THE USE OF LOCAL BUILDING MATERIALS IN OFFSITE PREFABRICATION FOR LOW COST HOUSE BUILDING IN NIGERIA

Zaharaddeen Al-kaleel Ahamad

School of the Built Environment, Faculty of Technology, Design and Environment

OXFORD BROOKES UNIVERSITY

A thesis submitted in partial fulfilment of the requirements of Oxford Brookes University for the award of Doctor of Philosophy

JUNE 2016

ABSTRACT

Urbanization and population growth has prompted high demand for housing in Nigeria, with the current housing deficit standing at about 17 million units. There were several housing delivery attempts in the form of mostly mass housing using traditional methods of construction and through the creation of housing policies to tackle the housing problems in the country. Despite the efforts made, the housing situation in Nigeria remains a major problem.

Nigeria is endowed with abundant local building materials (such as timber, bamboo, clay, sand and granite stones). Countries such as; Sweden, Finland and Norway use similar local building materials like the ones in Nigeria to provide affordable prefabricated houses. Prefabrication techniques using local building materials offer many benefits such as; speed, time savings and affordability. Therefore, there is a need to develop a better understanding to ascertain why local building materials are not being used to improve prefabricated components for house building to meet affordable (low cost) housing needs in Nigeria. This research aims to develop a framework that facilitates the understanding of the utilization of local building materials in the production of offsite prefabricated components for low-cost house building in Nigeria through the formal building sector. A theoretical framework on innovation diffusion has been developed to underpin this study.

Based on a pragmatic ontological perspective both qualitative and quantitative approaches were utilized in order to get a better understanding of the factors that affect the utilization and diffusion of prefabrication construction techniques using local building materials for low cost house building. The research findings reveal factors such as; lack of awareness of prefabrication techniques, lack of policy, corruption, lack of access to prefabricated component, cost of components, standard and quality and lack of training and promotion to be among the reasons for the limited adoption of prefabricated local building materials in Nigeria. These findings will help in the development of a framework that will possibly inform policy and assist in the utilization and diffusion of prefabricated local building materials for low cost house building in Nigeria. This research suggests future investigation on infrastructural impact on prefabricated house building and sustainability comparison between prefabricated and traditional methods of construction of identical house buildings.

ACKNOWLEDGEMENT

In the name of Allah, Most Gracious, Most Merciful. Praise be to God, Lord of the universe.

I would like to thank my father Alkaleel Ahamad and my mother Hajiya Heendu Alkaleel Ahamad for supporting me financially and encouraging me to further my education up to a PhD level. Their sacrifices, faithfulness and support will never be forgotten.

Special Thanks to my supervisors, Professor Joseph Tah and Professor Ramin Keivani for their patience, commitment, guidance and mentoring through out this research. I am and will always be grateful for the experience and knowledge I have acquired. May God bless both of you for offering me words of encouragement and pushing me to work hard towards the completion of this research.

Sincere thanks to my siblings (Rasheedat, Bilyameen, Alqadeem, Laila, Muhammad, Kaleela and Suraiya) who have all supported and encouraged me in many ways through out the course of this research.

I would like to thank my wife Sadeeya MC Tahir for her prayers, support and most importantly patience during the course of my research.

Finally, I would like to thank my friend whom I regard as a brother, Alhaji Muhammad Kabir who has assisted in many ways to enable the completion of this thesis.

DEDICATION

I dedicated this thesis to some of the most important people in my life. They include; my father, Al-kaleel Ahamad, my mother Hajiya Heendu A Ahamad, my late grand father Alhaji Yahya Ahamad, my late grand father His Royal Highness Dr Aliyu Mustapha, my grand mothers Hajiya Ameenatu AK Sambo and Hajiya Zubainatu Aliyu Mustapha. I hope I make you all proud. I love you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ANT	Actor Network Theory
CEO	Chief Executive Officer
CIDB	Construction Industry Development Board
COREN	Council for the Regulation of Engineering in Nigeria
DETI	Department of Enterprise Trade and Investment
DOI	Diffusion of Innovation
EPS	Expanded Polystyrene System
FCT	Federal Capital Territory
FGN	Federal Government of Nigeria
FHA	Federal Housing Authority
FMLHUD	Federal Ministry of Land Housing and Urban Development
GDP	Gross Domestic Product
GRA's	Government Reservation Areas
IBM	Imported Building Materials
IBS	Industrialized Building System
LBM	Local Building Materials
MBI	Modular Building Institute
MBS	Miller Building System
MBSA	Modular Building Systems Association
MMC	Modern Methods of Construction
MTN	Multi-Choice Network
NAO	National Audit Office
NBS	National Building Scheme
NBRRI	Nigerian Building Road and Research Institute
NCEH	National Centre for Excellence in Housing
NDP	National Development Plan
NEEDS	National Economic and Empowerment Development Strategy
NIA	Nigeria's Institute of Architect
NIOB	Nigeria Institute of Builders
NIQS	Nigeria Institute of Quantity Surveyors
NRP	National Rolling Plan
NIS	Nigerian Standard
OPC	Ordinary Portland Cement
OSC	Offsite Construction
OSM	Offsite Manufacturing
OSP	Offsite Production
PPP	Public Private Partnership
R&D	Research and Development
RHA	Rice Husk Ash
SCOT	Social Construction of Technology
SIB	Solid Interlocking Blocks
SME	Small and Medium Enterprises
SPSS	Statistical Package for Social Sciences
UN	Unite Nations
UN Habitat	United Nations Habitat

CHAPTER ONE

INTRODUCTION

1.1 Rationale

Shelter is among the most important basic human needs and it has been recognized among the most vital necessities of human life (Ademiluyi, 2010; Jiboye, 2009; Udechukwu, 2008; Bayode, 2008; Adejumo, 2008; Andrew, 2007; Akinmoladun and Oluwale, 2007; Oladapo, 2006; Olayiwola *et al*., 2005). The effectiveness of any form of individual activity largely depends on the provision of efficient infrastructural facilities (Gabriel and Abraham, 2009). Jiboye (2010c) stated that "*housing could be seen as a multi dimensional parcel of goods and services expanding beyond shelter it self*". Therefore, its significance cannot be ignored. As a result of its importance, the problems of housing have received a great deal of attention internationally. According to Aderamo and Ayobolu (2010), the United Nations has set up the 1st Monday of October every year as the world habitat day to prove how important a shelter is to the world. This further emphasizes how important it is for every government to make sure they provide adequate housing for their citizens.

The problem of housing provision in the developing countries is mostly severe in the urban regions due to the high urbanization rate and population growth. According to the United Nations (2014), about 54% of the world population is now in urban areas. Mutizwa-mangiza (2012) stated that, more than 60% of the world population will live in urban areas by 2030. According to Opoko and Oluwatayo (2014), the world urban population is expected to increase to about 6.3 billion (72% of world population) by 2050. About 3.9 billion people currently live in the urban areas (United Nations, 2014). According to Omatson and Dimuna (2010), the increasing trend of urbanization is more felt in Asia, Africa and Latin America. As a result of the increasing urbanization, the world summit on sustainable development has called on every government to tackle the increasing challenge of urbanization by providing adequate houses and urban infrastructures to the urban dwellers (Daramola and Ibem, 2010).

Nigeria is among the countries experiencing rapid urbanization. The national population commission puts Nigerian urbanization rate at 40% in 1996 and 48,2% in 2005 (Olayiwola and Adedokun, 2014). More than half of the Nigerian populace will be living in urban areas in the next five years (Daramola and Ibem, 2010). Daramola and Ibem further noted that there would be a further increase in the population and urban growth in the country. According to Nwaka (2005a), the urbanization rate in Nigeria may perhaps reach 65% to 70% of its total population by year 2020. The urban growth has occurred mostly as a result of rural-urban migration in Nigeria (Festus and Amos, 2014; Kalu *et al*., 2014; Olotuah, 2002). The urbanization growth rate at some Nigerian cities is at a state known as mega cities (with population of more than 10 million) (Ekpeni, 2010). According to Ekpeni (2010) Ibadan, Maiduguri, Kano, Port Harcourt, Kaduna and Benin are all among the cities that are in verge of becoming a mega city in Nigeria and Lagos have been classified as a mega city. According to Raji (2008), the issue of social, economic and environmental challenges must be addressed because the rural dwellers that moved to the cities have already considered the urban areas as their homes.

The rate at which the Nigerian population is growing is faster than the infrastructure and housing provision rate in the country (Marshal and Onyekachi, 2014; Omatson and Dimuna, 2010; Oyewole, 2010). Daramola and Ibem (2010) argue that, there is no balance between the population growth and infrastructural provision in the country, which has affected the urban areas carrying capacity and increased the poor state of living in the urban parts of the country. Therefore, the rapid rate of urbanization has generated pressure towards a higher demand for affordable low cost housing in the urban parts of Nigeria (Femi and Khan, 2014; Oyewole, 2010; Olotuah and Ajayi, 2008). The houses for sale in the Nigerian market are very expensive (Nubi, 2008). Whereas, the housing need is remarkably increasing (Olotuah, 2006). Housing problems are usually recognized as being diverse and complicated (Oyewola *et al*., 2005). Housing problems are of different types and degree depending on the technological and socio-economic development of the society (Olotuah and Ajayi, 2008). The housing problems in Nigeria are both in quantitative and qualitative form (Olayiwola and Adedokun, 2014). There have been rapidly deteriorating houses in the country as well as housing shortage (Olayiwola *et al*., 2005; Olotuah, 2002). This has intensified Nigeria's housing problems into a more appalling state. Olujimi (2009) stated that, Nigeria needs at least 8 million houses by the year 2015 to reduce the housing shortage in the country. The efforts made to improve the housing paucity have failed because housing deficit still stands at over 17 million units and at least N60trillion naira (£20billion or $30billion) is needed for the provision of 17million housing units at N3.5million per unit (Marshal and Onyekachi, 2014; FMLHUD, 2012; Adeloye, 2011; Gabriel and Abraham, 2009). Ademiluyi (2010), puts the housing stock at 23 per 1000 inhabitants and housing production rate at 3 per 1000 population per annum as against the 8-10 per annum recommended by the United Nations. According to Ademiluyi and Raji (2008) the shortage and deteriorating housing problems in the country affect both owner occupied and rental houses and affect almost all the various economic classes (low, medium and high income earners) in the country.

The delivery of adequate and affordable housing in Nigeria still remains among the most persistent challenges the country faces (Jiboye, 2010a). Several attempts were made to bolster and ameliorate the housing problems in the country but the situation still remains intractable (Jiboye, 2010a). The lack of adequate housing in Nigeria is becoming more appalling especially within the lower income earners who amount to almost 75% of the countries population (Marshal and Onyekachi, 2014; Nwaka, 2005a; FRN, 1991). Therefore, there is an urgent need to find a solution to the on-going problems within the building sector of Nigeria especially that of adequate and affordable low cost house building. Since housing is a part of a national investment and the right of all people, the main aim is to enhance its sufficiency in order to contain the need of every inhabitant (Jiboye, 2010a).

Attempts have been made by government agencies, planners and developers to unravel the housing problems in the country through public and private sector intervention (Jiboye, 2010a). These efforts include the formation of housing plans, establishment of housing institutes, policy formulation and policy amendments. Other efforts also include land allocation and delivery of mass affordable housing (Ademiluyi, 2010; Ibem, 2010; Jiboye, 2010a; Oyewole, 2010). However, the efforts were not successful partially due to corruption and politics involved during the initiation process and due to the poor quality of the houses that were built (Olotuah and Bobadoye, 2009; Jiboye, 2010b). The frustration over the poor construction quality using traditional methods of construction has driven the industry to explore different methods of construction that demonstrate sustainability, quality and efficiency yet at an affordable rate. Windapo and Balogun (2009), investigated the use of modern methods of construction (MMC) in other words offsite prefabrication techniques to deliver low-cost housing in Nigeria. However, according to Windapo and Balogun (2009), there is an insignificant use of offsite prefabrication techniques especially towards the delivery of low cost housing in Nigeria due to the higher cost of prefabrication techniques of construction. According to Abdullah and Egbu (2010) similar constraints were found in Malaysia. However, the study by Windapo and Balogun, was limited to the property developers in Lagos State of Nigeria. Furthermore, it focuses generally on the cost comparison between conventional building methods and prefabricated building techniques using mostly imported building materials.

Nevertheless, the majority of houses in Nigeria are built using imported building materials such as, cement, steel components, timber components and other imported house building finishes (Akinmoladun and Oluwale, 2007). Even though, local building materials are usually cheaper compared to imported ones. According to Udechukwu (2008), the high cost of building materials in Nigeria is due to the inability to encourage the use of local building materials in housing provision. According to Olotuah (2002), Nigeria is endowed with abundant local building materials, such as timber, clay, bamboo, stones, sands etc., in almost all the regions in the country. Yet, the building industry of Nigeria depends on importation of building materials, which are usually expensive and largely contribute to the high cost of housing in the country (Ayegun and Oluwatobi, 2011; Akinmoladun and Oluwale, 2007). Cement cost for instance covers up to about 40% of the building materials use for a house building in Nigeria, and its production is relatively low in the country, which leaves consumers with no option than to import it (Adewale, 2010).

In countries like, Sweden, Norway, Finland and Japan, prefabrication has become a mainstream construction method and it continues to grow (Smith, 2009). Unlike Nigeria, in Scandinavia and Japan offsite prefabrication technique is encouraged and has mostly been utilized with local building materials mostly timber, bamboo and clay also present in Nigeria. Nigeria may possibly learn from the wider adoption of innovations in prefabrication in the above countries. Prefabrication techniques of construction have many benefits including; speed of construction, time savings, less or zero waste on site, sustainability, high quality, cost effectiveness and minimizes risk onsite among many other benefits (Hassim *et. al.*, 2009; Kamar *et. al* 2009; Windapo and Balogun, 2009; Alinaitwe *et al.*, 2006; Emmitt and Gorse, 2006; Hashemi, 2006; Constructing Excellence, 2004; Gorgolewski, 2003). Considering the intractable housing predicament in Nigeria, prefabrication techniques of construction using local building materials could possibly be adopted towards the delivery of adequate and affordable housing. Moreover, considering the urgent need for housing units in Nigeria, prefabrication techniques of construction using local building materials could offer construction speed and time-savings which is not possible to achieve using the conventional methods.

Therefore, it is upon this reason that experts such as Windapo and Balogun and housing developers such as CITEC and Cubic homes are in search for various types of building methods that could adapt to local socio-economic conditions and level of techniques of building with the aim to achieving adequate and affordable house buildings in Nigeria (CITEC, 2013; Windapo and Balogun, 2009). One of such methods is the utilization of local building materials to provide prefabricated components for low cost house building provision in Nigeria, which forms the focus of this research. Therefore, there is a need to develop a better understanding to ascertain why local materials are not being vastly used to develop prefabricated components for house building to meet affordable (low cost) housing demand in Nigeria.

1.2 Aim and Objectives

The aim of this research is to examine the utilization of local building materials in the production of offsite-prefabricated components for low-cost house building in Nigeria through the formal building sector. The objectives are:

1. To examine the degree to which local building materials have been utilized in offsite prefabrication construction methods in low cost house building provision in Nigeria.
2. To identify the factors that affect the diffusion and use of local building materials for offsite prefabrication components in the provision of low cost house building in Nigeria.

3. To explore the potential for the utilization and diffusion of local building materials for prefabricated low cost house building in Nigeria.
4. To develop a framework for understanding the utilization and diffusion of offsite prefabricated local building materials towards the provision of low cost house building in Nigeria.

1.3 Research Methodology

This research used a combination of quantitative and qualitative approaches allowing for a strong analysis of interrelationships among factors that affect the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. The combination of qualitative and quantitative method offers huge potential for practicing researchers who would like to see methodologists define and develop methods that are closer to what researchers truly utilize in practice (Johnson and Onwuegbuzie, 2004). "*By combining multiple observers, theories, methods, and data sources, researchers can hope to overcome the intrinsic bias that comes from single-methods, single-observer, and single-theory studies*" (Denzin, 1989, p. 307). Mixed methods approach was utilized in order to get a better understanding of the factors that affect the utilization and diffusion of prefabrication construction techniques using local building materials for low cost house building in Nigeria.

An in-depth knowledge of Nigeria's building industry with an unbiased viewpoint is essential for this study. However, the researcher has no control over the building environment in Nigeria. Thus, an appropriate research design method will be the use of self-administered survey questionnaire and face-to-face audio recorded interview. Qualitative approach was adopted in order to engage in an in-depth conversation and probe deeper with some questions that could not be addressed using quantitative approach. A self-administered survey questionnaire was used as the primary source of data collection technique. The self-administered questionnaire allows the participants to complete the questionnaire at their own convenient time. In addition, it also enables coverage of a larger population and is therefore cheaper, quicker and more convenient to use (Bryman, 2008). This research adopted the semi-structured type of interview. According to Stuckey (2013 p.2), "*the semi-structured interview guide and provides a* *clear set of instruction for interviewers and can provide reliable, comparable qualitative data*". In qualitative interviews the researcher tries to understand a phenomenon from the subject viewpoint and to reveal the meaning of their experiences (Silverman, 2004).

There is the need to systematically seek for the appropriate philosophical assumption to better understand the phenomena within the context of the building industry of Nigeria. The research philosophy adopted in this study is the pragmatists worldview. The pragmatists approach has been selected so that rich and interesting data can be collected through both qualitative and quantitative methods. Certainly, this is the most appropriate approach to be used for any meaningful data to be collected within the building industry of Nigeria. Pragmatism is not committed to any one system of philosophy and reality (Cherryholmes, 1992). Therefore, all the philosophical considerations, theories depicted and the research strategies adopted in this study were deemed suitable when investigating innovation diffusion.

The study comprised of actors (professionals) within the Nigeria's building industry. Their categories are registered Engineers of the Council for the Regulation of Engineering in Nigeria (COREN), registered Architects from the Nigeria's Institute of Architect (NIA), registered Quantity surveyors from the Nigeria Institute of Quantity Surveyors (NIQS), registered Builders of The Nigeria Institute of Builders (NIOB), projects managers and professional Chief Executive Officers in the building industry. This choice seemed appropriate because these experts are the actors and agents of change within the building industry and they have a vast knowledge and experience of prefabrication techniques of construction. These experts represent both the private and public sector of the Nigerian building industry. The theoretical framework adopted for this research contains both the network of actors within the building industry of Nigeria as well as the adoption decision stages of Rogers diffusion of innovation theory in order to shape the research topic and underpin the research questions. The theoretical framework also helped to determine which research strategy and design appropriate for this study.

The geographical location of the study was considered important to obtaining representatives of the target population. Therefore, this study has mainly focused on

Abuja the federal capital territory of Nigeria. According to UN Habitat (2008), it is one of the fastest growing and one of the most urbanized cities in Africa. Moreover, it's where the housing institute and most of the construction company's headquarters are located.

