Awareness Level and Adoption of Modular Construction for Affordable Housing in Nigeria: Architects' Perspective

Sholanke A. B., Opoko A. P., Onakoya A. O., Adigun T. F.

Abstract*: Modular construction is a construction method where pre-designed building units are constructed off-site, conveyed to site as components and assembled to form a building or structure. The construction method is adjudged to significantly reduce building time and offers good economic value which are some of its key benefits over traditional construction methods. This study evaluated architects' awareness level and adoption of modular construction method in Nigeria, in order to ascertain its application level towards providing prompt affordable housing projects delivery in the country. The study is a survey research that engaged a pragmatic research approach. Both qualitative and quantitative inquiry methods were employed to carry out the research. Qualitative inquiry method was employed to gather relevant data used to develop a structured questionnaire that was used to collect quantitative data. The questionnaire was distributed to a hundred architects who were randomly selected from a hundred architectural firms registered to practice in Lagos State, the most populous state in Nigeria. A total of seventy-one participants provided data for the study. The data were analysed with statistical package for social sciences (SPSS) software, version 21. The result depicts that majority (87%) of the respondents are aware of modular construction as an approach used in building construction, but just few (32%) of the respondents have adopted modular construction in the delivery of affordable housing scheme in the study area. In addition, it was found that modular construction for affordable housing projects is mostly adopted for its waste reduction, construction time reduction and cost saving benefits. The study concludes that though architects' awareness level of modular construction method and its benefits is high in Nigeria, its adoption by the architects for prompt delivery of affordable housing projects in the study area is low. Hence, appropriate measures were recommended to enhance the adoption of modular construction method by architects to combat housing challenges experienced in Nigeria.

Index Terms*: *Affordable Housing, Architects' Perspective, Modular Construction, Nigeria.

I. INTRODUCTION

Shelter is a necessity and the second most crucial human need after food [1]. However, copious evidence from research revealed that there is an unabated housing deficit of about 21 million units in Nigeria which can be traced as far back as the colonial era. Though, the Nigerian government has at various times tried to implement different policies and programmes to tackle the problem of housing deficiency in the country, nonetheless, there has been an increase in the urban housing crisis in the country [2]. The high cost of materials poses a major challenge in the provision of affordable housing in Nigeria. Construction processes and the built environment also have great impact on the environment, human well-being as well as the overall economy. However, modular construction is a method that involves the use of pre-designed building units or parts that are constructed off-site, conveyed to site as components and assembled to form a building or structure. Modular construction method significantly reduces building time and offers good economic value which are some of its benefits over traditional construction methods [3]. To this end, modular construction is being preferred and used to delivery projects promptly and at good economic value in many countries.

It is against this backdrop that this study evaluated architects' awareness level and adoption of modular construction method in Nigeria, in order to ascertain its application level towards providing prompt affordable housing projects delivery in the country. To this end, two research questions were developed as follows:

1. What is the level of awareness of modular construction method among architects in Nigeria?
2. To what extent is modular construction method adopted by architects in Nigeria for affordable housing delivery in the country?

Based on the research questions, two research objectives were formulated as follows:

1. To evaluate the level of awareness of modular construction method among architects in Nigeria.
2. To examine the extent to which modular construction is adopted by architects in Nigeria for affordable housing delivery in the country.

The scope of this study is limited to Lagos State in Nigeria. The study was restricted to Lagos State as it is one of the most populous and continuously growing cities in Nigeria with a high rate of housing deficiency [3]. Currently, the state is experiencing rapid growth in infrastructural and building developments, which is attracting several construction professionals, including architects, from different parts of the country and the world to practice in the state.

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Sholanke A. B. is an Architect and a Lecturer at Covenant University, Ota, Ogun State, Nigeria.

Opoko A. B. is an Architect and a Senior Lecturer at Covenant University, Ota, Ogun State, Nigeria.

Onakoya A. O. is a graduate Architect currently undergoing her masters at Covenant University, Ota, Ogun State, Nigeria.

Adigun T. F. is a graduate Architect currently undergoing her masters at Covenant University, Ota, Ogun State, Nigeria.

