*Kufa Journal of Engineering*
*Vol. 13, No. 4, October 2022, P.P. 25-38*
*Article history: Received date: 2 July 2022, accepted date: 13 October 2022*

# PRIVATE DEVELOPERS' PERCEIVED USEFULNESS OF THE PREFABRICATION TECHNOLOGY IN NIGERIA'S HOUSING DEVELOPMENT INDUSTRY

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**HTTPS://DOI.ORG/10.30572/2018/KJE/130403**

## ABSTRACT

Private developers in Nigeria's housing development industry still face challenges of increasing housing stock, with a current housing deficit of 20 million units. Prefabrication, a known, yet unpopular housing construction method, has witnessed low usage. The effect of system characteristics on user acceptance of prefabrication technology is examined through the Perceived Usefulness (PU), of prefabrication system amongst private developers in the Nigerian housing development. The paper draws on the technology acceptance model (TAM) as the basis for investigation. A quantitative research approach and convenient sampling technique to select 400 private developers- members of the Real Estate Developers Association of Nigeria (REDAN) in Lagos and Abuja. Data obtained were analyzed using descriptive analysis and Freidman's ANOVA test. Findings showed that prefabrication amongst private developers in Nigeria is perceived as being highly useful for increasing housing stock. PU increases the degree of positivity toward usage, which subsequently triggers the intention to adopt.

**KEYWORDS:** Housing, Perceived Usefulness, Prefabrication, Private Developers, Technology Acceptance Model.

## 1. INTRODUCTION

Prefabrication technology acceptance and use is an issue that has received the attention of researchers and practitioners since the industrial revolution till current date. This is because Prefabrication technology usage has risen beyond its conventional role of operational support and now plays a central role in formulating operational strategies in the housing development industry. Successful investment in technology can lead to enhanced productivity, while failed systems can lead to undesirable consequences such as financial losses, unavailability of product and dissatisfaction among end users. Despite significant technological advances and increasing organizational investment in these technologies, the problems of underutilized systems plague any form operations (Moore, 1991). Also, though prefabricated construction technology has attracted considerable attention worldwide because of its significant role in the global fight against COVID-19, market-driven adoption is still limited. Since technology that is not used cannot be effective, no matter their technical merits, it is important to understand how people decide whether they will use a particular prefabrication technology. The issues that influence this decision are likely to vary with the technology, the individual and the context.

The acceptance of technologies like prefabrication has not been frequently investigated in the recent times, and has little or no seminal literature or studies with regards to Nigerian context. Issues related to technology, including diffusion, acceptance, adoption and adaption, have been the focus of research for different disciplines like Information Systems (IS) but rarely within the construction industry where change is reluctantly embraced. Knowing what motivates individuals to use any technology in an organizations or process is key to increasing its usage. Although it is acknowledged that prefabrication bring benefits for stakeholders in the housing development sector, there is still some resistance in using them as a construction process.

The construction industry has not been known to embrace technological change quickly. However, with outside factors such as skilled labor shortage, tight schedules and budget overruns impacting the industry today and housing supply shortage caused by huge urbanization rate, change is inevitable (Adebayo & Dixon-Ogbechi, 2017). Changes like transiting from conventional methods of construction to alternative innovative methods like the prefabrication technology has been highly accepted globally, though in developing countries like Nigeria, the prefabrication system has not made notable impact in the housing development industry. Despite the increasing development of prefabrication as a sustainable alternative approach to conventional construction methods, and its advantages such as improved construction speed, labor productivity, and lower waste of resources, in some countries, most

concrete buildings are still built using traditional methods (Katebi, Homami, and Najmeddin 2022). For instance, though the Nigerian housing development industry considers prefabrication technology a vital necessity in current housing delivery operations, the under-utilization of the prefabrication technology leaves the Nigerian housing development industry with a low value output. Therefore, studying the factors that influence private developers within the Nigerian housing development industry to actually use the prefabrication system, serves as a measure of acceptance. The study will help both the policy makers and users gain a better understanding of the key factors driving the diffusion of prefabrication technologies. Over time such experiences could contribute towards improving the design of policies aimed at fostering the adoption, acceptance and usage of the prefabrication technology. The study might be a basis for further research studies by subsequent researchers. Technology Acceptance through usage helps organizations to optimize benefits of acquiring new prefabrication technologies. Therefore, prefabrication technology implementing organizations should consider factors that lead to technology acceptance in the local environment before acquiring it.