1.4 Summary of Research Findings

Prefabricated local building materials are not being widely adopted in low cost housing delivery in the Nigerian building industry in comparison to the conventional method of construction. Many factors were highlighted as to why local building materials are not highly utilized for prefabricated components towards low cost house building provision in Nigeria. Some of these factors were acknowledged in the literature review and others were emerging factors that were identified as a result of this research. The major factors identified during the course of this research include lack of awareness amongst housing experts and other potential adopters. Related to this is lack of government support in terms of policy creation, incentives, promotion and encouragement through training of local artisans to assist and support the acquisition of local technological capabilities. Although some of the professionals representing the government argued that policies such as high import duty was created to encourage the acquisition of local technological capabilities, and there is no policy for prefabricated local building components. Another major issue identified was corruption within the building sector and other sectors of the country that collectively affected the utilization and diffusion of prefabricated local building materials for low cost housing provision. These include corruption through awarding contracts to mostly the bigger or foreign companies who use mainly imported building components and have the financial strength to bribe and secure most of the mass housing contracts. It could also be corruption through compromising standards and quality of building or building materials for personal gain. The lack of adequate and basic infrastructural development such as power supply and water is also among the major challenges encountered by the experts of the Nigerian building industry. Other major challenges encountered include: accessibility of components, cost of components due to importation of building material, poor standard and quality of locally produced components and the lack of proper communication flow channels within the industry especially in terms of promotion and training on prefabrication techniques of construction. The innovation decision adoption process of Rogers theory (such as;

relative advantages of an innovation, compatibility, complexity, trial-ability and observe-ability) was also confirmed to be among the challenges confronting the diffusion and utilization of prefabricated local building materials for low cost housing provision in Nigeria.

This study reveals that the possibility of utilizing local building materials in the production of prefabricated components for low cost house building provision in Nigeria can and will improve gradually or even rapidly if certain conditions are met. These conditions were discussed extensively in the form of a strategic framework that could perhaps assist and increase the diffusion and utilization of prefabricated local building materials for low cost house building provision in Nigeria. This research has also contributed to the Rogers theory by revealing some major factors that could prevent the diffusion and utilization of an innovation within a community apart from the ones mentioned by Rogers. The research has helped close some knowledge gaps by revealing the level of knowledge and application of prefabricated local building materials within the Nigerian building industry, the factors that affect the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building and the potential for prefabricated local building materials towards affordable low cost housing. Lastly the research helped close the knowledge gap through developing a framework that could perhaps assist in understanding and facilitating the utilization and diffusion of prefabricated local building materials for low cost housing provision in Nigeria.

1.5 Structure of Thesis

Chapter one; the introduction, sets out the background and the rationale behind this research which include the aim and objectives of the study. It further gives a comprehensive explanation of the motivation for the research topic as well as the choice of the study.

Chapter two consists of a critical literature review on the housing delivery efforts in Nigeria including the methods of housing provision in the country and the housing policies that were adopted. The review further addresses some major factors that intensifies the need for house building in Nigeria and the major factors that affect the housing delivery effort in the country especially that of low cost affordable housing.

Chapter three focuses on the Nigerian local building materials underdevelopment trend and types of local building materials used for house building in Nigeria. It critically assesses the main local indigenous building materials used within the building industry of Nigeria and the potential and viability of the local building material components to be utilized towards low cost house building provision in Nigeria.

Chapter four critically evaluates and assesses offsite prefabrication techniques of construction particularly its benefits compared to the traditional methods of construction. A particular focus of this chapter is to examine the level of prefabrication techniques of construction application within the Nigerian building industry and other building industries around the world and perhaps look at how Nigeria could improve from the successful application of the technique from other building industries around the world.

Chapter five consists of an extensive literature review on innovation diffusion theory. The chapter critically assesses the theory and uses the theory to investigate the particularities of diffusion mechanism that may possibly have an impact on the successful exploitation of innovative solution for the use of prefabricated local building materials for low cost house building in Nigeria. The theory adopted in this chapter will be use to underpin the research topic by establishing a theoretical framework that will be applied throughout this research.

Chapter six presents the research methodology adopted. This includes the rationale behind the selection of the research philosophy, research strategy, research design and developing the research methods which would be utilized to achieve the aim and objectives of this research.

Chapter seven presents the research data analyses. The chapter consists of the finding from both qualitative and quantitative data collected during the fieldwork. The first section of the chapter presents the findings from quantitative approach. The second part of the chapter presents the findings from the qualitative data.

Chapter eight thoroughly discussed the findings of this study and combines the themes identified from the questionnaire survey and the in-depth interviews in order to develop a framework that can improve understanding and facilitate the utilization and diffusion of prefabricated local building materials for low cost housing provision in Nigeria. The discussion involves triangulation of the findings from the qualitative and quantitative approach and the literature review to confirm or refute the arguments from the literature.

Chapter nine concludes by highlighting the major contribution of the research to knowledge and Roger's theory and by making recommendations for providing more appropriate and viable support that would assist in the higher utilization and diffusion of prefabricated local building materials for low cost housing provision in Nigeria. Figure 1.1 represents the structure of this thesis.

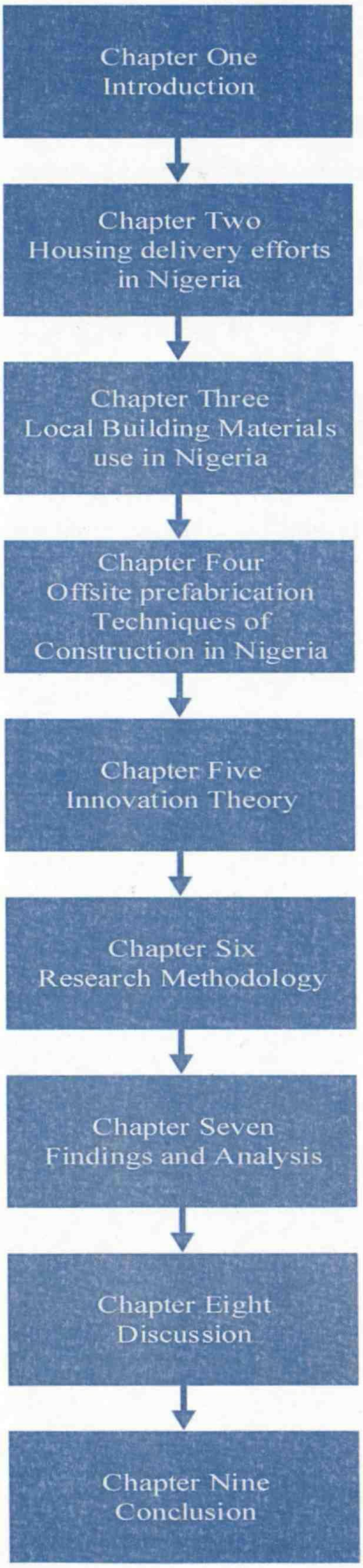

Figure 1.1: Research Structure

CHAPTER TWO

HOUSING DELIVERY EFFORT IN NIGERIA

2.1 Introduction

Problems with housing have been increasing at an alarming rate, especially in developing countries. In regards to the Nigerian building industry, these problems are both qualitative and quantitative (Adeloye, 2011; Gabriel and Abraham, 2009; Olotuah, 2005). The qualitative problems include dilapidated and substandard buildings, while the quantitative problem are mainly due to the housing shortage caused by population growth and housing demand in the country (Olotuah and Bobadoye, 2009). The need for housing in Nigeria increases day by day, but its supply remains inadequate. Thus, the number of houses provided in the country does not meet the need of the populace and is far beyond the reach of the average Nigerian. In addition, the quantities of housing units built are increasingly becoming more expensive because the material cost is increasing. Several efforts have been made through the public and private sectors of the country to mitigate the housing problems confronting the nation, yet the gap between housing demand and supply still persists in Nigeria.

This chapter - divided into four sections - will systematically review the housing situation in Nigeria. The first section examines the factors aggravating housing demand. The second examines the public sector intervention in housing provision. The third examines the private sector intervention in housing delivery and the last section tries to investigate the factors affecting housing supply.

2.2 The Factors Aggravating Housing Demand in Nigeria

Housing problems in Nigeria have soared beyond measure with an estimated 17 million units needed in the country to balance the gap between demand and supply (Marshal and Onyekachi, 2014; FMLHUD, 2012; Adeloye, 2011; Gabriel and Abraham, 2009). Thus, many factors have aggravated the high demand for more houses in Nigeria, and these factors include: population growth, urbanization, slums proliferation in urban Nigeria and affordable housing.

2.2.1 Population Growth

Population growth is generally caused as a result of increase in number of individuals in a society. The population growth rate in Nigeria is high and accompanied by rapid urbanization (Ayedun and Oluwatobi, 2011). The rapid growth rate of urban population since the seventies was mainly due to migration prompted by the gains from oil sector in the urban areas (Abimaje *et al.*, 2014). According to Odebiyi (2010), the increase in population growth and urbanization could also be the main source of degradation and issues such as housing paucity and unemployment. The current population of Nigeria stands at around 160 million (Marshal and Onyekachi, 2014; Olayiwola and Adedokun, 2014; Olawande and Ayodele, 2011). Another study conducted by the United States Census Bureau forecasted that the population of Nigeria will increase to more than 264 million by 2050. According to Dimuna and Omatsone (2010), housing problems caused by population growth are more keenly felt in Africa, Asia and Latin America, where at least half of the respective populations are considered homeless. The phenomenal increase in population, number and size of cities over the past few decades have manifested in the severe housing paucity which resulted in high rents, lack of adequate infrastructure and slums proliferation (Abimaje *et al.*, 2014). Therefore, there is a need for an urgent strategic plan on how to balance the housing demand with that of supply; if not the teeming population will soon become a burden to the country and the housing predicament could become even more difficult to tackle.

2.2.2 Urbanization

Urbanization has been a feature of most cities in the world over the past century (Aderamo and Ayobolu, 2010; Kabir, 2006). *Urbanization is the outcome of social, economic and political developments that lead to urban concentration and growth of large cities, changes in land use and transformation from rural to metropolitan pattern of organization and governance* (Opoko and Oluwatayo, 2014: p.16). According to Boudreaux (2008), urbanization is among the most persistent challenges confronting many African countries. Urbanization affects developing countries most of all (Dimuna and Omatsone, 2010). According to Alagbe and Adeboye (2005), developing countries are quick in adjusting their socio-economic lives, thus drawing people towards the cities and escalating urbanization further. In Nigeria for instance, the 1991 census revealed that there were about 183 urban centres in the country (Aderamo and Ayobolu, 2010). However, urban centres in Nigeria have now reached the 840 mark, with more than 10 cities having a population of over 1 million. Four of these are predicated to become 'mega cities' (with a population of 10 million) in the next decade (Alkali, 2005).

Nigeria is currently experiencing one of the fastest rates of urbanization in the world (Olotuah and Bobadoye, 2009; Alkali, 2005). According to Aderamo and Ayobolu (2010), it is possible that Nigeria's urban centers are the fastest growing in Africa. The urbanization trends in the country have increased the need for housing units (Festus and Amos, 2015; Olayiwola and Adedokun, 2014; Ajanlekoko, 2001). According to Aderamo and Ayobolu (2010), the housing shortage is witnessed in all urban centers of Nigeria. However, the urban growth has caused an increase in the cost of houses and the demand for urban commodities (Olotuah, 2010).

Unlike Nigeria, in most developed countries urbanization is usually accompanied with provisions of adequate housing, basic infrastructures and facilities (Odebiyi, 2010; Dimuna and Omatsone, 2010). The unavailability of adequate infrastructural development and facilities in Nigeria has created the proliferation of squatter settlements and slums in the country (Alkali, 2005). People usually migrate to the cities because of high levels of unemployment and poverty in rural areas (Odebiyi, 2010; Alkali, 2005). The degree of unemployment and poverty levels in the country has caused an outbreak of rural to urban migration (Olajide, 2010; Olujimi, 2009; Boudreaux, 2008). People are moving to urban areas in search of jobs and to better their standard of living (Opoko and Oluwatayo, 2014). However, the rural to urban migration is not supported with adequate housing supply.

The census of the early 1950s revealed that about 10.5% of Nigeria's population live in the city, and this figure increased to 19.2% in 1963, 20% in 1970, 27% in the 1980s and 42% in the early 2000's (Olawande and Ayodele, 2011; Gbadegesin and Aluko, 2010; Olotuah and Bobadoye, 2009; Alkali, 2005; Okupe, 2002; Ajanlekoko, 2001). According to Olayiwola and Adedokun (2014), more than 50% of Nigerians live in the urban centers in 2010. Another estimate shows that the urbanization rate could reach 66.5% by the year 2020 (Gbadegesin and Aluko, 2010; Nwaka, 2005). Ajanlekoko (2001) stated that about 85% of urban dwellers live in single rooms with an occupant ratio of 8-12 people, which has a horrible effect on health and hygiene. Furthermore, about 75% of the urban dwellers live in either slums or squatter settlements (Olotuah and Bobadoye, 2009). According to Ayedun and Oluwatobi (2011), the housing shortage is more acute and pronounced in the urban areas of the country.

The 2020 agenda on housing provision in Nigeria involves dealing with the issues that accompany urbanization in the country (Olawande and Ayodele, 2011). The swift increase of urbanization has advanced to an unplanned and uncontrolled state that increases slum proliferation in the urban parts of the country (Olawande and Ayodele, 2011). According to Olujimi (2009), urbanization has become an ineludible phenomenon, especially in developing countries. Therefore, since the challenges accompanied by urbanization are regarded as expected phenomena, the Government must make sure it citizens have access to adequate shelter regardless of class or status. Nevertheless, the major challenges caused by urbanization include; slums proliferation, urban sprawl, housing shortages, deteriorated infrastructures, squatter settlements and congestion (Olujimi, 2009).

2.2.3 Slums Proliferation in Urban Nigeria

Alagbe and Adeboye (2005) stated that slums are extremely crowded urban areas occupied by squatters, and exhibit dilapidated and unsanitary house buildings, poverty, housing paucity, poor urban standards of living, congestion, social disorder, very low level of urban infrastructural facilities and high crime rates. They define squatter settlements as the occupancy of land by an individual, particularly public or vacant land without any right or permit. The lack of adequate low-cost housing in Nigeria has further increased the level of slum proliferation in the country (Nnanna, 2010). The urban areas in cities of Abuja and Lagos state of Nigeria usually benefit the rich and middle class citizens with little or no attention given to the poor. According to Ukwayi *et al.,* (2012), about 1 billion people in Africa, Asia and North America were either homeless or living in houses considered dangerous to health. Therefore, the poorer citizens have to find a shelter for themselves, usually in the form of a squatter settlement or slum.

The living standard in the slums could be life threatening (Nwaka, 2005b). This was reinforced by Olotuah (2009), who suggested that the less affluent citizens, i.e. those who live in urban slums, are usually the victims of the following; congestion of people, lack of proper ventilation within buildings, dilapidated and poor standard house buildings. Nwaka also suggested that slums in Nigeria are characterized by a lack of clean water, which in turn causes water borne diseases. In addition, waste in the slums is not disposed of properly, which increases the manifestation of rubbish in the streets and stash in open junkyards where insects and flies procreate (Ahianba *et al*., 2008; Nwaka, 2005b).

The main ideology of good housing conditions and healthy living is to provide quality shelter that will conform to economic and social benefits to a logical level for the wellbeing of its residents (Aliu and Adebayo, 2010). According to Aliu and Adebayo, the essence of human life is to live in constant health - a mostly satisfying and joyous existence. However, the urban poor in Nigeria have so far not been living in decent and affordable houses and do not enjoy the comfort that comes along with a healthy, decent living standard in the country. Therefore, there is an urgent need for slums upgrades in Nigeria.

2.2.4 Affordable Housing

Affordability is concerned with securing a given standard of housing at a price or rent, which does not impose a burden on household income (Aribigbola, 2008). The issue of affordable housing has been making headway for quite a while now in Nigeria. A survey on urban housing in Nigeria shows that rent constitutes to about 60% of the average worker's income, leaving the remaining 40% for feeding, transport etc. (Eke, 2004). However, this amount is almost two times the usual low cost affordability rate. The housing affordability scheme is classified to be no more than 30% of the family income on rent and no more than 30% on bills and mortgages for those who own their houses (Abimaje *et al*., 2014; Aribigbola, 2008; Daramola, 2006). However, about 70% of Nigerian citizens live under a dollar per day (Alagbe and Adeboye, 2005). According to Olotuah and Bobayode (2009), housing the urban poor is one of the most persistent problems confronting many nations in the 21st century. Unless houses are provided at a very affordable rate, the lack of adequate low cost housing will only escalate, especially among the urban poor.

According to Ayeyemi (2011), the delivery of mass low cost housing used to be among the major priorities of Nigeria's public sector. However, less than 10% of houses are considered to be low cost in Nigeria (Ayeyemi, 2011). The housing shortage in urban Nigeria, especially the affordable (low cost) housing, is attributed to the large number of people with low-income wages and irregular jobs dwelling in the urban areas of the country (Olotuah, 2010). Urbanization problems and population growth are ongoing processes and will only increase considering the laxities and decadence of the Nigerian government in housing provision and urban development. Therefore, there is a need for the public and private sector of the country to act as quickly as possible to tackle the ongoing housing crisis before it becomes even more catastrophic. The Nigerian government has already made several attempts through direct and indirect intervention on housing provision in the country. The public sector involvement in housing provision was through the formulation of robust policies and direct involvement in housing deliveries.

2.3 Public Sector Intervention in Housing Provision in Nigeria

2.3.1 The Nigerian National Housing Policies

The Nigerian building industry has developed and implemented several housing policies and strategies, all in an attempt to address the qualitative and the quantitative housing problems in the country, particularly those of the low income earners (Abdullahi and Abd-Aziz, 2010; Ademiluyi, 2010). The major building plans established by the Nigerian government include both the National Development Plan and the National Rolling Plan (Ademiluyi, 2010; Olayiwola *et al.*, 2005; Kabir, 2005; Kabir, 2004). The National Development Plan was introduced in 1962, two years after the Nigerian independence, and lasted until 1985 when it was decommissioned. The National Rolling Plan was commissioned in 1990, five years after the National Development Plan was cancelled (Gbolagade, 2005). Many policies were created and implemented within the Nigerian building sector, but without impact, especially in terms of adequate housing provision (Kabir, 2005; Kabir, 2004). Despite the effort made, the Nigerian housing problem still remains intractable. The intervention made by the public sector on housing provision, from the Nigerian independence to the present day, is discussed below.

2.3.2 The Colonial Period (up to 1960)

Before Nigeria's independence, government housing programmes and policies were focused mainly on the delivery of housing units for the expatriate staff and for some selected indigenous staff in specialized occupations, such as railway workers, the police, the armed forces, and the marines (FMLHUD, 2012; Olotuah, 2000). The Nigerian government did not make any effort and nothing was done to ameliorate the growth of settlement outside the Government Reservation Areas (FMLHUD, 2012). The Government Reservation Areas (GRA) were built for colonial masters using European methods of house building (Olotuah and Bobadoye, 2009; Adeboye, 2005). These areas consisted of nursing centers, hospitals, schools, leisure centers and all the basic amenities needed to attain a good standard of living (Adeboye, 2005). Unfortunately, they soon became suburban areas for those with a higher income immediately after the colonial era (Alagbe and Adeboye, 2005). Olotuah and Bobadoye (2009) supported this claim by stating that the houses had become official house for Nigerian administrators and political elites. However, due to the higher increase in the number of administrative staff in the country, the demand for these houses swiftly became higher than the supply rate and in the end the system turned out to be a fiasco (Olotuah and Bobadoye, 2009).