The state was therefore preferable for the study, because it is one of the states in Nigeria with the highest number of practicing professional architects' in the country. Architects' perspectives were sort after, because they are the leading consultants in housing building development schemes. They are usually responsible for determining the construction method to be employed based on their design.

The study contributes to knowledge by providing empirical data on architects' awareness level and adoption of modular construction method towards prompt delivery of affordable housing projects in the study area. The demand for adequate affordable housing both in quantity and quality justifies the need for an alternative to the traditional method of construction that provides speed, accuracy and reduces waste in housing construction processes. The study highlights a solution in this regard and provides insight on a construction method that can aid the development of prompt and affordable housing projects delivery, towards reducing housing deficit in Nigeria. The study is beneficial to the general public, potential clients (government and private investors) and the building industry professionals', especially architects. The study will also be useful to students and educators as a reference material on issues pertaining to modular construction for prompt affordable housing project delivery. The following part of the paper is structured into five sections as follows: literature review; methodology; result, analysis and discussion; conclusion and recommendations; and acknowledgements.

II. LITERATURE REVIEW

Housing Policy in Nigeria

Housing is beyond mere shelter. It encircles utilities and social services that creates a liveable community and environment. It is a major indicator of a person's standard of living and societal place. Housing deficits are experienced in both rural areas and urban centres in both qualitative and quantitative measures. The product of this deficit can be characterised spatially as slums and squalors which have emerged to proffer a solution, though inadequate [5]. Section 16(2d) of the Nigeria 1999 constitution on the fundamental objectives of state policy, highlights the state's intention to ensure the provision of suitable and adequate housing for all citizen. Although this policy has not been implemented all the way through, it places the responsibility of mass housing production on the public sector in Nigeria. Housing provision for the various strata of a society being the duty of the government requires the public sector to provide safe and decent housing for citizens at affordable prices either for sale or rental.

Affordable Housing

Affordability can be defined as a state of being inexpensive enough for people to buy. Affordability is comparison of what people earn and what they have to pay. Affordability of housing has to do with securing some given standards of housing or diverse standards at a cost or rent which does not inflict an irrational liability on household incomes [6]. Also, affordable housing connotes housing units that can be afforded by the segment of a society whose income is beneath the median household income. However, affordable housing does not mean substandard housing. It only addresses the housing needs of medium and low income earners [7].

Challenges of Affordable Housing

The housing problems experienced in Nigeria have their origin prior to her independence [1]. The Nigerian government has made efforts at different points in time to improve the housing situation by implementing various policies and programmes. However, a number of problems still persists, some of which include: lack of infrastructure, poor documentation process, limited supporting financial institution, inadequate implementation of planning policies, urbanisation, high cost of building materials and lack of enlightenment [1].

The growing urbanisation process experienced mostly in developing countries including Nigeria, has been alarming. Over 40% of Nigeria's population reside in urban areas, such as Lagos, Ibadan and Jos [8]. Lagos is the most populous. Some of the factors that encourage this urban population growth comprises of a high fertility rate of about 2.8% and rural-urban migration. These factors directly stimulate the urbanisation process, hence, the severe shortage of adequate housing. Building materials make up more than half of the total housing cost in developing countries. The high cost of materials challenges the provision of affordable housing in Nigeria [9]. Lack of enlightenment in the use of materials and methods presents challenges to affordability as well. The introduction of an alternate construction method, such as modular construction provides a solution to some of the outlined challenges. The investigation of modular construction as a construction method is of relevance to provide an alternative construction method for affordable housing.

Modular Construction

Construction processes and the built environment have great impact on the environment, human well-being, as well as the overall economy. Sustainable construction in the environmental, social and economic dimensions are feasible through practical innovations and developments [10]. Modular construction portrays the use of off-site pre-designed building units or parts that are conveyed to site as components of a building called modules [11]. Modular construction provides high quality products under controlled conditions, economies of scale through the use of prefabricated units, provides positive labour training implications by encouraging technical knowledge through the use of semi-skilled personnel significantly reduce building time and offer good economic value, which are some benefits over traditional construction methods [3]. Modular construction can be used for either temporary or permanent building structures and are not subject to severe weather conditions unlike site-built structures. The modular construction concept can be applied to all types of building construction including offices, hotels, houses and retail stores [12]. Modular construction occur in phases which are: predesign, design, develop, detail, order, fabricate, deliver and assembly [13].

