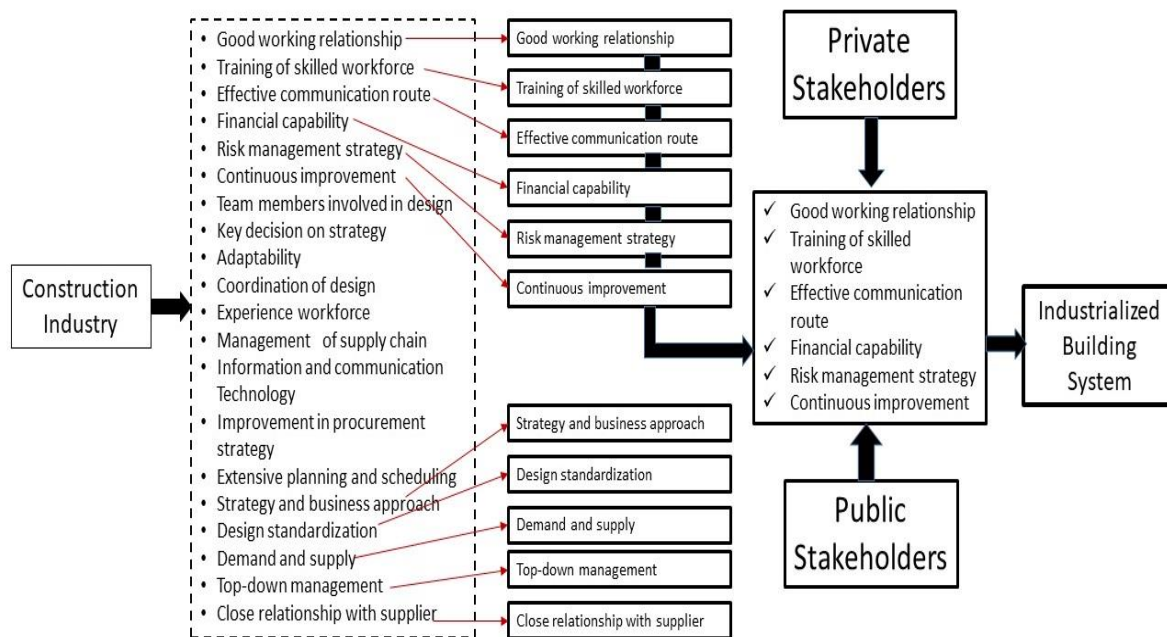
creates a balance in IBS implementation. These preceding thoughts on evaluation of CSFs for positive implementation of IBS initiatives in Nigeria have proposed eleven CSFs of: Good working relationship, Training of skilled workforce, Effective communication route, Financial capability, Risk management strategy, Continuous improvement, Strategy and business approach, Design standardization, Demand and supply, Top-down management and Close relationship with supplier as CSFs contributing to implementation of IBS technique in Nigeria.

**Table 3:** One sample ‘T’ test for evaluation of CSFs for implementation of IBS projects

<b>Critical Success Factors</b>	<b>t statistics</b>	<b>df</b>	<b>Sig. (2 tailed)</b>
Good working relationship	3.65	88	0.000
Training of skilled workforce	2.96	88	0.004
Effective communication route	2.96	88	0.004
Financial capability	2.55	88	0.012
Risk management strategy	2.29	88	0.025
Continuous improvement	2.22	88	0.029
Team members involved in design	1.70	88	0.092
Key decision on strategy	1.53	88	0.129
Adaptability	1.04	88	0.411
Coordination of design	0.83	88	0.304
Experience workforce	0.86	88	0.391
Management of supply chain	-0.48	88	0.635
Information and communication Technology	-0.62	88	0.539
Improvement in procurement strategy	-1.05	88	0.295
Extensive planning and scheduling	-1.10	88	0.273
Strategy and business approach	-2.07	88	0.042
Design standardization	-2.48	88	0.015
Demand and supply	-2.43	88	0.017
Top-down management	-2.79	88	0.006
Close relationship with supplier	-6.75	88	0.000

#### 4.2. Implications of the Study for Practice and Theory

The implications of this study for practice in IBS projects is to develop a complete and strong working relationship and training frameworks that would permit project stakeholders to function maximally for IBS projects. This will fascinate policy makers, private and public entities to the industry and increase competency of built environment professionals in executing IBS projects. Results of this study present strong evidence that reinforce CSF theory that all CSFs are nominally deemed to be ‘critical’ in literature but by analysis can propose ones that are more critical for success of IBS in particular situations and conditions. Findings of this study proposed some CSFs that are critical for developing countries such as in the Nigerian scenario. Also, for practice, contactors with skilled workforce in IBS and adequate financial capability should initiate and be engaged for potential IBS biddings. Such contractors will provide realistic template for proper execution of projects and ultimately achieve triple objective of time, cost and quality in construction projects. Using the CSFs, the study developed a framework that the project stakeholders can implement for an efficient IBS system on construction projects (Fig.1). The framework showed that the expertise and contribution of public and private stakeholders is essential for IBS to be actualized.



**Figure 1.** Framework on CSFs influencing the implementation of industrialized building systems (IBS)

## 5. Conclusions and Recommendations

This paper investigated the CSFs influencing the implementation of IBS in Nigeria. The results of this article revealed that good working relationship, training of skilled workforce, effective communication route, financial capability and risk management strategy were CSFs to consider for effective implementation of IBS in a developing country such as Nigeria. Added to these, inferential statistics further gave a broader CSFs that had significant difference among the construction professionals which were Good working relationship, Training of skilled workforce, Effective communication route, Financial capability, Risk management strategy, Continuous improvement, Strategy and business approach, Design standardization, Demand and supply, Top-down management and Close relationship with supplier. The study recommends that in order to deepen the housing supply stock, there is need for a comprehensive and strong working relationship, training frameworks for IBS to be developed and favorable monetary policies through a public-private partnership, this will encourage IBS skilled contractors. Actualization of total IBS programme in housing and other urban infrastructures requires a collaborative effort among project stakeholders. Future studies could be aimed on qualitative study that will focus on maintenance challenges confronting already built prefabricated buildings in Nigeria.

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