

Challenges of industrialized building system (IBS) adoption for quality low-cost housing in Kano Municipal, Kano State, Nigeria

Raji, A.U.¹ and Busari, H.I.¹

¹Faculty of Earth & Environmental Sciences, Bayero University Kano

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Abstract:

The slow pace and quality of housing delivery using the conventional approach is seen as setback in minimizing the housing deficit in Nigeria. The primary success parameters of every project are time, cost and quality. The adoption of new technological advancement in the construction sector is seen as a key factor for achieving timely project delivery within budget. The aim of this study was to identify the challenges for adopting Industrial Building System (IBS) for Quality low-cost housing delivery in Kano Municipal construction sector. A quantitative approach was employed with a Delphi technique as a method of data collection to achieve research. The experts were identified through a snowball sampling technique. Twenty (20) questionnaires were administered to Delphi experts and 16 were returned (80%) in the construction industry. Descriptive statistics and mean score ranking was used to analyse the data using SPSS 22. Findings of the study indicates that poor skills and supervision by the developers, lack of availability of skilled labour, poor communication of design requirements by client are among the key factors that affect the quality of housing delivery through the use of conventional cast-in-situ. The challenges of IBS adoption identified were, high financial cost, lack of direct financial grants, lack of practical technical training, inadequate suppliers of prefabrication, no policy to promote prefabrication, due to the production process, it possess great potential for higher quality than the conventional method. Interestingly, stakeholders recommend the need to explore the application of IBS, as it is seen as a better technology that will minimize the huge Nigerian housing deficit and facilitate the industrialization of the construction industry.

Corresponding author

Raji, A. U.

auraji.esm@buk.edu.ng

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1. Introduction

Industrial Building System (IBS) may be defined as the production of entire building, or substantial building constituent's offsite, in a factory location prior to fitting or assembly onsite. This is an encouraging invention with a clear association to more environmentally friendly building practices [1]. IBS components are considered to be a feasible method of construction, and the use of precast concrete has been gaining popularity as an alternative construction method as opposed to the more common in-situ construction method Irish Precast Concrete Association [2]. There are two ways by which construction works are erected; these are in-situ and IBS. The former is the most common construction method used while the latter is rarely used in Nigeria, even though this method is more efficient in terms of working within cost targets, meeting project time deadlines and achieving high quality works due to factory control processes. The decision between construction methods is usually based on project time, cost, quality, safety, environmental performance, socioeconomic aspects (labour) and client satisfaction [3].

The use of IBS components for construction works offers virtually infinite diversity of products and strategic possibilities due to the convenience that workers have when making prefabricated elements which is mostly done at ground levels. IBS is one of the most versatile and sustainable building materials available for today's profligate paced, ecologically mindful building [4]. IBS components can be used for both load and non-load bearing units.

In recent years, especially in the UK, US, Finland, Netherland and many other countries, there has been sufficient experience on the use of IBS components for a number of design guides for major and mass construction works for both private and public construction works [5].

The gradual adoption of the new modern trends and methods in technological advancement is a necessity for the success of companies and the development of the construction industry. For instance the use of precast concrete elements can be used to help reduce the amount of waste generated on the construction site by up to 50% of a construction project as compared to cast in-situ method. According to Raghavendra, *et al.* [6], the current technological advances lead to the changes in the way of doing business in areas of the construction industry, such technological advances in construction industry is the IBS. It is obvious that a better quality control system is achieved when IBS is used [7]. It can therefore be established that IBS is economical when carefully compared to other conventional in-situ methods which are being used since 700 B.C.

According to Kamar, *et al.* [8], the Malaysian government showed careful efforts to ensure that IBS components were widely used amid all specialists involved in the built environment. They indicated in their report that the process spanned from 2003 -2010, this effort was given a strong cabinet backing by an endorsed blueprint document to use IBS method of construction for the industrialization of the Malaysian construction sector. Currently,

there is no measured policy in Nigeria to promote the adoption of industrialized building system for construction projects. This paper looks at the challenges of IBS adoption by professionals for construction industry for quality low-cost housing delivery in Kano municipal local Government.

