OFFSITE MANUFACTURING: THE WAY FORWARD FOR NIGERIA'S HOUSING INDUSTRY

Kolo, Shaba James*, Pour Rahimian, Farzad, Goulding, Jack Steven

Centre for Sustainable Development, The Grenfell-Baines School of Architecture, Construction and Environment, University of Central Lancashire, Preston, PR1 2HE, UK

*Corresponding author: SJKolo@uclan.ac.uk

ABSTRACT

Nigeria is one of the most developed countries in Africa, with construction contributing to approximately 9% of its Gross Domestic Product. From a housing perspective, new initiatives are now being explored, one of which is Offsite Manufacturing (OSM). Globally, the OSM market uses several terms interchangeably, the most prevalent of which include: prefabrication, offsite production, industrialised building systems, dry construction, modern methods of construction etc. These collective approaches have been successfully used in many countries as means of improving housing delivery, particularly in countries like the UK, USA, Australia, Sweden, Japan and Malaysia. Despite the myriad of benefits associated with OSM (e.g. speed of construction, improved quality, reduced risk etc.), there are various barriers identified in the course of adopting OSM; some of these barriers include: client resistance, lack of established codes and standards, negative perception etc. Given these opportunities and barriers, this study investigates the feasibility of adopting OSM and ways of overcoming the barriers hindering its uptake in Nigeria based on the experiences of developed countries. The first part of this paper presents a synthesised literature review which explores the benefits and challenges of using OSM in different countries (including Nigeria as a comparator). Research findings highlight core OSM uptake barriers, including issues such as: reluctance to innovate, paucity of codes and standards, lack of guidance and information, high capital cost, supply chain integrations, skill requirements etc. Whilst many of these countries have now established strategies to offset these uncertainties, it was also observed that governmental support was pivotal in helping to establish OSM as a viable alternative to traditional approaches. From a Nigerian context, similar parallels are observed, most notably the need to encourage OSM through greater awareness, better government policies, and through skilled supply chain partners in order to help improve the problem of housing shortage.

Keywords: *Barriers, housing delivery, Nigeria, offsite manufacturing*

1 INTRODUCTION

Offsite manufacturing (OSM) has been adopted in a good number of countries, e.g. United Kingdom, United States of America, Japan, Scandinavia, Australia, New Zealand, Malaysia as a means of improving construction processes (Blismas et al., 2010; Goodier & Gibb, 2005; Goulding et al., 2014; McGraw-Hill Construction, 2011; PrefabNZ Incorporated, 2013). In Nigeria, construction professionals have advocated for a change from the conventional methods of construction to a better way of construction; as such, "Dry construction" was recommended (Ashkin, 2013; Dada, 2013). Dada (2013) described "Dry Construction" as a method of construction where majority of the components of the building are pre-fabricated off site and brought to site for assembling. This definition has some similarities with some definitions of OSM. Research has shown that there are several benefits

obtainable from the adoption of OSM in the construction industry (Arif & Egbu, 2010). In as much as OSM has a good number of benefits associated with it, its adoption has been low in countries where it is highly used e.g. UK (Taylor, 2010), US (McGraw-Hill Construction, 2011; Polat, 2010), Australia (Blismas et al., 2010), Malaysia (Yunus & Yang, 2013) etc. Moreover, the uptake of OSM has also been hindered by some barriers, including: high capital costs, negative image, lack of guidance and information, reluctance to innovate etc (Arif et al., 2012a; Jonsson & Rudberg, 2013; Zhai et al., 2014). In order to mitigate these issues in countries where OSM is used, efforts have been put to ensure these barriers are reduced.

In the context of Nigeria, there is shortfall in housing in terms of quantity and quality (Kabir & Bustani, 2009) and there are suggestions from construction experts that housing can be improved by adopting OSM/Dry Construction (Dada, 2013). Dry Construction is quite new to the Nigerian housing industry as about 90% of the industry still uses the conventional block (Ashkin, 2013). The use of OSM in Nigeria has also been affected by factors like: high capital costs, few factories for production of components, reliance on expatriate skills, negative perception etc. (Opara, 2011).

This paper forms part of an ongoing research leading to the development of a theoretical framework. As such, the information presented is based on literature relevant to the study area. Research shows that OSM has many benefits associated with it, but its uptake in developing countries has been slow due to different reasons. This paper identifies OSM uptake barriers in Nigeria and presents a way forward based on the experience of other countries that have faced similar problems.

