Journal of Sustainable Development in Africa (Volume 21, No.3, 2019)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

SUSTAINABLE HOUSING DEVELOPMENT THROUGH INDUSTRIALISED BUILDING SYSTEM APPROACH IN NIGERIA

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ABSTRACT

To achieve sustainable housing development in Nigeria, natural building material resources must be used sustainably. Industrialised Building System (IBS) is a method where prefabricated components are used for construction in sustainable manner. This study investigated the prospects, challenges, and strategies for improving IBS usage for sustainable housing development in Abuja, Nigeria. The method adopted was purposive sampling technique where questionnaire were distributed to 100 built environment professionals, who handle housing projects. Data obtained from the 80 questionnaire returned were analysed. The findings revealed that conventional method of construction is still prevalent. The challenges to IBS adoption for sustainable housing development are; insufficient IBS manufacturer, unfamiliarity due to resistance to change, enormous capital cost and lack of government intervention. The study concluded that Government support and increase awareness on the prospects of IBS would improve the usage of IBS in sustainable housing development.

Keywords: Industrialised Building System, Housing, Sustainable Development, Construction Method, Building Materials

INTRODUCTION

Housing deficit is a global menace occasioned by soaring population growth. It has been predicted that world population will soar by 90 percent by the year 2030 with 60 percent of the population living in urban areas. This indicates that 450million housing unit will be required for accommodating people in mega world cities. Currently, construction activities account for 70 percent of energy consumption and 75 percent of global carbon emission. (Ojoko, Abubakar & Ikpe, 2016) These scenario is unsustainable hence the need to adopt sustainable housing development strategy such as industrialised building system. IBS has been defined as a construction technique where all the components are manufactured in a controlled environment, and are then transported, placed and assembled at the work site with minimal additional structures (Nurul, Hamzah & Mahanim 2009; Kamar, Alshawi, Hamid, Nawi, Haron, & Abdullah, 2009). IBS is not only efficient in accelerating the construction of housing projects, but it improves the quality and affordability of the projects. (Wong and Lau, 2015). Despite the IBS being accepted by most construction firms as a viable method, because of the advantages in terms of speed, safety and quality, the wet construction method which is costly and has slow completion time, is still the most common construction method, in construction projects (Khalil, Aziz, Hassim & Jaafar, 2016).

Nigeria is currently facing a progressive housing deficit which is similar to many other rapidly developing countries. For example, Nigeria has a population of over 187 million, with an annual growth rate of about 2.5% with an urgent need of about 17 million new houses. (Dada, 2013) Thus, in order to address this housing deficit, mitigation efforts such as a paradigm shift from the conventional construction method to a more innovative housing production processes like industrialised building system approach is vital.

In IBS efforts are made to move some risk-prone construction site activities into a controlled environment - typically associated with a manufacturing or factory facility. This controlled environment and application of IBS offers several benefits, particularly: a higher speed of construction; improved quality of the finished product; lower costs; and lower labour requirements on-site (Mohammad, Baharin,Musa, & Yusof, 2016). This approach offers a platform for addressing the specific problems inherent, in conventional housing delivery systems. The population of Nigeria and the huge housing deficit, requires that the country will continue to embark on housing development. Furthermore, the increasing demand for construction of housing units will require that new technology and sustainable strategies such as IBS be adopted. The prospect for IBS adoption in Nigeria is bright, but great work is still needed from both the government and professionals to be able to increase the application of this construction method in housing development. Therefore, the focus of this study is to investigate the level of adoption of IBS in housing development in Nigeria. Professionals' perception on critical success factors and challenges to IBS utilisation in housing projects will be investigated. Furthermore, the strategies for promoting the adopting of IBS will be determined.

LITERATURE REVIEW

The Concept of Sustainable Development in Housing Projects

Sustainable development ensures that the present generation is able to meet its need without depriving future generation of meeting their needs (Oyedepo, 2014). The three pillars of sustainable development involve environmental, economic and social development. Sustainable practices in construction means reduction in consumption of large volume of natural resources particularly timber, sand, stone, iron, limestone and fresh water because construction activities consume 50% of fresh water. (Omole & Ndambuku, 2014) Sustainable development is the practice of reduction in the use of building materials with embodied energy which could be released as toxic gases that are detrimental to the environment (Oyedepo, 2014). Minimising activities that generate large quantity of waste deposited on landfills that results in environmental degradation and carbon emission is sustainable development. Embracing environmental friendly strategies which ensures that natural resources are used in optimally and not depleted is sustainable development. (Bashir, Mohd, Adetunji & Dodo, 2013). For sustainable housing development to meet 17 million housing needs professionals in the business have to develop and adopt strategies such as industrialised building system to utilize resources in sustainable ways.

