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An Analysis of the Benefits of Adopting Modular Construction: A Nigerian Construction Industry Context

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Abstract: On site and off site are the main construction methods used in the construction industry with the former being majorly adopted. Off-site construction offers significant opportunity to improve project performance. However, there is little awareness of its benefits in the Nigerian construction industry. This study aims to assess the benefits of adopting modular integrated construction in Nigeria to improve the level of understanding, usage for stakeholders and enhance productivity. Purposive and snowballing technique were used to select the prefab construction experts. Professionals that were involved in the study are engineers, architects and quantity surveyors in the study area. The most rated benefits are enhanced teamwork and collaboration, improved productivity, simplicity and ease in the construction, enhances sustainable building and improved quality of work. Five variables have significant difference between the respondents while the others do not. The study concludes that modular construction is at its nascent stage and could be developed and be more implemented if the government takes the lead. It is therefore recommended that stakeholders must be ready and willing to use modern method for better collaboration and teamwork. Also, more awareness and training programmes should be conducted to the stakeholders who could implement its usage in the Nigerian construction industry. The government should also provide financial support to encourage private clients and other people who are keen to execute the construction projects with prefabs.

Keywords: Benefits, Modular construction, Prefab, Construction industry, Off-site construction

INTRODUCTION

Since the late 19th century, on-site construction has been the common construction method and nowadays it accounts for a significant portion of the housing industry (Zenga and Javor, 2008). However, in light of the industrialisation of the construction process, the construction industry has experienced different construction methods during the past few decades (Kamali and Hewage, 2015). The off-site construction process is significantly different than that of on site. In the case of off-site construction, different elements and components of a building are first manufactured and preassembled, and then they are transported to the final project site and installed to form the building (Kamali and Hewage, 2015).

Modular construction is one of the significant and rapidly growing off-site construction methods that is mainly used in North America and several European and Asian countries (Annan, Youssef and El Naggar, 2008; Li et al., 2013).

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A module consists of a volume fitted with all structural elements, finishes and process components, which, regardless of system, function or installing craft are designed to occupy that space (Azhar, Lukkad and Ahmad, 2013). Modules may contain prefab components or assemblies and are frequently constructed away from the jobsite. Modular construction, on the other hand, is the technique of exporting a portion of site-based work to off site, such as at fabrication and modular assembly shops or yards (Choi, Chen and Kim, 2017). When properly implemented, modular construction offers considerable opportunity to improve project performance by reducing capital costs, project duration, construction waste, accidents and noise while improve labour productivity, product quality and environmental performance (Haas et al., 2000; Song et al., 2005; MBI, 2010; McGraw Hill Construction, 2011; O'Connor, O'Brien and Choi, 2013; Choi, 2014).

Modular integrated construction (MIC) also called modular construction, industrialised building systems (IBS), off-site manufacturing, off-site production, modern methods of construction and prefab prefinished volumetric construction (Nadim and Goulding, 2011; Yunus and Yang, 2014; Hwang, Shan and Looi, 2018; Wuni and Shen, 2020a; Wuni and Shen, 2022). The modular construction technique is not a new concept nowadays and has been reasonably used in the USA, Japan, Sweden and the UK whilst becoming popular in Australia, Germany, Netherlands, China and Hong Kong (Annan, Youssef and El Naggar, 2008; Larsson and Simonsson, 2012; Steinhardt and Manley, 2016). The modularisation technique has been utilised by the industry for centuries; however, the building industry including the engineering, procurement and construction (EPC) sector and the architectural, engineering and construction (AEC) sector have been struggling to achieve high levels of modularisation (Haas et al., 2000; O'Connor, O'Brien and Choi, 2013).

Previous researches have been conducted on the benefits of modular construction in Hong Kong (Choi, Chen and Kim, 2017), the USA (Velamati, 2012; Lu, 2007), Malaysia (Musa et al., 2016; Paliwal, 2019) and Australia (Ferdous et al., 2019). In Nigeria, Kolo, Rahimian and Goulding (2014) opined that the usage of prefab construction will resolve deficit housing. Ogunde et al. (2016) assessed the challenges and prospects of prefab methods in Lagos state. It was shown that unawareness of the MIC, high cost, challenges in installation, unavailability of prefab companies locally and technology are the major stumbling blocks. Dixon-Ogbechi, Adebayo and Adelore (2018) evaluated prefab methodology for building in Nigeria but their study was from the clients' perspective only. Alagbe and Aina-Badejo (2019) reviewed the literature on how the low- and middle-income groups can use the prefab building for smart and fast housing delivery to meet up the high demand for housing. Sholanke et. al (2019) examined the level of awareness and adoption of prefab construction for affordable housing. This study was not holistic in view because it was from the architects' perspective.

There is no empirical study on the benefits from the perspective of all professionals in the built environment in Nigeria. This necessitates this research and therefore it is pertinent to examine the benefits so that there will be better awareness and adoption of off-site construction in Nigeria to enhance affordable and sustainable housing. This article will only assess the awareness or knowledge of the construction professionals on the benefits of modular where consideration was not given to barriers. The barriers of prefabrication have been examined in another article. This study is important to professionals such as architects, clients, quantity surveyors, builders, government and other construction stakeholders.

