# Offsite Manufacturing in Nigeria: Feasibility Research and Future Directions

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## Abstract

Nigeria is facing a deficit of 17 million houses due to a myriad of issues. This paper reports on the findings of a feasibility study which investigated Nigerian stakeholders' perceptions on the needs, promises and barriers of adopting Offsite Manufactured Construction (OSM) in Nigeria, in order to address this challenge. In-depth interviews were conducted with domain experts directly involved in housing delivery, the data of which was analysed using thematic analysis, powered by Nvivo software. Results showed that although OSM could improve housing delivery efforts in Nigeria, any such initiatives to support this were perceived to be considerably low. As such, this study concluded that there is a need for high-level awareness, greater collaboration, investment in training and education, and endorsement/encouragement from the Government. This study presents additional understanding of OSM in Nigeria based on expert opinion, the results of which were used in the development of a framework for the effective adoption of OSM in Nigeria. It is proffered that adopting OSM can help support housing delivery efforts in Nigeria, and may also leverage wider benefits to the construction industry and associated supply chain.

**Keywords:** Offsite Manufacturing, Housing Delivery, Stakeholders, Nigeria

# 1. Introduction

Nigeria is currently facing a significant and progressive housing deficit. Whilst it could be argued that this is similar to many other rapidly developing countries, there are some unique contextual facts that need to be noted. For example, it has a population of 177 million, with an annual growth rate of about 2.5% (PRB, 2014). It also needs about 17 million new houses in the short term (Okonjo-Iweala, 2014). Thus, in order to address these issues, several mitigation efforts have been deployed by the local industry, including: promoting locally manufactured building materials as a means of improving housing delivery (Olayiwola & Adedokun, 2014); directing the industry towards better implementation of the Nigeria National Housing Policy (Makinde, 2014); and seeking possibilities of introducing better mortgage systems in Nigeria (Olayiwola & Adedokun, 2014). Despite the success of some of these innovative attempts to address the problems affecting housing delivery in Nigeria, a wide margin still exists between housing demand and supply (Ibimilua & Ibitoye, 2015). Acknowledging this, it has been argued in seminal literature that this is mainly due to the inherent problems of the exiting conventional housing delivery systems in Nigeria and concomitant challenges, such as time and cost overruns, skills shortage, inadequate quality, and labour intensive activities (Femi & Khan, 2014; Makinde, 2014). As such, Dada (2013) suggested that a paradigm shift from the conventional construction approach to a more innovative housing production processes was vital in the context of Nigeria.

This kind of radical change in housing delivery methods was also advocated in several other countries, e.g. in the UK, USA, Australia and South Africa. Several Government reports have also noted that collaborative working and integrated project delivery must be promoted in order to make a 'revolution' in construction projects. To leverage these, literature has proffered the adoption of Modern Methods of Construction (MMC) and Offsite Manufactured Construction (OSM) as viable delivery mechanisms for both developed and developing countries (Gibb & Pendlebury, 2006; Goulding et al., 2014; Mullens & Arif, 2006; Nadim & Goulding, 2010; Taylor, 2009). In this respect, the primary role of OSM here is to move some of the effort and risk prone construction site activities into a 'controlled environment' typically associated with a manufacturing or factory facility (Arif et al., 2012). This controlled environment and application of OSM offers several benefits, particularly: a higher speed of construction, improved quality of the finished product, lower costs, and lower labour requirements on-site (Mullens & Arif, 2006). These achievements are sustained and significant; and it is therefore proffered here, that such offerings may act as a platform for addressing the specific housing problems of Nigeria (discussed above).