## 2. PREFABRICATION SYSTEM IN NIGERIAS HOUSING DEVELOPMENT INDUSTRY

Nigeria is one of the most developed countries in Africa, with construction contributing to approximately 9% of its Gross Domestic Product. From a housing perspective, new initiatives are now being explored, one of which is prefabrication (Kolo, Pour -Rahimian and Goulding, 2014). Housing development projects in Nigeria has become spontaneous and haphazard, especially amongst private developers. This however is in response to the increase in urbanization, being one of the fastest growing countries in Africa, and the increasing gap between housing demand and supply where current housing deficit is over 17million units. One of the factors responsible for the huge housing deficit in Nigeria is that houses are not being delivered fast enough in tandem with population growth, especially in major cities like Lagos and Abuja (Kolawole, 2015).Hence, the search for an efficient method of construction leads to the subject of prefabrication; an attempt to explore it as an alternative method of construction. In the context of Nigeria, there is shortfall in housing in terms of quantity and quality (Kabir and Bustani, 2009) and there are suggestions from construction experts that housing can be improved by adopting the prefabrication system (Oloto, 2021). Prefabrication construction is quite new to the Nigerian housing industry as about 90% of the industry still uses the conventional mortar and block method (Ashkin, 2013). The use of prefabrication in Nigeria has

also been affected by factors like: high capital costs, few factories for production of components, reliance on expatriate skills, negative perception etc. (Opara, 2011).

Gibb (2001) presents four (4) categories of prefabrication, based on increasing amounts of pre-assembly. They are, component manufacture and sub-assembly, non-volumetric pre-assembly, volumetric pre-assembly and modular building. In the Nigerian housing development industry, prefabrication is predominantly used at the sub-assembly and non-volumetric pre-assembly category. However, there are sporadic cases of prefabrication application adopting the modular building category. This form of prefabrication is mostly expressed using ISO standard shipping containers. Another building method is what is called the Hybrid category, which is the integration between the non-volumetric pre-assembly (e.g. precast concrete) and the conventional method of construction (mortar and concrete blocks). However, the hybrid category is challenged as not being prefabricated enough to be categorized as such. Schoenborn (2012), argues that a building is classified as a prefabricated structure, when the prefabricated components making up the structure, are more than 50% of the total building value and vice versa. There are several companies in the Nigerian housing development industry that engage in prefabrication application, though this application needs increased visibility, due to the insignificant scale of adoption, the efforts being plowed into ensuring its growing popularity is highly commendable. Table 1 shows some private developer housing firms and the type of prefabrication commonly adopted for construction. Despite the advantage of prefabrication, it still meets many barriers for adoption. The top three barriers in the industry are attachment to traditional system of construction, site specifics, constraints and transportation and the nature of Nigeria planning system respectively. A comparison by Tempohouisng Nigeria between the conventional and pre-fabrication buildings, shows that prefabrication is more cost effective compared to the conventional construction method, due to economies of scale derived from bulk purchase, mass production and standardization.

**Table 1. Private developer firms and prefabrication category adopted**

| S/No | Name of Private Developing Firm | Prefabrication Category |
|---|---|---|
| 1 | HFP Engineering (Nigeria) Limited | Component manufacture and Sub-assembly, Non-volumetric pre-assembly, Hybrid (precast concrete panels) |
| 2 | Karmod Nigeria Limited | Component manufacture and Sub-assembly, Non-volumetric pre-assembly (steel, precast concrete panels) |
| 3 | Temphousing Nigeria (THN) | Component manufacture and Sub-assembly Modular building (ISO standard shipping containers) |
| 4 | Nigerite Limited | Component manufacture and Sub-assembly, Non-volumetric pre-assembly (steel, cladding wall panels) |