This study explores the benefits of MIC in Nigeria towards facilitating its adoption and enhancing sustainable housing.

LITERATURE REVIEW

Benefits of MIC

According to Bhattacharjee, Pishdad-Bozorgi and Ganapathy (2016), the benefits of modular construction were categorised into three dimensions of sustainability which are social, economic and environmental. Social sustainability includes productivity of labour and reduction in time of labour, the economic aspects deal with minimisation of cost of construction while economic sustainability is reducing waste, rework and pollution. There are some factors that make modular construction to be the most preferred choice over the conventional construction process such as construction in congested cities, a clustered building where noise needs to be minimised, a high degree of repetition of work and so on (Jaillon, Poon and Chiang, 2009). Other benefits of prefabrication are discussed in the following section.

Improved productivity in construction

Pan and Hon (2020) revealed that off-site construction resulted to 30% increase in labour productivity compared to on-site projects. Similarly, FMI (2013) concluded that off-site construction reduces construction risks.

Speedy completion of construction work

Conventional method of construction is associated with issues such as material shortage, time and cost overruns, low quality, poor weather conditions and skills shortage (Omotayo and Kulatunga, 2014; Femi and Khan, 2014). With the adoption of modern method of construction, there is fast completion of work because all components have been done off site (Lawson, Ogden and Bergin, 2012). Completion can be done 30% to 50% sooner for modular projects when compared to the traditional construction because 60% to 90% is completed in the factory which reduces the risk of weather delay (MBI, 2013; Kolo, Jaafar and Ahmad, 2017). This will remove the delay which been spent on the conventional process of construction. Faster and efficient factory processes is been replaced with slow, less productive and ineffective site processes. A high level of fabrication will provide less interruption during the construction process (Chen, Okudan and Riley, 2010). A USD90 million of project for the construction of canyon lodge and cabins in Yellowstone National Park in the USA was fabricated by Guerdon Modular Buildings in Boise, Idaho facility. The proposed completion time for the five structures was 30 months but by the use of modular construction, 10 months was used for its completion and was reported that it reduced construction waste by 85% (Guerdon Modular Buildings, 2018).

Reduction in life cycle cost

Despite a high capital at the initial stage of the off-site construction, there is a reduced in the operation and maintenance cost at the long-run of the building. Reduction in the life cycle cost is achievable when quality materials are used for initial construction. The costs used for the operation and maintenance and the disposal of modular construction are minimised at the course of the use of the building (Blismas, Pasquire and Gibb, 2006).

Improved quality of work

Modules produced in the factory are of a high quality due to the strict quality assessment and control with inspection and testing protocol before it is transported to the site (Kolo, Jaafar and Ahmad, 2017; Killingsworth, Mehany and Ladhari, 2020). This quality requirements are performance, whole life cost and durability. The quality of work is increased because of the skilled workers in the factory are more permanent than the temporary workers on site. Modular components that are used for building are constructed in the same standards as the conventional process and according to the architect-specified materials (MBI, 2013).

Reduction in greenhouse gas emission

The US Geological Survey (2012) reported that of 3.4 billion tonnes of cement produced contribute to 5% of global carbon dioxide emissions. These emissions can be minimised if MIC is adopted in the construction industry. Mao et. al (2013) noted that the gas emission is reduced by 40% to 50% with the implementation of the off-site construction. It was noted that there is a reduction of carbon emissions when modular construction is implemented.

Lessens construction waste, possibility of reuse and resale of materials

These derived principles from lean and factory environment have enhanced control and reduction in waste (Kolo, Jaafar and Ahmad, 2017). In Nigerian construction projects, a large percentage of waste is being generated for conventional buildings. In Hong Kong, it was observed that construction wastes are reduced by 52% when MIC is used (Jaillon, Poon and Chiang, 2009). Lachimpadi et al. (2012) carried out research on the IBS for the construction of high-rise buildings in Malaysia and proved that the waste generated from precast (or IBS) construction in comparison to the conventional in-situ casting is as low as 25%. Furthermore, fewer wastes are been produced in the factory for the production of modular products at every step of the way (Musa and Mohammad, 2015). Modular construction helps in reducing, reusing and recycling waste because materials that are not used can be kept in the inventory which can be used later in another project.

Also, modular construction helps in deconstructing a building and these materials can be relocated to another site and reconstructed for a new building (NRB Modular Solutions, 2014). These materials can be sold to those that need modular components or elements. Most repetitive projects like hotels and so on had a reduction of construction waste by 50% and waste produced in the off-site area is either reused or recycled (Mtech Consult Group, 2012).

Reduces pollution in the environment

Effective implementation of MIC reduces pollution in the construction, any form of noise nuisance and disruption of work in the area. When the construction time is reduced, it also reduces the construction noise in the environment compared to the conventional process (Velamati, 2012). For example, sandwich exterior walls prefabrication aid in minimising the construction dust emission by 30%. These help in reducing noise on site because it have been produced in the factory shop (Wilkinson, Xia and Bing, 2016).

