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PROSPECTS OF INDUSTRIALIZED MATERIALS IN BUILDING PRODUCTION IN NIGERIA

[1]Aladeloba, E. A., [2*]Okesoto, J. O. and [3]Olawale, S. O.

[1,3]Building Technology Department, Yaba College of Technology, Yaba- Lagos, Nigeria
[2]Urban and Regional Planning Department, Yaba College of Technology, Yaba- Lagos, Nigeria

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ABSTRACT

The paper amidst the issues of growing demand for affordable housing, increasing construction costs, heightened concern for energy-efficiency, fragmentation of the industry; delays in production and delivery time; unnecessary wastages and lack of sustainable practice arising from the widespread adoption of the traditional method of construction examines the need to explore other constructional methods - Industrialized Building System (IBS) so as to satisfy the concerns of construction players. The paper adopts qualitative research method, which entails thematic review of literature appropriate for the study. The paper espouses the immense benefits of industrialized building system, which is considered to be an important part of sustainable construction initiative, no doubt meet the above and the awareness and adoption of current trends and latest innovation in same is essential in order to survive in the emerging competitive market. However reviewed literatures equally shows that , the system has failed to gather momentum due to the perception that the system increases construction costs; the traditional financing practice is at variance to its adoption; the lack of adequate skills and knowledge on the IBS; project delivery and supply chain issues; negative perception of stakeholders on the flexibility of the system and the lack of incentives and seriousness in its promotion by the authorities in both public and private sectors. Based on the review of literature and field survey carried out, this paper discusses the identified barriers with the aim of determining the prospects of industrialized materials in Building production implementation in the Nigerian construction industry.

INTRODUCATION

Nigeria, like any other developing country, considers the construction industry as one of the main contributors to its Gross Domestic Product (GDP). It, influences the country's economic activity, adds up to the government revenue, creates investment benefits and creates employment to specially trained workers. The population of Nigeria is about 160 million and with a claim of about 17million housing deficit, the country will continue to embark on developing an affordable and sustainable low and medium house. Furthermore, the increasing demand for construction witnessed shall continue as long as the Population increases and there is improvement in the quality of life of the populace. Meeting the housing need of Nigeria within the framework of sustainable development will require that new technology and sustainable strategies be adopted. Waleed *et al*., 1997 stated that to meet the ever- increasing housing demand by sticking to the current traditional building process requires a large workforce (mostly unskilled). This is due to the low productivity rate in such an outdated system. Agus, 1997 and Senturer, 2001 opine that the traditional construction method, which is commonly practiced, is high in cost, unable to respond to this huge demand within a short space of time and failing to produce acceptable quality construction products and slow in considering sustainable development strategies. Industrialized materials in the building process minimizes accident rate in the construction industry. Aladeloba, 2003 opines that bad construction is an accident waiting to happen, no matter the length of time, surely; it must happen. Building construction activities have to do with the effective management of all resources namely money, manpower, methods, materials and machine at an appropriate time. Aladeloba, 2014 posited that material is a substance of which a thing is made or composed and industrialized is the act of producing something by efforts or some mechanical or

Corresponding author: Okesoto, J. O.
Urban and Regional Planning Department, Yaba College of Technology, Yaba- Lagos, Nigeria

industrial process. The production and harvesting of raw materials for building purposes has attracted a worldwide attention so much so that it has become major trade key point between nations which has resulted in a multibillion dollar Building industry. The use to which these materials are put and the processes of its production have elicited the emergence of specific specialty trades such as Carpentry, Plumbing, Bricklaying (masonry) and Electrical installation work, Welding works etc. In many countries of the world, the manufacture of building materials is an established industry. They provide the make-up of habitats and structures including homes. Also thrummed up are issues of Environmental concerns which have become a major world topic regarding the availability and sustainability of certain materials, and the extraction of such large quantities needed for the human habitat. Industrialized building materials allowed for sustainable use of production inputs.

Since, the list of building products exclusively used to construct the building architecture and supporting fixtures like windows, doors, cabinets, etc. resulting from the increasing population and subsequently the increasing need for building development for varying uses has been on the increase, it therefore becomes necessary that a country like Nigeria with a population of over 180 million people should embrace industrial production of building materials.. It should however be noted that Building products do not make any part of a building rather, they support and make them work in a modular fashion. The paper is aimed at canvassing for paradigm shift in the construction process from the conventional or traditional approach to industrialization perspective in Nigeria with the view of increasing the stock of buildings in supply within the construction sector of the nation's economy.