## 3. CONCEPTUAL FRAMEWORK

The theoretical basis of this study stems from the Technology Acceptance Model, (TAM) by Davis (1991). The tool of study postulates that individuals may be motivated to use an information system, in this case a technology system, because of the intrinsic rewards derived, like perceived usefulness, perceived ease of use and attitude towards using the system. Davis (1991) assumes that a user's perceived ease of use towards the system can contribute to improving a person's performance. Due to the fact that the user will have to deploy less effort with a tool that is easy to use, he will be able to spare efforts to accomplish other tasks. Davis (1991) also assumes that with perceived usefulness the quality of work and productivity will increase, because the system should help the user perform better. Both perceived usefulness and perceived ease of use predict attitude towards using a system, defined as the user's desirability of his or her using the system (Bugembe, 2003). Bugembe (2003) states that a user's overall attitude towards using the given system is hypothesized to be a major determinant of whether or not he actually uses it. Attitude and perceived usefulness influence the individual to actually use the system.

The acceptance of new technologies has long been an area of inquiry, especially in the construction industry. User technology acceptance is a critical factor for prefabrication adoption and many studies have predicted this using the technology acceptance model. Davis (1989) came up with a model that explains the effects of system characteristics on user acceptance of computer- based Information Systems, which was adopted by researchers in other fields. The model referred to as the Technology Acceptance Mode (TAM) is an information systems model that shows how users come to accept and use a technology. The model suggests that when users

are presented with a new technology, a number of factors influence their decision about how and when they will use it, notably: Perceived usefulness (PU) and Perceived ease of use (PEOU) and their attitudes towards the use of the system. The technology acceptance model (TAM) developed by Davis et al., (1989) is one of the most widely used and influential models in the field of information systems, technology and services. It has been validated to be powerful as a framework to predict user acceptance of new technology. The goal of TAM is to predict information system, technology or services acceptance and diagnose design problems before users have any significant experience with the system. TAM has been widely utilized by several researchers in various fields, including the construction industry, to understand the factors that determine technology acceptance and usage (Majid et al. 2011; Gao et al., 2013; Anakwe et al., 2000). The variable perceived usefulness is adapted for use in this study. Understanding why individuals, in this case private developers, accept or reject the prefabrication technology has proven to be one of the most challenging issues in prefabrication technology research. User acceptance of prefabrication technology- a phenomenon which is not yet well understood and usage are unquestionably crucial factors in the ultimate determination of the prefabrication technology success, since prefabrication technologies that are not used are of little value.

## 4. PERCEIVED USEFULNESS

According to TAM, the perceived usefulness indicates the extent to which an individual comprehends the improvement gained in performance and efficiency due to the use of specific technology (Davis, 1989). Perceived usefulness is the consumers' perceptions regarding the outcome of an experience (Davis, Bagozzi, and Warshaw, 1992). A system high in perceived usefulness, is one for which a user believes in the existence of a positive use-performance relationship. People tend to use or not to use a system application to the extent they believe it will help them perform their job better (Davis, Bagozzi, and Warshaw, 1989). Usefulness can also be defined as the prospective adopter's subjective probability that applying the new technology from foreign sources would improve the way a user could complete a given task (Bugembe, 2003). Perceived usefulness explains the user's perception to the extent that the technology will improve the user's workplace performance (Davis et al., 1989). This means that the user has a perception of how useful the technology is in performing his job tasks. This includes decreasing the time for doing the job, more efficiency and accuracy (Bugembe, 2003).

## 5. METHODOLOGY

Adopting a quantitative research approach using a convenient sampling technique for selection, the study adopted a cross sectional survey design. This was because data and information

derived from it could be obtained at a particular point in time and was gathered once. It was based on survey of Real Estate Developers Association of Nigeria (REDAN) members.

The study population comprised 2000 REDAN members as of the time of data collection and research study. These individuals were particularly selected because they represented the formal private developers in the Nigerian housing development industry, were literate to understand the study instrument and most had used or were aware of prefabrication technology at a certain time. The total numbers of members in REDAN is well over 2000 (www.redanonline.org.ng), however the population of interest (sample frame), were narrowed down to Lagos state and the Federal Capital Territory, Abuja. Based on the information provided by REDAN, there were 446 private developer organizations as of the time data was provided, registered and operating in Lagos, while 650 members operated in Abuja. Therefore, a total of 1096 private developer organization were determined as the sample frame, which represented the study scope. Registered members of REDAN in Lagos and Abuja alone made up 55% of the total members of the association. The study sample size was 388 members from REDAN. This sample was used based on Cochran formula (*95% confidence level and 0.04 acceptable error margins). The convenient sampling technique was used to obtain a sample size of 400 private developers from a population of 1096 members, as seen in Table 2.