Enhances sustainable/green building

Modular building promotes sustainability because there is less disturbance from the suppliers, workers and equipment. Most of the works are been done in the plant before they are transported to the construction site. Also, this can be dismantled and relocated to a new place or refurbished for a new use. Thus, it reduces raw materials and minimises energy costs to create a new building. This sustainability is also improved because there is less waste and improved safety on the construction site (Musa et al., 2014a).

Reduces health and safety risks

MIC enhances the safety and the security of the construction workers on site due to the prefab products are brought to the site for fabrication and joining (Killingsworth, Mehany and Ladhari, 2020). Most of the works in modular construction are done by plant and equipment like the lifting of modular components, fixing and joining. In the conventional process, more labours are needed on site which is prone to accidents and other risks. Safety in modular construction is higher compared to the traditional or conventional process of construction because most work is done off site (Nahmens and Ikuma, 2012).

Minimise defects in the building

Prefab components are not easily affected by the adverse weather conditions compared to the traditional process like rain, sun and relative humidity. Defects are been minimise in prefab building because of the level of standard and quality of the modular components.

Certainty of project cost

Modular construction gives certainty of cost and this can lead to the possibility of a reduction in the cost of construction (Killingsworth, Mehany and Ladhari, 2020). The Kings Park's accommodation in Queensland, Australia was able to save up to 40% of the expected cost by using the modular construction. Those modules were prefabricated within 50 days in China and were assembled on site for a week (Paliwal, 2019). The reduction in the construction time brings about the certainty of cost because fewer resources will be spent on the project which gives a glimpse of money that will be executed on a subsequent project.

Improved aesthetic view

Velamati (2012) noted that there is an improved aesthetic view of the building compared to the conventional process. In the factory, strong expertise is used in the production of modules in high standard and quality but there is the possibility of using quack artisans in the conventional which diminishes the aesthetic of the building. Also, thermal and airtightness performance is enhanced for the building fabric when modular construction is adopted due to tighter joints that can be achieved in the factory environment.

Minimisation in labour, material demand and cost

MIC reduces labour skills needed in the construction because work is less complicated. Also, few and expert labourers are used for the work compared to the conventional process. Modular construction can reduce the labour and material cost but this cost saving is partially offset by the transportation cost. The transportation of modular units is also subject to the country's road department. Jaillon, Poon and Chiang (2009) observed that when in-situ concrete was replaced with the precast concrete, the concrete quantities was saved by 55%, quantities of reinforcement was saved by 40% and 70% of the timber formwork was replaced from different projects.

Lessens weather disruptions onsite

When there is fast completion of work, there is less disturbance of weather such as heavy rain and adverse heat on site. In the conventional process of building, numerous delays affect the progress of building which makes shut down and stoppage of certain specific trade or delay in the delivery of materials (Velamati, 2012). These delays are compensated when subcontractors are forced to work extra hours to meet the schedule. In modular method of construction, there is never a factory delay which makes time to be saved.

Safe and better site operations

The use of a factory for the production of the modular unit reduces the risks of accidents and various liabilities that can be experienced by the workers on site. This improved safety is more significant in fabrication than on-site operation where it is characterised by the lack of space, skilled labours and bad weather (Bohari et al., 2015)

Simplicity and ease in the construction process

Modular building is easily constructed by connecting the modular components. It is also movable and flexible when the components are not needed. The joints and connections are removed and then moved to another place of use. There is also the possibility of executing construction in remote locations because projects that are not feasible using traditional construction are often feasible using modular construction.

Increased competition on foreign firms

The national research council of the USA noted that the implementation of modular construction will enhance the efficiency and competitiveness of the construction industry. Therefore, there is a need for construction companies to be leaner to be competitive to win foreign and better contract (McGraw Hill Construction, 2011). Table 1 shows the summary of the benefits of the modular construction and the codes used in this study.

Table 1. Summary of variables and their codes

Benefits of Modular Construction	**Code**
Enhance teamwork and collaboration	BFT 1
Improved productivity in construction	BFT 2
Simplicity and ease in the construction process	BFT 3
Enhances sustainable/green building	BFT 4
Improved quality of work	BFT 5
Speedy completion of construction work	BFT 6
Reduces pollution in the environment	BFT 7
Theft reduction onsite	BFT 8
Minimise defects in the building	BFT 9
Lessens weather disruptions onsite	BFT 10
Acoustic insulation and installation benefit	BFT 11
Airtightness and thermal performance of building fabric	BFT 12
Reduction in greenhouse gas emission	BFT 13
Lessens construction waste	BFT 14
Safe and better site operations	BFT 15
Reduces design/construction rework	BFT 16
Minimisation in labour demand and cost	BFT 17
Reduces health and safety risks	BFT 18
Reduction in life cycle cost	BFT 19
Improved aesthetic view	BFT 20
The possibility for reuse and resale	BFT 21
Increased competition for foreign firms	BFT 22
Certainty of project cost	BFT 23

Hindrances to the Usage of MIC

There are various factors limiting the adoption of modular construction. These are explained in the following paragraph.