1.1 IBS practice in Nigeria

The earliest form of Industrialized Building System recorded in Nigeria was the old residency buildings constructed by the British colonial masters. The various building parts were shipped from Britain through boats and ferries down to the site of their various consular offices here in Nigeria. Most of the prefabricated buildings were offices and residencies for the colonial masters and their families. The various building typologies ranged from single one bedroom to two bedrooms and also duplexes. An example of such building is the old residency building for the consulate located in Calabar. It is a building made from wood and it was made in Britain before the 1880s. It was transported in parts by sea to Old Calabar and built on the Consular Hill in 1884. The main building is a large one storey building with large halls and four spacious rooms on the ground floor and an expansive parlor upstairs. It remains one of the finest examples of the early British colonial architecture in Nigeria, during the period of its use as the colonial residence to the period it served as a ministerial guest-house and state government offices, some ancillary buildings were built in close proximity to the main building. Federal Ministry of tourism, culture & national orientation [9].

1.2 Low-cost housing development

Agbola [10] have noted that for housing to be affordable for the low income earners, it must be tailored to total income level. Inexpensive housing is used to define dwelling units whose total housing budgets are considered reasonable to a group of people in a definite salary scale. However, the governmental agency of 2002 on housing and inner-city development, defines low income earners as all employee or entrepreneurs whose yearly revenue in 2001 is N100,000 or below (with N260 = £1). When the monthly budget of a home surpasses 30 – 35 % of family wages, then the housing is measured excessive for that family. The City Council of Calgary in (2002) approved and defined affordable housing as housing that adequately suits the needs of low- and moderate-income households at costs below those generally found in the market. Affordable housing may take on a number of forms that exist along a continuum, from emergency shelters, to transitional housing, to non-market rental (also known as social or subsidized housing), to formal and informal rentals [11]. Adedeji [12] stated that a household survey in Nigeria indicates that accommodation takes a generous portion of a salary earner and has remained a standard for judging any regime's performance in the socio-economic and political spheres of a country.

A normative definition of quality of housing or housing quality standards generally refers to the grade or level of acceptability of dwelling units and their associated and immediate residential environment, including the design and functionality of housing structures, building materials used, the amount of internal and external space pertaining to the dwelling, housing utilities, and basic service provision [13]. Quality of Housing standards are often used as norms or measures that are applicable in legal cases where there is some question as to the acceptability of construction relative to prevailing laws or conventions that operate within the residential building industry. The definition of quality of housing embraces many factors which include the physical condition of the building and other facilities and services that make living in a particular area conducive. The quality of housing within any neighborhood should be such that satisfies minimum health standards and good living standard, but should also be affordable to all categories of households [14].

However, the quality of low-cost housing is a rather more complex concept with broader social and economic meaning. It accounts for both quantitative and qualitative dimensions of residential units, their immediate surroundings, and the needs of the occupants. Moreover, the concept of the quality of low-cost housing is relative as it relates to local standards and conditions. What is considered to be reasonable quality in one context may be considered poor quality in another context and vice versa [15].

1.3 Challenges of IBS adoption

Despite several identified benefits prefabricated construction system have over the traditional method, it also poses challenges such as a higher initial cost, inadequate communication in the supply chain, and difficulties in altering the design at various stages of construction [16]. Other identified challenges include design problems, production problems, transportation problems, installation process problems, and lack of experience regarding prefabricated construction techniques [17]. Since the components are produced by several parties, they are often prone to design errors and installation difficulties. Another major setback of this method is that the components are difficult to correct in the event of an error and this often results in rework, time, and cost overruns.

