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Dynamics in the Adoption of Offsite Construction in the Federal Capital Territory, Abuja.

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Abstract

Construction work involves three major activities namely; material selection, fabrication of components and elements and lastly erection or assembling. The methods of fabrication are either onsite or offsite with the offsite construction established in literature as the most efficient means of erecting high-density housing units within short periods. The slow rate of its adoption and innovation in Nigeria's construction industry is however a matter of concern. This prompted a study on the dynamics involved in adopting offsite construction processes in the Federal Capital Territory, Abuja with a view to stimulate improved adoption in housing projects. The specific objectives are to identify mechanisms for increasing innovations in construction, to evaluate the level of use of offsite construction processes across housing supply chains and to examine the significance level of forces that interplay in the adoption of offsite construction processes across the housing supply chain. A survey design approach was adopted to achieve this objective while data collected from structured questionnaires using a 5 point Likert scale was analysed with mean item score and ranking. 50 questionnaires were administered and 47 supply chain participants responded from 20 housing projects within the F.C.T. Abuja. The questionnaire comprised of characteristics of supply chain participants, levels in adopting offsite processes in selected building components and elements and relative importance of forces that interplay in adopting offsite construction. Results revealed that the raw material and labour availability with (MIS =4.00) were the most significant influences on housing supply chains. It was concluded that managing raw materials and labour supply more effectively will significantly influence the adoption of offsite construction in housing projects and has direct effects on the performance of the construction industry. The study suggests that stakeholders in construction view themselves as members of a supply chains and collaborate more effectively to ensure better project outcome.

Keywords: Adoption, housing projects, dynamics, supply chains, offsite construction.

1 INTRODUCTION

Professionals in Nigeria's construction industry have been advocating for a departure from the traditional means of construction to more innovative methods (Dada, 2013). Offsite construction has been identified as the driving force for innovations in Construction globally (Yu, Cheng, Shie & Lo, 2006; Benjaoron & Dawood, 2006). Blismas, Wakefield & Hauser (2010) and Azman, Ahamad, Majid & Hanafi (2010) described off-site construction as the vehicle for improving the effectiveness of construction processes and housing delivery efforts. However, its adoption in Nigeria has been rather slow (Kolo, Rahimian & Goulding: Taylor, 2010). The rate of adoption of offsite construction as a process requires the cumulative efforts of all members of the construction supply chain. Mohamad and Saeed (2008) described supply chains to be a network of facilities and distribution options that perform the function of procurement of materials and transformation of these materials into intermediate and finished products for customers. A survey of Architects, Builders and general Contractors in the United

Kingdom was conducted on the challenges of using offsite construction without the input of manufacturers and their experience in component prefabrication and pre-assembly (Bertelsen, 2004). Egan (1998) remarked that the roles of supply chain partnering and offsite construction on the performance of housing construction cannot be ignored. It is on this premise that this study seeks to investigate the dynamics involved in adopting offsite construction in F.C.T. Abuja with a view to stimulate improved adoption in housing projects. This research seeks to address the following questions ; are there mechanisms that can increase innovations in the construction industry, what are the levels of adoption of offsite construction processes in housing supply chains for selected building components in the Federal Capital Territory, Abuja and what is the significance level of forces that interplay in adopting off site construction in housing supply chains in the Federal Capital Territory.The specific objectives are to identify mechanisms that will increase innovations in construction, to evaluate the level of use of offsite construction processes across housing supply chains and to examine the significance level of forces that interplay in the adoption of offsite construction processes across housing supply chains. The term offsite construction is used interchangeably in literature with names such as; dry construction, prefabrication, modern methods of construction, industrialized construction, offsite manufacturing, offsite production (Arif & Egbu, 2010). Gibb & Isack (2003) defined it as the process of completing substantial parts of construction works prior to their installation on the site. Abosaod, Underwood, Isikdag, & Barony (2010) also defined it as the manufacture and pre-assembly of construction components, elements or modules in a factory before installation into their final location. The Building Research Establishment (2009): Abosaod *et al* (2010) stated that there are five categories of offsite construction used in housing namely; the volumetric, panelized, hybrid, sub-assemblies and component modular. Several benefits accrue to the use of off-site construction on construction sites (Arif & Egbu, 2010). These includes; speed of completion, quality and increased safety, reduced overall costs, reduced material waste, and less impact on the environment (Bernstein, Gudgel & Laquidara-Carr, 2011).