Modular construction is a very capital intensive as was noted by Pan and Sidwell (2011) and that it is cost saving in the whole life cycle. Hong et al. (2018) and Sun et al. (2020) emphasised that the cost of the prefab is higher than the conventional buildings. Furthermore, lack of government support is one of the critical factors that affects the adoption of modular construction (Xu, Zayed and Niu, 2020; Ferdous et al., 2019). When only the government promotes, encourages, enforces and provides incentive and subsidies for modular buildings, then it will gain more wider adoption (Luo et al., 2015).

It was also observed that the lack of qualified professionals hinders the adoption of the MIC projects (Wuni and Shen, 2020a). Highly skilled and experience contractors and labourers can suggest modular buildings to clients who do not have an idea of the prefab (Sun et al., 2020). Also, lack of advancement in technology is a problem in the use of modular building (Pan, Gibb and Dainty, 2007; Shahtaheri et al., 2017). It requires interfacing of modules and a level of technological requirements is needed to avoid assembly errors, rectification of problems and reworks (Wuni and Shen, 2020b). Lack of standard and codes for certifying modular construction which includes architecture, structure, services, safety, durability and sustainability. The limited availability of MIC design codes, technical guidance and standards contributes to the low level of usage (Gan et al., 2018; Sun et al., 2020)

Kamali and Hewage (2016) revealed that logistics related issues such as transportation and limited storage space impede the MIC adoption. In addition, the risk associated in transporting those modules can discourage owners and increase the amount of the budget (Meehleis, 2020). Other obstacles identified by various authors are client resistance to change and dissatisfaction of clients (Gan et al., 2018; Havinga and Schellen, 2018), lack of manufacturers and suppliers of the MIC products (Wuni and Shen, 2020b), limited contractors that are specialised in the prefab (Polat, 2010), complex procurement and contract system (Wuni and Shen, 2020b), lack of awareness by stakeholders and clients (Blismas et al., 2005), skilled labour with high wages (Wuni and Shen, 2020b), inflexibility of design changes (Jaillon, Poon and Chiang, 2009), untimely supply of modular products (Luo et al., 2015) and dominance of the traditional process and practices (Nawi et al., 2009).

RESEARCH METHODOLOGY

The quantitative research approach was used in the study. This involves collecting data relating to the objective of the study through the distribution of questionnaires to the professionals that have handled modular construction in the Lagos, Port Harcourt, Abuja. Some of the executed or ongoing modular projects in Nigeria are Nigeria Immigration Service, NCDC Abuja Testing Laboratory Project, Spring Hall British School modular cabin classrooms, Skye Bank Experience Hub Project, police transit camp project and defense headquarter, amongst others. The questionnaire was designed to retrieve respondents' demographic information (academic qualification, the number of prefab projects handled, years of working experience and profession of the respondents). This is a significant aspect of the research study before getting their views on the benefits of the modular construction. Five-point likert scale was used in the ranking where 1 represents "Strongly disagree", 2 represents "Disagree", 3 represents "Undecided", 4 was noted for "Agree" and 5 represents "Strongly agree". The target populations for this study were professionals that have handled prefab construction in the study area.

A pilot study was conducted with experts in prefab construction regarding the research instruments, where three participants/professionals were used in the pilot study. This pilot study was used to correct the ambiguity of words and errors in some statements for clarity and the correct rating for the survey. Those experts that constituted the study were the ones that directed to unknown professionals (experts). The data collection was collected from 15th May 2020 to 10th July 2020. The questionnaire was administered to the experts in modular construction by hand. The purposive and snowballing techniques were used in identifying the professionals in the study area. The purposive sampling was used to contact the professionals for the pilot study. These professionals then connect us to other unknown professionals. 87 professionals were identified in the study area and were given a questionnaire to fill. At the end of the whole data collection, 75 were returned and 64 questionnaires were suitable for further analysis. The other 11 questionnaires were not included because it was partially filled. Despite the sample size was very small, statistical analyses can still be conducted due to the generally accepted rule. Hwang et al. (2015) noted that a sample size of 30 or above makes the central limit theorem to be true. Also, modular construction or prefab have not been generally utilised in the Nigerian construction industry which makes it difficult to get a large sample of experienced professionals.

After data collection, percentile, frequency table, pie chart and bar chart were used to analyse the demographic aspect of the respondents which is on a nominal scale. The other part in the ordinal scale was analysed with Statistical Package for Social Sciences (SPSS 23). The reliability/Cronbach alpha (α) test was used to test the reliable of the research instrument and scale. The reliability test value for this study was 0.870; this value is found to be reliable because it is above 0.70 (Doloi, Iyer and Sawhney, 2011). The mean item score was used to find the average of the factors for the benefits of modular construction. The benefits were ranked from the highest to lowest in their values. Kruskal-Wallis test was also used for further analysis to find the difference in the views of the respondents. This was conducted to perceive whether there are significant differences or not.