Despite these potential benefits, OSM only has a negligible share of the housing market in Nigeria (Kolo *et al.*, 2014). Taylor (2009) asserted that this failure in many countries could be due to inaccurate public assumptions regarding offsite. This study therefore posits that, if offsite production and manufacturing are to make a positive contribution to the Nigerian construction industry, there is a need to identify the causal issues associated with its uptake and adoption. This undertaking would need to encompass several areas, not least, market drivers and dynamics, culture, societal issues, and existing economic business model

## 2. Background of the Study

Statistics are not promising at all about housing delivery in Nigeria, where only 10% of Nigerians can currently afford to either purchase or build their desired quality houses, compared to those for other countries 72% in USA, 78% in UK, 60% in China, 54% in Korea and 92% in Singapore (Ayedun & Oluwatobi, 2011). Olayiwola and Adedokun (2014) complained that the housing situation in Nigeria is far from being satisfactory, taking into account the high rates of urbanisation and population growth in this country. Makinde (2014) asserted that there was no perspective of improvement in near future; if the country decides to continue to rely on its conventional housing delivery systems, which are deficient in terms of quantity and quality of housing units delivered. These problems tend to have a cascading effect that results in the other housing problems, such as unstable businesses, shortage of skills and materials, inadequate infrastructure, lack of innovation and unfair distribution of resources.

## 3. Offsite Manufacturing and the Opportunity for Its Adoption in Nigeria

Offsite manufacturing falls under the broad umbrella of Modern Methods of Construction (MMC) (Nadim & Goulding, 2010) and, there are several acronyms associated with OSM. OSM can be defined as set of processes that incorporates prefabrication and pre-assembly to produce units and or modules that are then transported to site and positioned to form a permanent work (Gibb, 1999). From a system point of view, Gibb and Pendlebury (2006) defined OSM as a range of applications which involve moving operations that are traditionally completed onsite to a manufacturing environment. This transformation improves the quality, customer satisfaction, efficiency, predictability of delivery timescale and sustainability of a project (Nadim & Goulding, 2010). It has been widely advocated that several benefits are obtainable from the use/adoption of OSM. The following paragraphs provide a categorised summary of these benefits in accordance to main themes of housing challenges in Nigeria, which were discussed in the previous section.

Ajayi *et al.* (2008) presented shocking statistics about waste generation in Nigerian construction projects where more than one-ton per day waste is generated in more than 75 per cent of conventional building sites. They also argued that most wastes are generated from demolition works on site and material handling. According to a report by Waste and Resources Action Programme (WRAP, 2007) within the context of UK, 40 per cent of all council waste come from construction projects. OSM has been successful in 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 OSM than those for conventional construction projects (WRAP, 2007).

Gibb and Pendlebury (2006) asserted that “time is a big-plus for offsite”. Similar to other countries, construction projects in Nigeria often delay due to some regular issues, such as material shortage, skills shortage and bad weather conditions (Mansfield *et al.*, 1994). With OSM, these issues are inherently addressed, since most of the building components are

manufactured in factories and transported to site for speedy assembly at very predicted times with limited workforce (as per discussed with very much detail in: Arif *et al.*, 2012; Gibb & Isack, 2003; Taylor, 2009). (See Figure 1).

Despite the higher initial cost of OSM projects (NAO, 2005), savings from OSM can be achieved in the areas of cost certainty and reduced risk, reduced running and maintenance costs, reduced preliminaries and site overhead, and reduced construction time (Gibb & Pendlebury, 2006). WRAP (2007) also identified that, savings can be achieved by using OSM as a result of reduction in waste of building materials especially bricks. In Nigeria were sandcrete blocks are predominantly used, incorporating OSM will go a long way in reducing waste on site and this will in turn augment for the high cost of construction when using OSM.