Nigeria: Description and the need for industrialized building materials

Nigeria is situated on longitude $4^{o}14'$N and latitudes $2^{o}15^{o}$E, existing to the west of the coast of Africa. The country has a total of 183 million people (National Population Commission (NPC), 2006) and an estimated population of 210millon at a projected rate of 1.83% per annum. It covers a land area of about 923,768km2. The country is one of the most populated in the continent of Africa, suggesting that the country is in dare need of housing and other building development to meet the requirements of its teeming population. The country's building sector is the second largest employer of labor, the first been the agricultural sector.

The sector provides an estimated employment of over 10million, with a Gross Domestic Product (GDP) of=N= 539,676.12 million in 2012 accounting for about 12.85% of the total GDP of =N=41,181,617.09 trillion for that year. In 2013, the sector contributed a total GDP of =N=173,242.4 million about 15.5% of the total GDP for the year. It is estimated that the sector's contribution will be 15.59, 13.0 and 9.13 in 2015, 2016 and 2017 respectively (Federal Republic of Nigeria, 2013). The decline can only be arrested, if the nation embraces industrialized materials in Building production. This will accelerate the growth in the industry and promote rapid growth and development of the building and construction sector.

MATERIALS AND METHODS

The study employs qualitative research method which entails review of existing literature on the appropriate themes of the study. Reviewed literatures have their main thrusts synthesized and presented in logical order and findings deduced from them were literarily presented.

Thematic Issues

An industrialized building system (IBS): Conceptual definitions

Rollet, 1986, Trikha, 1999 define an Industrialized Building System (IBS) as one in which all building components such as beam, column ,wall, floor slab and staircase are mass produced either in factory or at site under strict quality control and minimal on-site activities. Esa and Nuruddin (1998) further asserted that an IBS is a continuum beginning from utilizing craftsmen for every aspect of construction to a system that make use of manufacturing production in order to minimize resource wastage and enhance value for end users. Junid, 1986 defines IBS in the construction industry to include the industrialized process by which components of a building are conceived, planned, fabricated, transported and erected on site. The arrays of these definitions suggest that the system includes a balanced combination between the software and hardware components.

The software elements include system design, which is a complex process of studying the requirement of the end user, market analysis, development of standardized components, establishment of manufacturing and assembly layout and process, allocation of resources and materials and definition of a building designer conceptual framework. The software elements provide a prerequisite to create the conducive environment for IBS to expand. Meanwhile, the hardware elements are categorized into three major groups. These include frame or post and beam system, panel system, and box system. The framed structures are defined as those structures that carry the loads through their beams and girders to columns and to the ground whilst in panel system loads are distributed through large floor and wall panels. The box systems include those systems that employ three-dimensional modules (or boxes) for fabrication of habitable units and are capable of withstanding load from various directions due to their internal stability.

According to the IBS Roadmap (2003), industrialization is a process of social and economic change whereby a society is transformed from pre-industrial to industrial state. It is part of a wider modernization process through the gainful utilization of relevant and viable technologies. Generally, IBS (also known as offsite manufacturing in the UK construction industry) is defined from two perspectives namely system and process of construction. Cheong (1997) defines IBS as a system which uses industrialized techniques either in the production of components or assembly of a building, or both. Similarly, Trikha (1999) describes IBS as "a system in which concrete components prefabricated at sites or in factories are assembled to form structures under strict quality control and minimum in situ construction activity." In view of the above IBS from the perception of the authors whose were reviewed

represents a gap between pre- industrialization and industrialization.

Classifications of Industrialized *Building System*

Badir *et al*., 1998 classified Building systems into four categories namely cast in-situ, conventional, prefabricated and composite building systems. Each building system is represented by its respective construction method which is further characterized by its construction technology, functional and geometrical configuration. Warszawski, 1999 asserted that the building system could be classified in different ways, depending on the particular interest of their users or producers. For instance, construction technology classification recognizes four major classifications namely; precast concrete, steel, cast in situ concrete and timber as their main structural and space enclosing materials whereas the geometrical configuration of the main framing components recognizes the following: linear system (beams and columns), three dimensional or box systems and planar or panel systems. It is pertinent to note that classification of the Building systems is not limited to the above as researchers like Majzub, 1977 expounded that the relative weight of components should be used as a basis for building classification believing that the weight has significant impact on the transportability of the components and also has influence on the production method of the components and their erection method on site and so cannot be ignored.