The Concept of Industrialised Building System

Industrialised Building System (IBS) is a term used for a technique of construction where by components are manufactured in a controlled environment, either at site or off site, placed and assembled into construction works. IBS requires a short period for completion for the erection of structures. The quality of the buildings that are constructed using the conventional method depends on the technical knowledge of the labourers as well as their conduct at the construction sites. IBS offers good quality components with better surface finishes, which are more refined than those made possible by the conventional method (Khalil, et, al. 2016).

Industrialisation is a process of social and economic change whereby a society is transformed from pre-industrial to industrial state. It was further defined as a part of a wider modernization process through the gainful utilisation of relevant and viable technologies. (IBS Roadmap, 2003), Generally, IBS also known as offsite construction or prefabricated component in the UK construction industry is defined from two perspectives namely system and process of construction. IBS is a "a system in which concrete components prefabricated at sites or in factories are assembled to form structures under strict quality control. (Azman, Majid, Ahamad, & Hanafi, 2011; Pan, Gibb, & Dainty, 2012)

Sustainable Features of IBS in Housing Development

Statistics are not promising on the housing delivery success in Nigeria, where only 10% of Nigerians can currently afford to either purchase or build their desired house, compared to other countries where housing delivery has recorded up to; 72% in USA, 78% in UK, 60% in China, 54% in Korea and 92% in Singapore (Dada, 2013). Housing situation in Nigeria is far from being satisfactory, taking into account the high rates of urbanisation and population growth. There is no prospect of improvement in the near future, if the country decides to continue to rely on its conventional housing delivery systems. The present system of housing delivery presently is deficient in terms of quantity and quality of housing units delivered. These problems will have multiple effect and may results in other problems, such as unstable businesses, shortage of skills shortage of non - renewable materials, inadequate infrastructure, lack of innovation and unbalanced distribution of resources.

Globally, skills shortage within the construction industry is a recurrent challenge over the past 30 years and this problem exists in almost all parts of the world to varying degrees. In Nigeria, this problem is one of the main issues that hampered effective delivery of housing. Similar to other countries, the Nigerian construction industry lags behind other industries in terms of new technologies. This includes slacking in adopting innovative technologies in order to improve the speed and quality of building production (Marshall and onyekachi, (2015). Nigeria currently requires about 17million more housing units annually to bridge the gap between its housing supply and demand.

Reduction in Material Wastage

Statistics about waste generation in Nigerian construction projects, showed that more than one-ton per day of waste is generated in more than 70 per cent of building sites where conventional construction methods are engaged. It was also reported that most waste were generated from demolition works on site and material handling (Adeagbo, Achuenu & Oyemogun, 2016). According to a report by Waste and Resources Action Programme (WRAP, 2007) within the context of the UK, where 40 per cent of all council waste is attributed to construction projects, IBS has been successful by reducing waste generation of typical construction projects by 70% to 90%. It has also been advocated that it is much easier to gather and recycle waste generated from prefabricated construction (Jaillon, Poon,& Chiang, 2009; WRAP, 2007).

Speedy Delivery of Construction Projects

The significant value of time is of great consideration in IBS. Similar to other countries, construction projects in Nigeria are often delayed due to issues such as material shortage, skills shortage and poor weather conditions. With IBS, these issues are inherently addressed, since most of the building components are manufactured in factories and transported to site for speedy assembly with predictable time. Furthermore, where there is need to deliver project within a short time, prefabrication has the potential to allow different aspects of parallel activities of site development to take place with a possibility of 30- 50% faster delivery times. (Dada,2013)

Economical for Repetitive Construction

The higher initial cost of IBS projects, can be offset through savings from cost certainty, reduction in risk, maintenance costs, site overheads, and durable projects. Savings can be achieved by using IBS as a result of reduction in wastage of building materials especially concrete because the volume of materials required for formwork and scaffolding are reduced substantially if no completely eliminated. (Blismas, & Wakefield, 2009; WRAP, 2007). In Nigeria where sandcrete blocks are predominantly used, incorporating IBS has the potential of making a significant impact on the reduction of waste on site, thereby offsetting the initial high cost and it is highly economical in repetitive large scale construction projects.