1.3 IBS and quality construction

Quality is the entirety of features and characteristics of a product, service or its entity that allow on its capacity to fulfill specified or implicit requirements. Pierk [18] and Lombard [3] asserted that construction quality has the ability to reduce potential time and cost savings when the quality aspects of applications in construction are overlooked. From the customer perspective, conformance to requirement and fitness of use is quality. These have an indirect impact on the time and cost of construction projects, and for that matter should be critically looked at to ensure the project success.

Lombard [3] defined construction quality by identifying different scopes of quality. He identified them as long and short term quality, noting the construction phase of a project as the short term quality and the operational phase of the project as the long term quality. For instance, in Spain, the government built over 200 public school centers at Catalonia using industrialized precast expertise since the year 2000. These schools were erected in a remarkably short time quick on-site assembly, high quality product and within reasonable cost [19].

The benefits of prefabricated components in the management of construction projects has been tried and tested in so many countries and for that matter Nigeria can emulate that in the management of construction projects especially when mass production is required within a specific time and quality required within an estimated budget.

According to Raghavendra *et al.*, [6], the gradual adoption of the new modern trends and methods in technological advancement is a necessity for the success of companies and the development of the construction industry. For instance the use of precast concrete elements can be used to help reduce the amount of waste generated on the construction site by up to 50% of a construction project as compared to cast in-situ method. They further outlined that the design system which can be executed by the manufacturing company is tridimensional (3D) modelling software that helps keep the different interface between the construction elements. A further study on the software will help designers to better understand the design and specification of components that cannot be manufactured or transported. Practically, the waste reduction principle needs to be implied as basis to manufacturing and construction on site as much as possible [6].

The use of prefabrication considerably reduces mistakes and increases construction speed. This leads to savings in

construction time and cost. It is obvious that a better quality control system is achieved when prefabrication is used [7]. It can therefore be concluded that prefabrication is economical when carefully compared to other conventional in-situ methods which are being used since 700 B.C. industrialized building system and precast is a cost and time saving construction method which ensures quality of concrete to its maximum extent.

2. Methodology

This paper presents the findings from a research conducted on the challenges of industrialized building system adoption for quality low-cost housing by construction industry (the built industry/building team) in Kano municipal, Kano State, Nigeria. The methodology employed in this study is quantitative method; while the target population is the construction industry (the built industry/building team) in Kano municipal, Kano State, Nigeria. This study adopted snowballing sampling technique with Delphi method in obtaining data among the construction industry in Kano Municipal Local Government, Kano State for the administration of questionnaire in this study. After taking into consideration the number of potential respondents in the sample size along with the information required to achieve the research objectives the research instrument decided on was a questionnaire in a form of Likert scale. Snowballing Sampling is the sampling technique whereby after identifying a single respondent as expert, the expert recommends another expert based on his experience in the field. Saunders, *et al.* [20] illustrates snowball sampling is commonly used when it is difficult to identify respondents of at the desired

population. Snowball was used in this study to identify IBS expert in the construction industry.

2.1 Delphi Technique

Irdayanti, *et al.* [21] defined Delphi technique as a framework used to conduct a research by collecting and analyzing opinions of a group of experts in the fields of the chosen study. Furthermore, it is the process of arriving at group consensus by providing experts with rounds of questionnaires, as well as the group response before each subsequent round. They continue, this technique is said to be a unique method, especially in the process of collecting and refining the review of all the information thus obtained feedback from a group of experts who have been selected. This technique does not require a large population.

2.2 Delphi Survey Panel Selection

The most decisive stage in any Delphi study is the panel selection process [22]. This is because the caliber of the panel of experts largely determines the character of the results obtained [23]. The purpose of the panel selection process was to identify people that agreed the criteria outlined for inclusion in the survey. The importance of the panel selection process when conducting consensus techniques cannot be overemphasized [24]. The experts in this study were identified through a snowball sampling technique. The Delphi was conducted in three (3) rounds to achieve consensus amongst experts. Figure 1, illustrates the Delphi process utilized in this study.