FINDINGS AND DISCUSSION

Table 2 shows the profession of the respondents. Depicting 23.4% of the population, 15 of them were the quantity surveyors. The builders represent 15.6% and the project managers connotes 10.9%. The architects and engineers represent 18.8% and 31.3%, respectively.

Table 2. Profession of the respondent

Profession	Frequency	%
Quantity surveyors	15	23.4
Architects	12	18.8
Engineers	20	31.3
Builders	10	15.6
Project managers	7	10.9
Total	64	100.0

Figure 1 depicts the types of organisation where the respondents work. From 64 respondents, 33% of them work in the consulting firm, i.e., 21 professionals, while 67% of the respondents work in the contracting firm which connotes 43 professionals.

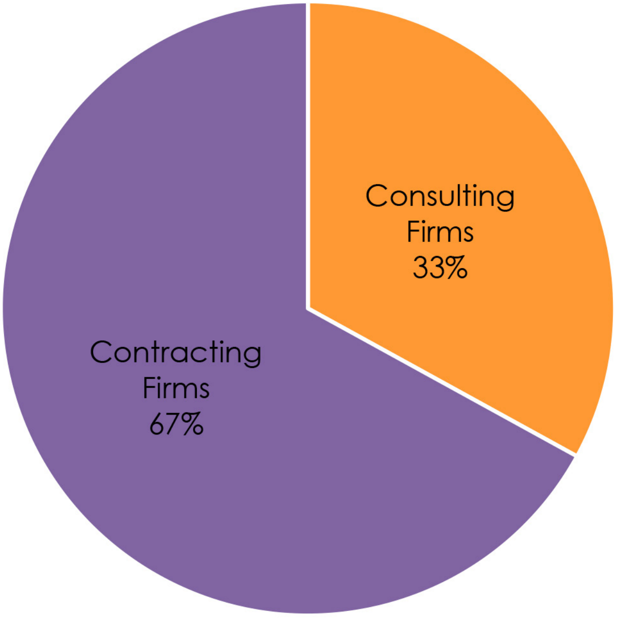

Figure 1. Types of organisation

Figure 2 reveals the number of MIC projects handled by the respondents. There are 28 respondents who have handled 1 to 5 projects, i.e., 43.8% while 18 were engaged in 6 to 10 projects, i.e., 28.1%. Those who handled the range of 11 to 15 projects were 10 respondents which represent 15.6% of the population: 16 to 20 projects execution were handled by 8 respondents which also represents 12.5% of the entire population.

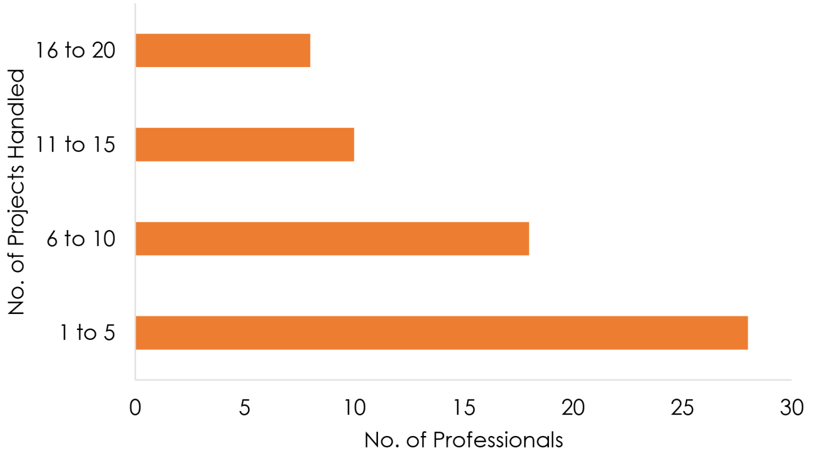

Figure 2. The number of projects handled by the respondents

The academic qualification of the respondents engaged are higher national diploma (HND), bachelor's degree (BSc/BTech) and master's degree (MSc/MTech). From 64 respondents, 12 were classified into the HND groups, 37 were grouped into BSc/BTech and 15 were classified into the MSc/MTech groups. This represents 18.8%, 57.8% and 23.4% of the population, respectively. In the aspect of professional qualification, the respondents were certified under Nigerian Institute of Architects (NIA), Nigerian Institute of Quantity Surveyors (NIQS) or Nigerian Society of Engineers (NSE). Respondents with fellow were 18 which represents 28.1% of the population. Those with membership in their professional bodies were 38 depicting 59.4% while those with associate membership in each professional body were 8 which connoting 12.5% of the population. Regarding the years of working experience of the respondents, those with 1 year to 5 years of working experience were just 12 respondents which represent 18.8% of the population, 30 respondents have 6 years to 10 years of working experience which depict 46.8% of the population and 20 respondents were found to have 11 years to 15 years of working experience with 31.3% of the whole respondents. Only 2 respondents have 16 years to 20 years of working experience which connotes 3.1% of the population. All of these information are shown in Table 3.