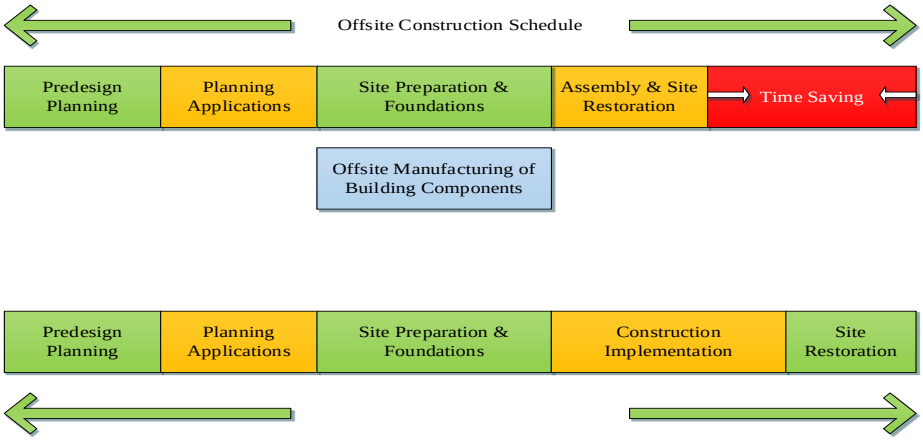


**Figure 1:** Comparison between OSM Schedule and Conventional Construction Schedule; Adapted from *MBI (2010)*

NAO (2005) advocated that OSM 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 OSM in various contexts of different countries such as India (Arif *et al.*, 2012) and UK (Gibb & Isack, 2003). Gibb and Isack (2003) linked this superiority in the production quality and output consistency to the controlled factory environment in OSM as opposed to the uncertain conditions of a conventional construction site.

Despite all benefits, seminal literature highlights myriad of barriers hindering the uptake of OSM (e.g., Arif *et al.*, 2012; Goulding *et al.*, 2014). It was crucial for this research to identify these barriers through reviewing literature and investigate their likelihood within the context of Nigeria based on evidence from primary data.

Initial cost of products has often been considered as the main barrier to the uptake of OSM in many countries including Nigeria. Scofield *et al.* (2009) also identified manufacturing capacity as another barrier to the uptake of OSM. Countries in which OSM usage has already been established, (e.g. UK, US, Japan and Nordic countries) have a robust supply chain including good number of factories to support OSM market. In a country like Nigeria, there are only few factories involved in the manufacturing of OSM components. This can certainly hinder update

of this industry in the future. Another barrier hindering the uptake of OSM is the negative public and stakeholders' perceptions towards OSM. Arif *et al.* (2012) argued that one reason for this is that prefabricated housing was used during periods of high demand (e.g. post-world wars), resulting in mostly low quality shelters. Although this has changed in many countries, Opara (2011) confirmed that similar negative perception still is a real barrier in Nigeria.

Another major barrier for adopting OSM in many countries is lack of suitable building codes and standards (Goulding *et al.*, 2014). This is a problem in Nigeria also where there are no official codes and standards to guide the use of OSM. Shortage of skilled workers and labour specific for OSM has also been a regular issue for OSM adoption (Goulding *et al.*, 2014). This problem is even magnified in countries like Nigeria where the OSM industry is too small, so that there is too much reliance on expatriate skills (Opara, 2011).

# 4. Research Methodology

This study focuses explicitly on the barriers of adoption of OSM in Nigeria. As such, a narrow-bounded literature review lens was used to identify the main problems affecting housing delivery in Nigeria, cognisant of the globally recognised capabilities of OSM in addressing these issues, barriers and subsequent transformation from conventional construction to OSM. The results of the conducted literature developed the theoretical framework and identified main constructs, factors and variables of this study. It was also essential to get affirmation for the developed theories through checking them against tacit knowledge of stakeholders involved in the Nigerian housing industry. Since not much research have been conducted in the past to investigate issues related to OSM adoption in the context of Nigeria, a qualitative research approach was adopted, using in-depth interviews as the instrument for data collection, to engage profoundly with actual stakeholders, get their views and opinions, and capture deeper knowledge about the nature of these issues. Due to the nature of qualitative study, very high-level experts from various sectors of the Nigerian housing industry were selected and invited as the participants for the in-depth interviews.

The study followed Gu and London (2010) in shaping the main constructs of the study and interview questions around the three main dimensions of OSM, i.e. people, process and technology. Cost was also included as the fourth construct, since it has been identified as a major player in housing delivery by various studies. The interview questions were divided into three main categories in accordance with the main aim of this study, specifically: 1) The main problems of housing in Nigeria, 2) The potential capabilities of OSM, which can leverage housing delivery in Nigeria, and 3) The probable barriers to OSM adoption in Nigeria.