Improvement in Quality of Construction

The need to improve quality of construction has made IBS adoption critical because its meets the three quality requirements of durability, whole life cost and performance. It was ascertained that achieving greater quality was a major benefit and a key driver to the adoption of IBS, in different countries such a: India; Australia; and UK. The production quality and output consistency is as a result of controlled factory environment associated with offsite construction as opposed to the uncertain conditions of a conventional construction site. (Gibb, 2001)

Reduction of Construction Duration

IBS approach to construction can cut down on the overall construction period. Statistically, IBS construction projects can save up to 30% in time compared to conventional methods. Construction can be completed rapidly because of the speedy manufacturing and assembling of pre-cast components in factories. In contrast, projects that deploy the conventional method are difficult to complete within a short period of time. This method requires a long duration before completion since moulds need to be built and the concrete has to be given enough time to set. With IBS, site disruptions and environmental factors are eliminated and having more control over projects, has been identified as an important benefit of IBS. (CIDB, 2016; Haroon, Rahman & Hanid, 2009; Mohammad, et, al. 2016)

Labour Efficiency

Construction of housing units is labour - intensive, using conventional construction methods. However, with the IBS, the fabrication and assemblage of the pre-cast components is relatively less labour-intensive, but still requires few skilled labour for installation on-site. This explains the minimal number of labourers because they are only used for the installation of the IBS components. Labour efficiency is one of the factors that contribute to improvement in productivity. (Malaysia Equity Research, 2014; Yunus, 2017).

Barriers to Sustainable Housing Development through IBS

Some of the challenges to the usage of IBS for sustainable housing development is because the system requires high initial investment of capital for the purpose of acquiring plant, equipment, steel mold, foreign technology, transportation and the wages of skilled workers for the installation process (Yunus, 2017). There is limited research and inadequate knowledge on IBS which is a major barrier to IBS usage. In an IBS project, the contractor is expected to be paid initial deposit which will be paid to the manufacturer for prefabricated components (Ogunde, Selekere, Joshua, Kukoyi, & Omuh, 2016). IBS manufacturers normally require an advance payment of about 75% of the capital to manufacture the components before delivery to construction sites. Most times, local contractors don't have sufficient funds to finance the project (Jaillon, 2009).

Leakage sometimes occurs at the connection between two components. This problem may be due to an error in the installation of the components or probably because of an error which occurred during the manufacturing stage. IBS involves high cost during the initial stages of construction because it requires the involvement of heavy machineries during the manufacturing, delivery and the erection of components at the project sites. IBS components are considered to be expensive due to lack of IBS components manufacturers. However, it offers a lower cost of construction in the long run, because wastage is kept to a minimum level (Rahim, Hamid, Zen, Ismail, & Kamar, 2012; WRAP, 2007).

RESEARCHMETHODOLOGY

Research methods are the different processes, systems and algorithms used in study, while research methodology is a science of how to conduct studies, research design involves scientific research methods and processes. (Bishop & Herron, 2015). The study is a research survey involving the use of cross-sectional survey design. The data used in the study was made up of variables of the same sample observed at one point in time in Abuja. The population of this study includes in particular, the Architects, Quantity Surveyors, Contractors, Project Managers, Estate Surveyors, Civil Engineers and Builders. The sampling techniques used in this research is purposive methods of sampling. This technique was used as participants were chosen among professionals with expertise in housing projects. Saunders, Lewis, and Thornhill, (2009) recommend the use of such technique when a researcher wishes to select respondents that have particular information in fulfilling the research objective. A total of 100 questionnaire were distributed and 80 questionnaire were returned. This reflects a 80 percent response rate. With the help of Statistical Packages for Social Science (SPSS), data collected from the administration of the research tool were analysed using descriptive statistics where the mean was used as a basis to rank the factors studied. This data analysis technique is informed by the works of (Bishop & Herron, 2015)

ANALYSIS OF RESULTS AND DISCUSSIONS

Table1 knowledge on IBS as a tool for sustainable housing development

Parameter	Frequency	Percent
Yes	6	07.50
No	74	92.50
Total	80	100

knowledge on IBS as a tool for sustainable housing development

Table 1 shows the level of knowledge in IBS as a tool for sustainable housing development. According to the table, the percentage of respondents with sufficient knowledge is 7.5% of the total number of the respondents while 74 respondents indicated that they do not have practical knowledge, this constitutes 92.50% of the total number of respondents. This implies that majority of the respondent do not have practical exposure to IBS usage in their projects. which means that most respondents do not make use of IBS.