2 HOUSING EFFORT IN THE F.C.T. ABUJA, NIGERIA

The housing deficit in Nigeria stands at about 17 Million and the challenge of inadequate housing continues to worry successive governments (National Bureau of Statistics, 2015). According to Johnson (2016), 80% of the residents in Nigeria are estimated to be living in indecent or informal housing structures with a population of squatters outnumbering the decently accommodated. 800,000 housing units in Nigeria are required yearly to bridge the housing gap as against the estimated production capacity of 100,000 per year (Johnson, 2016). Experts have established that the Federal Capital Territory (FCT), Abuja alone has a housing shortage of 1.7 Million that may not be alleviated unless there is a paradigm shift in the housing policy (Uwadinma, 2016). Attempts at addressing insufficient housing in the FCT, Abuja resulted in the collaboration of the private sector with Federal Capital Development Authority– F.C.D.A. (Jibril & Garba, 2012).

2.1 DYNAMICS IN THE ADOPTION OF OFFSITE CONSTRUCTION

Dedi and Sidwell (2004) identified three concepts to innovation in construction namely; product and process innovation, the radical and incremental innovation, the technical and administrative innovation. However, adopting product and process innovations in construction is observed to take effect in two major stages namely: the initiation stage and the implementation stage. Innovations at the initiation stage are only proposed and not yet in use

while innovations at the implementation stage have been fully adopted or put to use. Furthermore, the implementation stage of innovations is subdivided into two stages i.e. trial implementation stage and sustained implementation stage. Implementing innovative methods and techniques in housing projects requires the efforts of all actors in the supply chain (Simonsson, 2011). The use of off-site construction internationally is due to improved customer perceptions, government support initiatives, competitions amongst construction firms and contractors' involvement in design (Goulding & Arif, 2013; Dedi & Sidwell, 2004). However, in construction supply chains twenty (20) items were identified from literature as dynamics or forces that interplay in the adoption of offsite construction as having influence in the adoption of offsite construction as a housing delivery effort across supply chains (Naude & Badenhosrt-Weiss, 2011; Zhai, Reed & Mills, 2013; Hairstans, *et al,* 2016). These are:

i. Raw materials availability;
ii. Capacity limitations;
iii. Housing demand pattern;
iv. Location and distance to the factory;
v. Availability of specialized labour;
vi. Compatibility with other components;
vii. Haulage weight of components;
viii. Housing demand management;
ix. Onsite energy demands;
x. Environmental impact;
xi. Acceptability of standards &specification;
xii. Thermal requirements;
xiii. Aesthetic requirement;
xiv. Noise and sound requirements;
xv. Onsite handling constraints;
xvi. Availability of onsite storage systems;
xvii. Erection time constraints;
xviii. Weather pattern;
xix. Supplier relationship management;
xx. Information management system

For innovations to be successfully adopted, their implementation largely depends on the management of the entire construction supply chain and not just isolated sections but the sum of all parts. (Dedi & Sidwell, 2004).

3 RESEARCH METHODOLOGY

The study adopted a quantitative approach and a descriptive survey research design was chosen to achieve the research objectives. The survey was carried out using structured questionnaires administered by hand and the requisite data was collected on the characteristics of supply chain participants, levels of adoption of offsite processes in selected building components and elements and relative importance of forces that interplay in adopting offsite construction. A pilot study was initially conducted to identify 20 ongoing and completed housing projects in the F.C.T. Abuja and a purposive sampling technique was adopted. Supply chain participants in housing development projects formed the population of the study. 50 participants in the construction supply chain were selected out of which 47 responded. This comprised of building component manufacturers, raw materials suppliers, approval agencies in property development, design professionals, construction firms, estate developers and factory managers of building components. The Federal Capital Territory Abuja was chosen as the study area for the research due to the numerous ongoing housing projects. The levels in the adoption of offsite

Construction for selected building components were measured using a 5 point Likert scale namely: 5 = Very Often, 4 = Often, 3 = Sometimes, 2 = Rarely,1 = Never and analysed with mean item score and ranked. The significance level of forces that interplay in adopting offsite construction were also measured using a 5 point Likert scale namely: 5 = Very Significant, 4 = Significant, 3 = Moderately Significant, 2 = Less Significant, 1 = Not Significant also analysed with mean item score and ranked.