Fig. 1 shows an example of a modular housing construction in progress.

Fig 1: Installation of Modular Housing
Source: Lawrence (2017).

Benefits of Modular Construction in Affordable Housing

Innovative technologies are major contributors to enhancing productivity, quality and safety in construction. Modular houses are constructed repeated segments called modules which are turned to homes by final finishing by contractors. Modular houses are standardized volumetric or 3-dimensional units [14]. Factory built housing presents developers with cost saving, reduced construction time and a variety of other benefits. Time saving is an aspect that is entwined with cost saving [15]. Fig. 2 shows an example of a conventional construction schedule and a modular construction schedule.

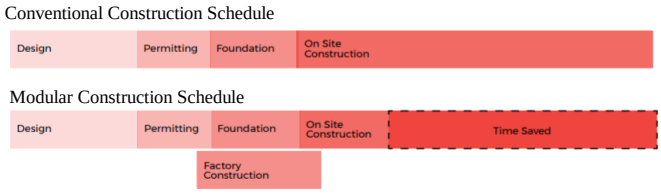

Fig. 2: Construction Schedules Process Comparison
Source: Edmonds, Golden & McKenna (2018).

Fig. 2 indicates that, on site construction in conventional construction process take a longer time than in modular construction process. The time saved has financial benefit as there is less interest on construction loans and debts can be repaid in good time. Cost saving is central to modular construction as some projects have recorded up to 20% cost reduction [15]. Common construction methods that result in about 60% of cost reduction are prefabricated building methods and container housing [16]. Housing construction cost is controlled and savings principally come from more efficient workers in a factory setting, reduced transportation delay, reduced weather related delay, economies of scale as materials are acquired in bulk which saves cost by reducing variation, change orders and cost overturns. Other benefits include: waste reduction, reduced noise and dust on site which improves the environmental quality [14]. However, these methods are not without challenges, some of which are the substantive amount of capital required at the earlier stage of construction compared to traditional methods and lack of market which creates an uncertain market environment and price [17]. From the foregoing, it is clear that some studies have highlighted the benefits and challenges of modular construction, but its awareness and adoption by architects who are a foremost determinant of its adoption based on their design, is yet to be investigated, particularly in Nigeria. This is the gap which this study was carried out to fill.

III. METHODOLOGY

To achieve the aim of the study, a mixed method research technique that combines a qualitative gathering of data from literature and a quantitative measurement of variables from field survey was considered most appropriate and adopted. The study is a survey research that engaged a pragmatic approach to conduct the research. The qualitative approach was used to gather relevant information used to develop a structured questionnaire that was employed to collect quantitative data. The qualitative data were gathered by textual analysis and analysed by content analysis. The quantitative approach involved the administration of the structured questionnaire developed in a standard format to architects in registered architectural firms within Lagos State in Nigeria. Lagos State was purposively selected as the study area as a result of the housing deficit experienced in the state as well as being the most populous state in Nigeria. To select the respondents used in the study, the Architects Registeration Council of Nigeria (ARCON)(2016) register was relied upon [18]. One hundred of the firms were randomly selected from the list and a senior architect in each of the selected firms was administered a questionnaire, out of which seventy-one was retrieved. The structured questionnaire contained a sequence of questions distributed into three sections. Section A covers the profile of the respondents. Section B was used to gather data on the level of awareness of modular construction as a construction method using a five point Likert scale. Section C was used to gather data on the adoption of modular construction as a construction method in building generally and in the delivery of affordable housing in particular. The data gathered with the questionnaire was analysed with statistical package for the social sciences (SPSS) software version 21. The information gathered was evaluated, sorted and presented with tables and charts using descriptive approach. The data used for the study was collected and analysed between January and April 2019

IV. RESULT, ANALYSIS AND DISCUSSION

Response Rate

As earlier mentioned, seventy-one of the one hundred questionnaires administered to architects in the study area were retrieved, representing 71% response rate. The response rate of 71% is considered reasonable to obtain a reliable result, as it is far more than half of the questionnaires distributed.

Profile of the Respondents

Table I shows the profile of the respondents.