2 GLOBAL TREND OF OFFSITE MANUFACTURING

OSM is a construction technique that existed during the 1850s (Gibb, 2001; Goulding & Arif, 2013); and its use became more prominent after World War I and II (Taylor, 2009). Since then, OSM has been adopted in different countries, most notably including: UK, USA, Australia, Malaysia, New Zealand, Sweden, Japan, India etc.

2.1 Offsite Manufacturing in UK

In the UK, OSM has existed for a long time Taylor (2009), albeit taking a small percentage of the market. However, the greater demand for productivity through such influential UK reports (e.g. Latham Report and Egan Report) has advocated the UK construction industry to embrace manufacturing (Wolstenholme, 2009). Since OSM involves moving some parts of the construction process to a controlled environment (factory), the construction project can achieve better quality, less time on projects, less cost, reduced risk etc. (Arif et al., 2012a; Gibb & Isack, 2003).

In the case of Nigeria, the current housing deficit is over 16 million housing units (Adetayo, 2013). For this housing deficit to be significantly reduced, one million housing units need to be built annually (Adetayo, 2013). Given this position, professionals within the Nigerian built environment have advocated a change from the conventional way of construction to a more advanced way of construction for this housing need to be met (Ashkin, 2013). Since Nigeria has a similar problem to what was experienced in the UK during the post war era, based on the suggestions of experts in Nigeria, this problem of housing deficit can be managed with the use of OSM, since OSM has the benefit of speed and better quality of buildings associated with it.

In the UK, the government has played a major role in the development of OSM by sponsoring reports, putting policies in place and also setting up an organisation (Buildoffsite) which is responsible for promoting greater uptake of OSM within the construction industry (Buildoffsite, 2006). Currently, 90% of houses in Nigeria are constructed using traditional construction techniques (Ashkin, 2013). As such, the government and other stakeholders have major roles to play towards the growth of OSM in Nigeria.

2.2 Offsite Manufacturing in USA

In the opinion of McGraw-Hill Construction (2011), modern prefabrication and modularization started in the early 1900s in USA. The commercial application of modular construction began to emerge in the 1970s, 1980s through to 2000s (McGraw-Hill Construction, 2011). In the USA, it was observed that the use of OSM has been fluctuating over time based on time of serious need (e.g. post world war). A committee in the USA identified the adoption of OSM in the construction industry as a means of managing the acute skills shortage faced by the construction industry (McGraw-Hill Construction, 2011). Similar to the UK, the body responsible for promoting OSM in USA is the Modular Building Institute (Goulding & Arif, 2013).

In the USA, OSM was not adopted for the purpose of delivering housing units only but also to manage skills shortage experienced in the construction industry. Likewise, Nigeria is currently experiencing skills shortage in the construction industry (Ayedun & Oluwatobi, 2011) and OSM adoption can help in the area of skills shortage.

2.3 Offsite Manufacturing in Australia and New Zealand

The Australian construction industry identified offsite manufacturing as one of its visions before the year 2020 (Hampson & Brandon, 2004). Like many other countries, OSM in Australia and New Zealand came into prominence as a result of housing shortage (Blismas et al., 2010; PrefabNZIncorporated, 2013). Cooperative Research Centres (CRC) - Construction Innovation is the government body saddled with the responsibility of researching into ways in which the Australian construction industry can be moved forward (Hampson & Brandon, 2004).

2.4 Offsite Manufacturing in Malaysia

In Malaysia, OSM is referred to as Industrialized Building Systems (IBS) and it was first used in the 1960s (Goulding & Arif, 2013). Like in some other countries, growth in population caused an increase in the market price of houses and as a result, there was the need for government to come up with ways of providing more houses to meet the demands of the citizens (Azman et al., 2010). Also, the adoption of IBS was seen as a way of reducing the influx of foreigners into the Malaysian construction industry (Azman et al., 2012). In Nigeria, Opara (2011), identified reliance on foreign expertise as a problem with the Nigerian construction industry. Based on the experience of Malaysia, this problem can be mitigated by adopting OSM.

The Construction Industry Development Board (CIDB) is the body that coordinates the construction industry in Malaysia and it has been able to create an IBS Centre which is responsible for promoting IBS in Malaysia (Goulding & Arif, 2013). Apart from establishing the CIDB, the Malaysian government put initiatives in place to encourage the use of IBS (Kamar et al., 2009). Some of these initiatives included:

- In the 2005 budget announced by the Malaysian government, the government pledged to construct 100,000 units of houses using IBS technique, also, government mandated that all new government building projects were required to have 50% IBS components;
- From year 2007, the government introduced incentives for individuals and organisation that adopted the use of IBS in projects;
- By 2008, a circular was passed that emphasised that all government projects must have at least 70% IBS components and also the inclusion of IBS component as part of contract documents for all building works.