4 RESULTS AND DISCUSSION

4.1 Qualifications and Experience of Respondents

The characteristics of respondents that formed the housing supply chain in F.C.T. Abuja are presented in Table 1.

Table 1: Characteristics of Respondents in Housing Supply Chain

Item	Characteristics	Freq.	%
Role in The Supply Chain	Component Manufacturer	1.0	2.1
	Raw materials supplier	5.0	10.6
	Design professionals	18.0	38.3
	Approval authorities	2.0	4.3
	Construction Firms	11.0	23.4
	Estate Developers	8.0	17
	Factory Managers	2.0	4.3
	Total	**47.0**	**100**
Years of Experience in Housing Delivery	<5	9.0	19.1
	5-10	25.0	53.2
	11-15	7.0	14.9
	16 - 20	2.0	4.3
	21-25	3.0	6.4
	Above 26	1.0	2.1
	Total	**47.0**	**100**
Educational Qualification	H.N.D.	5.0	10.6
	B.Sc./B.Eng.	24.0	51.1
	M.Sc.	17.0	36.2
	PhD	1.0	2.1
	Total	**47.0**	**100**

The responses in Table 1 shows that majority of the participants in the housing supply chain were design professionals having 38.3% while component manufacturers are the least with 2.1%. The result further showed that 53.2% of respondents in the housing supply chain have between 5-10 years' experience while only 2.1% of the respondents have above 26 years' experience in housing construction. The results reveal that majority of respondents are experienced hands in the housing supply chain. The results further reveal that majority of the respondents are academically trained with 51.1% of the respondents possessing B. Sc./B.Eng. as their highest academic qualifications while 2.1 % of the respondents has PhD.

4.2 ADOPTION OF OFFSITE CONSTRUCTION IN HOUSING PROJECTS

The Extent to which Offsite construction was adopted in Housing Construction in the FCT, Abuja is presented below in Table 2.

Table 2: Adoption of Offsite Construction in Housing Projects

Item	Characteristic	Freq.	%
Type of Construction	Onsite alone	10.0	50.0
	Offsite alone	1.0	5.0
	Combination	9.0	45.0
	Total	**20.0**	**100**
Most Preferred Method of offsite Construction Adopted	Volumetric	3.0	15.0
	Hybrid	2.0	10.0
	Panelised	3.0	15.0
	Component	10.0	50.0
	Modular	2.0	10.0
	Total	**20.0**	**100**
Location Predominantly Used	Walling/Panels	4.0	20.0
	Fence	3.0	15.0
	Floor structures	2.0	10.0
	Roof Cornice	6.0	30.0
	Foundation /Pile	1.0	5.0
	Inspection Chambers	4.0	20.0
	Total	**20.0**	**100**

Table 2 shows that 50% of the housing supply chain participants adopted onsite construction only in constructing housing projects while 5% of the housing supply chain adopted offsite construction means only in the FCT. The results further revealed that the component method is the most preferred type of construction used by participants in the housing supply chain in the F.C.T. Abuja while the modular process and the hybrid type were the least adopted method. The result also revealed that the construction of Roof cornices is the leading element where offsite construction is adopted with 30%, while only 5% use offsite construction to install foundations. The results revealed quite a paradox owing to the fact that 50% of the same respondents who signified onsite construction also indicated one or more locations where offsite construction is applied in constructing their housing projects; it thereby suffices to say that not all supply chain participants understand fully the application of offsite construction in Construction as majority of construction sites in Abuja implement offsite Construction to certain levels.

4.3 LEVELS IN ADOPTING OFFSITE CONSTRUCTION IN HOUSING PROJECTS

Table 3 presented below shows the levels of adoption of Offsite Construction Method in housing projects in the FCT, Abuja.