**Table 2. Summary of study population and characteristics**

| S/No | | Source | Target number |
|---|---|---|---|
| 1 | Target population | REDAN members (Nationwide) | 2000 |
| 2 | Accessible population | REDAN Lagos | 446 |
| 3 | Accessible population | REDAN Abuja | 650 |
| 4 | Accessible population (Total) | REDAN (Lagos & Abuja) 55% of REDAN members | 1096 |
| 5 | Sample Size | Cochran formula *95% confidence level and 0.04 acceptable error margins | 388 |

Validated scales from previous research were used to measure the variable. Perceived usefulness was measured using the five point Likert rating scale, ten-item scales were used to measure for perceived usefulness. The primary sources of data that were used were questionnaires. The questionnaires were semi-structured comprising of pre-determined and logically related questions, both open ended and closed questions. The secondary sources of data were internet sources journals, text books and documents written on the subject. These methods were used because they were more efficient in terms of times and costs, they were

easy to use and administer. Also the questionnaire could be generalized. The survey was specifically designed for dissemination and access through internet and self-administered technique. The technique used to distribute the questionnaire was a non-probability sampling technique which included a combination of convenient sampling techniques. Primary data was collected from 402 respondents.

## 6. RESULTS AND DISCUSSIONS

Validity which determines whether the research fully measures to that which is intended to measure was done and the instruments were rated relevant. The reliability test was done by performing Cronbach's Alpha tests (1946). The Cronbach reliability test was found to be satisfactory since the result (0.758) was above the required rule of thumb value 0.6 (Sekaran, 2000). This meant that the scales used to measure the variables were consistent and reliable. Data from questionnaires was analyzed using SPSS (Statistical Package for Social Scientists) computer package. Analysis of variance (ANOVA) to establish the difference across the variables under the study was also measured and results shows that the Cronbach alpha value for the administered seven questions (items) of the survey instrument as shown in Table 3 is 0.758 which is very acceptable. Since the Cronbach alpha value also measures the inter-correlations and the construct that is measured are the same, then the inter-correlation measurements for the construct which is to evaluate the perceived attribute of prefabrication method of construction is 0.758 which means that these items portrays a strong inter-correlation for perceived usefulness.

To achieve studies objectives, questions were also generated to ascertain the perceived usefulness (PU) of prefabrication, framed from the Technology Acceptance Model (TAM). Table 4 shows that a majority of the respondents all agreed that prefabrication is useful and a relevant method of housing construction that could improve productivity, enhance effectiveness, accomplish tasks faster, and improve quality of work. Two questions had equal values in the highest mean rank. These were, "Technology innovations like prefabrication may enable me to accomplish tasks more quickly" (4.26) and "Technology innovations like prefabrication may improve my quality of work." (4.26) respectively, while the question with the least mean rank score was "I can recover from mistakes quickly and easily from technology innovations like prefabrication" (3.45). The post hoc test supports this with a p-value less than 0.017.

**Table 3. Reliability statistics for perceived usefulness**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| 0.758 | 0.767 | 7 |

**Table 4. Mean rank distribution for perceived usefulness (PU)**

| Variables | Mean | Std. Deviation | Mean Rank | MIS |
|---|---|---|---|---|
| Technology innovations like prefabrication may enable me to accomplish tasks more quickly | 3.89 | .757 | 4.26 | 1st |
| Technology innovations like prefabrication may improve my quality of work. | 3.86 | .741 | 4.26 | 2nd |
| Technology innovations like prefabrication can improve housing productivity. | 3.90 | .646 | 4.22 | 3rd |
| Technology innovations like prefabrication make it easier for housing production. | 3.86 | .793 | 4.17 | 4th |
| Technology innovations like prefabrication can give greater control over the building process. | 3.84 | .733 | 4.02 | 5th |
| Technology innovations like prefabrication enhance effectiveness on the construction site. | 3.65 | .820 | 3.63 | 6th |
| I can recover from mistakes quickly and easily from technology innovations like prefabrication | 3.50 | .880 | 3.45 | 7th |