In 1956 the National Building Scheme (NBS) was introduced in Nigeria, designed to help improve mortgage loans to its citizens (FGN, 2004). However, the scheme achieved little success due to the poor response to the saving and funding elements of the society (FMLHUD, 2012). The scheme was planned to favour the elites, rather than the poor majority (Olotuah and Bobadoye, 2009; Nwaka, 2005a). According to Aribigbola, (2008), it failed to make headway because of the limited financial resources coupled with the bad perception of the scheme among the Nigerian populace. In 1956, the African Housing Scheme was introduced to help civil servants of the country own a decent home (FMLHUD, 2012). However, there is no record of its level of success (or failure). Colonial approaches to African urban housing before the Nigerian independence in 1960 were through redeployment of decaying areas coupled with the regeneration of slums areas, as well as the construction of housing estates (Usman *et al.*, 2014). Before Nigeria's independence housing corporations were created by its government to help provide houses in all regions of the country (FMLHUD, 2012).

These corporations formed the basis for modern housing estates in Nigeria. (FMLHUD, 2012).

2.3.3 Post Colonial Era (First National Development Plan 1962-1968)

The Government initiated a new housing plan between 1962-1968 to bolster and increase the number of housing units in Nigeria (Ademiluyi, 2010). Part of the planning initiative was to provide 24,000 housing units in Lagos, which was the capital of the country at the time, but due to the civil war outbreak in 1967, only 500 housing units were built (Olayiwola *et al*., 2005). Not even 3% of the initial target was achieved. Therefore, the first national development plan (NDP) in 1962-1968 mentioned housing as part of industrial estates, land acquisition, town planning and delivering affordable public housing delivery for all Nigerian citizens (Olayiwola *et al*., 2005).

2.3.4 Second National Development Plan (1970-1974)

The Government initiated the second national development plan from 1970-1974, which was aimed at delivering 60,000 houses across all the Nigerian state capitals, with Lagos being the main target (Ademiluyi, 2010). Ademuluyi further noted that the project was successful. According to Olayiwola *et al*. (2005), the second national development plan was more unique and vibrant because the Nigerian government had embraced housing provision as part of its political and socioeconomic responsibility.

The National Council on Housing was established in 1971, which consists of all the housing commissioners in the country (FMLHUD, 2012; FGN, 2004). However, this led to the establishment of a national housing programme in 1972, during the National Development Period (FMLHUD, 2012). In 1972, the Federal Government initiated the construction of 59,000 houses with 15,000 in Lagos and the remaining 4,000 houses in each of the other eleven state capitals of the country at the time (FMLHUD, 2012). A different scheme known as the Staff Housing Board was established in 1972 to help grant loans to the civil servants who wanted to build their own houses (Olotuah and Bobadoye, 2009).

However, there is no report on the impact of the scheme. Moreover, the Federal Housing Authority (FHA) was created in 1973 to co-ordinate the Nigerian housing programmes. According to Olotuah and Bobadoye, (2009), the Federal Mortgage Bank was created that same year to help alleviate the housing paucity in the country. The Government through the Central Bank of Nigeria directed the commercial banks to allocate about 6% of their total income to real estate (Usman *et al*., 2014). Usman *et al.,* (2014) further noted that, despite the effort made, the housing problems remain persistent.

2.3.5 Third National Development Plan (1975 to 1980)

Between 1975-1980, the Nigerian government created a new Federal Ministry of Environment Housing and Urban development (FMEHUD) to re-evaluate housing policies, as well as to monitor and control the housing developments in the country (Kabir, 2005; Kabir, 2004). The ministry was aimed at implementing a successful policy on housing provision and urban development in the country (Ikejiofor, 2005). In 1976, after a change in the Nigerian government, the housing policy and construction standards was reassessed and amended (Olayiwola *et al*., 2005).

2.3.6 Fourth National Development Plan (1981-1985)

Between 1975-1984, a project worth more than two billion naira was allocated to the building sector for the provision of 202,000 house building units, 50,000 of which were planned for Lagos. The remaining 152,000 were to be shared equally between the country's remaining states (Ademiluyi, 2010; Kabir, 2005; Kabir, 2004). A success rate of only 13.3% was recorded (Ademiluyi, 2010). No reason was given as to why the project failed, nor was anyone called to account. In 1979, after a change of government from the military regime to a civilian regime, the new government initiated a new plan to provide a target of 200,000 housing units yearly in order to increase and alleviate the provision of housing in Nigeria (Kabir, 2005; Olayiwola *et al*., 2005; Kabir, 2004). The impact of the plan was not recorded. Nevertheless, an elaborate national housing programme was initiated in 1980 based on the idea of affordability and citizen participation (FMLHUD, 2012). The programme was aimed at the low and medium income earners with an annual income not exceeding 5,000 and 8,000 naira respectively (FMLHUD, 2012). The construction of 40,000 housing units yearly was initiated, with 2,000 of these to be built in each state of the country including the Federal Capital Territory (FCT) (Onyekachi, 2014; FMLHUD, 2012). However, only 20% (32,000 units) of the overall intended housing units were achieved by June 1983 (Onyekachi, 2014; FMLHUD, 2012). Again, there was no reason given as to why this plan failed.

A committee was set up in 1985 by the Nigerian government to create a feasible national housing policy that would provide a solution to Nigeria's housing problems (Onyekachi, 2014; Olotuah and Bobadoye, 2009). The aim of the policy was to guarantee access to adequate houses for all Nigerians at an affordable rate. They further noted that the objective of the national housing policies includes reformation of existing structures, the establishment of new ones and the proclamation of new laws. According to Onyekachi (2014), the policy was criticized to lack strategic plans for implementation. In the same year, the federal housing authority (FHA) initiated its agenda to provide 143,000 low-cost housing units across the states of the country (Ademiluyi, 2010; Olayiwola et al., 2005; Kabir, 2005). The success of the plan was not specified. However, in 1984, there was a change in Nigeria's government from democracy to military rule (personal communication, 2014). According to Olayiwola et al. (2005), the initial 50,000 housing units intended to be delivered to Lagos were abandoned, and the new military government initiated a new plan to build 8,000 units in Lagos. However, there was no record as to the success or failure of the project initiated by the new government.

According to the Federal Ministry of Land Housing and Urban Development (FMLHUD), about 2 billion naira was budgeted for housing provision during the fourth national development plan, but in the end only about a quarter of the amount was spent on the intended housing target. Therefore, the overall impact of the programme was affected. However, some of the factors responsible for the failure of the programme include; the location of the land allocated by state governments, the adoption of a similar housing design regardless of the state's climatic differences and the number of units and project locations across the country that were beyond the execution capacity of Nigeria's building industry (FMLHUD, 2012).

2.3.7 Military Regime (1984-1999)

After a change of government in 1983, the new government abolished the Federal Ministry of Housing and Environment and merged it with the then Federal Ministry of

Works and Surveys to become the Federal Ministry of Works and Housing (FMLHUD, 2012). In 1986, the military government had distanced itself with the direct involvement of housing provision due to the poor and dwindling situation of the Nigerian economy (Olayiwola et al., 2005).

2.3.8 National Rolling Plan (1991)

The housing predicament led to the establishment of a new housing plan in 1991 known as the National Rolling Plan (NRP), which aimed to make sure every citizen acquired affordable low-cost housing units by the year 2000 to meet the United Nations Millennium Development Goal agenda (FMLHUD, 2012; Ademiluyi and Raji, 2008; Olayiwola *et al*., 2005). "*Consequent upon this, it became necessary to restructure institutions and/or create the following new structures and promulgate new enabling laws, among others, for the purpose of realizing the goal of the policy via Employees Housing Scheme (Special Provisions) Act; Federal Housing Authority Act, 1990; Mortgage Institutions Act, 1989; National Housing Fund Act, 1992; Urban Development Bank of Nigeria Act, 1992; Urban and Regional Planning Act, 1992; Nigerian Social Insurance Trust Fund Act, 1993; Federal Mortgage Bank of Nigeria Act, 1993; National Construction Policy, 1991; and National Urban Development Policy, 1997 (FMLHUD, 2012. Pp.123).*"

Therefore, as part of the National Rolling Plan (NRP), 2,892 plots were allocated in Lagos, Kano, Kwara, Imo, Ondo, and River by the Nigerian government to help ease housing problems in the country (Ademiluyi, 2010). In addition, between 1993-1995, a further 10,474 plots were allocated for the public who were willing to build their individual private homes. Nevertheless, an additional 121,000 houses were built in the new states that were created at the time (Ademiluyi, 2010; Udechukwu, 2008; Ademiluyi and Raji, 2008; Olayiwola *et al*., 2005). However, the 1991 National Rolling Plan (NRP) showed no positive impact on the reassessment of the new housing plan (Ikejiofor, 2005).

In 1996, the Federal Housing Authority initiated the Gwarinpa II Housing Scheme in order to reduce the housing shortage in the Federal Capital Territory (FMLHUD, 2012). "The entire project covers a total of 1,090 hectares of land with over 5,000 housing units" (FMLHUD, 2012). Kabir (2004) suggests that these plots of land provided by the Government were allocated mostly away from the existing structure with no road access or basic amenities. Public sociocultural attitudes were not considered at all during the design initiation stage. There is no record to the success of this scheme. According to GDA, 2012, Gwarinpa housing estate is set to be the largest housing estates in West Africa. This perhaps shows some level of impact on the overall effort made.

However, about 3.5 billion naira was apportioned by the Government to housing provision under the National Rolling Plan from 1999-2001 (FRN, 2000; NPC, 2000; FRN, 1998). The public sector had also intervened through providing houses for military officers, university lecturers, students, police officers and other government organizations and institutions within the country (Oladapo, 2006). Oladapo further noted that the university housing accommodations are among the largest housing units provided by the public sector of Nigeria.

Since early 1999, when the civilian government was formed, the public sector had yet to regard housing provision as part of its main agenda in improving and strengthening the country's economy (FMLHUD, 2012). Therefore, housing problems have been neglected. In August 2000, the Federal Ministry of Works and Housing formed a committee to look into and articulate the process of integrating the Federal Mortgage Finance Limited and Federal Mortgage Bank of Nigeria (FMLHUD, 2012). The committee suggested the abrogation of the Federal Mortgage Finance Limited and the restructuring of the Federal Mortgage Bank of Nigeria (FMLHUD, 2012).

Another committee of fifteen members was set up in May 2001 to discuss the issues of urban development and housing provision in the country (FMLHUD, 2012). The committee submitted its report known as the National Policy on Housing and Urban Development. (FMLHUD, 2012). The main aim of the policy was "*…to ensure that all Nigerians own or have access to decent, safe and sanitary housing accommodation at affordable cost with secured tenure through private sector initiative with government encouragement and involvement*" (FMLHUD, 2012, Pp.112).

In 2004, the Nigerian government vowed to encourage and fund research on the utilization of indigenous building materials for the delivery of at least 1,000 housing units in every state of the country before the year 2007 (Ademiluyi, 2010). However, the plan was not successful due to political uncertainty and over centralized means of decision and implementation (Olayiwola *et al*., 2005). This was despite the fact that the utilization of local building materials could have been a huge step towards the revitalization of affordable houses and the acquisition of local technological capabilities in Nigeria.

2.3.9 Civilian Administration (2007 to 2010)

In May 2007, there was a change of administration in Nigeria. However, the new government inherited the responsibilities and assets of the previous administration (FMLHUD, 2012). In order to maintain the momentum of the past, the public sector felt the need for a vibrant and urgent strategic housing delivery plan to tackle the housing problems in the country. According to the Report of the Federal Ministry of Lands Housing and Urban Development (2012), the efforts made by the new administration on housing provision included:

1. The Seven Point Agenda (land reform);
2. The setting up of the following committees:

- Land Use Act Review Committee (2007)
- Presidential Committee on the Implementation of Policy on Affordable Housing Delivery (2007)
- The Presidential Technical Committee on Land Reform (2009)

Therefore, this entire effort was merely government propaganda as nothing was done in terms of actual implementation of the plans.

2.3.10 Civilian Administration (6th May, 2010 to present day)

After the death of Nigerian president (Alhaji Umaru Musa Yar'Adua), the country saw a change in its government in May 2010. However, the new government still retained the existing housing policies of the country and enhanced the policy by re-establishing a new Ministry of Housing known as the Federal Ministry of Lands Housing and Urban Development (FMLHUD, 2012). Part of its objectives included:

(i) The Federal Ministry of Housing will provide land and infrastructures for states in collaboration with local government. Part of the aim of the initiative is that the states and local governments will provide at least 150,000 – 200,000 housing units across the major cities of the country annually. This includes the use of local building materials and the involvement of local contractors to create jobs within the sector.

(ii) Housing provisions help to increase economic growth and form significant and vital parts of the Gross Domestic Product (GDP) of most countries. "*Nigeria, with an estimated population of 150 million, requires at least 720,000 additional housing units per annum (based on an estimate of nine dwelling units a year per 1,000 people), not only to replenish decaying housing stock, but also to meet rising demand and avert a further housing crisis by 2020*" (FMLHUD, 2012. PP.113).

However, other housing delivery plans initiated by the current administration include the national technical working group in housing delivery, which in Nigeria is known as vision 20:20. The report of vision 20:20 stated that: "Housing would be achieved through a private sector led housing delivery system anchored on mass construction of houses and strong mortgage finance." The implementation plan of the technical working committee on vision 20:20 added that 10 million new houses to the national housing stock should increase by an average of 1 million every year, and ensure that at least 50 percent of the new homes are built in urban centers and the remaining in rural areas as well as providing incentives to encourage Public Private Partnership (PPP) in mass housing development" (FMLHUD, 2012).

The financial sector strategy on housing mortgage for vision 20:20 is summarized as follows:

(i) The creation of a vibrant mortgage market that would provide access to housing finance to more than 30% of Nigerian citizens from all the social classes in the urban centers. Part of this goal is to increase the access of housing finance in the country from the present level of 0.5% to 30%.

(ii) A market that would account for at least 15% of Nigeria's gross domestic product (GDP) as well as providing at least 10% of people with jobs within the building sector. Part of this goal is to improve the contribution of the current GDP of mortgages from 0.76% to 15%.

(iii) "*A market that has multiple long-term funding sources including full integration with the Nigerian capital market where the value of listed mortgage-backed securities would be at least 20% of the market capitalisation of equities*."

Several housing programmes were initiated by the public sector since independence of Nigeria, but most of the housing schemes remained unsuccessful. Nigeria is yet to develop an effective and workable housing delivery programme that would enable the country to achieve the goals of its housing for all policy (Marshal and Onyekachi, 2014). Thus, the major intervention made on housing delivery in Nigeria is through the private sector as discussed below.

2.4 Private Sector Intervention in Housing Delivery in Nigeria

2.4.1 Individual

In regards to housing delivery, private sector intervention in Nigeria mainly comes in the form of personal effort. According to Mordi (2002), about 90% of housing units in Nigeria were funded by individuals. People usually buy land to build a house of their choice, an individual effort which could take a lifetime (Andrew, 2007). The individuals represent the highest source of housing provision within the private sector (Gbadeyan, 2011). In most parts of the country, individuals build their houses using their own personal savings. Some build for business purposes such as rental housing units while others built for personal reasons. The rental houses are usually tailored to all income classes in the country, but the issue of affordability is still a huge problem because every proprietor fixes the price they deem profitable and this causes the low-income earners to miss out. There is no record on the number of houses delivered using this method, but there is no doubt that majority of houses built in Nigeria are based on individuals effort.

2.4.2 Cooperative Societies

The concept of cooperative house building is when an individual wishing to build a house seeks help, usually from family, friends, neighbours or in-laws (Wahab, 1988). Wahab further noted that this method of house provision largely depends on the utilization of local building materials and are usually practiced in the rural areas of

Nigeria. According to Olajide (1992), the cooperative housing scheme in Nigeria is a conceptual aim rather than an achievement package for the people, by the people and of the people. Olajide further noted that the system is considered a constructive development in the delivery of house building because the scheme is non-profitable. Every month, members of the society will contribute a little amount of money and loan it to one of their members (Oyewole, 2010). The cooperative sometimes builds houses and allocates them to members within the society based on a lottery process with a time limit on the payment date (Ogunnubi, 1997).

The community offers support, which includes; free labour, free food and free building materials and equipment (Wahab, 1988). According to Daramola (2010), the cooperative system of housing provision is also making headway in countries like Sweden, the Philippines, Italy and Zambia. Gbadeyan (2011) stated that this scheme is becoming more and more feasible and acceptable in Nigeria. According to Daramola (2006), this system of house building should be seen as an effort in providing low cost house buildings with minimal available materials, rather than an alternative step to providing adequate mass housing in the country. Daramola further added that it should be seen as a sociocultural way of providing shelter in Nigeria. However, despite the contribution of cooperative individuals towards housing provision in Nigeria, the plan is being criticized as an inappropriate means of mass housing delivery (Oyewole, 2010). However, there is very limited information on corporative housing scheme in Nigeria. There is no record to the level of contribution of corporative housing scheme in Nigeria.

2.4.3 Corporate Bodies

The Nigeria government has urged corporate bodies to intervene in the ongoing house building supply in the country. In 1979, the Nigerian government created a new law known as Decree 54 (special provision), urging any company or governmental organization with more than 500 employees to provide at least 50 houses for their staff, 75% of which had to be allocated to non-executives (Nubi, 2000). This scheme may have been the obvious means of reducing the housing deficit confronting the country. However, the scheme faced severe confrontation from intermediaries who increased the cost of these houses far beyond the reach of the low-income earners (Nubi, 2000). There is no record on the number of units delivered through special provision decree 54.

2.4.4 Non-governmental and Voluntary Organizations

Non-governmental and voluntary organizations have been increasingly contributing towards the provision of housing in Nigeria, both in the urban and rural parts of the country (Gbadeyan, 2011). These organizations are usually non-profitable organizations such as the multi-choice network (MTN) foundation for low cost house building projects and other religious organizations. These organizations offer their support to people who are affected by war, flood and other natural disasters. In 2005, the MTN foundation and habitat for humanity low-cost housing project was launched to help the low income earners acquire adequate low cost housing through mortgage loan scheme (Makinde, 2014). Makinde (2014) stated that, the Mobile Telecommunication of Nigeria (MTN) organization plans to build 600 low cost housing units in blocks of 100 units in each of the six geo-political zones in Nigeria. Makinde further noted that, 100 units have been completed in Nasarawa State (North Central) region of Nigeria. Gbadeyan (2011) states that Muslim and Christian organizations are also involved in providing low cost house buildings and reselling them at a subsidizing rate to their members (Gbadeyan, 2011). Even though this method of housing provision is practiced in Nigeria, the impact of non-governmental and voluntary organizations are not always felt considering the soaring gap between the housing need and the limited supply of house buildings in the country.