Table I: Profile of Respondents

	Frequency (n=71)	**Valid** Percent (%)
A. Gender		
Male	48	67.6
Female	23	32.4
B. Age Group		
16-25	32	45.1
26-35	20	28.2
36-45	10	14.1
46-55	6	8.5
56 and above	3	4.2
C. Highest Level of Education		
Bachelor's degree	27	38.6
Master's degree	36	51.4
Doctorate degree	7	10.0
D. Years of Work Experience		
1-5 years	45	63.4
6-10 years	7	9.9
11-15 years	8	11.3
16-20 years	5	7.0
21-25 years	2	2.8
more than 25 years	4	5.6

From Table I, most (67.6%) of the respondents are male, within the age group of 16 and 25 years (45.1%), had master's degree as their highest level of education (51.4%) and had between 1 and 5 years of work experience (63.4%). This result infers that most of the architects in architectural firms in Lagos State are young male adults. Notably, all the respondents are well educated having at least a bachelor's degree. Based on their educational status, their responses are most likely credibility. In addition, the respondents all have some reasonable years of work experience in the field, hence considered qualified to provide reliable data for the study.

Awareness of Modular Construction as a Building Construction Method

Fig. 3 shows the result on the respondents' level of awareness of modular construction as a building construction method.

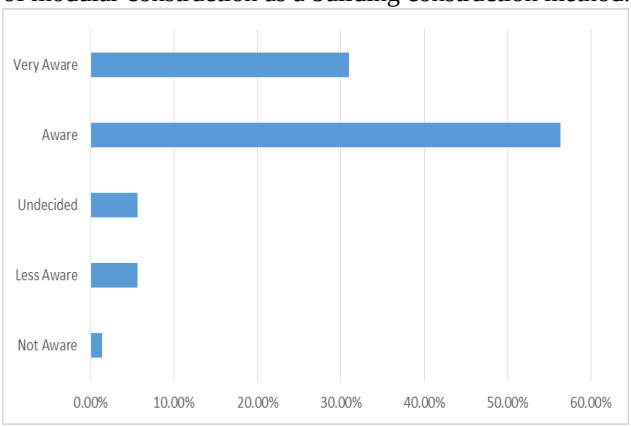

Fig. 3: Awareness of Modular Construction as a Building Construction Method

The data presented in Fig. 3 indicates that majority (87%) of the respondents are conversant with modular construction a building construction method. Only about 13% are unfamiliar with this construction method. This implies that architects in the study area are to a reasonable extent aware of modular construction as a building development method. In addition to finding out the awareness level of modular construction as a building construction approach, the extent of the respondents' awareness of its benefits were also investigated. Table II shows the result obtained on the awareness of the benefits by architects in the study area.

Table II: Awareness of Modular Construction Method Benefits

	Frequency (n)	Mean	Std. Deviation	Rank
Modular construction for reduced construction time	70	4.3000	.74891	1
Modular construction for reduced waste	70	4.2571	.84589	2
Differences between modular construction and traditional construction method	71	4.2113	.67434	3
Modular construction for affordable housing	70	4.1000	.78297	4
Modular construction as an approach used in building construction	71	4.0986	.84777	5
Modular construction as a cost saving alternative	71	4.0845	.82369	6
Modular construction for economies of scale of materials	71	3.9296	.89959	7
Modular construction for reduced variation	71	3.8732	1.06810	8
Modular construction for reduced weather related delay	71	3.8451	1.00921	9
Modular construction for reduced transportation delay	70	3.7429	1.08595	10

From the result, it is evident that generally, the respondents are aware of modular construction and its identified benefits from literature. Respondents are most aware of modular construction for its reduction in construction time and reduction in waste benefits, as well as the differences between modular construction and traditional construction methods.

Adoption of Modular Construction as a Construction Method

Fig. 4 shows a summary of the result on the adoption of modular construction by architects as a construction method, while Fig. 5 indicates the type of modular construction method adopted by the architects in the study area.