**Table 5. ANOVA with Friedman's test for perceived usefulness (PU)**

| | | Sum of Squares | df | Mean Square | Friedman's Chi-Square | Sig |
|---|---|---|---|---|---|---|
| Between People | | 555.464 | 328 | 1.693 | | |
| Within People | Between Items | 45.306[a] | 6 | 7.551 | 104.899 | .000 |
| | Residual | 807.265 | 1968 | .410 | | |
| | Total | 852.571 | 1974 | .432 | | |
| Total | | 1408.036 | 2302 | .612 | | |
| **Grand Mean** = 3.79 | | | | | | |

Table 5 shows results of the Friedman's ANOVA. It is seen that there was a statistical significant difference in the perceived usefulness based on this study with a p-value of 0.000 and at $\alpha = 0.05$. Also, the grand mean is above 3.0 which implies that majority of the respondents who chose from the Likert scale agree, while others were spreads from indifferent to strongly agree with a very little response in the strongly disagree and disagree. This is illustrated in Fig 1.

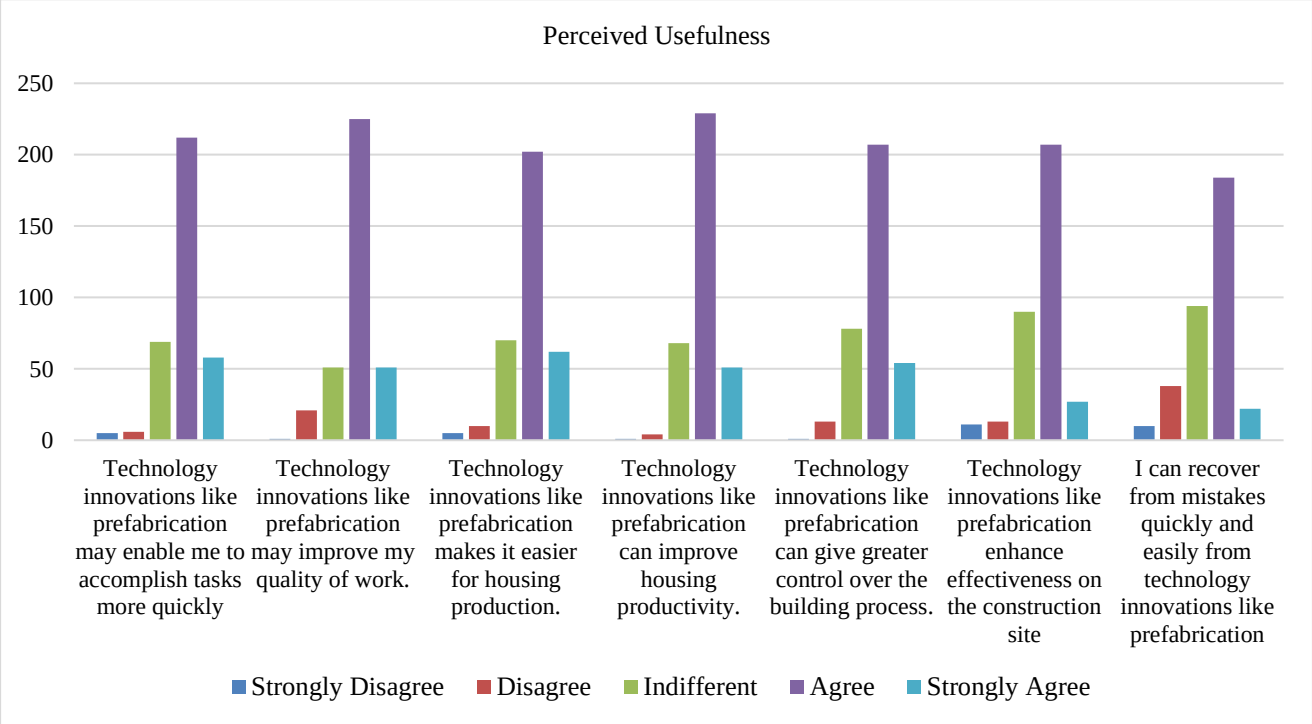


**Fig. 1. Perceived usefulness of prefabrication amongst the private developer.**

The average results from all seven (7) questions administered to identify the PU of prefabrication, showed that a majority of the respondents(>70%) all agreed that prefabrication is useful and a relevant method of housing construction that could improve productivity, enhance effectiveness, accomplish tasks faster, and improve quality of work. One could conclusively state that prefabrication amongst private developers in Nigeria is perceived as being highly useful and relevant for curbing the current housing crisis in the Nigerian housing industry. The top three responses with the highest mean rank are: accomplish task quickly (4.26); improve my quality of work (4.26); improve housing productivity (4.22). Perceived usefulness (PU) increases the degree of positivity toward usage, which subsequently triggers the intention to adopt (Rogers, 1983). With the right structure and mechanism in place,

prefabrication adoption will surely witness a heralding moment amongst private developers and all housing construction stakeholders.

## 7. CONCLUSION

Prefabrication construction could be a ground-breaking movement, unfortunately, within the Nigerian context, and amongst private developers, though they are very aware of the existence of the technology and its benefits, how best a user perceives its relevance to his/her performance output directly affect the technologies usage. The study presented examined perceived usefulness without investigating its relationship with perceived ease of use, attitude towards using the system and actual usage amongst REDAN members who are private developers. All relationships with other variables within TAM are not within the scope of this study, but rater investigated and analyzed in further studies. Many designers believe that the key barrier to user acceptance is the lack of user friendliness of current systems, and that adding user interfaces that increase usability is the key to success (Branscomb & Thomas, 1985). The present results indicate that the usefulness of a system is very important, and should not be overlooked. Users may be willing to tolerate a difficult interface