2.4.5 Investors

The Nigerian government has also encouraged many companies to invest in the building sector, all in an effort to bolster and reduce the housing problems in the country (Gbadeyan, 2011). These companies usually form a partnership with the Nigerian local estate developers to give them more capital support that will get the local estate developers to engage in a larger capital based projects within the country (Gbadeyan, 2011). According to Kalu *et al*., (2014), lack of adequate incentives to investors contributes to the housing intervention failure. Kalu *et al*., (2014) further opined that the Nigerian government must provide incentives and other stimulating factors for the investors in order to engage them in low cost housing provision. However, there is no record of the impact of foreign investors in Nigeria. According to Eni and Danson (2014), the major factor lacking in the private sector initiative is that of affordable low cost. Eni and Danson further stated that, majority of the housing units produced by the sector are usually very expensive beyond the reach of the low-income earners. Thus, the issue of affordability among the low-income group must be taken in to consideration. In order to address the problems of housing especially that of affordable low cost housing in Nigeria, the public and private needs to come together and collectively initiate and implement a strategic plan for low cost housing provision in the country.

2.5 Public-private Partnership Scheme in Nigeria

"(The) public-private partnership scheme refers to a larger formal or informal association between the housing market members from the public and private sectors, planners, city officials, community organizations, major corporations, housing developers, housing consumers, banks and other financial institutions" (Ikejiofor, 2005. Pp.1). Public and private partnerships are certified agreements made by governmental and private companies for the delivery of infrastructural services (Ibem, 2010; ADB, 2006). Enhancing the performance of the housing market by encouraging both the public and private parties to get involved in housing provision and joint decision making is of the utmost importance (UN-Habitat, 2006).

Public-private partnership is where both the public and private sector come together to achieve a common goal. According to UN-Habitat (2006), the partnership between government and civil societies has been one of the most effective means of providing house buildings to the urban poor. Evidence of such partnership include; Gwarinpa housing estate of over 5000 units (FMLHUD, 2012). Another evidence of public private partnership is the construction of over 2500 housing units in Mboura district Abuja Nigeria (CITEC, 2013). However, considering the number of housing deficit in Nigeria, this number of units far behind the number of units required. The public-private partnership scheme has been very effective towards delivering low-cost housing in the country (Ibem, 2010; Kinyunga, 2004).

In contrary, there is no evidence to support Ibem and Kinyunga's argument. According to Jimoh and Onochie (2015), the Nigerian national minimum wage salary is N18, 000 per month (About £60 or $100). An average two-bedroom house in Mboura District costs about N17,000,000 (approximately £50,000) and N20,000,000 in Gwarinpa (approximately £60,000) (Nigeria Property Centre, 2015). Therefore, the housing affordability scheme is classified to be no more than 30% of the family income on rent and no more than 30% on bills and mortgages for those who own their houses (Abimaje *et al*., 2014; Aribigbola, 2008; Daramola, 2006). According to the affordability scheme, 30% of N18,000 (approximately £60) per month is N5400 (£18). This shows that, the houses built using this scheme is far beyond affordability rate of a low-income earner in Nigeria. Sengupta (2005) argues that the extent of the scheme depends on economic strength and the political situation of the area.

The Government agreed to back out from direct involvement in the building and sale of houses due to past failures of the public sector in regards to housing delivery (Ikejiofor, 2005). According to Abdullahi and Abd-Aziz (2010), the current public-private partnership plan accepted the private sector as the source through which the housing problems will be tackled, and the Government will act as an enabler and the initiator of the house building provision in Nigeria. Since both the public and private sector could not efficiently provide adequate housing individually in Nigeria, the recent plan adopted to tackle the housing problem is through the public and private partnership (NEEDS, 2003). However, the partnership aims to combine the capabilities of both public and private sectors to create vibrant shared advantages (Ibem, 2010; PPP, 2003).

Using a public-private partnership, more than 19,000 housing projects were initiated in Lagos alone (Adeloye, 2011). Part of the agreement made was that the Government should provide land while the private sector would arrange the resources for the housing estates (Adeloye, 2011). Ibem (2010) stated that although the public-private partnership scheme in Nigeria had so far been making progress, the scheme did not address the persistent increase in the country's housing problems, especially within the low-income earners who constitute to the greater majority of the population. According to Olofa and Nwosu (2015), major actors in the public-private partnership in Nigeria are government (public sector) and real estate developers (private sector), while other stakeholders could be insurance companies, financial institutions, building materials suppliers and construction companies.

2.6 Factors Affecting Housing Supply in Nigeria

Several plans had been put in place in order to tackle and ease the housing predicament facing the Nigerian building industry. As already noted some of these efforts include public sector intervention, private sector intervention and public-private partnerships. However, there had not been any efficient or reliable solutions to tackle the housing problems confronting the nation. According to Bayode (2008), the housing shortage in Nigeria only increases day by day. Some of the factors contributing to the housing delivery failure in Nigeria include: building material cost, lack of infrastructure, corruption, affordability, poor finance mechanism, unstable economy and land.

2.6.1 Building Materials Cost

The high cost of building materials in Nigeria has strongly affected the provision of housing in the country (Olofa and Nwosu, 2015; Kalu *et al.*, 2014; Adewale, 2010; Adedeji, 2008; Raji, 2008; Udechukwu, 2008). The cost of building materials usually amounts to about 60% of the building's total expenditure (Onibokun *et al.*, 1990). The building materials used in Nigeria have evolved over the past five decades, from the utilization of local indigenous building materials such as; timber, mud and bamboo, to the use of mostly imported western building materials such as; concrete, cement, steel and glass. (Makinde, 2014; Akinmoladun and Oluwale, 2007). Therefore, due to the higher dependence and utilization of imported building materials in the country, houses have become so expensive that they are beyond the reach of the average Nigerian (Kalu *et al.*, 2014; Makinde, 2014; Olayiwola and Adedokun, 2014; Ayegun and Oluwatobi, 2011; Akinmoladun and Oluwale, 2007). Cement, in particular, makes up about 40% of the total cost, and its production is relatively low in the country, which leaves consumers with no option other than to import it (Adewale, 2010; Andrew, 2007).

The higher cost of building materials in Nigeria is due to the incompetence of the Government and the building industry in supporting the use of the locally produced building materials (Udechukwu, 2008). The issues of finance and rising cost of building materials have contributed to the housing shortage in Nigeria (Olayiwola and Adedokun, 2014). The Nigerian government has not been supportive enough in funding research and development that could aid in improving the standards of local building materials (Kalu *et al.*, 2014). The higher cost of building materials have increased the housing prices in Nigeria and as a result affected the entire idea and possibility of affordable mass housing delivery (Gbadeyan, 2011). However, in order to solve the problems related to the high cost of building materials, readily available local building materials should be researched into with a vision to improve their qualities and make them suitable for the construction of affordable low cost housing (Ayedun and Oluwatobi, 2011).

2.6.2 Lack of Infrastructure

Lack of basic infrastructures such as roads, electricity and water has created a huge setback to housing provisions in Nigeria (Makinde, 2014; Adewale, 2010; Akinmoladum and Oluwale, 2007; Andrew, 2007). The lack of infrastructure in the country has forced many building companies to close down, and some have relocated to neighbouring countries where there are adequate infrastructures that will help keep their operations running at minimal cost (Adewale, 2010). Andrew (2007) stated that in most cases the companies themselves provide the infrastructures in order to perform their building projects at ease. According to Makinde (2014), the cost of infrastructure accounts for about 30% of housing expenditures. Marshal and Onyekachi (2014), stated that, the Nigerian government has failed to provide basic infrastructures in the country. Therefore, the high cost of infrastructure significantly influences the final price of the serviced land and ultimately the cost of houses in Nigeria (Makinde, 2014).

2.6.3 Corruption

The high level of corruption has also contributed to the qualitative and quantitative affordable housing problem in the country. The corruption within the building industry has played a huge part in past failures of housing delivery effort by the public sector. According to Marshal and Onyekachi (2014), corruption, public probity and accountability, inefficient and ineffective administrative machinery has all contributed to the housing paucity in Nigeria. In 1982, Chief Obafemi Awolowo alerted the country that about 5.4 million naira (equivalent to almost 2 million dollars at the time) was missing, highlighting the intensity of corruption within the building industry (Olayiwola *et al.*, 2005). The value of the missing money was huge at the time. This may be among the reasons why most of the housing projects initiated by the Government in the past were never completed and the ones that were completed were sometimes not up to standard. However, the issue of corruption has continued to be a major factor that affects almost every sector of Nigeria, not just housing.

2.6.4 The Problem of Affordability of the Low-income Earners

An average citizen of Nigeria cannot afford to build or buy a decent house due to their low level of income and the escalating housing costs (Anugwom, 2003). According to Udechukwu (2008), an average citizen of Nigeria spends about 60% of their salary on rent which leaves them with little money left to spend on other miscellaneous items needed. Where as, the standard affordability rate should not be more than 30% of an individual's salary (Abimaje *et al.*, 2014). The trend in housing cost, building materials and salaries of workers, especially those of the civil servants in Nigeria, do not correlate with each other (Ayedun and Oluwatobi, 2011). Ayedun and Oluwatobi further stated that the salaries of civil servants do not increase at the same pace as the building materials and housing costs. The issue of affordable low cost housing must be addressed among the low-income earners in Nigeria; if not the situation could only escalate the number of slums and squatter settlements around the urban areas of the country.

2.6.5 Poor finance mechanism and Mortgage system

The mortgage market in Nigeria is still relatively new (Adewale, 2010; Andrew, 2007). The mortgage practice and system of adopting loan in Nigeria makes it difficult for the low-income earners to benefit, and the majority of the mortgage loans went to the upper class (Olofa and Nwosu, 2015; Marshal and Onyekachi, 2014). According to Ayedun and Oluwatobi (2011), the commercial banks and insurance companies have not played a significant role in housing delivery in Nigeria. Lending policy for mortgages from insurance companies and banks are conservative while commercial banks find it difficult to give out long-term loans (Eni and Danson, 2014; Ayedun and Oluwatobi, 2011). Lack of long term finance to develop housing is a major hindrance (Bernard, 2014). Bernard (2014) further stated that, the existing mortgage system that should provide housing loan is incapable of satisfying the needs of the populace.

Most households in Nigeria fall under the category of low income and a three-bedroom house in federal housing authority of Nigeria costs close to 9.5million Naira (approximately \$43,000 or £28,000) (Ayodele *et al.*, 2013). *Under the current rules a* *buyer via the NHF will have contributed to the Fund for up to 6 months and will be required to pay 30% of the asking price (roughly N3.2 Million) to a PMI, before applying to FMBN for the remaining balance of about 6.3 million naira (Ayodele et al., 2013. p.34).* This figure is far beyond the affordability rate of an average Nigerian. Nevertheless, the eligibility criteria for borrowing in Nigeria usually involve a steady income and other collateral. According to Kalu *et al*., (2014), the low income earners do not have the collaterals required by the mortgage institution and could not satisfy the stringent administrative conditions required. Makinde (2014) opined that, appropriate finance mechanism for low-cost housing must be leveraged with particular emphasis on more realistic eligibility criteria and low interest rate.

2.6.6 Unstable Economic Environment

The instability of Nigeria's economy has prevented investors and borrowers from involving themselves with the housing provisions in the country (Makinde, 2014; Adewale, 2010; Andrew, 2007). According to Nwoye *et al.,* (2014), GDP could serve as an effective evaluation tool for weighing the general health of the economy towards revealing the stabilization status of the country's economy. The Nigerian current GDP stands at about 5.5%, which is far beyond the target estimate of maintaining at least 12% growth rate (Nwoye *et al*., 2014). According to Udechukwu (2008), the loss of currency value and the inflation rate in Nigeria over the past few decades has further affected the economic situation of the country (Udechukwu, 2008). The issue of inflation varies from one country to another. Inflation in Nigeria has been attributed to mostly, excess liquidity in the financial system, poor infrastructure, perennial high cost of funds, depreciation of Nigerian currency value, poor transportation network, incongruous fiscal and monetary policies and corrupt government (Nwude, 2013). Inflation in Nigeria is still in double digits (Makinde, 2014). In Nigeria, inflationary pressure has been dense and persistent and the nation is yet to break out from this vicious circle. Inflation in Nigeria increased from 13% in 1991 to 46% 1992 and to 72.8% in 1995. From then, it steadily dropped to 6.9% in 2000 before increasing to 10.8% in 2011 and has stayed within +2% brackets since (Nwude, 2013). The poor state of the Nigerian economy could also have contributed to the housing paucity in the country, mainly because it discourages any platform for competition between investors within the building sector. The issue of insecurity caused by the intrusion of insurgents in the country may perhaps have a negative effect on the country's economy as well as its potential to attract foreign investors whom might be interested in housing and infrastructural development.

2.6.7 Unavailability of Land

Land availability is vital to the provision of housing in any society. Land is a crucial element in property development process and its accessibility is important to achieving efficient and sustainable housing delivery in urban environment (Owoeye and Adedeji, 2015). The relatively small size of the land resource base coupled with its historical and current pattern of ownership in Nigeria presents serious constraints to housing provision (Makinde, 2014). Therefore, the issue of land availability deserves a special attention. Many private developers increase the prices of their houses tremendously due to the unavailability of adequate land (Personal communication, 2015). Land acquisition in the prime locations especially in the urban areas are beyond the reach of low and medium income households in Nigeria and this has a huge negative impact on affordable housing delivery (Eni and Danson, 2014; Festus and Amos, 2014; Makinde, 2014). The problem attributed to land access in Nigeria includes the bottlenecks in the processing of certificate of occupancy as well as building plans approval (Festus and Amos, 2014). According to Onyekachi (2014), any reform in housing sector must include a reform in the housing institution that supports the acquisition of housing. Therefore, housing reform that is aimed at mortgage improvement will lead to reforms in the financial sector with a view of evolving an effective mortgage scheme, while reforms in land administration aims at ensuring accessibility of land to all Nigerians (Onyekachi, 2014).

2.7 Conclusion

Several generic plans on housing provision were initiated and executed in Nigeria, all in the attempt to mitigate the persistent qualitative and quantitative housing problems confronting the building industry. Despite the effort made by the Government in the implementation of national development plans, the housing plans were overall considered a failure in terms of meeting the exact initial targets for the housing units intended to be delivered in the country (Olotuah and Ajayi, 2008). Olotuah and

Bobadoye (2009) concluded that the public sector intervention in housing delivery in Nigeria is more related to policy formulation than actual housing provisions. Issues such as political motivation, institutionalized policy, corruption within the Government, the lack of mortgage institutions to assist with funding, and the lack of good social and economic structural facilities have been attributed to the housing delivery failure in Nigeria (Aribigbola, 2008; Ndubueze, 2009).

Therefore, it can be argued that the entire housing intervention from both the public and private sectors yielded very little success. The little impact made in the delivery of adequate house buildings in the country is heavily attributed to the high cost of imported building materials and the lack of zeal to promote the acquisition of local technological capabilities, especially the revitalization and use of local indigenous building materials. However, Nigeria needs a robust and vibrant plan on housing provision that will involve both the public and private sectors collaborating together to tackle the intractable housing dilemma confronting the nation.

The urgency to confront these problems must be taken as seriously as other national priorities because of the soaring population growth and urbanization in the country; with Nigeria's population currently approaching 160 million and more than half of the population living in urban areas of the country. It is clear that the methods of building inherited from the expatriates after the Independence is increasing becoming more expensive and beyond the reach of the average Nigeria. There is a need to go back to the traditional ways of providing house buildings using the locally sourced sustainable building materials in order to provide affordable low cost house buildings for the teeming population. The next chapter will review the local building materials trend in Nigeria and examine the types of building materials available. The chapter also seeks to examine the potential for local building materials towards housing applications and how the local building materials are efficiently utilized within the Nigerian building industry.

CHAPTER THREE

LOCAL BUILDING MATERIALS USED IN NIGERIA

3.1 Introduction

In Nigeria, the need for locally sourced building materials can hardly be overstressed due to the imbalance between the housing demand and supply caused as a result of utilization of high cost conventional building methods using imported building materials (Yar'adua and Aliyu, 2012). Ifesanya (2007) stated that building materials contain up to about 70% of a building construction's entire input. According to Gasu *et al.*, (2011), the right step towards overcoming the infrastructural problems is to find cost effective building materials, since they constitute about 65-70% of the total building cost.

The above argument further highlights how vital cost effective building materials are to overcoming the economic side of housing problems. Adedeji (2012) argues that house building delivery efforts have clearly been constrained by the excessive cost of building materials; this issue cannot be practically overcome by simply turning to the utilization of readily available local building materials without due considerations to the applicable initiative, the sustainability of materials and the processing cost. However, it is paramount to look for alternative building materials that are cost effective with a similar or higher quality than those imported and at the same time remain sustainable. In view of this, the search for low cost building materials that are economically available and socially acceptable within the reach of an average man becomes a continuous topic of interest (Ikechukwu, 2012). According to Adebakin *et al.* (2012), the high cost of building materials coupled with the housing shortage, especially in urban areas, have encouraged the search for alternative, innovative and cost effective building materials.

This chapter consists of two sections. The first examines the local building material trend in Nigeria. The second mainly focuses on the types of indigenous building materials use in the country as well as their potential for low cost housing provision. The next chapter will critically evaluate and assess offsite prefabrication techniques of construction, particularly if they benefit the traditional methods of construction.

3.2 Local Building Materials Trend in Nigeria

3.2.1 The Effect of Colonialism on Local Building Materials and Building Techniques

To date, the reorientation concerning local ethnic values has not been accomplished with any outstanding achievement among Nigerian citizens (Atolagbe, 2009). Atolagbe further noted that the current state of industrial and technological fatalities of most developing countries could be attributed to the effect of colonialism experience. The period of colonialism has brought so many changes in Nigeria, including the building methods and materials used for house building. From 1814-1960, Nigeria witnessed the influx and intrusion of Europe in the country's political, economic, social and cultural lifestyle (Atolagbe, 2009). By the 1920's, the western influence had begun to have an impact on the cultural, social and economic nature of the Nigerian populace. According to Fadahunsi (1985), the traditional system of building, which had been with local building materials, had started to pave the way for imported building materials utilized by the Europeans. Therefore, the change in the building industry has affected the acquisition of local technological capabilities, especially the development of local building materials. Such materials produced locally are classified as obsolete, to the extent that the developers prefer to import building components rather than utilize the readily available local building materials for house building in Nigeria. Atolagbe (2009) stated that the living standard and styles of the expatriates became the envy of Nigerians, and the ambition of most citizens became to embrace those standards. According to Adedeji (2012, Pp.1), "*these changes rendered the undeveloped local building materials inadequate while there was an increased demand for exotic ones*".