Table 3: Levels in the adoption of Offsite Construction in Housing Projects

Items	Very Often	Often	Sometimes	Rarely	Never	Sum	MIS	Rank
Fencing	4	10	12	16	5	133	2.8	9th
Column Cast	7	15	11	10	4	152	3.2	7th
Ceiling Finish	13	9	8	11	6	153	3.3	6th
Beams	4	8	20	11	4	138	2.9	8th
Roof Cornice	14	12	13	7	1	172	3.7	4th
Lintels	9	12	16	10	0	161	3.4	5th
Windows	24	15	4	3	1	199	4.2	1st
Wall Panels	5	5	16	14	7	128	2.7	10th
Doors	20	13	6	5	3	183	3.9	3rd
Cabinets	24	9	7	3	4	187	4.0	2nd

MIS: Mean Item Score

The responses of the housing supply chain in Tables 3 reveals that windows and cabinets have the highest levels of adoption in the construction housing projects ranking first and second with Mean item score of 4.2 and 4.0 respectively. Furthermore, wall panels with a Mean item score of 2.7 ranking 10th with the lowest levels of adoption. These unanimous response implies that majority of the participants in the housing supply chains readily adopt offsite fabrication in the producing windows and cabinets that can provide a fertile atmosphere for innovations in windows and cabinets production to be sustained.

4.4 Dynamics in Adopting Offsite Construction in Housing Projects

The forces that interplay in the adoption of offsite construction in Housing Projects in the Federal Capital Territory Abuja is presented in Table 4.

Table 4: Dynamics in Adopting Offsite Construction in Housing Projects

Items	N. S	L.S	M.S	S	V.S.	Sum	MIS	Decision
Raw Materials Availability	1	3	8	16	19	135	4.0	S
Capacity Limitations (Production)	2	5	11	20	9	124	3.6	S
Housing Demand Pattern	3	7	10	19	8	115	3.5	S
Location & Distance to the Factory	1	3	11	16	16	126	3.9	S
Availability of Specialized Labour	1	0	10	21	15	138	4.0	S
Compatibility with other Components	1	2	13	17	14	134	3.9	S
Haulage Weight of Components	5	4	8	21	9	124	3.5	S
Housing Demand Management	4	7	12	17	7	111	3.3	M.S.
Onsite Energy Demands	3	6	8	19	11	129	3.6	S
Environmental Impact	2	7	11	18	9	122	3.5	S
Acceptability of Standards & Specification	1	6	9	15	16	133	3.8	S
Thermal Requirements	4	9	12	16	6	105	3.2	M.S.
Aesthetic Requirement	3	8	9	17	10	116	3.5	S
Noise and Sound Requirements	3	10	15	16	3	102	3.1	M.S.
Onsite Handling constraints	1	7	10	16	13	128	3.7	S
Availability of Onsite Storage systems	4	6	8	16	13	133	3.6	S
Erection Time Constraints	0	6	13	17	11	123	3.7	S
Weather Pattern	4	4	15	17	7	116	3.4	M.S..
Supplier Relationship Management	2	9	8	21	7	118	3.5	S
Information Management systems	3	6	13	17	8	121	3.4	M.S..

V.S.=Very Significant; S.=Significant; M.S.=Moderately Significant; L.S.=Less Significant; N. S.=Not Significant

The responses of supply chain participants in Table 4 reveals that the availability of raw materials in offsite production and the availability of trained or skilled labour have the highest significance level with the Mean item scores (MIS) of 4.0 respectively; these results indicate that there is the need to manage more effectively supply chain disruptions as a result of raw material availability as well as specialised labour in adopting offsite construction. Thermal requirements, noise and sound requirements had the lowest significance level with mean item scores of 3.2 and 3.1 respectively indicating less influence in adopting offsite construction by members of the supply chain. Raw material availability as well as availability of specialised labour are critical in the success of adopting improved levels of offsite construction and can contribute to the performance of the construction industry.

5 CONCLUSION

The applications of offsite construction in housing are limitless; this however depends on how receptive housing supply chains are to innovations. Supply chains can at any point be disrupted therefore a sustainable approach to housing delivery requires managing our supply chains.

The level of the adoption of offsite construction varied in applications. The dynamics in fabrication and assembling of building components and elements can at any point disrupt the housing supply chain and directly affect the performance of the construction industry. It is only when supply chain efforts are organised that innovations implemented can be sustained.

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