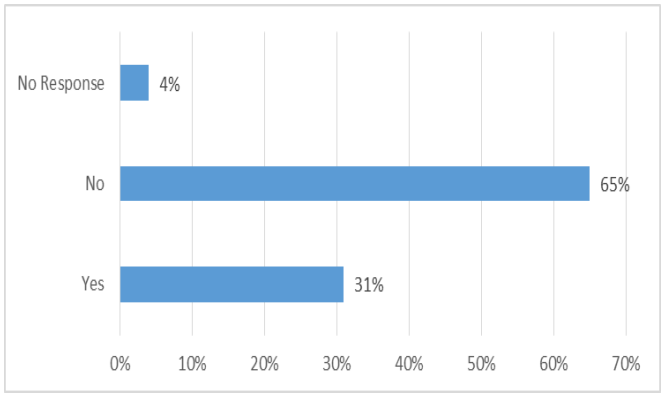

Fig. 4: Adoption of Modular Construction

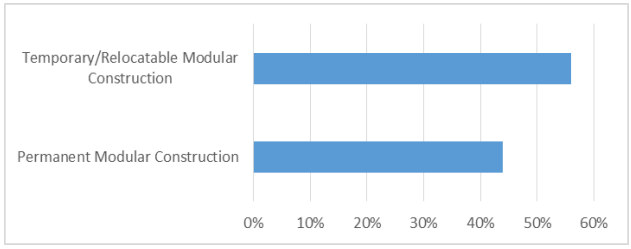

Fig. 5: Type of Modular Construction Adopted

From the result, most (56%) of the architects that have used modular construction as a construction method adopt temporary/ re-locatable modular construction, while 44% adopted permanent modular construction. In narrowing the adoption of modular construction down to the delivery of affordable housing in Lagos, Nigeria, Fig.6 shows the result obtained.

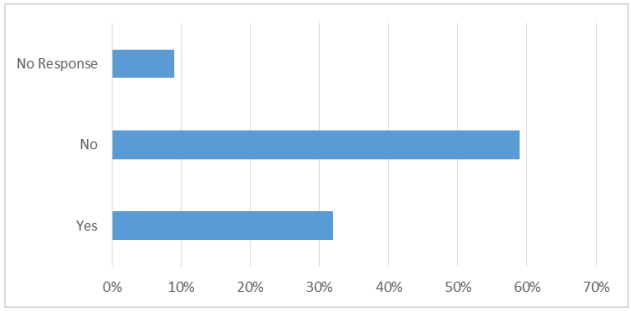

Fig. 6: Adoption of Modular Construction for Affordable Housing Delivery

From Fig. 6, it is depicted that most (58%) of the respondents have not adopted modular construction for affordable housing schemes, while just few (32%) of them have.

The study further investigated reasons for the adoption of modular construction for affordable housing delivery by the respondents and the result obtained is presented in Table III.

Table III: Reasons for the Adoption of Modular Construction for Affordable Housing

	N	Mean	Std. Deviation	Rank
Reduced waste	22	4.5000	.51177	1st
Reduced construction time	23	4.3913	.49901	2nd
Its cost saving attribute	23	4.3043	.47047	3rd
Reduced variation	22	4.2273	.52841	4th
Reduced weather related delay	22	4.2273	.68534	5th
Reduced transportation delay	22	4.0455	.78542	6th
Economies of scale of materials	22	3.9545	.84387	7th

From the result in Table III, modular construction is adopted for affordable housing for all the benefits outlined by Edmonds, Golden & McKenna (2018) and Musa, Yusof, Mohammad & Sahidah (2016). Although Edmonds, Golden & McKenna (2018) found that cost saving is central to modular construction, the result in Table III shows that the architects in Lagos State adopted modular construction for affordable housing first for its waste reduction benefits, then for its construction time reduction benefits before its cost saving benefits. The two least reasons for its adoption are reduced transportation delay and economies of scale of materials.

In addition, the study investigated the processes involved in the various stages of modular construction for affordable housing delivery by respondents. The result is shown in Table IV.