Long after this period the Government intervention in housing delivery has been in the form of Government Reservation Area's (GRA's) for the expatriate staff (Atolagbe, 2009). The basic idea in the GRA policy was to provide liveable housing and housing environment for those expatriate administrators comparable to the best in their respective countries (Ukwayi *et al*., 2013). The transition continued at a very fast rate after the postcolonial era in 1960 (year of Nigeria's independent), and the Nigerian senior government officially took over the residential quarters after the Europeans left (Atolagbe, 2009). Since the vacation of the expatriates, the Nigerian building industry has adopted the European techniques of house building. The majority of social housing built after the postcolonial era consists largely of the European building methods using imported materials. This change had a huge influence on the types of building materials used for house building.

Consequently, despite the fact that it has now been almost two centuries after the intrusion of the Europeans, Nigeria still depends on imported building materials and largely ignores locally endowed indigenous building materials (Oruwari *et al*., 2002). According to Atolagbe (2009), the change from utilizing local building materials to the adoption of foreign materials happened by manner of sociocultural reorientation. However, a similar scenario could be adopted to reverse the predicament in favour of local indigenous building materials. The Nigerian government could promote the use of local building materials with true leadership. When the Government shows a bit of interest in the local building materials and uses it in their mass housing project effectively, Nigerians may possibly adopt similar techniques and style. Examples from Scandinavian countries show that it is possible to use local building materials to provide onsite or offsite prefabricated components for low cost house buildings (Smith, 2009). Those local building materials used in the Scandinavian countries are similar to the ones in Nigeria (such as timber, bamboo and clay).

3.2.2 Vision of Indigenous Building Techniques

The dispute over the return to pre-colonial techniques of house building in Nigeria should not be seen as a return to primitive practices (Atolagbe, 2009). Housing provision should be seen as a cultural symbol of sociocultural heritage (Olotuah, 1997). Therefore, a change in local housing practices indicates a change in an individual's living and life values, from the acquired to native socio-cultural values, to the user's home environment, materials, techniques, styles, etc. (Olotuah 1997). A return to housing practices and the use of local indigenous building materials based in Nigeria, its environment, its people and its sociocultural values will be significant for the nation (Atolagbe, 2009). Atolagbe further argues that a call to order within the Nigerian building industry is a call for optimism, good vision, adequate housing, self-dependence and national identity. The return to the utilization of indigenous building materials should be embraced as a return to a more sustainable and economic system of building, yet preserving the Nigerian building and building materials heritage. Most importantly, in order to enhance the acquisition of local technological capabilities within the Nigerian building industry, it is paramount to revisit the pre-colonial ways of housing delivery in the country using the available local building materials.

The majority of developing countries, Nigeria included, are facing severe problems with the supply of adequate building materials for the delivery and increase of housing units as well as the upgrade of existing buildings (Oruwari *et al.*, 2002). The continuous increase in building materials cost makes it impossible to provide low cost housing. According to Oruwari *et al.*, (2002), the building material sectors in various developing countries still find it difficult to balance the gap between demand and supply. Therefore, part of the human settlement objective for most developing countries is to improve the economic, social and environmental quality of shelter (Oruwari *et al.*, 2002). The above objective can only be achieved by providing adequate housing for all (Oruwari *et al.*, 2002). Since building materials are the key components to attaining any form of house building, it is of the utmost importance to make available cost effective building materials for house building delivery.

Nevertheless, the under supply of indigenous building materials in Nigeria has paved the way for a higher augmentation in the use of imported building materials. According to Oruwari *et al.* (2002), Nigeria continues to depend mainly on imported building materials, especially for building finishes and machineries. Continuous increase in the utilization of imported building material has increased inflation in housing projects within the Nigerian building sector (Oruwari *et al.*, 2002). The above disputes have further stressed the importance of locally sourced indigenous building materials for affordable housing provisions in the country. Other important factors such as; sustainability, availability, ease of use, social acceptability and cost effectiveness of building materials has further stressed the need as to why locally available building materials must be enhanced, perfected and utilized towards low cost housing delivery in Nigeria.

3.3 The Utilization of Indigenous Building Materials in Nigeria

This entire literature review has been emphasizing the importance of locally sourced indigenous building materials in Nigeria, as well as exploring how and why local building materials are underdeveloped or even considered obsolete by some individuals within the Nigerian building industry. A large number of housing experts acknowledged that local building materials serve as good alternative in housing construction and the use of local building materials will go along way in improving the housing shortage in developing countries such as Nigeria, thereby reducing importation and cut down the cost of construction (Omole and Bako, 2013). Nonetheless, it is important to assess the local indigenous building material use within the building industry of Nigeria. Therefore, these local building materials include, but are not limited to, the following:

3.3.1 Sand

Sand is a naturally occurring granular material of finely separated rock and mineral particles (Adebakin *et al.*, 2012). However, sand as a natural material can be utilized for various purposes, especially within the building industries around the world. In Nigeria, for instance, the general application of sand - in regards to buildings - is mostly towards the production of sandcrete blocks and other concrete mixtures. Sandcrete block is widely used for house buildings in many African countries (Anosike and Oyebade, 2012; Abdullahi, 2005). According to Baiden and Tuuli (2004), more than 85% of Nigerian buildings use them. Sandcrete blocks are a mixture of natural sand, binder and water (Oyekan and Kamiyo, 2011). In Nigeria, the majority of builders use cement as a binder. Out of all the materials used for the production of sandcrete blocks, cement is the most expensive. Thus, the utilization of cement for a sandcrete block mixture and binder makes the block more expensive and beyond the reach of low-income earners (Adebakin *et al.*, 2012; Hornbostel 1991).

The producers of blocks within the Nigerian building industry use a low amount of Ordinary Portland Cement (OPC) content to produce affordable blocks for the people (Oyetola and Abdullahi, 2006). This also means good business for the producers of blocks. Because of compromises in its quality and standard, the moulders will be able to produce 45 to 50 blocks with one bag of 50 kg cement; while according to the standard mix ratio 1:3, only 25 blocks should be produced. However, the quality of blocks produced differs from one industry to the other because of the production methods employed as well as the properties of constituents used in production (Abdullahi 2005). This lack of quality control has today become an anomaly in the Nigerian building industry. The improper mixture of block constituents affects the durability of the blocks by forming cracks on the walls after construction (Oyetola and Abdullahi, 2006). Sometimes it even leads to building collapses, destruction of properties, economic loss and loss of lives. Therefore, there is a need for an alternative, cheaper local material to serve as a binder to improve the production of sandcrete blocks with the aim of creating low-cost house buildings. These will enhance the production of sandcrete blocks for low cost housing and reduce overall costs (Adebakin *et al*., 2012). According to Oyekan and Kamiyo (2011), "availability of an alternative to these materials for construction is very desirable in both the short and long terms as a stimulant for socioeconomic development."

Several professionals within Nigeria's building industry have experimented with trying to find a cheaper replacement for cement. The Nigerian Building Road and Research Institute (NBRRI), for example, have stressed the importance of developing viable and suitable local building materials that are readily available at little or no cost (Nnamdi 2011). Some of these include; rice husk, saw dust, coconut fibre, palm kernel fiber, marble dust and stone dust (Nnamdi 2011). These are all agro industrial waste and mineral deposits that have the potential to be utilized as cement. However, Oyetola and Abdullahi (2006) stated that the use of agricultural waste as a stabilizer has not been given the required attention within the Nigerian building industry. The one most commonly experimented on is rice husk as it is readily available in almost all parts of Nigeria (Nnamdi 2011). Oyetola and Abdullahi (2006) noted that the utilization of rice husk ash as a binder or a fractional replacement for cement would aid in the production of cheaper blocks for low-cost house buildings.

3.3.2 Rice Husk

Rice husk residue is used as fuel in some parts of the country and considered a waste in other areas because of disposal problems (Oyekan and Kamiyo, 2011). However, when the residue is utilized in an environmentally friendly way, it can be quite useful. For example, rice husk can be used in the making of cement blocks as, when burnt under a controlled location, its ash could be used as a replacement for Portland cement (Rodriguez *et al*., 2008). The rice husk ash obtained from charcoal, Pozzolanic, is suitable for block constituent (Oyetola and Abdullahi, 2006). A study conducted at the

Federal University of Technology, Minna, on the utilization of rice husk ash for low-cost sandcrete block production also shows its suitability for block making (Oyetola and Abdullahi 2006). This is undeniably a great development within the building industry considering the increasing inflation in building materials and house prices in Nigeria.

3.3.3 Sandcrete Blocks

Sandcrete blocks come in different sizes and shapes, but the most commonly ones utilized within the building industry of Nigeria are the ones shown in Table 3.1. According to Anosike and Oyebade (2012), The Nigerian Standard (NIS) specified two types of block; the load bearing and non-load bearing and those blocks that can be either hollow or solid (see Table 1 for the (NIS) approved sizes). Blocks can be produced onsite or off-site. They can be prefabricated or fabricated on site.

Table 3.1: Nigerian building standard specifications of solid and hollow blocks

The Nigerian Standard Types of Sandcrete Block Specifications	
Solid block for non-load bearing and partition wall	450*225*100mm
Hollow block for non-load bearing and partition wall	450*225*113mm
Hollow block for load bearing wall	450*225*150mm or 450*225*225mm

Other types of sandcrete blocks include ventilating and decorating blocks used for non-load bearing wall construction (Anosike and Oyebade, 2012).

3.3.4 Interlocking Block

The development of interlocking blocks for affordable house buildings in Nigeria has a lot of advantages when compared to conventional types (Adedeji, 2011). Adedeji (2008) stated that some of the benefits of using interlocking blocks are; they are easy to assemble, environmentally friendly, cost efficient, do not require high skilled labour, create minimal onsite waste and take less time. Adedeji (2008) further noted that interlocking blocks produced with laterite soil are; fire resistance, sustainable, bulletproof, have incomparable aesthetics and are low maintenance. Interlocking blocks are a typical example of prefabricated blocks highly appreciated and utilized in Nigeria. Interlocking blocks use mortarless masonry methods of block production. They are easy to handle and yet multipurpose blocks made from either using concrete mix or cement and sand alone (Adedeji, 2012; Adedeji and Fa, 2012). There are different types of interlocking blocks used in regards to Nigeria's building industry. Sparlock system, Meccano system, Sparfil system, Haener system, and solid interlocking blocks (SIB) or Hydraform blocks, which are an improvement over the traditional adobe bricks (Anand and Ramamurthy, 2003).

The increase in the cost of constituents (cement) may possibly have contributed to the housing paucity in both the rural and urban parts of Nigeria. There is no doubt that sandcrete and interlocking blocks have a high potential towards affordable housing delivery in Nigeria, but their greatest weakness would be the use of cement as a binder. However, if a good replacement for sandcrete blocks binder (such as rice husk ash) is properly researched, there is no doubt that sand, as a building material, would have a greater potential for low cost housing delivery in the country.

3.3.5 Bamboo

Bamboo is a name used to describe a giant species of grass (ranging from 10 cm to 40 metres in height) that mainly grows in the tropical regions (Scurlock *et al*., 2000). According to Lugt *et al*. (2006), bamboo has an efficient natural structural design because of the hollowness and fibers in its longitudinal direction. Bamboo has many opportunities and benefits such as; high flexibility, low weight, durability, low cost, easy assembly and a quick growing rate (Lugt *et al*., 2006). Bamboo can be utilized for so many applications ranging from fuel, pulp and paper, building material, tools etc. (Ogunjinmi *et al*., 2009). Bamboo can be used for almost every section of a building (from roofing to flooring).

In the majority of Africa, Asia and South America, bamboo components are utilized for house building due to its sustainability and feasibility (Leake *et al*., 2010). It is a cheap local building material (Ukoba *et al*., 2011). Leak et al. (2010) stated that due to the economic consideration and the material properties of bamboo, the material is suitable for the implementation of low cost building in developing countries. According to

Dannenmann et al., (2007) experience from Asian countries reveals that bamboo may be useful as sustainable and valuable natural resources. Some people regard it as a poor man's timber (Salam 2008).

There are indigenous species of bamboo in Nigeria and many other African countries (Ogunjinmi *et al.*, 2009). As a building component, it is mostly utilized in the rural eastern parts of Nigeria (Nwoke and Ugwuishiwu, 2011). However, the utilization and implementation of bamboo as a building material is very low in Nigeria (Leak *et al.*, 2010). In order to reduce cost and deliver adequate low cost house buildings, the utilization of indigenous building materials (particularly bamboo) must be carefully reconsidered due to its cost saving and sustainable nature. There is no research on the extent to which bamboo components are used within the Nigerian building industry. However, the extent of its application within the building industry of Nigeria will be further assessed during the course of this research. Many countries around the world, including Nigeria, are facing a dilemma due to the dwindling of natural building materials usage (Nwoke and Ugwuishiwu, 2011). Therefore, attention must be given to the enhancement and reconsideration of local building materials in order to achieve the desired objective of providing affordable housing for all.

3.3.6 Timber

Timber is a great biomass material sourced from trees; it is also an important structural material that can be utilized for many purposes ranging from medicines, fuels and building materials (Oruwari *et al.*, 2002). It is a sustainable material that is easy to work with and one of the oldest building materials. It is of low cost, and can be applied to all sections of a house (Oruwari *et al.*, 2002). Its versatility as a building material allows it to be utilized as finishes, flooring, roofing, internal, external walling etc. According to Ejiga *et al.*, (2011), it can be used for structural elements such as column, beams, frames and panels. It has some weaknesses, just like any other building material, but its strength makes it ideal for usage in many building industries around the world, particularly Nigeria. Lucas *et al.*, (2006) stated that its strength, renewable nature, availability, fairly high fatigue resistance, durability, affordability, flexibility, shapes and colours makes it one of the major structural materials for building within the construction industry worldwide. Timber as a building material is efficient in use, reliable in service and cost effective (Adesogan, 2013).

Therefore, timber is one of the most important building materials utilized within the building industries, especially in developing countries. Timber is usually available in most forestry regions and the cost of building materials resourced from the forest is fairly cheap (Odeyale and Adekunle, 2008). According to Olotuah (2002), when timber components are used for house buildings over Sandcrete blocks, the savings in cost can reach up to about 30%. Olotuah (200) further asserted that timber is readily available in most parts of Nigeria's regions, especially the southern parts. This further highlights the reason as to why timber components should be utilized more often towards the delivery of low cost house buildings in Nigeria.

3.3.7 Granite Stones

Granite stones are usually fragments of mounting broken down into smaller particles of stones. "*The term 'granite' includes a range of the deposit itself - such as density, fracturing/bedding and other types of non-granite dimension stone including planes and depth-financial considerations...any Feld spathic crystalline rocks or other igneous or owner's preference*" (Jalil *et al*., 2014, Pp.1). Granite stones are readily available in Nigeria (Aigbedion, 2007). They can be broken down into different sizes depending on their specific usage. Stones are used for almost all sections of a house building including; roofing, external wall finishes, walls, flooring and block making. There are various colours of granite components in the building market, including grey, white, red and pink (Jalil *et al*., 2014). Aigbedion (2007) stated that rock has not been given the appropriate attention in terms of improvement in Nigeria, thus increasing the rate of imported decorative finished stones in the country.

Therefore, this has further stressed the need for the evaluation, development and production of rock components in Nigeria for local use. The utilization of stones as building materials is currently making headway in Nigeria due to its versatility and availability. These stones are broken down into smaller particles to produce blocks known as stonecrete blocks. The professionals within the Nigerian building industry regard it as a suitable substitute for sand. However, it has a similar weakness like that of sandcrete because of its dependency on cement as a binder. Nevertheless, other components mostly produced using this stone extracted in Nigeria include; external wall finishes and the stone coated roof. Granite stone as a building material has shown some glimpses of hope toward house building application. However, the issue of affordability and the extent of its usage in low cost house building is not well understood Therefore, it will be examined during the course of this study to establish it practical viability and potential towards low cost house building provisions in Nigeria.

3.3.8 Clay

Clay is a natural fine-grained soil material that, when mixed with water, develops plasticity (McGraw 1977). Olotuah (2002) stated that clay is a laterite fined grained soil particle that is less than 0.002mm in size. Therefore, clay can bond together with the help of water to form building components. Because of its tendency to be applied in different forms, it makes it a multifaceted building material both academically and practically (Ojo *et al.*, 2009). Clay has been a treasure to humanity since the beginning of mankind (Yar' adua and Aliyu, 2012). Houses built using clay offers a good thermal performance. According to Yar'adua and Aliyu (2012), clay is usually cool during the hot season, and warm during the cold season, but also has a weakness of rendering, frequently.

However, with the introduction of simple production machineries and modern building techniques, clay could be efficiently enhanced and utilized in low cost house building. Clay deposits are available in almost all the regions of the country (Ojo *et al.*, 2009; Oruwari *et al.*, 2002). Oruwari *et al.*, (2002) stated that clay can be applied in almost all parts of a building, including; wall making, partition blocks, wall tiles, bricks and sanitary fittings. According to Olotuah (2002), clay blocks offer a saving of about 30% compared to sandcrete blocks. Therefore, it would be an ideal building material to utilize for low cost house building provision in Nigeria.

3.3.9 Earthen Building

Earth, as a natural building material that exists in different compositions, can be processed in many ways, and is a key source for materials in most countries (Olotuah, 2002). According to Akinkunmi (2012), earth construction is one of the most interesting environmental impact processes as it incorporates a broad range of materials and methods. Olotuah (2002) stated that earth-based buildings in developing countries are the most economical way of providing house buildings for low-income earners. Olotuah also noted that the source for the promotion of earth buildings is cost effectiveness. According to Akinwumi (2014), earth buildings are widely available locally, environmentally friendly and economically attractive. The most popular types of earth building construction used in Nigeria include; rammed earth, adobe and compressed earth bricks (Kabir, 2005).

3.3.9.1 Rammed Earth

Rammed earth involves the compaction of saturated soil between rigid forms to produce solid massive earth (Nwoke and Ugwushiwu, 2011; Kabir, 2005). Kabir (2005) noted that the process of rammed earth wall buildings include raising the form and pouring the earth into it, as well as compacting it using tampers to produce a massive wall. The foundation must be placed firmly on either stone or concrete just like every earth building. The soil for rammed earth construction usually consists of a mixture of sand, clay and gravels. According to Nwoke and Ugwushiwu (2011), the mixture of rammed earth must include at least 70% sand and gravel and 30% clay. If a wall is not properly moistened with water, it could lead to a weaker or even fragile wall (Allen and Thallon, 2011). Therefore, it is necessary to ensure that the mixture is exact.

3.3.9.2 Adobe Laterite

Adobe laterite blocks are "*air/sun dried bricks from mud composed of inorganic soil and sand*" (Kabir, 2005, p.756). According to Nwoke and Ugwuishiwu (2011), the soil should have a clay content of at least 10%. The blocks/bricks are stacked over one another and bonded together using a mud mortar or, in some cases, cement. Adobe laterite can be utilized for dams, roads and houses, and does not require high-energy demand or cost in the initial construction phase (Yar'adua and Aliyu, 2012). Okunade (2007) asserted that the utilization of adobe for low cost house buildings had become even more prominent due to the high cost of cement and other materials.