With these kind of initiatives in place, the manufacturing and construction industry in Malaysia has have been experiencing steady growth (Azman et al., 2012).

In Nigeria, the government will need to come up with ways of encouraging the use of OSM - if they need to facilitate the industry from the current 10%.

OSM came into prominence in different countries due to a number of reasons. Some of the common reasons include; housing deficit, skills shortage, innovation in terms of construction, better quality in construction projects etc. Nigeria is currently faced with some of these problems and from the experiences of developed countries; the uptake of OSM is one technique that can eliminate these problems.

3 BARRIERS TO THE UPTAKE OF OFFSITE MANUFACTURING

Review of seminal literature shows that there are myriad of barriers hindering the uptake of offsite manufacturing (e.g., Arif et al., 2012a; Goulding et al., 2014; Jonsson & Rudberg, 2013; Zhai et al., 2014).

Cost in usually seen as the main barrier to the uptake of OSM (Arif et al., 2012a; PrefabNZ Incorporated, 2013). On the contrary, Alistair and Pendlebury (2006) argued that savings from OSM can be achieved in the areas of cost certainty and reduced risk, less overall life cycle costs, better quality of building which will in-turn lead to reduced maintenance cost, reduced preliminaries and site overhead, reduced construction time which can result in cost benefit from early occupation of properties. Also, WRAP (2007) suggested that savings can be achieved in the use of OSM as a result of reduction in waste of building materials especially bricks/blocks.

Opara (2011) identified high cost as a barrier to the uptake of OSM in Nigeria. Arif et al. (2012b) suggested that, it is more important for the offsite industry to focus more on visualisation and simulation technologies as means of increasing awareness on OSM.

Furthermore, Scofield et al. (2009) identified manufacturing capacity as a barrier to the uptake of OSM. Countries that are more established in the use of OSM, for instance UK, US, Japan etc. have a good number of factories that are into the manufacturing of OSM components. In Nigeria, there a few factories involved in the manufacture of OSM components e.g. Nigerite, Nigeria Portable Cabins etc. Certainly, Nigeria needs to have more factories manufacturing OSM components to meet increasing and future demands. Another barrier hindering the uptake of OSM is the negative perception and few codes/standards (Arif et al., 2012a). In the opinion of Arif et al. (2012a), prefabricated housing was used in the U.K during periods of high demand, that is after the world wars and most of these buildings were of low quality and standard. As a result, there was a general notion that factory manufactured buildings are of low quality but current research shows otherwise. Arif et al. (2012a) identified improved quality as one of the major drivers to the uptake of OSM. Opara (2011), also identified negative perception as a barrier to the uptake of OSM in Nigeria. Apart from that, currently there are no codes guiding the use of OSM in Nigeria.

Currently, the OSM industry in Nigeria is quite small, as such, there is too much reliance on expatriate skills (Opara, 2011). The construction sector needs to train construction professionals in the area of OSM. This training will create more awareness among professionals and also potential clients.

4 DISCUSSIONS

The current situation in Nigeria demands for speed in the delivery of housing. Many scholars ascertained that there are several benefits associated with the use of OSM (e.g., Arif et al., 2012a; Arif & Egbu, 2010; Goulding et al., 2014; Pan et al., 2004). While these benefits are there to be gained, there are barriers that hinder its uptake e.g. high costs, negative image etc. (Arif et al., 2012a). From the experiences of developed countries, these barriers hindering the uptake of OSM can be tamed; however, for this to be achieved, stakeholders need to put hands together. Since Nigeria is still gradually trying to incorporate OSM, so much can be learnt from countries that have long practiced the system. In most of these countries, it was observed that government played key roles in driving the OSM industry forward. In Malaysia, CIDB established an IBS Centre that is responsible for championing IBS. Aside from that, the government also put policies in place to help boost the IBS market.

Similarly, in the UK and USA, Buildoffsite and Modular Building Institute are responsible for driving the change needed in the construction industry; i.e., seeing construction as a manufacturing process and also promoting the use of OSM. These bodies were set up by various governments to drive OSM in particular and the construction industry as a whole to the next level. In the case of Nigeria, the government and other stakeholders need to come together to set up a body to champion this change that is needed in the construction industry.