In order to engagement effectively with the respondents, face-to-face interview was selected as the method of conducting the interviews and about 30 minutes was allocated for each interview. Interview questions were also tailored to the expertise of each participant to assure maximum productivity of meetings. Reaching theoretical saturation (Kumar & Phrommathed, 2005) was the main strategy for determining sample size of each set of interviews; i.e., the study continued the interviews with new participants from each group, until the point whereby no new data was

received from the new respondents. Data gathered for the interviews were audio recorded with the permission of the interviewees to ensure all necessary information were captured for proper analysis of the data.

Total of 26 experts were approached for interview based on the roles they play in the housing delivery value chain of Nigeria. All data gathered from 26 interviews was transcribed and analysed using the QSR - NVivo Data Analysis Software (V10.0.638). In order to systematically investigate the core issues of housing delivery in Nigeria and the potentials of OSM to address these issues, this study adopted thematic content analysis.

# 5. Results and Discussions

## 5.1. The Problems of Housing Delivery in Nigeria

From an exploratory analysis of the interview results, it was obvious that despite the various mitigation attempts, the problem of housing deficit in Nigeria continues to remain. It was reaffirmed by results of this study that a large housing deficit still exists in Nigeria and currently, there is no promising prospect for improvement. It was strongly pointed by many interviewees that this problem is likely to be even more serious than what has been officially reported, and nothing significant is being done to tackle this issue. The following paragraphs present the details of the problems of effective housing delivery in Nigeria.

Respondents of this study identified *financial issues* as a major hindrance to effective housing delivery in Nigeria. High cost of construction in Nigeria was brought into conversation by many of interviewees and this concurs with results of a previous research conducted by Odunjo (2013) highlighting this issue. The results of the interviews point out several factors which account for the high cost of housing in Nigeria. One of the most crucial issues highlighted here was overheads imposed due to lack of proper infrastructure. Another subset of cost is the cost of getting title documents in Nigeria which is usually very high and this also impacts on the overall building cost. Other sub categories indicted as major factors contributing to high cost of construction in Nigeria included importation of building materials and poor earning power.

In terms of *construction sector related issues*, this study identified various factors which have negative impact on housing delivery in Nigeria. Lack of construction standards and poor professional ethics were identified as two main codes under construction sector related issues. One of the interviewees argued that *"so many people tend to cut corners with regards to building materials…"*. This concurs with the findings of an earlier study by Solaja (2015) which complained about poor ethics within the Nigerian construction industry at every level. Similarly, it also reaffirms the findings of Oseghale *et al.* (2015) who argued that use of unqualified professionals, lack of maintenance culture, poor quality materials and inadequate fund are some of the major causes of building failure in Nigeria. Similar to every other context (Kamara *et al.*, 2004), the issue of the fragmented nature of the construction industry was also identified as a major contributor to hindrance of housing delivery in Nigeria. Other sub

categories identified under this theme by the interviewees were reluctance to innovate and lack of investment and research.

The last theme identified in this section was *Government related issues*. This theme referred to issues concerning the Government role in supporting or hindering housing delivery at all levels. Importance of the Government to assure that everyone has access to at least a quality shelter as basic need of mankind (Olayiwola *et al.*, 2005) was highlighted by many of respondents. The respondents complained that the Government has not been successful in providing this in Nigeria. Other codes highlighted under this theme were inflation of contract prices, poor Government policies and lack of control on corrupt practices. The results of the interviews conducted revealed that these three areas tend to significantly affect housing delivery in Nigeria. It was also argued by the interviewees that Nigeria needs a robust mortgage system to assure continuity of supply and demand within the construction industry. It was also brought to attention through the interviews that the issue of poverty affects the acquisition of housing in Nigeria and this is further compounded by the poor Government policies concerning housing and mortgage.