Laterite as a building material is readily available in Nigeria. It is cheaper to utilize laterite for brick construction because it requires just a little amount of gypsum or cement (Taiwo and Adeboye, 2013; Yar'adua and Aliyu, 2012). Because of its cost effectiveness and availability, it has a high potential to be utilized for affordable low cost house building provision in Nigeria. Odunjo (2013) states that, people are ready to use laterite for house building in Nigeria because the material has high quality, it is cost effective and readily available. Therefore, adobe could be a suitable solution for housing the poor. However, the utilization of adobe bricks and blocks for houses has fallen behind to other modern building materials (Kabir, 2005). According to Yar'adua and Aliyu (2012), this material is not effectively utilized within the building industry of Nigeria.

3.3.9.3 Compressed Earth Blocks

Compressed earth block is the combination of modern and local, traditional processes of brick making. The earth is poured into moulds before it is manually or mechanically compressed using hydraform machine (Nwoke and Ugwushiwu, 2011). This process involves the mixture of soil, gravel and clay, but appears to be more durable and weather resistant than the adobe earthen construction (Kabir, 2005). It was Kabir's opinion that the compressed earth block or bricks were better than all the other methods of earthen construction because they ensure a durable building that has all the positive qualities of earthen construction with minimal disadvantages.

The current application of compressed earth towards the provision of low cost housing in urban Nigeria today is through the production of hydraform blocks or bricks. According to Adedeji (2011), the major advantages of the hydraform block is its excellent thermal capacity as it is three times more efficient than concrete and about two times more efficient than fired clay bricks (in terms of thermal insulation). Hydraform, brick and block, conforms to sustainability, quality, ease of use and cost effectiveness according to the Nigerian Building Road and Research Institute (NBRRI). According to a study conducted by Adedeji (2011), hydraform interlocking blocks offer cost savings of more than 50% compared to the conventional cement interlocking blocks. Therefore, if hydraform is applied efficiently, it could be a viable option towards overcoming the low cost housing problems in the country. Since earthen building material offers a great potential towards low cost housing delivery, there is the need to enhance the material and its building techniques for the sake of poor Nigerians.

3.3.9 Conclusion

There is no doubt that Nigeria has different types of local indigenous building materials that are readily available. These materials have the potential to be adopted towards an effective delivery of low cost house buildings in the country. However, the influx of foreign building materials and methods of construction have affected the amount of locally sourced building materials used in the country. These factors have today jeopardized the augmentation and the acquisition of local technological capabilities and contributed to the rise in housing and building material prices in Nigeria.

In order to re-establish Nigeria's building identity and find an effective way of delivering affordable housing using local building materials, a robust and assertive plan must be put in place. The first step to achieving this policy is to reduce and regulate the importation of building materials into the country. Secondly, the Nigerian government must provide an enabling environment to access the locally sourced building materials easily and at a cheap rate. The Government and the experts of Nigeria's building industry must come together to find a feasible way to improve the standard of local building materials and promote their use in the country. Lastly, the Nigerian building industry must adopt the production of modern construction techniques using the local indigenous building materials to provide low cost house building, as seen in countries such as Japan, Finland and Norway (Smith, 2009). The above steps may definitely make an impact to the economic and social problems confronting the low cost housing provision and would improve the utilization of local building materials within the building industry of Nigeria in the near future.

The next chapter will be to examine the level of prefabricated techniques of construction application within the Nigerian building industry and other building industries around the world, and look at how Nigeria could improve the successful application of the technique from foreign building industries.

CHAPTER FOUR

OFFSITE PREFABRICATION TECHNIQUES OF CONSTRUCTION IN NIGERIA

4.1 Introduction

The building sector of Nigeria is one of the most important in the country (Adedeji and Ajayi, 2008). The building and construction sector recorded a 12.9% growth rate in 2010 compared to11.9% in 2009, reflecting greater investments in the building and construction sector (Isa et al., 2013). The sectors share of GDP has improved 2.86% to 3.22% in recent years (Isa *et al.*, 2013). However, as already discussed Nigeria faces severe challenges in both quantity and quality of housing delivery. In addition, concerns about construction practices within the environment and local society is starting to make stakeholders and clients take into account the sustainable effects of how houses are being built and maintained. Aside from the shortage of housing units, the conventional method of house building using wet masonry is plagued with waste problems and other disadvantages, which can be overcome or avoided using modern techniques of construction. Adedeji (2011) stated that a more coherent building process could be created and implemented if there was a focus on cutting down construction cost, labour and reducing the amount of construction time.

Conversely, there has been increased interest in the use of modern techniques of construction among some experts in the Nigerian building industry. The modern techniques of construction have so many benefits, which is why many clients and stakeholders use them. However, there are still factors that prevent the diffusion and utilization of prefabrication techniques of construction in most developed and developing countries, despite examples from other countries (such as Japan, Sweden, Malaysia, Finland, the USA and the UK) proving their practical viability (Smith, 2009).

This chapter mainly consists of three sections. The first section seeks to examine offsite prefabrication techniques of construction in general, including their benefits and barriers compared to traditional or conventional methods. The second investigates the level of prefabrication techniques of construction application in building industries around the world. In particular, the study will look at how other countries successfully studied and applied these techniques of building construction to bolster and improve their own building systems to a more economically and commercially recognized level. The third section seeks to thoroughly examine the level of prefabrication techniques of construction application within the building industry of Nigeria, the types of prefabrication techniques used and the case studies of prefabricated construction techniques.

4.2 Offsite Prefabrication Methods of Construction

Many diverse terms are used to describe industrialized and prefabrication construction methods. Prefabrication, Offsite Manufacturing (OSM), Offsite Construction (OSC), Offsite Production (OSP) and Modern Method of Construction (MMC) are all such terms used in literature (Arif and Egbu, 2010). According to Kamar (2011), the term Industrialized Building System (IBS) is similarly used with other terms. Irrespective of usage, the ideology of the term is the same when referred to the production of components for the construction of buildings in a factory rather than onsite (Goodier and Gibb, 2006). The other terms used to describe industrialized construction are Prefabrication and Offsite Construction. While all Offsite Manufacturing are Modern Methods of Construction, not all Modern Methods of Construction are Offsite Manufacturing (Burwood et al., 2005). Modern Method of Construction (MMC) is a term used in the United Kingdom as a cooperative explanation for both offsite based construction technologies and innovative onsite technologies (Kamar, 2011). MMC includes both industrialized and non-industrialized innovation. Some prefabricated components are produced onsite (onsite fabrication) (Kamar, 2011).

Prefabrication is a term used to describe the construction of buildings or building components at a location, usually a factory, remote from the building site (Emmitt and Gorse, 2006). Offsite production is another term used to describe the production of prefabricated buildings. Emmitt and Gorse further stated that this method of construction enables a high level of accuracy and quality control of the building elements, which are then transported to the site within a precise timetable and erected into position in a perfectly defined order. Typically prefabrication techniques of construction involve the production of house building components in a particularly designed factory. Research observed that offsite construction techniques could be either product or process based. Thus, whether offsite construction techniques are considered products, processes or systems deeply depends on context. In general, reviews on offsite construction techniques classifies them into two categories; offsite prefabrication as a method, approach and process, and offsite prefabrication as a product, system and technology (Kamar, 2011; Warszawski, 1999; Sarja, 1998).

The Industrial Building System (IBS) is unambiguously defined from two perspectives; systems or processes (Nawi *et al*., 2011). However, the most common definitions widely used in literature include:

Parid (1997) defined the Industrial Building Scheme as a system that utilizes industrialized techniques of construction in the assembly of building or the production of components. Similarly, Trikha (1999) described IBS as a system in which building material components are manufactured in factories or building sites before being erected to create buildings under strict quality controls.

Warszawski (1999, p.6) stated that an industrialization process is "*an investment in equipment, facilities and technology with the aim of increasing production output, improving quality and reducing labour resources.*" Rahman and Omar (2006) defined Industrialized Building System as a method of construction that utilizes pre-fabricated building or building material components. Machines and other kinds of mechanical equipment systematically create the latter. Hassim *et al*., (2009, p.937) defined the Industrialized Building System as "*an organizational process-continuity of production implying a steady flow of demand, standardization, integration of the whole production process, a high degree of organization of work, mechanization to replace human labour wherever possible.*"

In the interpretation of construction, CIB (2010) described industrialized techniques of construction as a general process of rationalization and improvement of the work exercises in the industry to attain affordability, greater productivity and quality. Haron *et al*. (2005) and Marsono *et al*., (2006) further described the Industrialized Building System as a new method of construction that can improve the productivity and quality of work via the use of enriched construction machineries, materials, equipment and extensive project planning. Furthermore, Badir *et al*., (2002) defined the Industrialized

Building System as the utilization of new techniques of construction and factory made building components for adequate mass building production.

4.3 Forms of Offsite Construction Methods

Offsite construction techniques are categorized into different forms. The most recognized forms include; Volumetric, Panelize, Hybrid and Offsite Pre-assembly.

4.3.1 Volumetric Construction

This method of construction usually involves the construction of three-dimensional structures that are manufactured off site before being transported for assembly (Kamar, 2011; Lawson and Ogden, 2010; MMC, 2006; Ross 2005). It comprises of units that form a building or part of a building (Gibb, 1999). This system is also known as modular construction (Kamar, 2011; Burwood *et al.*, 2005). The volumetric systems for kitchens and bathrooms are known as "pods" (Burwood *et al.*, 2005; Ely 2005; National Audit Office, 2005; Ross, 2005; POST, 2003). About 90% of volumetric components are completed in the factory (Burwood *et al.*, 2005). The units can provide complete house buildings or rooms or can be connected together to make large offices, house buildings and rooms (Emmitt and Gorse, 2006).

Lawson and Ogden (2010) stated that in modular construction there are load bearing modules in which loads are transferred through the sidewalls, and corner supported modules through which loads are transferred via edge beams to corner. Lawson and Ogden further noted that the corners of the modules are tied so that, structurally, they can act together to transfer wind loads and make provisions for other load paths in case one of the modules gets damaged. According to Windapo and Balogun (2009), the units can be made from a variety of materials, but the most commonly used materials are framed structures in timber or light gauge steel (Windapo and Balogun, 2009).

Volumetric is mainly made in three forms (Ross *et al.*, 2006), and they are, as follows:

1. Timber frames
2. Concrete frames
3. Light steel frames

4.3.1.1 Timber Frames

Timber frames are one of the most general types of construction. These types of modules use timber frames as structural support. The whole module is assembled using different timber fittings. Timber frames are usually lightweight and considerably strong when designed properly, and the slabs and roofs of timber frame houses help gain overall stability of the structure at intermediate levels. All timber frame services are usually installed in a factory according to the required specifications and standards.

Main Characteristics of Timber Frames: (Timber Frame Association, 2008).

- Timber frames offer a better quality of sound insulation when compared to other materials.
- Timber frames can be reusable and timber is a sustainable material.
- Timber frames have a high efficiency of thermal insulation.
- Timber framed structures are good in holding self-weight during fire accidents.
- Timber frames are good in minimizing noises.
- Timber frames are the most- eco-friendly technique of construction.

4.3.1.2 Concrete Frame

Concrete frames play a crucial role within the building and construction industry in the development of offsite prefabrication techniques of construction. The modules are produced in a factory and delivered to site according to the client's specifications and standards (Concrete Centre, 2008).

Main Characteristics of Concrete Frames: (British Precast, 2006).

- Concrete frame production is carried out offsite, therefore, it cannot be delayed due to weather conditions.
- Concrete frames offer a higher quality finish both internally and externally.
- Concrete frame units support the reduction of energy consumption in buildings.
- Concrete frames have a huge resistance to fire and climate change.
- Concrete frame units can be easily assimilated with existing buildings.

4.3.1.3 Light Steel Frames

Volumetric light steel frames are prefabricated tested and assembled in a controlled factory before they are transported to site; the frames are usually made from lightweight galvanized steel. The components are then connected together to form structural frames of units (Corus Construction, 2008).

Main Characteristics of Light Steel Frames: (MBS, 2005)

- Light steel galvanized frames have a higher resistance against corrosion and rust.
- A light steel frame can be reused or recycled even after its life cycle.
- Light steel frames can reduce the foundation requirements of the building due to its lightweight.
- Light steel frame modules have high acoustic requirements due to their physical properties.
- Light steel frames can offer a variety of internal and external finishes due to their flexibility.

4.3.2 Panelized Construction

Panelized construction is the process by which flat panels are produced in a factory before being brought to site and assembled to produce a three dimensional structure (Kamar, 2011; Emmitt and Gorse, 2006). Panelized forms of offsite construction techniques are usually comprised of factory built elements instead of complete modules (MMC, 2008). In most cases, panelized walls are prefabricated factory built components. Thus, panels can be made from various materials that include; concrete, timber, aluminium, veneer glass, polystyrene, composite materials and acrylics (Adedeji and Ajayi, 2008). Some panels do come with full plumbing and wiring inside them, making construction even quicker (POST, 2003). Panelized methods of construction include;

1. Open panels
2. Closed panels
3. Composite panels
4. Infill panels
5. Concrete panels
6. Curtain wall panels
7. Structural insulated panels

4.3.2.1 Open Panels

Open panels are skeletal structures only. In an open panel system, structural components are taken to a site where the rest of the work is completed (Burwood et al., 2005; National Audit Office, 2005). These panels can be delivered in the form of load bearing or non-load bearing components depending on the client's requirements (NCEH, 2006).

4.3.2.2 Closed Panels

Closed panels: these panelized construction methods include services such as windows, doors, decorative finishes, internal decoration and external insulation (MMC, 2006; Burwood *et al*., 2005; National Audit Office, 2005).

4.3.2.3 Composite Panels

Composite panels: these panels are insulated and finished in controlled, industrialized conditions and are usually left for doors and windows in the prefabrication stage (Energy Saving Trust, 2005).

4.3.2.4 Infill Panels

Infill Panels: these panels are integrated with structural frames because they are categorized as non-load bearing. The structural components can be applied with masonry for installation (Ross *et al*., 2006).

4.3.2.5 Concrete Panels

Concrete panels: These panels mainly consist of prefabricated floor and walls made in a factory before been transported to site for assembly. The panels are mostly used for satisfying the purpose of structural load bearing components and they come in different shapes and sizes with better strength (Energy Saving Trust, 2005).

4.3.2.6 Curtain Wall Panels

Curtain wall panels: these types of panels are mainly manufactured for external facade. The panel is designed to withstand its own load, as well as the atmospheric load imposed on it.

4.3.2.7 Structural Insulated Panels

Structural insulated panels: these types of panels are well known for their building strength and quality. The panels are made up of structural boards and foam layers.

4.3.3 Hybrid Construction

The hybrid method of construction is a combination of both the volumetric and panelized approach (Burwood *et al.*, 2005; National Audit Office, 2005). Highly serviced areas such as kitchens, toilets and bathrooms are fully completed in a factory before been delivered to assemble onsite. This system enables the combination of panelised and volumetric systems, with the latter commonly used in kitchens, bathrooms and other highly serviced places (Kamar, 2011; Burwood *et al.*, 2005; Ely 2005; National Audit Office, 2005; Ross, 2005).

4.3.4 Offsite Pre-assembly

Offsite pre-assembly is described as the manufacture and assembly of buildings or parts of a construction ahead of the time that they would traditionally be constructed onsite (Constructing Excellence, 2004, p.2). Common examples of pre-assembly methods are roof trusses and platforms. However, there are different types of pre assembly (CIDB, 2003).

4.3.4.1 Preassembled Components and Sub-assemblies

This pre-assembly method includes components such as doors or windows that are usually fitted into other modules on the construction site, and may or may not contain their own sub-assemblies (Constructing Excellence, 2004).

4.3.4.2 Non-volumetric Pre-assembly

"*This pre-assembly is all preassembled, but non-volumetric, in that they do not enfold serviceable space and they are also items that the project team must choose to preassemble in preference to in situ construction*" (Constructing Excellence, 2004, p.2). Elements usually comprise of structural steelwork, trusses, cladding panels and precast concrete bridge (Constructing Excellence, 2004).

4.3.4.3 Sub-assemblies and Components

Sub-assemblies and components are mostly factory made roof cassettes or floors, as well as components such as precast foundations (National Audit Office, 2005; Ross, 2005).

4.4 Major Issues with Offsite Prefabrication

There are many benefits in the utilization of offsite prefabricated construction techniques. The most widely emphasized benefits for the use of this method include; the speeding up of the construction process, the integration of sustainability strategies, reduction of wastages during construction, quality, environmental and government initiatives, reducing housing shortages, overcoming skill shortages and the minimization of hazards and risks (Hassim *et al*., 2009; Kamar *et al*., 2009; Windapo and Balogun, 2009 Nawi *et al*., 2007a; Gaze *et al*., 2007; Alinaitwe *et al*., 2006; Nawi *et al*., 2005; Shaari and Ismail, 2003; Thanoon *et al*., 2003b). However, there are issues affecting the wider diffusion and use within the construction industries around the world. The issues include: the cost of offsite prefabrication methods of construction, public acceptance, its environmental and social benefits, the quality of such housing and production capacity. The most common reasons for and against the use of offsite prefabrication techniques are discussed below.

4.4.1 Cost

Offsite construction techniques can offer benefits such as lower costs (Mullens and Arif, 2006). Numerous house builders argue that the offsite prefabrication construction method is cheaper than traditional construction methods whereas, others still argue that it is more expensive than the traditional methods of construction (Constructing Excellence, 2004; Bell, 2010). Gaze *et al*., (2007) asserted that offsite techniques of construction are perceived as being more expensive than traditional methods. Alinaitwe *et al*., (2006) stated that the cost of prefabricated construction techniques, the possibility of damage during transportation and the cost of equipment are usually high in the beginning. Other industry sources showed an increased cost of about 9% when compared to tradition methods (POST, 2003). Thus, the building materials being used could also determine the overall cost of prefabricated techniques of construction. However, Alinaitwe *et al*., (2006) stated that strategies such as industrialization would reduce the cost of construction by 30% while increasing productivity. Therefore, the issue of cost of prefabrication techniques might vary from one country to the other or from one region of the country to the other depending on the environment and building materials used to produce the components.

4.4.2 Time Savings

Experience shows that using offsite techniques of construction can save a considerable amount of time. According to the case study of Murray Grove in Hackney; volumetric units of about 30 flats were brought to the site and assembled in just 10 days, saving about 18 weeks of construction time (Gorgolewski, 2003). Faster construction could be hugely beneficial to the builders, as well as for the housing associations who will be able to let out buildings earlier (Gorgolewski, 2003). However, it is not so easy to respond to fluctuating demands whilst using offsite construction techniques because the majority of factory overhead costs are fixed irrespective of output. In comparison to traditional methods of construction, costs are incurred only if the building is taking place (POST, 2003). However, the National Audit Office (NAO, 2005) reported that, as the market matured, the cost of building components could be reduced by almost 15%, which would reduce the gap in costs between prefabrication and the traditional methods of construction.