Table IV: Processes Involved in the Modular Construction Stages

Stages	N	Mean	Std. Deviation	Rank
Prefabrication performed with prototypes	22	4.1818	.58849	1st
Integration of project design with stakeholders for offsite manufacture, transport and assembly	23	4.0435	.47465	2nd
Development of detailing in collaboration with the contractor, fabricator and installer	23	4.0000	.90453	3rd
Collaborative design of assembly operations to ensure safety, quality, time and cost parameters are met	23	3.9565	.92826	4th
Reduced design changes	23	3.9565	.76742	5th

The design of the project is developed so that work is structured for what is done on-site and what is manufactured in the factory	23	3.8261	.88688	6th
Site deliveries are made just in-time	23	3.5652	.89575	7th

The result presented in Table IV shows that the processes adopted by architects involved in modular construction for affordable housing delivery in Lagos State, Nigeria are in line with the processes involved in the predesign, design, development, detail, order, fabrication, delivery and assembly stages of modular construction presented by Smith (2016). However, timely site delivery is the least correlating process. This could be as a result of local factors peculiar to Nigeria.

Discussion

The study focused on the level of awareness of modular construction method among architects in Lagos State, Nigeria as well as the extent to which modular construction method is adopted by the architects for affordable housing. From the findings, a higher percentage of respondents are generally aware of the concept of modular construction. The findings show that most architects in the study area understand the concept of modular construction as a time efficient construction technique. It is also understood for its waste efficiency. However, the findings on the level of adoption of modular construction for affordable housing by the architects, do not align with the level of awareness as a larger number of the architects do not employ this construction method when planning for affordable housing. This indicates that the idea of modular constrcution is minimally practicalised with regards to affortable housing delivery in the study area. According to Iwuagwu & Iwuagwu (2015), lack of enlightenment in the use of building materials and methods challenges the provision of affordable housing in Nigeria. From the findings, the various stages of modular construction adopted by the architects who have used modular construction, range from prefabrication performed with prototypes to detailing's in collaboration with contractors, fabricators and installers, among others. These is most likely to contribute to alleviating the construction activities on site and in the long run, affordable housing can be attainable as a large part of the construction processes is carried out offsite during the production process, leaving the builder with a more manageable product that can be finished well on site.

V. CONCLUSION AND RECOMMENDATIONS

The awareness level and adoption of modular construction by architects in Lagos, Nigeria were examined based on empirical data from a field survey among architects in Lagos State, Nigeria. Based on the results presented, the following conclusions are drawn: Firstly, majority of the architects are aware of modular construction as an approach used in building construction and its benefits. Secondly, only about one-third of the respondents have actually adopted modular construction in affordable housing schemes which is relatively low. Hence, architects in the study area are yet to satisfactorily embrace the adoption of modular construction for affordable housing delivery towards the promotion of modular construction as an alternative to traditional construction method for affordable housing delivery. To help provide more affordable housing to reduce the present housing deficit in Lagos State, it is important that the architects are encouraged to develop affordable housing designs that can make use of the modular construction method in the study area. This is necessary as some of them are still either not aware of the modular construction method or are aware, but have just not factored the construction technique into their housing scheme designs. The influence of architectural professional associations such as the Architects Registration Council of Nigeria & the Nigerian Institute of Architects (NIA) is required in this regard. The bodies should organise seminars to educate and enlighten the architects from time to time on the need and benefits that modular construction method can offer in the delivery of affordable housing. The government as a major player in the provision of affordable housing schemes in the country also has a role to play. The government should make it a matter of policy that architectural proposals for any government sponsored social housing scheme, should be capable of been delivered by the use of modular construction method. Also, since some of the architects are yet to adopt the modular construction method in procurement of affordable housing delivery in Nigeria, it is necessary to investigate the reason for this scenario. To this end, further studies may investigate the barriers to the adoption of modular construction as an alternative to traditional construction methods in the study area.

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AUTHORS PROFILE

Sholanke A. B. is an Architect and a Lecturer at Covenant University, Ota, Ogun State, Nigeria. His research interests include: Universal Design in Public Buildings and Environments, Built-Environment Development studies and All-inclusive design concepts.

Opoko A. B. is an Architect and a Senior Lecturer at Covenant University, Ota, Ogun State, Nigeria. Her research interests include Informal settlements; Housing, architectural education and Environment.

Onakoya A. O. is a graduate Architect currently undergoing her masters at Covenant University, Ota, Ogun State, Nigeria. Her research interests include: Universal design, User Experience, Social Sustainability and Building Maintenance.

Adigun T. F. is a graduate Architect currently undergoing her masters at Covenant University, Ota, Ogun State, Nigeria. Her research interests include: Flood Resilient design, Housing and Traditional Architecture.