5 CONCLUSION

Housing has been identified by many as an area where OSM can be highly utilised. For the current housing demand in Nigeria to be met, work needs to be done in the area of housing delivery. To facilitate the growth of OSM in Nigeria, it is essential for Nigeria to learn from the experiences of developed countries that are more established in the use of OSM. Findings showed that there were similar barriers hindering the uptake of OSM in the countries highlighted and these barriers were also found to be common with Nigeria. It is proposed that the government should facilitate the growth by establishing a body to create the framework, strategies and codes to guide OSM. This could perhaps reduce some of these barriers discussed such as high cost, negative perception, few factories, lack of codes and standards etc. It is also suggested that these barriers hindering the uptake of OSM can be managed using Building Information Modelling (BIM).

In the area of negative image with regards to OSM, BIM concepts and BIM-based preconstruction simulations could contribute to the acceptance of OSM, as this approach could make the process controllable before production and component assembly (Ezcan et al., 2013). BIM can also help with the transportation of building components manufactured offsite, especially through simulation and modelling (logistics) where manufactured components can be micro-managed from the factory (where they are manufactured) to the site where (they will be used); and can also be visualised to see how these components will be fixed or attached to the building (Ezcan et al., 2013). These opportunities were also supported by Sarno (2012).

With the aid of visualisation and simulation, construction professionals and other stakeholders in the Nigeria construction industry can see what can be achieved using OSM. A strong correlation now exists between BIM and OSM. This is an important step for moving the construction industry to the next level. From a Nigerian perspective, it is acknowledged that there is an exigent need to identify the type of OSM that 'fits' the current environment, cognisant of the market needs, technological drivers, and prevalent infrastructure and supply chain.

REFERENCES

Adetayo, O. (2013). FG takes $300m loan to tackle housing deficit, Newspaper, The Punch. Retrieved from http://www.punchng.com/business/business-economy/fg-takes-300m-loan-to-tackle-housing-deficit/

Alistair, G., & Pendlebury, M. (2006). Buildoffsite Glossary of Terms. from Buildoffsite http://www.buildoffsite.org/pdf/BuildoffsiteglossaryV1.3revised_july06.pdf

Arif, M., Bendi, D., Sawhney, A., & Iyer, K. C. (2012a). State of offsite construction in India-Drivers and barriers. Journal of Physics: Conference Series, 364(1), 012109.

Arif, M., & Egbu, C. (2010). Making a Case for Offsite Construction in China. Engineering, Construction and Architectural Management, 17(6), 536 - 548. doi: 10.1108/09699981011090170

Arif, M., Goulding, J., & Rahimian, F. (2012b). Promoting Off-Site Construction: Future Challenges and Opportunities. Journal of Architectural Engineering, 18(2), 75-78. doi: doi:10.1061/(ASCE)AE.1943-5568.0000081

Ashkin, R. (2013). Innovative Building Technologies – The Social Housing Angle. Paper presented at the Housing Africa 2013, Abuja, Nigeria. http://gemsnigeria.com/wordpress/wp-content/uploads/2012/12/Innovative-Building-Technologies-Housing-Africa.pdf

Ayedun, C. A., & Oluwatobi, A. O. (2011). Issues and Challenges Militating against the Sustainability of Affordable Housing Provision in Nigeria. Business Management Dynamics, 1(4), 1 - 8.

Azman, M. N. A., Ahamad, M. S. S., & Hussin, W. M. A. W. (2012). Comparative Study on Prefabrication Construction Process. International surveying research journal, 2(01), 45-58.

Azman, M. N. A., Ahamad, M. S. S., Majid, T. A., & Hanafi, M. H. (2010). Perspective of Malaysian Industrialized Building System on the Modern Method of Construction. Paper presented at the 11th Asia Pacific Industrial Engineering and Management Systems Conference, Melaka, Malaysia. http://www.apiems.net/archive/apiems2010/pdf/MM/427.pdf

Blismas, N., Wakefield, R., & Hauser, B. (2010). Concrete prefabricated housing via advances in systems technologies: Development of a technology roadmap. [Research Paper]. Engineering, Construction and Architectural Management, 17(1), 99 -110. doi: 10.1108/09699981011011357

Buildoffsite. (2006). Vision, Mission, Metrics & Goals. from Buildoffsite http://www.buildoffsite.com/market_strategy.pdf

Dada, A. (2013, February 4, 2013). Housing deficit: Experts canvass new construction system, Newspaper, The Punch. Retrieved from http://www.punchng.com/business/homes-property/housing-deficit-experts-canvass-new-construction-system/

Ezcan, V., Isikdag, U., & Goulding, J. (2013). BIM and Off-Site Manufacturing: Recent Research and Opportunities. Paper presented at the 19th CIB World Building Congress Brisbane, Australia.