4.4.3 Reduced Local Impacts

Public disturbance such as noise, dust and vehicle movement could be minimized where offsite prefabricated techniques are utilized (OCB, 2009). Site deliveries and traffic due to construction activities are reduced by up to 70% compared to the tradition methods (Lawson and Ogden, 2010). Prefabricated components are produced in a factory, usually at a remote location, which reduces the amount of time spent on site and many other negative impacts.

4.4.4 Quality

According to Gorgolewski (2003), it is easier to set up quality control measures in a factory while prototyping, testing and inspecting the components systematically. Gorgolewski further added that manufacturing in a factory provides much better and safer working conditions than at a building site. 80% of prefabricated construction is done in a factory, which will help the building components to remain dry during assembly while the workflow will be steady and easier to control in order to reach a specific quality standard (Emmitt and Gorse, 2006). Therefore, the utilization of offsite prefabrication can reduce defects in buildings because there is less risk of weather damage during construction, and materials can be more simply standardized and tested

(POST, 2003; Constructing Excellence, 2004). According to Gorgolewski (2003), the exposure of building components to rain, snow, wind and mud are not beneficial to achieving quality buildings (Gorgolewski, 2003).

4.4.5 Waste

The quantity of waste produced using offsite construction techniques is likely to be reduced because factory components can be ordered to exact specifications, and there is less risk of onsite wastage (Hashemi, 2006; Constructing Excellence, 2004; POST, 2003). According to Gorgolewski (2003), almost 13% of materials delivered to site are never used but go straight into the waste stream. Materials can be used more resourcefully and a precise amount of material components can be ordered using offsite construction techniques (Gorgolewski, 2003). Therefore, prefabricated building sites have been well known to look tidier and more organized compared to the wet and dirty traditional construction method sites (Abdullah and Egbu, 2010). Assembly of prefabricated components onsite should produce little waste because the components come to the site pre-engineered before being assembled together (Bing et al., 2001).

4.4.6 Deliveries and Transportation

In general, offsite construction techniques led to a reduction in the number of deliveries in comparison to traditional construction methods (Gorgolewski, 2003). Little comprehensive analysis has been conducted to date on the advantages of transportation, although they are likely to vary significantly subject to the distance between the building site and the factory (Hashemi, 2006; POST, 2003). According to Gorgolewski (2003), recent monitoring of a volumetric site suggested that deliveries were reduced by up to 90% for a volumetric building compared to the similar traditional method of buildings nearby. The components are designed to keep in mind the size of the trucks for loading as well as the transportation (Lukiantchuki *et al*., 2010).

4.4.7 Health and Safety

On-site building or construction work can be a dangerous activity that could lead to a large number of casualties and even fatalities. More demanding health and safety requirements within the building industry is pushing many builders to consider other ways of working, including offsite construction techniques (Gorgolewski, 2003).

Gorgolewski further added that offsite construction techniques could improve safety because there is a decreased risk of accidents in a controlled factory environment as less time is spent on the construction site.

Abdullah and Egbu (2010) stated that in off-site prefabrication construction techniques, the transportation and delivery of components issues are related to safety issues, such as traffic regulations, route planning and logistics. However, the health and safety executives, who control and regulate construction safety, are highly encouraging the utilization of offsite construction methods (Hashemi, 2006; POST, 2003). The reduction of accidents within the construction environment is vital to a successful construction project. Thus, prefabricated building techniques can be utilized to ensure risks are reduced in the building site to a minimum.

4.4.8 Skills and Labor

Prefabricated construction techniques have reduced the amount of labour required onsite (Thanoon *et al*., 2003a). Heavy lifting can be minimized and difficult tasks can be done by machinery instead (Emmitt and Gorse, 2006). However, the reduction in site labour is sometimes criticized as unemployment within the building sector. According to Fawcett *et al*. (2005), the utilization of prefabricated construction techniques can halve the amount of time it usually takes to build using onsite methods of construction, making it possible to do four times as much building using the same onsite labour.

4.4.9 Better Environmental Performance of the Final Product

Prefabricated construction methods improve control over environmental issues that are usually faced by traditional methods of construction (Abdullah and Egbu, 2010). Pan et al. (2007) suggested that the use of offsite construction methods could provide the drive for increasing the environmental performance during the lifespan. Therefore, factory production may permit workers to be better trained and managed on the utilization and operation of offsite prefabricated techniques, as well as allowing systematic examination and testing of performance. Moreover, since manufacturers will be fabricating larger numbers of their products for a range of sites, they can take time to select environmental, friendlier materials for the production of components (Gorgolewski, 2003).

4.5 Barriers

Efforts made by the Government, house builders and experts within the building industries around the world, especially those in developing countries, to promote the utilization and diffusion of offsite construction techniques as an alternative to the traditional and labour-intensive construction methods, have not been progressing as anticipated even though they offer so many benefits. In an attempt to understand why diffusion and utilization of offsite prefabrication failed in some countries, researchers have investigated and identified a number of negative factors that affect the utilization and diffusion of prefabricated construction techniques. The common barriers associated with offsite methods of construction include; lack of knowledge and awareness, planning, complexity, public perception and durability (Kamar *et al*., 2009; Hamid *et al*., 2008; Thanoon *et al*., 2003a; Hussein, 2007; Nawi *et al*., 2007a; Nawi *et al*., 2007b; Nawi, *et al*., 2005).

4.5.1 Planning

Prefabricated construction methods require more clear structure of planning processes and control from inception to completion of the project in order to reach the goals and reduce defects and errors (Gibb, 2001; Warszawski, 1999). According to Emmitt and Gorse (2006), the problem of town planning could hinder the utilization and diffusion of offsite construction techniques. Emmitt and Gorse articulated further that the techniques of offsite prefabrication might not be suitable for some sites. According to Gaze *et al*., (2007), the limitation of planning on prefabricated construction techniques may be perceived rather than actual. The whole project is planned in such a way that as soon as the components are manufactured, it is possible to transport them to the construction site for assembly (Hamzah *et al*., 2010). Due to the negative perception of some that all prefabricated buildings are identical, planners are keen to make sure that all neighbourhoods do not look the same (Gaze *et al*., 2007).

4.5.2 Durability

Prefabricated construction techniques have a lower lifespan and durability compared to tradition methods of construction (Emmitt and Gorse, 2006). Therefore, the problem of durability can be a negative factor towards the adoption of prefabricated techniques of construction.

4.5.3 Failure of Joints

Prefabricated sections may sometimes need attention in regards to the strength and corrosion of the joining sections to avoid failure. Consequently, leaks can also form in the joints of prefabricated components (N Tech, 2010; Qays *et al*., 2010). Therefore, the joint needs to be properly fixed and designed to precise specifications to avoid any post-construction problems.

4.5.4 Site and Transportation Constraints

There is a limit to the weight and size of prefabricated materials transported to site. In the United Kingdom, for instance, the maximum allowed is 2.9m width and 4.5m height, but the width can be increased to 4.3m with a permit from the police (SCI, 2001). Some construction sites have a problem with clear and safe access points that would make craning or transportation of large building components problematic or impossible (Emmitt and Gorse, 2006). Some sites, due to physical access limitations, could be considered too small to accommodate larger sections of prefabricated components (Gaze et al., 2007).

4.5.5 Lack of Awareness and Knowledge

Abdullah and Egbu (2010) stated that the issues of awareness, knowledge, understanding and work culture have been among the major barriers for the adoption of prefabricated construction techniques. Therefore, a lack of knowledge of prefabricated construction may have attributed to the misinterpretation and misunderstanding of offsite prefabricated construction techniques (Hamzah *et al*., 2010). Lack of knowledge and awareness of prefabricated techniques of construction among the clients could also affect diffusion and utilization within the building industries.

4.5.6 Public Attitudes

There are industry concerns about the public attitude to offsite-prefabricated house buildings. A study of offsite prefabrication manufacturers identified a lack of market demand and public perception as the two most important limitations to the diffusion of prefabricated techniques of construction (Pan *et al*., 2007; POST, 2003). According to Bell (2010), the lack of effective diffusion of prefabricated construction techniques has led to widespread misunderstandings within the building industry and the general public at large. There are concerns that if more innovative offsite prefabricated building techniques are used exclusively for social housing, the design characteristic may mean that residents are stigmatized (Hashemi, 2006; POST, 2003). Hamzah *et al*., (2010) stated that prefabricated buildings are linked with drawbacks such as leakages and horrible architectural appearances. Gaze *et al*. (2007) stated that the adoption of offsite construction techniques require a shift towards the attitude of the adopters.

4.6 Development of Offsite Construction Techniques in the Developed and Developing Countries

4.6.1 United Kingdom

The UK government suggested that 4 million additional new dwellings would be needed over the next two and half decades (Gorgolewski, 2003). The National House Building Council estimated that about 10% of new UK homes are built using timber frames that are equivalent to about 25,000 offsite-prefabricated homes per year. Therefore, from the experience of the UK, offsite construction methods are used in search for more technically proficient buildings (Smith, 2009). According to POST (2003), a quarter of new publicly funded social house buildings must use the offsite construction techniques. The Government believes offsite construction techniques have economic, social and environmental benefits (POST, 2003).

There are organizations that are actively promoting the uptake of prefabrication in the United Kingdom. According to Bell (2010), Build Offsite is an organization that promotes the diffusion of offsite construction techniques in the United Kingdom. Bell further asserted that the organization comprises of the alliance of clients, designers, developers, manufacturers, contractors, suppliers, government and research, and part of its objective is to make a change in the application of offsite construction usage and to increase the utilization of offsite prefabrication techniques. Other organizations involved in promoting offsite techniques of construction in the country include Constructing Excellence UK.

4.6.2 United States

Offsite prefabrication construction techniques have been making headway in the United States. Thanoon et al. (2003a) stated that, in 1999, the prefabricated house buildings had gained a large market share with about 30% using this construction process. Most of the low-rise houses make use of timber frames and concrete precast systems; mostly in the areas that are liable for environmental hazards such as tornados and hurricanes. Therefore, the United States dominates about 26% of the global prefabricated housing market (Smith, 2009).

Similar to the United Kingdom, there are a number of organizations that promote the uptake of offsite construction techniques in the United States. They include; Modular Building Institute (MBI) and Modular Building Systems Association (MBSA) (Bell, 2010). According to Bell, MBI offers services and promotes proficiency through communication, recognition and education, while MBSA mostly attempts to increase the awareness and knowledge of the value of modular construction by builders, consumers, suppliers, the Government and the public. It also supports policies that make prefabricated construction techniques available on a cost effective basis. Goulding *et al.* (2012) asserted that in order to regulate offsite prefabricated construction techniques in the United States, a manufactured homes construction and safety act was introduced in 1976 (also known as the housing and urban development code).

4.6.3 Japan

Smith (2009, p.4) stated that, "*The vernacular method of construction in timber post and beam can be considered one of the earliest preindustrial advances in the principles of prefabrication.*" Smith further asserted that the use of industrialized manufacturing work in order to produce architecture was not completely realized in Japan until the post-war era. According to POST (2003), 40% of new house buildings use offsite construction techniques in the country. If Japan maintains the speed at which offsite construction techniques have been diffused and utilized, it will go on to become one of the world's most successful prefabricated house building industries (Smith, 2009; POST, 2003). According to Smith (2009, p.6) "*Japan is the fastest growing prefabrication economy.*" In 2004, one out of every seven new homes in the country was built using off-site construction techniques, and this figure has increased in the past few years. However, Smith also mentioned that the utilization of offsite construction techniques in Japan has so far been successful and it is possibly that they will continue to lead on the prefabrication front.

4.6.4 Scandinavia

In some Scandinavian countries (Finland, Norway, and Sweden), timber has been the major material used for offsite construction techniques (Smith, 2009). According to Smith (2009), in 1917, housing shortages increased the need for the utilization of offsite construction techniques to provide house buildings in Scandinavian countries, and the system of wood harvesting and production was used to improve the technique at the time.

However, It was during the early 1950s that the offsite construction techniques were well enough understood by the Scandinavian building industry as well as society at large (Thanoon *et al*., 2003a). Thanoon *et al.,* (2003a) further noted that this led to numerous models of new methods of production. By 1980, about 85% of all homes built in Scandinavia were offsite-prefabricated buildings and, by 1983, 90% of all single-family houses were produced using offsite construction techniques (Thanoon *et al*., 2003a). According to Smith (2009), the building industry market and society decide on whether offsite construction techniques take hold.

The housing market has become more familiar with offsite-prefabricated methods of construction in Scandinavia and thus the utilization of offsite construction techniques continues to grow (Smith, 2009). Smith further asserted that Scandinavia's populace perceive offsite construction techniques as a method of providing affordable housing for all, using local building materials to make the techniques less costly and efficient. According to Thanoon *et al*., (2003a), Swedish manufacturers export houses to Austria, Holland, West Germany, Denmark, Finland, Switzerland, North Africa and the Middle East.

4.6.5 Malaysia

In a developing country like Malaysia, the utilization of offsite construction techniques has been in existence for over 50 years (Mohamad *et al*., 2009; Abdullah, 2010; Nawi *et al*., 2011). However, even though they offer many benefits compared to traditional methods, the implementation remains slow due to some negative factors that include cost, awareness and knowledge of the construction technique (Rahman and Omar, 2006; Kamar *et al*., 2009; Mohamad *et al*., 2009; Qays *et al*., 2010; Nawi *et al*., 2011). However, a study conducted by the Construction Industry Development Board of Malaysia in 2003 showed that the adoption level of offsite construction methods stands at only 15% (CIDB, 2003). The Malaysian government was concerned that the uptake of offsite construction methods was relatively low despite the plausible potential of the system (Hamid *et a*l., 2008). Thus, in an effort to promote offsite construction methods, the Malaysian government introduced the exemption of construction tax as an incentive for contractors that use at least 50% of offsite construction methods in any of their house building projects in the country (Kamar *et al*., 2010).

4.7 Off-site Prefabrication Techniques of House Building in Nigeria

The use of prefabrication construction techniques in Nigeria has been traced back to the 1970s when the new states were created in the country. The demand for house building created the need for rapid construction methods, and offsite prefabrication techniques of construction were among the feasible means of achieving the urgent housing demand at the time. An interview conducted with the General Manager of the Federal Housing Authority Abuja revealed that majority of the prominent construction companies (Samuel Arthur Engineering Construction, Roger Reynolds, CIF Construction, etc.) have used prefabricated techniques of construction to deliver different types of houses, and most of the prefabricated houses delivered still stand across the country today.

The technology adopted by the prefabrication companies during the seventies in Nigeria were mostly the sophisticated forms of prefabrication techniques of construction, such as; concrete panels, concrete frames, reinforced concrete slabs, reinforced concrete beams and columns and concrete panels for internal and external walls rather than the prefabricated local building materials. Some examples of the major mass prefabricated building projects in the past include; the Jakande housing project in Lagos, the FESTAC housing projects in Lagos, Malali Kaduna, the first set of houses built after the creation of Niger State, the Nigerian Liquefied Natural Gas estates in Port Harcourt, the Nigerian National Petroleum Corporation estates in Kaduna, Worri and Port Harcourt, the teaching hospital in Kaduna, and the professorial quarters in Ahmadu Bello University Zaria. Many school buildings were prefabricated under the Universal Primary Education Scheme in 1976, and many Nigerian university buildings in the early 1970s were prefabricated. Nevertheless, local building materials were not utilized in the majority of prefabricated houses built during the 1970s. An interview conducted with the General Manager of the Federal Housing Authority Abuja reveals that none of these foreign prefabrication companies operate in Nigeria today. The reasons could be attributed to the country's low level of prefabrication markets.

4.8 Classification of Offsite Prefabrication Techniques of Construction in Nigeria

An interview conducted with the Chief Executive Officer of Mega Project Nigeria Limited (Former Deputy chairman Nigerian Institute of Architects) revealed that, Nigeria's classification of offsite-prefabricated techniques slightly differs. Prefabricated components are classified into three categories within the building industry of Nigeria. These categories include; low technology prefabricated components, medium technology prefabricated components and high technology prefabricated components. See Table 4.1 for the classifications of prefabricated components in Nigeria.

4.8.1 Low Technology

The low technology prefabricated components are the elements that involve the minimum technology requirements and low-levels of sophistication to produce the components. These components are usually not labour intensive compared to medium and high technology, and they do not require high skills proficiency to produce. The components labelled as low technology prefabricated products are used by small, medium and large construction companies in Nigeria. The low technology elements are readily available, well known and used by local builders

4.8.2 Medium Technology

The medium technology prefabricated components are usually slightly above the low technology level of sophistication, but below the high technology. The medium technology prefabricated components differ in terms of high proficiency requirements during production and erection onsite. Some require high levels of skill to produce while others are flexible and straightforward. Some are labour intensive and requires heavy lifting while others are completely easy to produce and assemble. The medium technology prefabricated components within the building industry of Nigeria are associated with building elements such as the panelised forms of prefabricated techniques

4.8.3 High Technology

The high technology prefabricated components are the most complicated among the categories of prefabricated elements due to high levels of sophistication and precision requirement during production and erection These components are mostly produced and assembled by the big prominent construction companies within the building industry of Nigeria because of labour intensiveness and heavy lifting requirements during the erection of the components. The high technology prefabricated components within the building industry of Nigeria are associated with building elements such as the volumetric/modular, bathroom or toilet pod systems, also known as container units

Table 4.1: Classification of prefabricated building components within the building industry of Nigeria

Low Technology	**Medium Technology**	**High Technology**
Interlocking Blocks or bricks Interlocking floor Pre-assembled Door and Windows Rails (Bamboo, Timber, Steel and Aluminium) Pre-assemble Drainage Elements Roof Trusses (Bamboo, Timber and Steel)	Panels Frames Beams Steel Gate Hollow Clay Pot Slab Universal Beams (I or T) Universal Columns (Stanchions) Plate Steel Stairs Wood Stairs Reinforced Concrete Stairs	Volumetric/Modular, also called Container Units Bathroom or Kitchen Pods Precast Concrete Slab Precast Concrete Beams Precast Concrete Columns

Roof Tiles (Stone Coated, Corrugated, Metro-Step Tile, Aluminium and Zinc) Floor Tiles (Stone, Ceramic and Timber) Wall Finishes (Granites, Marbles and Timber)		

(Source: Mega project Archives)

4.9 Current Application of Prefabrication Techniques in House building Provision in Nigeria

The use of prefabrication techniques of construction has dwindled over the past few decades. However, there are construction companies who are actively promoting the use of them in Nigeria. According to Opara (2011), in order to keep pace and compete with other parts of the world towards construction innovation, the Nigerian building industry is gradually accepting offsite construction methods, especially towards house building provision. Companies such as CITEC International and Cubic Homes Limited are among the leaders in promoting offsite prefabrication techniques of construction and have all been actively utilizing them to build affordable houses in Nigeria. Experts have urged stakeholders, policy makers and homebuilders within the Nigerian housing sector to consider using offsite techniques of construction such as modular systems to solve the housing paucity in the country (Opara, 2011). However, there are constraints to the utilization and diffusion of prefabricated techniques of construction in Nigeria.