Table 2 Extent of IBS usage in projects

Parameter	Frequency	Percent
Low	72	90.0
Medium	5	6.25
High	3	3.75
Total	80	100.0

Extent of IBS usage in projects

Table 2 presents the extent of usage of IBS in their various housing development. This revealed that out of a total number of 80 respondents, 72respondents which is 90.0% of the total number of respondents have low extent of IBS usage. 5 respondents which is 6.25% of the total number of respondents have medium extent of IBS usage. while 3 respondents which is 3.75% of the total respondents have high extent of IBS usage. This implies that a greater percentage of respondents have low extent of IBS usage in their housing development.

Table 3 Prospects of IBS in Sustainable Housing Development

S/N	Prospect of IBS in housing development	5	4	3	2	1	Mean	Rank
1	Time saving due to allowance for parallel activities on site	33	3	28	16	0	3.662	8
2	Conserves the use of water	24	34	0	22	0	3.750	6
3	Site can be located close to existing developments	14	0	38	20	8	2.900	15
4	Maximises contractors profit in repetitive projects	22	20	38	0	0	3.800	14
5	Conserves the use of large volume of non-renewable materials during construction	38	26	16	0	0	4.275	2
6	Improves workers' productivity	6	24	42	8	0	3.350	13
7	Minimises construction labour shortage	6	44	18	7	5	3.487	10
8	Enhances workers safety and health	8	38	34	0	0	3.675	7
9	Easy to disassemble and reuse components	9	34	15	22	0	3.375	12
10	The building components are more durable	42	10	28	0	0	4.175	3
11	minimises energy consumption during construction	38	11	31	0	0	4.087	4
12	Optimises operational and maintenance practices	18	12	44	6	0	3.525	9
13	Results in higher quality products for clients	14	13	46	7	0	3.425	11
14	Reduces environmental pollution during construction and toxic waste disposals	31	14	35	0	0	3.950	5
15	Reduces material wastage during construction	37	37	6	0	0	4.387	1

Prospects of IBS in Sustainable Housing Development

In Table 3, the prospect on the use of IBS as perceived by the professionals are ranked in descending order where reduction of material wastage during construction was ranked first with a mean score of 4.387, conservation of large volume of non-renewable materials during construction was ranked second with a mean of 4.275, the building components are more durable with a mean of 4.175 was ranked third, minimises energy consumption during construction

with a mean of 4.087 was ranked fourth, reduces environmental pollution during construction and toxic waste disposals was ranked fifth with a mean of 3.950. Further analysis of results revealed other prospects of IBS as it conserves the use of water which was ranked sixth with a mean of 3.750 it enhances workers safety and health was ranked seventh with a mean index of 3.675, it promotes time saving due to allowance for parallel activities on site was ranked eight with a mean index of 3.662.

On prospects of IBS, reduction of material wastage during construction has the highest rank, while the lowest ranked factor is that site can be located close to existing structures. This implies that majority of the respondents agreed that the application of IBS would improve sustainable housing development. The respondents ranked the highest barrier to the usage of IBS as Initial high cost of financing IBS projects and lack of familiarity and resistance to change. The findings of this study is in agreement with the work of (Dada, 2013 and Ogunde, et., al. 2016) This implies that stakeholders will need to address these problems to encourage the application of IBS in sustainable housing development.