Majzub, 1977 further argued that the classification by weight also has the advantage of distinguishing between the various basic materials used in the production of component which by itself could determine the characteristic of the system under study. However, the current technological advancement in the area of interlocking load bearing blocks which was the brainchild of a group of researchers in University Putra Malaysia has punctured Majzub's claim as this new building system cannot be categorized according to frame, panel or even box system and same can be said regarding the composite system that combines two or more construction method. However, the classification of basic components in any form enhances time reduction during mass production of prototype buildings for all categories of Nigerian citizens.

Essential characteristics of Industrialized *Building System*

The IBS is characterized by the following features which every construction system aspiring to adopt must put into consideration, the characteristics are as listed and explained below as contained in the reviewed literatures.

Closed system

A closed system where the client's needs are paramount as against that of the Precaster who may likely prefer to design and produce a uniform type of building such as school, parking garage, gas station, low cost housing, etc. or a group of building variants, which can be produced with a common assortments of component. Warszawski (1999) posited that these types of building arrangement can be justified economically only in the event of the following:

- The architectural design is characterized by standardization and large repetitive element which will eventually necessitate the adoption of automated design and production process.
- When the size of project is large enough to allow for distribution of design and production costs over the extra cost per component incurred as a result of the specific design.
- There exists a marketing strategy which will enlighten the clients and designer on the potential economics and noneconomic benefits of the system.
- There is ready demand for a typical/prototype building such as school which will be mas- produced.

Open system

This system allows greater flexibility of design and encourages greater interaction between the designers and Precaster - the precaster is allowed to produce a limited number of elements with a predetermined range of product and at the same time maintaining architectural aesthetic value. However, the major setback is the joint and connection problem which occur when two elements from different system are fixed together. This is observed to adversely affect structural performance.

Modular Coordination

According to Trikha (1999), it is a co-ordinated approach to unify the system for dimensioning spaces, components, fitting, etc. in order to ensure all elements fit together naturally without cutting or extending even when the components and fittings are sourced from different manufacturers and suppliers. Of great importance to modular co-ordination for building component is the application of the basic length unit or module of M=100cm which allows the designer to apply same or its multiple in the production of building components. Its application however, involves a great degree of coordination and adjustment in the manufacturing process and the interfacing aspects of components.

Standardization and Tolerances

Standardization and Tolerances allows resources meant for production to be well utilized while the production process, machinery, and workers' training can be best tailored towards the particular characteristics of the product. Such standardization of space and elements Trikha (1999) are however guided by the Tolerances at different stages of construction such as manufactured tolerances, setting out tolerances and erection tolerances so that the combined tolerance obtained on statistical considerations is within the permitted limits.

Mass Production

The huge investment requirements in equipment, human recourses and other facilities necessary for industrialization can be justified economically only when materials are produced in large volumes. Such volume CIDB Singapore (1992) provides a distribution of the fixed investment charge over a large number of product units without unduly inflating their ultimate cost

Specialization is enhanced

In the process of Large production of precast elements output and standardization of same, a high degree of labor

specialization is enhanced due to repetitiveness. This process can be subdivided into a large number of small homogenous tasks which will further engender higher productivity level. It therefore demands that an efficient and experienced organisation capable of a high level of planning, coordination, organizing and control function with respect to production and distribution of the products emerges (Warszawski, 1999).

Integration

In order to obtain an optimal result, a high degree of coordination must exist between various relevant parties such as designer, manufacturer, owner, and contractor. This is achieved through an integrated system in which all these functions are performed under a unified authority (Warszawski, 1999).

Production Facility

The initial capital outlay for setting up a permanent factor is relatively is high as Plant, equipment, skilled worker, management resources need to be acquired before production can be commenced. Therefore, the demand for product must be sufficiently established as such huge investment can only be breakeven if there is sufficiently demand for the products.