in order to access functionality that helps them increase productivity, in this case increased housing supply, while no amount of ease of use can compensate for a system that does not do a useful task. Conclusion can therefore be made that factors that motivate individual users in different societies to accept technology should be co35nducted prior to introducing the technology. These studies could enable organizations to determine the factors that are likely to lead to high outcomes rather than simply copying what has worked elsewhere; due to the differences in settings and perceptions.

The findings of the study posit that perceived usefulness was found to be important and relevant in influencing technology acceptance amongst private developers. Therefore, the enhancement of perceived usefulness through additions of new functional capabilities to prefabrication technology, or by making it easier to invoke the functions which already exist, is highly essential. The findings of this study also revealed that factors that motivate individual users in different societies to accept technology should be conducted prior to introducing a new technology that is to say, training of staff, the benefits of new technology, technology simplified users manuals, trial usage, persuasion for usefulness, and so on, rather than simply copying what has worked elsewhere. The study recommends that top management in each private development organizations should understand what the technology does and should not only be left to the technical staff and the actual users. Therefore, organizations should allow end users to participate in the decisions to adopt new prefabricated technologies. This increases the

likelihood that the chosen technology fits the pre-existing values. Developers should continuously enhance usefulness and user-friendliness of a system to facilitate its adoption. A particularly noteworthy finding is that external isomorphic pressures, including normative, coercive, mimetic, or a combination thereof, can affect users' attitudes toward a smart construction system, and, in turn, influence the uptake of the system (Liu, Lu and Niu, 2018). REDAN should also foster a higher level of commitment of end users by educating them about the need and relevance of the chosen prefabrication technology for individual and organizational performance. They should be a fit between the task, job and appropriate technology. That is to say, the technology to be utilized should be able to resolve the expected bottlenecks for which it is acquired. This is because technology is accepted and utilized because of its usefulness to the job or task being performed (Bugembe, 2010). This paper to the best of the authors' knowledge, is the first attempt to explore industry perceptions toward prefabrication technology adoption in the Nigerian housing development industry, drawn on the TAM model, providing valuable data and strategies for the effective increase in prefabrication usage and laying a reliable foundation for research on other construction innovation adoption with the context of the Nigerian housing development industry context.

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