Table 4 Barriers to Sustainable Housing Development through IBS

S/N	Barriers	5	4	3	2	1	Mean	Rank
1	Inability to make changes to building after it has been installed	6	26	48	0	0	3.475	6
2	Unfamiliarity and resistance to change	52	28	0	0	0	4.650	2
3	Insufficient IBS manufacturers	14	58	8	0	0	4.075	4
4	Lack of knowledge on IBS	8	14	58	0	0	3.375	7
5	Limited availability of personnel to install components	7	29	44	0	0	3.537	5
6	Expensive plant and equipment to establish IBS factory	6	12	62	0	0	3.300	8
7	Initial high cost of financing projects using IBS	60	20	0	0	0	4.750	1
8	Lack of subsidy and policy to promote IBS usage	20	60	0	0	0	4.250	3

Barriers to Sustainable Housing Development through IBS

Table 4 focuses on the barriers to IBS usage in housing projects for sustainable development. In this section several factors were listed out for the respondents. The ranking according to the table is arranged in descending order with barrier of initial high cost of financing IBS by contactors ranked first with an index of 4.750, unfamiliarity and resistance to change ranked second with an index of 4.650, lack of subsidy and policy to promote IBS usage ranked third with an index of 4.250, insufficient IBS manufacturer ranked fourth with an index of 4.075, limited availability of personnel to install components ranked fifth with an index of 3.537, and inability to make changes to building after it has been installed ranked sixth with an index of 3.475. From the results it shows that more effort needs to be deployed to address the barriers to IBS usage for sustainable housing development.

Table 5 Strategies for improving IBS for Sustainable Housing projects

S/N	Strategies	5	4	3	2	1	Mean	Ranking
1	Educational courses on IBS in institutions	42	10	28	0	0	4.175	2
2	Application of IBS in repetitive government housing projects	38	11	31	0	0	4.087	3
3	Promoting market acceptance of IBS housing units	18	12	44	6	0	3.125	5
4	Establishment of IBS manufacturing factories at strategic housing project locations	38	26	16	0	0	4.275	1
5	Government support with startup capital and financial incentive for users	24	34	0	22	0	3.750	4
6	Specialist and experts in IBS should promote it as a faster and cheaper option in repetitive housing projects.	33	3	28	16	0	3.000	6

Strategies for improving IBS for Sustainable Housing projects

The ranking according to table 4 is arranged in descending order where establishment of IBS manufacturing factories at strategic housing project locations has been ranked first with an index of 4.275, introduction of educational courses on IBS in institutions is ranked second with an index of 4.175, application of IBS in repetitive government housing projects ranked third with an index of 4.087, Government support with startup capital ranked fourth with an index of 3.750, promoting market acceptance of IBS housing units ranked fifth with a mean index of 3.125, specialist and experts on IBS should promote it as sustainable option in repetitive housing projects was ranked sixth with a mean index of 3.000 According to the table only few professionals are involved in the usage of IBS for sustainable housing development which means that IBS has not been fully embraced in sustainable housing development.

Strategies to improve the usage of IBS in sustainable housing development as suggested by respondents should include; establishment of IBS manufacturing factories at strategic housing project locations, introduction of educational courses on IBS in institutions, application of IBS in repetitive government housing projects , government support with startup capital, specialist and experts in IBS should promote it as a faster and cheaper option in repetitive housing projects and promotion of market acceptance of IBS housing units. Again this is in consonance with the submission of (Yunus, 2017; and Ogunde, et., al. 2016). The implementation of these strategies would encourage the adoption of IBS in sustainable housing delivery.

CONCLUSION AND RECOMMENDATIONS

The study has indeed revealed that there is a lot of factors militating against the use of IBS in sustainable housing development. The low usage of IBS is the perception of being initially financially expensive and limited knowledge on the benefits of IBS in sustainable housing development.

It was discovered that the level of IBS adoption is still very far from what it should be and those who know the benefits of IBS are not taking steps to promote its usage. It is indeed a change issue as professionals accept that they have been exposed and trained in the conventional construction method for decades and have mastered the act. Shifting to IBS will be too complicated. It is undeniably easy and tempting to stay within known boundaries than to venture out and seek new ideas; thus, the majority of Nigerian housing developers have naturally found it easier to stick to conventional construction methods for their construction projects than to adopt IBS. Therefore, it is recommended that the adoption of IBS would be enhanced if the Government introduces subsidy and invest in a long term comprehensive policy that would address the sustainability of the housing development sector. If the utilisation of IBS must be encouraged, various informative programmes and collaboration with the institutions should be developed to educate the private sector as well as the public sector involved in housing projects.

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ACKNOWLEDGEMENT

We acknowledge the support and assistance of Odulusi Oluwafemi in the coordination of data collected for this study.

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