Transportation

There are rules guiding the transportation of large panels subject to the country's road/ haulage policy. These limitations Peng (1986) must be taken into consideration when adopting a prefabrication system. Casting of large-panel system has been confirmed to reduce labour cost by 30 percent. However, these cost savings are partially offset by the transportation costs. Peng, 1986 further posited that a temporary casting yard or factory can be established at the project site in order to minimize the transportation costs.

Equipment at Site

Warszawski, 1999 advocated the incorporation of additional cost of procuring heavy crane for the purpose of erecting and assembling precast panels into their positions when adopting a prefabrication system, especially for multi-storey building.

Benefits of Industrialized *Building System*

Industrialized building system has the following benefits when compared to the conventional construction method.

a) The repetitive use of system formwork made up of steel, aluminum, etc and scaffolding provides considerable cost savings (Bing *et al*. 2001).
b) Construction operation is not affected by adverse weather condition because prefabricated component is done in a factory controlled environment (Peng, 1986).
c) Prefabrication takes place at a centralized factory, thus reducing labour requirement at site. This is true especially when high degree of mechanization is involved (Warszawski, 1999).
d) An industrialized building system allows for faster construction time because casting of precast element at factory and foundation work at site can occur simultaneously. This provides earlier occupation of the building, thus reducing interest payment or capital outlays (Peng, 1986).
e) An industrialized building system allows flexibility in architectural design in order to minimize the monotony of repetitive facades (Warszawski, 1999).
f) An industrialized building system provides flexibility in the design of precast element as well as in construction so that different systems may produce their own unique prefabrication construction methods (Zaini, 2000).
g) An industrialised building system component produces higher quality of components attainable through careful selection of materials, use of advanced technology and strict quality assurance control (Din, 1984). 6.

Shortcomings of Industrialized *Building System*

a) Up to date, the implementation of IBS has been characterized by lack of scientific information (Trikha, 1999). So, its benefits cannot be substantiated.
b) Standardization of building elements face resistance from the construction industry due to aesthetic reservation and economic reason.
c) Absence of assessment criteria has been identified as the most important inhibitor to the introduction of IBS system in the country (Trikha, 1999).
d) A general decline in demand and volatility of the building market for large public housing projects in most developed countries makes an investment in IBS more risky when compared with the conventional labour intensive methods (Warszawski, 1999).
e) The industrialization of building process cause monotonous "barrack-like" complexes that very often turned into dilapidated slums within several years. This shortcoming is further reinforced by production defects noticed in building components at the initial stages of prefabrication. Such defects resulting from lack of technical expertise and poor quality control Warswaski (1999)cause aesthetic and functional faults, such as cracks, blemishes, moisture penetration, and poor thermal insulation in completed buildings .
f) Prefabricated elements are considered inflexible with respect to changes which may be required over its life span.
g) There is a natural tendency among practioners to choose conventional methods at the expense of industrialized building system which is seldom thought at the tertiary level.

This is because an adaptation of standardization requires a tremendous education and training effort. Warsawski, 1999 claimed this is cited as one of the greater hindrance to the use of modular coordination apart from its cumbersome connections and jointing methods which are very sensitive to errors and sloppy work. Other shortcomings may include:

- Problems relating to manufacturer's requirement has been identified as one of the hurdles of IBS adoption in the construction industry (Fikri, 2005). In conventional construction method, contractor will be paid a specified percentage of the contract sum as mobilization fee by the client whereas in an IBS project, the contractor is expected to come out with the initial expenditures mostly to be paid

to manufacturers before any progress payment is made. Most times, local contractors don't have sufficient funds to finance the initial phase of projects using the IBS.