Table 3. Additional information of the respondents

Respondent Information	Frequency	%
Academic Qualification		
Higher national diploma (HND)	12	18.8
Bachelor's degree (BSc/BTech)	37	57.8
Master's degree (MSc/MTech)	15	23.4
Total	64	100.0
Professional Certification		
Fellowship	18	28.1
Membership	38	59.4
Associate membership	8	12.5
Total	64	100.0
Working Experience		
1 year to 5 years	12	18.8
6 years to 10 years	30	46.8
11 years to 15 years	20	31.3
16 years to 20 years	2	3.1
Total	64	100

The variables and codes from Table 1 were used to interpret the benefits of the MIC, as shown in Table 4. Enhance teamwork and collaboration was ranked first with a mean value of 4.86. Reduces pollution in the environment was ranked second with a mean value of 4.77. Improved productivity in construction and speedy completion of construction work were ranked third position having same mean value of 4.73 with the same standard deviation. Besides, improved quality of work was ranked fifth with a mean value of 4.72 and enhances sustainable/green building was ranked sixth with a 4.70 mean value. Simplicity and ease in the construction process was ranked seventh position having a mean value of 4.61.

Safe and better site operations was ranked eighth position with a mean value of 4.58. Theft reduction onsite and reduction in life cycle cost were ranked ninth and 10th positions, respectively. These variables or factors have the same mean value of 4.56 but different standard deviations. The variables with larger standard deviation are ranked last and this was applied in the ranking of the variables in Table 4 (Field, 2005). Reduction designs/construction rework and the possibility of reuse and resale were both ranked 11th position due to the fact they have same mean value and standard deviation. Also, reduction in greenhouse gas emission was ranked 13th with a 4.55 mean value while lessen weather disruptions onsite was ranked 14th. The 15th position was the acoustic insulation and installation benefits with a 4.48 mean value.

Improved aesthetic view and airtightness and thermal performance of building fabric were ranked 16th and 17th position with mean of 4.47 and 4.44, respectively. The 18th ranked variable was minimising defects in the building and 19th position was lessen construction waste having mean value of 4.43 and 4.41, respectively. Furthermore, minimisation in labour demand was ranked 20th position with a mean value of 4.33 and increased competition for foreign firms was ranked 21st position with a mean of 4.25. The factor ranked in the penultimate position was certainty of the project cost with a mean value of 4.11. The last ranked variable for benefits of MIC was reduce health and safety risk with a 3.95 mean value.

Table 4. The benefits ranking of the MIC

Benefits	QS	Rank	Engr.	Rank	Arch.	Rank	Bldr.	Rank	PM	Rank	Overall Rating	SD	Rank
BFT 1	4.93	1	4.95	2	4.67	7	4.90	3	4.71	9	4.86	0.350	1
BFT 7	4.60	6	4.90	5	4.67	6	4.90	2	4.71	6	4.77	0.427	2
BFT 2	4.80	2	4.75	6	4.58	8	4.80	4	4.71	2	4.73	0.445	3
BFT 6	4.47	8	4.75	7	4.92	1	4.90	1	4.71	3	4.73	0.445	3
BFT 5	4.60	7	4.90	3	4.58	9	4.70	8	4.71	5	4.72	0.548	5
BFT 4	4.73	4	4.95	1	4.42	16	4.70	9	4.43	11	4.70	0.460	6
BFT 3	4.80	3	4.55	14	4.58	10	4.60	14	4.43	14	4.61	0.492	7
BFT 15	4.33	15	4.40	19	4.83	2	4.70	11	5.00	1	4.58	0.586	8
BFT 8	4.47	10	4.70	10	4.50	14	4.60	15	4.43	15	4.56	0.500	9
BFT 19	4.20	19	4.70	12	4.58	12	4.70	7	4.71	4	4.56	0.639	10
BFT 16	4.33	16	4.50	17	4.83	3	4.80	6	4.43	16	4.56	0.753	11
BFT 21	4.20	20	4.65	13	4.58	11	4.80	5	4.71	8	4.56	0.753	11
BFT 13	4.60	5	4.90	4	4.00	21	4.70	12	4.14	21	4.55	0.958	13
BFT 10	4.47	9	4.25	20	4.75	4	4.60	13	4.71	7	4.50	0.504	14
BFT 11	4.07	23	4.55	15	4.75	5	4.50	19	4.71	10	4.48	0.712	15
BFT 20	4.27	18	4.50	16	4.50	13	4.70	10	4.43	13	4.47	0.616	16
BFT 12	4.40	14	4.70	11	4.17	19	4.50	18	4.14	20	4.44	0.710	17
BFT 9	4.40	11	4.40	18	4.42	15	4.50	16	4.43	12	4.43	0.498	18
BFT 14	4.13	21	4.75	8	4.17	18	4.50	17	4.29	17	4.41	0.684	19
BFT 17	4.40	13	4.70	9	3.83	22	4.40	21	3.86	22	4.33	0.960	20
BFT 22	4.27	17	4.25	21	4.17	17	4.40	20	4.14	18	4.25	0.713	21
BFT 23	4.13	22	4.10	22	4.00	20	4.20	22	4.14	19	4.11	0.620	22
BFT 18	4.40	12	3.95	23	3.67	23	3.90	23	3.57	23	3.95	0.677	23

Note: QS = Quantity surveyors; Arch. = Architects; Engr. = Engineers; PM = Project manager; Bldr. = Builders; SD = Standard deviation.