Gibb, A. (2001). Standardization and pre-assembly-distinguishing myth from reality using case study research. Construction Management & Economics, 19(3), 307-315.

Gibb, A., & Isack, F. (2003). Re-engineering through pre-assembly: client expectations and drivers. Building Research & Information, 31(2), 146-160.

Goodier, C., & Gibb, A. (2005). Barriers and opportunities for offsite in the UK. [Conference paper]. Abdul Samed Kazi (ed). Systematic Innovation in the Management of Project and Processes, cib Helsinki International Joint Symposium, 144 - 158.

Goulding, J., & Arif, M. (2013). Offsite Production and Manufacturing – Research Roadmap Report. In W. Bakens (Ed.): International Council for Research and Innovation in Building and Construction (CIB).

Goulding, J., Rahimian, F. P., Arif, M., & Sharp, M. D. (2014). New offsite production and business models in construction: priorities for the future research agenda. Architectural Engineering and Design Management 1 - 22.

Hampson, K., & Brandon, P. (2004). Construction 2020: A Vision for the Property and Construction Industry. Brisbane, Australia: Cooperative Research Centre for Construction Innovation.

Jonsson, H., & Rudberg, M. (2013). Classification of production systems for industrialized building: a production strategy perspective. Construction Management and Economics, 1-17. doi: 10.1080/01446193.2013.812226

Kabir, B., & Bustani, S. A. (2009). A Review of Housing Delivery Efforts in Nigeria. Paper presented at the ISA International Housing Conference, University of Glasgow, Scotland. http://www.gla.ac.uk/media/media_129767_en.pdf

Kamar, K. A. M., Alshawi, M., Hamid, Z. A., Nawi, M. N. M., Haron, A. T., & Abdullah, M. R. (2009). Industrialised Building Systems (IBS): A review of experience in UK and Malaysia construction industry. Paper presented at the 2nd Construction Industry Research Achievement International Conference (CIRAIC), Kuala Lumpur, Malaysia.

McGraw-HillConstruction. (2011). Prefabrication and Modularization: Increasing Productivity in the Construction Industry. In E. Fitch (Ed.), SmartMarket Report. Bedford, Massachusetts, USA.

Opara, S. (2011). Modular Housing System Gaining Popularity despite Huge Costs.

Pan, W., Dainty, A. R. J., & Gibb, A. G. F. (2004). Managing innovation: a focus on off-site production (osp) in the UK housebuilding industry. Paper presented at the 20th Annual ARCOM Conference, Heriot Watt University, Edinburgh, Scotland

Polat, G. (2010). Precast concrete systems in developing vs. industrialized countries. [Article]. Journal of Civil Engineering and Management 16(1), 85-94. doi: 10.3846/jcem.2010.08

PrefabNZIncorporated. (2013). Prefab Roadmap: A Way Forward for Prefabrication in New Zealand (2013-2018) (pp. 1 - 29). Wellington. New Zealand: PrefabNZ Incorporated.

Sarno, F. (2012). BIM Integrated Lifecycle Management. BIM Journal, 3(29), 43 - 47.

Scofield, R., Wilkinson, S., Potangaroa, R., & Rotimi, F. (2009). Driving Innovative Offsite Construction Techniques in New Zealand. Paper presented at the Global Innovation in Construction Conference Loughborough University, UK.

Taylor, M. D. (2010). A definition and valuation of the UK offsite construction sector. Construction Management and Economics, 28(8), 885-896. doi: 10.1080/01446193.2010.480976

Taylor, S. (2009). Offsite Production in the UK Construction Industry: Buildoffsite.

Wolstenholme, A. (2009). Never Waste a Good Crisis: A Review of Progress since Rethinking Construction and Thought for the Future (pp. 31). Warwick House, London: Constructing Excellence.

WRAP. (2007). Current Practices and Future Potential in Modern Methods of Construction (pp. 1 - 21). Banbury, Oxon: WRAP.

Yunus, R., & Yang, J. (2013). Improving ecological performance of industrialized building systems in Malaysia. Construction Management and Economics, 1-13. doi: 10.1080/01446193.2013.825373

Zhai, X., Reed, R., & Mills, A. (2014). Factors impeding the offsite production of housing construction in China: an investigation of current practice. Construction Management and Economics, 32(1 - 2), 40 - 52. doi: 10.1080/01446193.2013.787491