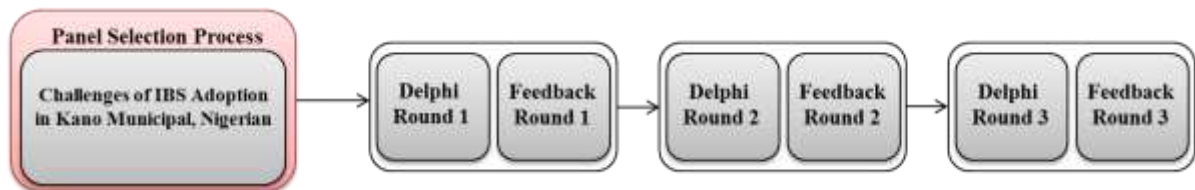


Figure 1. The Delphi process (adapted from Horan, [25])

The administration of the questionnaire is distributed to the experts at their various firms. SPSS 21 (Statistical Package for the Social Sciences, version 21) was adopted in analysing the data obtained from the questionnaires. A total of number of 20 questionnaires was distributed and 16 of them were filled and returned. This represents 80% of the distributed number. The returned questionnaires formed the basis for the analysis.

Table 2: Questionnaire Administered (Field survey, 2021)

Questionnaires Administered	Frequency	Percentage
Total Number of Valid Returned	16	80
Total Number of not Returned	4	20
Total Number Administered	20	100

3. Results and discussion

Table 2 shows the profession of the respondents with their percentages from the following category: Estate surveyors and valuers, Architect, Quantity surveyor, Building engineer, Structural engineer. 2 out of 16 (representing 12.5%) of the respondents were Estate surveyors and valuers, 8 out of 16 respondents were architect (representing 50%), 1 respondent out of 16 is a building engineer (representing 6.3%), and 1 respondent out of 16 is a structural engineer (representing 6.3%).

Similarly, the table also indicates the years of working experience of respondents, 5 respondents (representing 31.3%) have working experience between five to ten years. 9 respondents out of 16 respondents have 11-20 years working experience (representing 56.3%). In addition, 1 of the respondents have between 21-30 years working experience (representing 6.3%), 1 respondent also have over 30 years working experience (representing 6.3%).

Table 3: Expert profile (Authors field survey, 2021)

S/No.	Field of Expertise	Current Job position	Educational level	Years in practice
1.	Urban and Regional Planner	LIS Officer	B.Sc.	5 - 10
2.	Architect	Manager	M.Sc.	11 - 20
3.	Architect	Project manger	HND	11 - 20
4.	Architect	Site manager	OND	5 - 10
5.	Quantity Surveyor	Director	M.Sc.	21 - 30
6.	Building Engineer	Site manager	B.Sc.	5 - 10
7.	Estate Surveyors and Valuers	Principal partner	M.Sc.	11 - 20
8.	Estate Surveyors and Valuers	Manager management dept.	B.Sc.	5 - 10
9.	Structural Engineer	Site Engineer	B.Sc.	5 - 10

The challenges for adoption of industrialized building system for low-cost housing by construction industry in Kano municipal, Kano state, Nigeria. According to this survey, it shows that, Lack of experience in prefabricated construction and Inadequate communication in supply chain was ranked 1st with a mean of 4.06. The developers were of the opinion that their lack of experience in the methodology involve in industrialized building system was the main reason behind the adoption. Higher initial construction cost and lack of demand for it by client was ranked 3rd with a mean value of 4.00, the higher initial cost was seen as a demotivation toward the adoption of prefabrication. It must be noted that the project management hand book view a successful project as projects that are on time, within budget and with all features as originally specified. Lack of practical knowledge in the

university/ technical training and Inflexible for design changes was ranked 5th with a mean value of 3.18. Transport problem for prefabrication was ranked 7th with mean score of 3.31, Production problems and No cabinet blue print backing on the adoption and usage of prefabrication encounter in the manufacturing of industrialized building system was ranked 8th challenges to the adoption of prefabrication with mean value of 3.18. Industrialized building system not included in the design was the ranked 10th item with mean value of 3.12, and lastly Leakages problems may occur at joints of prefabrication if not properly sealed was found not to be a major problem in the adoption of prefabrication as it was the least ranked of all the factors that hinder on the adoption of prefabrication.