Table 5 shows the difference in the views of the respondents which was conducted with the Kruskal-Wallis test. Five variables have significant difference in the opinions of the respondents. These variables or factors are reducing construction waste, enhances sustainable/green building, reduce health and safety risk, lessen weather disruption on site and safe better site operations. The other 18 variables or factors have *p*-values greater than and equal to 0.05, i.e., there is no significant difference in the views of the respondents. This also means that these repondents have the same views and opinions on these variables.

Table 5. Kruskal-Wallis test of the respondents for the benefits of the MIC

Benefits	Mean Item Score					Kruskal-Wallis Test	
	QS	Engr.	Arch.	Bldr.	PM	Chi-square	Asymp. Sig
BFT 1	4.93	4.95	4.67	4.90	4.71	6.971	0.137
BFT 7	4.60	4.90	4.67	4.90	4.71	5.975	0.201
BFT 2	4.80	4.75	4.58	4.80	4.71	1.964	0.742
BFT 6	4.47	4.75	4.92	4.90	4.71	8.860	0.065
BFT 5	4.60	4.90	4.58	4.70	4.71	4.218	0.377
BFT 4	4.73	4.95	4.42	4.70	4.43	12.945	0.012*
BFT 3	4.80	4.55	4.58	4.60	4.43	3.529	0.473
BFT 15	4.33	4.40	4.83	4.70	5.00	11.038	0.026*
BFT 8	4.47	4.70	4.50	4.60	4.43	2.810	0.590
BFT 19	4.20	4.70	4.58	4.70	4.71	6.554	0.161
BFT 16	4.33	4.50	4.83	4.80	4.43	6.504	0.165
BFT 21	4.20	4.65	4.58	4.80	4.71	2.384	0.665
BFT 13	4.60	4.90	4.00	4.70	4.14	5.842	0.211
BFT 10	4.47	4.25	4.75	4.60	4.71	9.600	0.048*
BFT 11	4.07	4.55	4.75	4.50	4.71	9.296	0.054
BFT 20	4.27	4.50	4.50	4.70	4.43	2.109	0.716
BFT 12	4.40	4.70	4.17	4.50	4.14	4.428	0.351
BFT 9	4.40	4.40	4.42	4.50	4.43	0.317	0.989
BFT 14	4.13	4.75	4.17	4.50	4.29	10.449	0.034*
BFT 17	4.40	4.70	3.83	4.40	3.86	4.489	0.344
BFT 22	4.27	4.25	4.17	4.40	4.14	1.457	0.834
BFT 23	4.13	4.10	4.00	4.20	4.14	0.581	0.965
BFT 18	4.40	3.95	3.67	3.90	3.57	10.967	0.027*

Note: QS = Quantity surveyors; Arch. = Architects; Engr. = Engineers; PM = Project manager; Bldr. = Builders; SD = Standard deviation.*Significant at $p < 0.05$.

The result gotten from the USA and Hong Kong is slightly similar to the result in Nigeria. Hong Kong and the USA noted that the top five benefits are better site operations, better quality, improved schedule, lower cost and increased productivity (Choi, Chen and Kim, 2017; Edmonds, Golden and McKenna, 2018; Gbonegun, 2018; Wuni and Shen, 2019). Improved productivity, quality of works, improved quality of work and speedy completion of construction works are in line with the studies in the USA and Hong Kong. This implies that off-site construction enhances the productivity of workers which in turn leads to a high quality of work (modular unit). This modular unit when assembled eliminates unnecessary time that has been associated with the traditional method. Also, Velamati (2012) and Paliwal (2019) noted that prefab enhances improved schedule of the project by eliminating delays associated with the conventional method of construction such as weather condition.

Enhance teamwork and collaboration, reduces pollution in the environment and enhance sustainable/green building were rated among the top benefits of this study. This study has been able to show that teamwork and collaboration and reduces pollution in the environment are among the greatest benefits of prefab construction in Nigeria. Zhai, Reed and Mills (2014) revealed that off-site construction reduces noise or pollution, on-site dust and local community disruptions which is in support of this finding. Sustainable building is consistent with Musa and Mohammed (2015), Wilkinson, Xia and Bing (2016) and Musa et al. (2016) who opined of that off-site construction provides sustainability in the construction environment. This does not conform to the study of Zhai, Reed and Mills (2014), who noted that there have been sustainable challenges in China where stakeholders consider cast-in-situ method as effective approach making the off-site adoption relatively low. This might be because of cast-in-situ method is cost effective compared to the precast and stakeholders are not willing to change to modern method of construction (Havinga and Schellen, 2018). This implies that despite off-site construction reduces waste, materials, pollution and fewer disturbances in enhancing sustainability, some countries are yet to partake in this technology. Blismas, Pasquire and Gibb (2006) and the Construction Industry Council (2018) noted that modular construction reduces life cycle cost and carbon emission which is partially in line with this finding which was rated 10th and 13th positions, respectively. This means that the professionals are yet to observe how prefab minimise the cost of operation and maintenance and carbon emission to the environment in Nigeria.