- Manufacturers normally require an advance payment of about 75% of the capital to manufacture the IBS components before delivery to construction sites. It therefore behooves on contractors to raise this initial bill. Zaini , 2000 observes that the only way for a contractor to be able to do that is by applying for a bond from a financial institution as a guarantee to be deposited with the IBS manufacturer. Any hindrance to securing such bond, may well affect the IBS project development process.
- Peng, 1986 posited that the location of construction site too far away from the IBS manufacturers or suppliers may well be adduced as the reason for shortage or late supply of IBS information, equipment, and materials to sites which is a big barrier to its successful implementation. This situation according to Chung, 2006 will indirectly increase the component of logistics and transportation costs in a construction project budget. This has been identified as one of the major hindrances in the adoption of
- Poor jointing of prefabricated walls with other prefabricated or in-situ elements have been identified as a major shortcoming of the IBS as this may give rise to water seepage problem especially during a heavy downpour(Zaini , 2000). This problem according to Chung, 2006 may result in, for example, high moisture movement
- Blismass and Wakefield, 2008 identify the traditional design process as unsuitable to Offsite Manufacturing (or IBS construction) and poses a substantial barrier to its adoption. This was complemented by Kampempool, 1986; Hamid *et al*, 2008 and Che- Mat, 2006, as one of the main hindrances towards an effective communication and integration between the design and construction team in IBS projects
- Lack of Incentive and Promotion
- Warsawski,1999 observes that modular co-ordination and standardization are among prerequisite characteristics underlining the successful implementation of IBS. It therefore becomes necessary that to accomplish the requirements of modular co-ordination, all components need to be standardized. Implying that standard plans and standard component drawings are required, particularly to aid the production process. This is cited as one of the principal hindrances to the use of modular coordination Otherwise, even partial introduction of IBS components such as lintels or staircases is not looked upon favorably and is therefore rarely used for the construction project due to a lack of standardization of modular coordination.
- The IBS require more skill from the workers when compared to the conventional construction methods. Unlike the latter, the skills required in IBS are more machine-oriented on and off sites (in factories). According to Hamid *et al* . 2008 this leads to a transformation requiring the education and training of human resource in an organization.
- Hassim et al. 2009, pointed out the reversal of role in an IBS project as the contractor becomes more of an" assembler than a builder" on site. This made more imperative for contractors to be equipped technologically with IBS knowledge and skill if they were to promote their IBS products and compete in the industry.

Prospects of Industrialized *Building System*

The result of a study comparing the economic benefits between the IBS and conventional construction method carried out in Israel, in 1984. Warszawski, 1999 indicated that the use of IBS components brought considerable savings in site labour up to 70% while the total construction cost amounted to 5-8% less when compared with conventional method .In addition to that, in Singapore, the use of fully prefabricated system provides labour saving of 46.5% as compared to the conventional methods, thus reducing the dependency on foreign (Cheong, 1997). Cheong (1996) also corroborated Warszawski's claim by confirming that the construction cycle time for each floor of "Bay shore Condominium" in Singapore, using the conventional method was 14 days more than using the prefabricated method ceteris paribus. No doubt, the benefits offered by an IBS are immense especially in the light of the merits enumerated above. However, the commitment and cooperation between the public and private sectors is important in its successful implementation. As the construction workforce in Nigeria is aging and other distracting factors like okada, football e.t.c are emerging, fewer young people will enter the industry. It then implies that the industry will need to rely heavily on foreign workers. This will definitely result in increased construction. Hence, the industrialization of building construction method and the evolution of construction technology are inevitable and plausible.

Conclusion

If the utilization of IBS must be encouraged despite its various economic and non-economic benefits, various informative programs such as seminar, colloquiums and conferences or collaboration with the public universities should be devised to enlighten the private sector as well as the public sector. This paper has evaluated the prospects of industrialized materials vis-a-vis implementation of IBS in the Nigerian construction industry. It is found that the level of IBS adoption is still very far from what it should be considering the level of need for it as accentuated in the introduction above. Aside the need referred to above being the motivating factor to adopting a more dynamic system of construction, it becomes an albatross (Barrier factor) that impede the usage of IBS.

People's attitude to change remains that of resisting it, while those who desire it don't do enough to achieve it. Hence, the relevance of all the IBS barrier factors- skills and knowledge, project delivery and supply chains, customer perceptions and perceptions of professionals and lack of government policy, incentives and promotion- as the reason for refusal to adopt IBS. It is indeed a change issue as construction firms belief 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 Malaysian housing developers have naturally found it easier to stick to conventional construction methods for their construction projects than to adopt IBS (Hussein, 2007). Therefore, it is believed that the prospect of industrialized material would be enhanced if the Government introduces a long term comprehensive policy that would address the industrialization

of the building and construction sector in order to shape the future of the Nigerian construction industry.

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