## 5.2. Barriers to the Use of Offsite Manufacturing in Nigeria

With regards to contribution of OSM to the Nigerian construction industry, many interviewees that participated in this study argued that OSM is almost of non-existence in the context of Nigeria. Similarly, they also asserted that OSM has not been accepted formally or even informally in this country. However, some interviewees mentioned that OSM had an acceptable share of the construction market of Nigeria during the 1970s and 1980s, and then it gradually disappeared due to the minor demand for housing at that time, and the fact that it was only the Government demanding for prefabricated houses during that period. Nevertheless, the stakeholders interviewed in this study admitted that prefabrication is vastly used in some civil engineering projects carried out by large construction firms in Nigeria, but this has nothing to do with the housing sector, which heavily relies on the conventional bricks and blocks construction methods. Despite its missing role, this study argues that due to the typical challenges that the Nigerian housing industry currently faces, it would be paramount for this industry to adopt OSM, which is already capable of addressing many of these issues (Arif, 2012; PrefabNZ Incorporated, 2013). In the meantime, for OSM to be adopted in Nigeria there was a need to identify the barriers that can hinder its adoption. This study identified three core themes (Pan *et al.*, 2004) with respect to barriers to OSM adoption, namely “human barriers”, “technical barriers” and “industrial barriers”.

*Human barriers* covers barriers that are concerned with the stakeholders involved in the delivery of housing in Nigeria as well as the end-users. Several studies identified negative perception about OSM as a major barrier for its adoption (e.g. Arif *et al.*, 2012; Pan *et al.*, 2004; PrefabNZ Incorporated, 2013). This was also echoed by the respondents of this study who argued that people in Nigeria have a negative perception about OSM components and think they are not so strong. Based on the results of this study, other major codes identified under the

category of human barriers to OSM adoption in Nigeria include: maintenance difficulties, client's resistance, cultural issues and design flexibility.

*Technical barriers* refer to the barriers that hinder the construction process and the procedure that end up with the final product, i.e. a house. The main categories identified under this theme were lack of necessary infrastructure, lack of machinery, logistics and technical expertise. In terms of Infrastructure development, it was discussed by many respondents that Nigeria needs much better roads, transportation system, and power grid in order to be able to adopt OSM. These results resonate with the results of a similar study by Arif *et al.* (2012), which identified infrastructure as a major challenge to OSM adoption in a similar context such as India.

This study identified the *industrial barriers* as high cost of establishing factories, importation of materials, need for expatriate workers and limitation of existing OSM factories as major barriers to OSM adoption in Nigeria. Although cost has been identified as a major barrier, many of the interviewees argued that some of the initial costs could be offset through the areas such as cost certainty and reduced risk, less overall life cycle costs due to better quality of products, reduced preliminaries and site overhead, reduced construction time. This is very aligned with the findings of Gibb and Pendlebury (2006). Some interviewees also advocated that despite being capital intensive, investment in OSM could be very beneficial for Nigeria anyway, since the country would reap the benefits of OSM in the long-term.

# 6 Conclusion

Research findings indicate that whilst there is still a very large housing deficit in Nigeria, there are currently no significant measures implemented to address this challenge. However, OSM has been proffered as a potential solution, particularly though its ability to meet volumetric delivery patterns with reduced costs and improved quality thresholds. That being said, contextual conditions need to be assessed before this can be considered a viable solution. In doing so, several barriers to OSM adoption were presented and discussed. Based on this, low-impact construction methods (such as OSM) were considered viable methods for improving sustainability and particularly, feasible solutions for improving the housing deficit. This study presented a series of underpinning steps based on the view of various stakeholders on the issues regarding these housing challenges, and the possibility of OSM adoption. Whilst these context-specific OSM barriers highlighted the barriers, this is just a start. There is an exigent need to investigate these issues further, as it is important to proffer bespoke solutions to this environment e.g. infrastructure and local suitable materials for OSM. For this to be achieved, the experience garnered in other contexts need to evaluated regarding their suitability.

In pursuance of this, the ultimate goal of this research will be to develop a roadmap that will facilitate the effective adoption of OSM in Nigeria. This paper presented a series of underpinning steps based on the views of various stakeholders on the barriers to OSM adoption in Nigeria. Whilst OSM barriers have been highlighted within the Nigerian context, there is an exigent need to investigate these issues further, as it is important to proffer solutions to this environment e.g. infrastructure and local suitable materials for OSM. For this to be achieved, it

is imperative that these issues are studied further, cognisant of experience garnered in other contexts and this will be useful in developing a suitable roadmap for the successful adoption of OSM in Nigeria.

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