Certainty of the cost was rated among the least which does not corroborate with the findings of Edmonds, Golden and McKenna (2018) and partly consistent with Sholanke et al. (2019), who noted that modular construction minimises and guarantee the cost. This implies that the cost of projects does exceed the budgeted cost which might be an error in costing or not following the specifications in the drawing for prefab components. Also, Kamali and Hewage (2016) and Meehleis (2020) elaborated that the risk of transporting modules can cause an increase in the budgeted contract sum which is in tune with this finding. In the USA and Hong Kong, it was noted that there is better site operation which is partially in line with this finding where it was rated eighth positions. This means that the professionals could not perfectly fathom on how better and safe site operations be after been provided by the modular construction. Furthermore, the possibility of reuse and resale is partly in alignment with SteelConstruction.info (2011), Basu (2012) and NRB Modular Solutions' (2014) findings of that modular units can be reused and relocated for those that need it in another place like mobile offices and complex units. Buildings can be moved to different locations for use without difficulty. Mobile offices that are gotten by companies can be reused in different sites compared to the conventional offices which cannot be moved. This means that there is little utilisation of the aspect of reuse, resale and relocation of modular units in the Nigerian construction industry which has impede the wider adoption.

In a construction site, the researcher expects that increased safety, less site disruption and safe and better site operations should be well achieved and appreciated. It was shown in this finding that safe site operations and safety have not been fully realised or achieved. Musa et al. (2014b) and Musa and Mohammad (2015) noted that the off-site construction provides less waste in the industry which partly corroborates with this finding but in support of that Arif, Goulding and Rahimian (2012). This means that despite the off-site construction has the potential to minimise the waste, experts or professionals have not utilise how modular construction can reduce waste in the construction or see where wastes are been minimise compared to the conventional method. This will require operatives and professionals to be retrained and reskilled in order to harness the opportunity of the waste reduction. Mao et al. (2013) noted that implementation of modular construction reduces greenhouse emission which is partly in line with this study. This implies that this aspect of the reduction of green gas emission has not been maximised well in the Nigerian construction industry. Rahimian et al. (2017) emphasised that those stakeholders should be well informed and trained in the aspect of green gas emission so that it can be fully maximised.

Also, the government should be the frontier in the use of off-site construction which makes the benefits to be visible to the private organisations and other stakeholders in the industry. This is in support of Xu, Zayed and Niu (2020) who said that the major hindrance to wider adoption of MIC is that the government are not willing and ready to support, encourage and provides incentives for modular projects in the developing countries such as Nigeria. When there is a wider adoption of MIC, more of its benefits will be glaring to the stakeholders and the clients.

CONCLUSIONS AND RECOMMENDATIONS

Based on the finding, it has been shown that modern method of construction has huge benefits compared to the conventional method. The most emphasised benefits were speedy completion of work which in turn can increase housing in Nigeria when the governments and private organisation have a lot of projects to construct. Presently, Nigeria has the issue of housing deficit to accommodate Nigerians with affordable housing. With modular construction, buildings and offices will be executed at the targeted cost, time and at the best quality. This will reduce wastage that is associated with conventional methods. This study has revealed the benefits of the off-site construction to the stakeholders, society and the nation at large. The top five benefits rated by the experts engaged were enhanced teamwork and collaboration, reduces pollution in the environment, speedy completion of work, improved productivity and improved quality of work. The least rated benefits include lessen construction waste, minimisation in labour demand and cost, increased competition for foreign firms, certainty of project cost and reduces health and safety risks.

All factors or variables have no significant difference in the opinions of the respondents except lessen construction waste, enhances sustainable/green building, reduce health and safety risk, lessen weather disruption on site and safe and better site operations, which have significant difference in the views of the respondents. It is recommended that every stakeholder should be willing and ready to adopt these modern methods for better cooperation and effective teamwork. In addition, the government should take the lead in adopting it for public housing projects as it will inspire private clients and people. This will enhance more implementation and development. Also, more awareness and training program should be conducted to stakeholders who could implement its usage in the Nigerians construction industry. The government should also provide financial support to encourage private clients and people who are keen to execute the construction projects with prefab. This study was limited to industrialised part of Lagos state in Nigeria. Additional study can be done in other states, developing countries and through qualitative means. Further studies can be conducted on the post-occupancy evaluation of the modular buildings on users to know their perspective on the benefits in terms of energy-saving, cost and satisfaction.

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