Table 4 Findings on challenges of IBS adoption

S/no.	Challenges of IBS adoption	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree	Mean (x)	Std dev.
1	The construction industries do not adopt IBS because of its <i>initial cost</i> .	6(37.5%)	8(50%)	-	-	2(12.5%)	4.00	0.10
2	The construction industry do not adopt IBS because of <i>inadequate Communication in Supply Chain</i>	6(37.5%)	7(43.8%)	3(18.8%)	-	-	4.06	0.25
3	The construction industry do not adopt IBS because of <i>Difficulty to Make Changes to Design at construction stage</i>	1(6.3%)	5(31.3%)	7(43.8%)	3(18.8%)	-	3.31	0.70
4	The construction industry do not adopt IBS because of <i>Production Problems</i>	1(6.3%)	5(31.3%)	7(43.8%)	3(18.8%)	-	3.18	0.40
5	The construction industry do not adopt IBS because of <i>Transportation Problems</i>	-	8(50%)	6(37.5%)	2(12.5%)	-	3.31	0.47
6	The construction industry do not adopt IBS because of <i>Lack of Experience in Prefabricated Construction</i>	11(68.8%)	5(31.3%)	-	-	-	4.06	0.44
7	The construction industry do not adopt IBS because of <i>Lack of practical and knowledge in university/technical training</i>	8(50%)	4(25%)	2(12.5%)	-	2(12.5%)	3.93	0.25
8	The construction industries do not adopt IBS because of <i>lack of cabinet/policy to promote its usage</i> .	4(25%)	8(50%)	2(12.5%)	-	2(12.5%)	3.18	0.40
9	The construction industry do not adopt IBS because <i>it is not included in the design</i>	7(43.8%)	4(25%)	2(12.5%)	-	3(18.8%)	3.12	0.34
10	The construction industry do not adopt IBS <i>because of leakage problem</i>	2(12.5%)	3(18.8)	5(31.3%)	-	6(37.5%)	2.87	0.34
11	The construction industries do not adopt IBS because of <i>lack of demand for it by client</i> .	6(37.5%)	8(50%)	2(12.5%)	-	-	4.00	0.36

4. Conclusions

Good housing quality must be able to respond to the variety of human needs. The risk involved in not completing the project on time is high which further expose the building to many external factors will affect the performance of the project. Construction industry is ever changing, unique and complex in nature. IBS is economical when compared to other conventional methods of construction which are being used for centuries now. IBS is a cost and time saving construction method which assures high quality of construction to its maximum extent. Even though IBS is established to be very economical, it has its own challenges as the system has not been fully implemented in Nigeria and there is less practical knowledge about this method in the construction

sector of Nigeria. The finding reveal that stakeholders in the construction Nigerian construction industry are aware of IBS but skill-sets required for the implementation is not available. The skill-sets should be identified to assist in meeting the huge low-cost housing demand through IBS as an alternative building technology for quality housing delivery in Kano municipal, Kano state, Nigeria.

The government needs to come up with smart incentives to facilitate the establishment of Industrialized Building System (IBS) production plants to avoid any kind of productivity delay. Even on-site management is crucial for enhanced construction speed and ensuring quality and exact specification. The need for adoption of such a methodology also needs a

guaranteed market to function and thus contractors, suppliers and managers also need to be made aware of the potential of such a technology in Nigeria. Therefore, it would be of benefit if any future research in this area could be conducted in other Local Government areas in the state and in other states across the country. This would add more information to the construction industry and to the populace at large. The study recommends that, construction industry should adopt IBS and that government should make a guiding policy on the adoption and implementation of industrialized building system for low-cost housing for the housing sector.

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