Opara (2011) stated that the prefabricated construction techniques in Nigeria are more expensive than the conventional building systems. Opara further asserted that the higher cost of modular techniques of construction is attributed to insufficient factories to manufacture enough components and a lack of exploitation of locally available building materials in the country. Most of the prefabricated components used in Nigeria were imported (Abdulhamid, 2011; Opara, 2011). The higher importation of building materials and prefabricated components may possibly have had a significant impact on the cost of these techniques of construction in Nigeria. Virtually all inputs used in the construction of modern housing units are imported building materials (Kalu *et al.*, 2014). Local building materials (such as timber and bamboo) are used in countries like USA, Japan and Scandinavia to provide affordable house buildings (Smith, 2009). Therefore, the adoption of similar techniques like that of Scandinavian countries (using local building materials to produce prefabricated components) could be adopted and applied towards low cost house building provision in Nigeria.

Nevertheless, prefabrication techniques of construction are not being utilized to their full potential in Nigeria, especially towards the provision of low cost house buildings (Windapo and Balogun, 2009; Wahab and Lawal, 2011). According to Windapo and Balogun (2009), negative factors such as high cost, knowledge and awareness are among the major factors that affect the implementation of off-site prefabricated construction techniques in Nigeria. According to Kolo *et al.*, (2014), offsite prefabrication techniques of construction are largely unknown within the building industry of Nigeria. These negative factors are similar to that of Malaysia (Rahman and Omar, 2006; Kamar *et al.*, 2009; Mohamad et al., 2009; Qays *et al.*, 2010; Nawi *et al.*, 2011).

However, some prominent building companies in Abuja, the capital of Nigeria, have exploited the use of a local petroleum by-product known as expanded polystyrene (EPS) to produce different types of prefabricated building components for affordable house building provisions in the country.

4.10 Expanded Polystyrene Technology

Expanded Polystyrene (EPS) is mainly derived from styrene monomer and expanded to form a cellular structure substantially of closed cells (CITEC International, 2013). Expanded polystyrene (EPS) is a building system based on a group of structural panels of undulated foam polystyrene with a base reinforcement placed against the sides with high resistance steel mesh and each side joined to one another by means of electro-welded steel connectors (Ede and Ogundiran, 2014; CITEC International, 2013). See figure 4.1. These panels are arranged on the construction site according to the disposition of walls, partition and floors, and are finished on site by applying concrete with pneumatic devices (CITEC International, 2013).

In regards to building materials, EPS comes in various sizes and shapes. Ede and Ogundiran (2014) stated that EPS is used for insulation foam, closed cavity walls, roof and floor insulation, and wall and floor panels. CITEC International (2013) stated that, as a material, EPS is formed by a union of many beads of polystyrene produced during a modeling process with a supply of heat as water steam until the following characteristics are obtained:

- Normal density - 15kg/m2
- Thermal conductivity - 0.037W/mk
- Stream resistance - 0.15mm Hg m2 dia/g cm
- Compression stress at 10% of strain =50kpa

During the expansion stage, expanded polystyrene beds are heated in pre-expander using steam from boilers at temperatures of at least 85-100^0 C (Ogundiran and Adedeji, 2014). The pre-expansion process is usually followed by the intermediate conditioning and stabilization stage to allow the cooling of the dying expanded beads in a fluidized bed drier where the EPS cools and air gradually disseminate into the pores. This will continue until the beads contain up to 98% air which will enable them to achieve greater mechanical elasticity and regain a capacity to expand (Ogundiran and Adedeji, 2014). Next comes the molding stage where the pre-expanded beads are molded to form blocks or customized products which are then shaped or cut into the required specifications and shapes; then the finished products are laminated with foils, fiber boards, plastics, roof or wall cladding materials and wire mesh.

The thickness of foam polystyrene may vary from 4 to 25 cm according to the requirements of the architectural design. The steel mesh projection of 50 mm on the opposite sides joins the two panels which interlock into one another, guaranteeing continuity by superimposition with no need of placing additional joining elements like columns, lintel and beams (CITEC International, 2013). The wall erection is completed by applying concrete layers of acceptable thickness on both sides of the wall to protect against compressive forces and corrosion (Ede and Ogundiran, 2014). According to Ede and Ogundiran, EPS panels are an economical alternative to the conventional methods of construction.

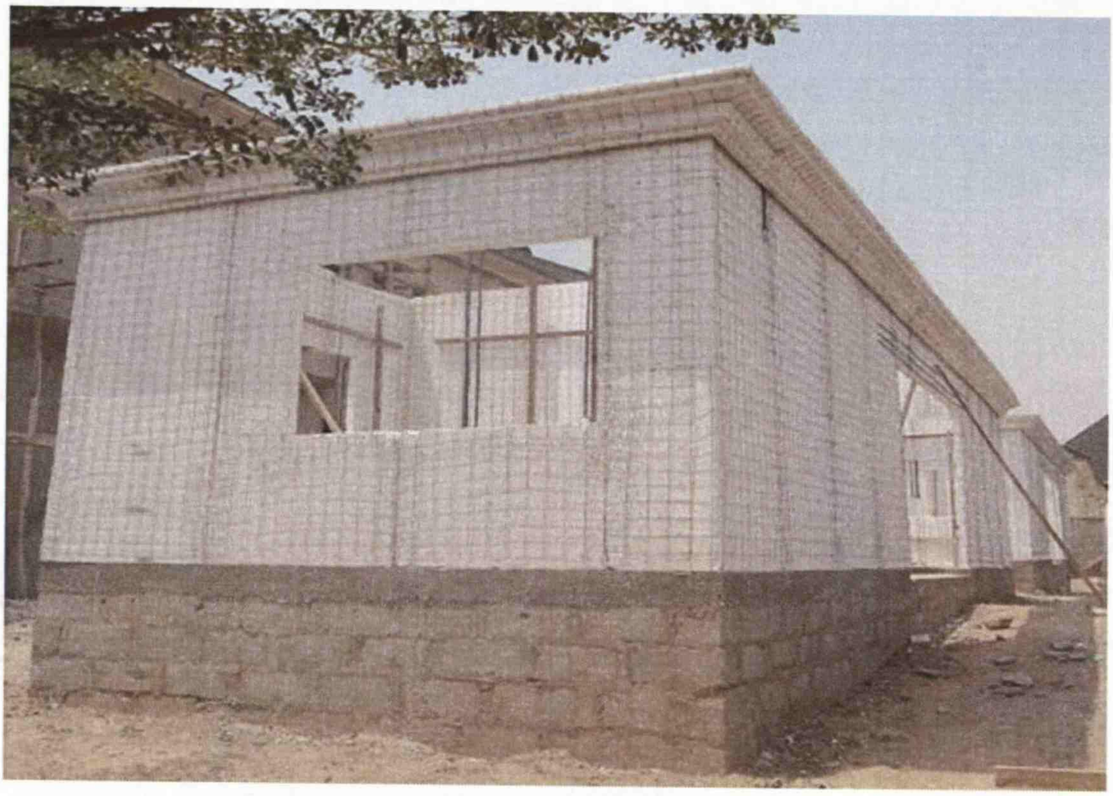

Figure 4.1: Expanded polystyrene panels meshed with steel to form a unit in Abuja, Nigeria (*Location: CITEC Abuja, photographed by the author*).

4.11 Why the Utilization of Expanded Polystyrene (EPS) Systems for House Buildings are Making Headway in Nigeria

4.11.1 Light Weight

EPS is very light in weight compared to many other building materials (Ede and Ogundiran, 2014). According to Ogundiran and Adedeji (2012), a standard EPS panel weighs around 5.5 kg and can be easily lifted into position by a single individual. Furthermore, it reduces the weight of construction by almost 40%, and can also prevent costs, especially on foundations (Ede and Ogundiran, 2014). Unlike concrete panels, EPS components do not need machinery such as cranes or hoists to lift them into position.

4.11.2 Sourced Locally

EPS materials are sourced locally from Nigeria, just like many other local building materials such as timber, bamboo, granite and clay. However, some experts argue that the petroleum by-product used in producing expanded polystyrene is sometimes imported because the quantity of the by-product that is acquired in Nigeria is not good enough to meet the increasing EPS demand in the country. Nigeria is endowed with an abundance of crude deposits that, when exploited and managed effectively, can produce the petroleum by-product to be made readily available for commercial purposes in the country.

4.11.3 High Strength

EPS compressive strength makes it ideal for wall and slab panels in storied buildings, as well as for residential, commercial and industrial building applications in Nigeria (Ogundiran and Adedeji, 2012). Ede and Ogundiran (2014) stated that EPS provides an exceptional compressive strength.

4.11.4 Flexibility and Unique Designs

EPS components can be produced into different size and shapes depending on the specification required. EPS versatility gives the designers a unique product that can be utilized alone or with any other building material to achieve a specified building purpose (Polystyrene Industries, 2013).

4.11.5 Energy Savings

EPS house buildings save more energy compared to the conventional building system. EPS can save energy because of its ability to keep the building cold for long periods compared to other building materials. EPS house occupants in the Mboura District, Abuja, mentioned that they only put on their air conditioning two or three times a day, and only for a short period, because of its ability to maintain a steady temperature for a long time. It helps reduce the amount of energy that is generated by a building. According to Ogundiran and Adedeji (2012), expanded polystyrene is not just foam for insulation, but an innovative building material that could be used in various parts of the building.

4.12 Case Study

4.12.1 The Case Study of the CITEC Expanded Polystyrene Housing Estate in the Mboura District, Abuja

The CITEC housing estate in the Mboura District is a housing project of two thousand eight hundred units with different phases. The project is currently in the fourth phase with more than half of the houses being built using the conventional and prefabricated techniques of construction. They are to be built in 250 hectares of land provided by the Federal Government. The types of houses are:

- 5 bedroom detached duplex
- 4 bedroom detached duplex
- 4 bedroom semi-detached duplex
- 4 bedroom detached bungalow
- 3 bedroom semi-detached bungalow
- 3 bedroom bungalow
- 2 bedroom semi-detached bungalow

4.12.2 General Phases of the CITEC Expanded Polystyrene Houses

4.12.2.1 The Substructure

- Excavation – deep (1.2m)
- Blinding – (50mm thick, Grade 15 concrete 1:3:6)
- Footing – (230mm strip, Grade 20 concrete 1:2:4)
- Sandcrete blocks filled with mass concrete
- Hard-core filling with bonders – (300mm thick)
- Ground floor slab

4.12.2.2 The Superstructure

- Erection of ground floor reinforced concrete columns – (with concrete Grade 20, 1:2:4)
- First floor slab and beams
- Erection of first floor reinforced concrete columns
- Erection of roof beams – (Grade 15 concrete)
- Erection of timber rafters
- Erection of EPS Fascia
- Assembling of roofing sheets - (Metro-step tile roofing sheet)
- Noggin
- Mantling of Prefabricated EPS wall panels
- Electrical works and plumbing

- Spraying mixture of sharp sand and cement on the EPS wall panels
- Spraying mixture of fine sand and cement on top of the already dried up sharp sand and cement
- Ceiling using P.O.P (Plaster of Paris)
- Fixing of doors and windows
- Tiling
- Electrical and plumbing fittings
- Finishes (painting)

Figure 4.2: Concrete frame structure and the internal view of the noggins used for the EPS houses (*Location: CITEC Abuja, photographed by the author*).

Figure 4.3: The timber rafters/trusses and the EPS Fascia used for the houses (*Location: CITEC Abuja, photographed by the author*).

Figure 4.4: The EPS fascia before and after cement/fine and sharp sand spray (*Location: CITEC Abuja, photographed by the author*).

Figure 4.5: First floor slab showing the wiring routes (*Location: CITEC Abuja, photographed by the author*).

Figure 4.6: Partly sprayed EPS panel meshed with steel connectors (*Location: CITEC Abuja, photographed by the author*).

Figure 4.7: Closer view of partly sprayed EPS Panel meshed with steel connectors (*Location: CITEC Abuja, photographed by the author*).

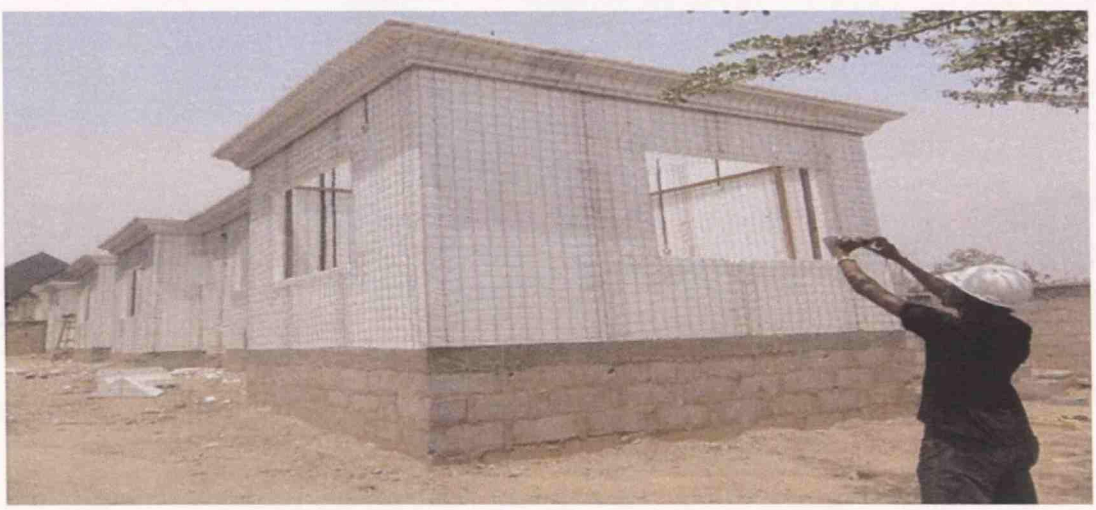

Figure 4.8: EPS bungalow (*Location: CITEC Abuja, photographed by the author*).

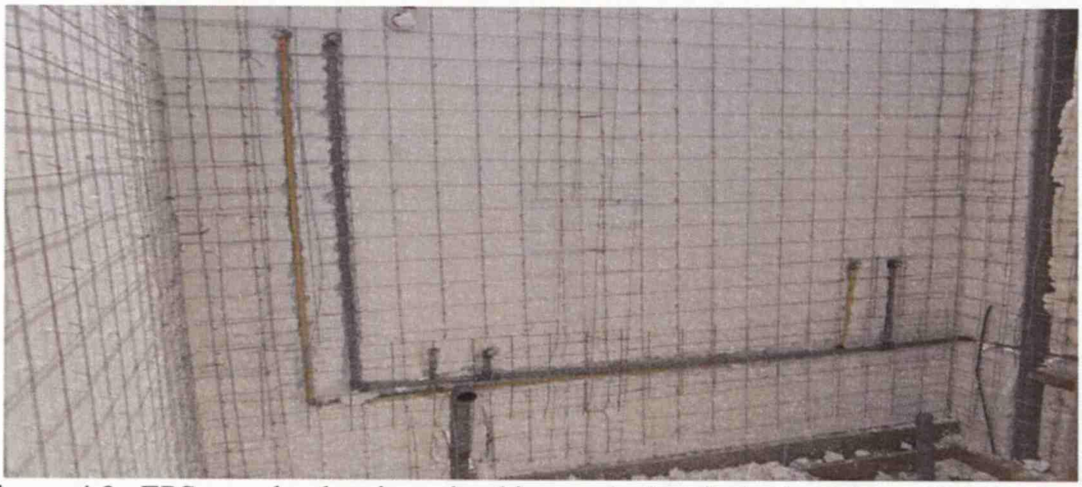

Figure 4.9: EPS panels showing plumbing and electrical (*Location: CITEC Abuja, photographed by the author*).

Figure 4.10: Internal view of a partly finished EPS house (*Location: CITEC Abuja, photographed by the author*).

Figure 4.11: Fully cement plastered EPS houses (*Location: CITEC Abuja, photographed by the author*).

Figure 4.12: Fully completed EPS houses showing the front and rear view from left to right (*Location: CITEC Abuja, photograghed by the author*).

Table 4.1: Comparison between the bills of quantities of two separate three bedroom semi-detached bungalows built with expanded polystyrene and conventional sandcrete blocks in Abuja, Nigeria

Building Elements	**Expanded Polystyrene**	**Traditional Sandcrete Blocks**	**Difference in Cost Savings**
Substructure	2,110, 000	2,110, 000	
Concrete Work	330, 100	330, 100	
Walls	2,750,000	3,050, 200	300,200
Doors and Windows	1,550,300	1,550,300	
Finishing's	3,506,000	3,506,000	
Fittings	612,500	612,500	
Roofing	2,600,500	2,600,500	
External Works	230,000	230,000	
Labour/Services	1,900,550	2,350,440	449,890
Total	**15,589,950**	**16,340,040**	**750,090**

Source: CITEC Nigeria Limited Documents 2013

According to the bills of quantities in Table 4.2, using prefabricated EPS components for house building delivery has saved about 5% on costs when compared to the convention sandcrete block method of house building. It can be argued that 5% isn't much, but when EPS is used for mass housing delivery, it could save the buyer a lot of money. The project also shows that the house built using the expanded polystyrene system took half the time it would have taken to build using the traditional method of wet block and mortar.

4.13 Conclusion

The Scandinavian countries have embraced offsite construction techniques as a way of producing quality affordable housing. They discovered that offsite construction techniques using indigenous (local) building materials are more affordable than traditional onsite methods. This was achieved as a result of utilizing the local building materials, learning from the prototype errors and improving the prefabrication techniques of buildings over time. Scandinavia has proved that using local building materials such as timber transformed traditionally crafted buildings into mass affordable crafted buildings. In addition, prefabrication techniques of construction excel in Japan not only because of the robust prefabrication philosophy and the excellence of the products, but above all because of its people's needs and processes.

It can be concluded that offsite prefabricated construction techniques in Nigeria have not been adequately diffused and utilized to a commercially and economically anticipated level like in Scandinavia, Japan and the USA, even though they offer so many benefits compared to conventional onsite construction. Unlike the Scandinavian countries, prefabrication techniques in Nigeria have dwindled over the past few decades... While other countries find effective ways of producing prefabricated components to deliver affordable house building, the diffusion and utilization of prefabrication techniques of construction in Nigeria fails to make headways despite all it benefits compared to the traditional methods of construction.

Factors such as high cost and a lack of awareness of the various techniques were among the major factors associated to the use of prefabrication techniques of construction in Nigeria. The Nigerian building industry relies so much on the importation of building materials that it has failed to improve its own local technological capabilities such as, the utilization of local building materials in the production of prefabricated components for low cost housing provision. There is the need to adopt a theory on innovation diffusion that would help to underpin the theoretical framework that will be develop and use to ascertain the level of diffusion and utilization of prefabrication techniques using local building materials in Nigeria. The next chapter will examine the theory depicted for this research and review how it is used to underpin the theoretical framework.

CHAPTER FIVE

DIFFUSION OF INNOVATION THEORY

5.1 Introduction

This research is dealing with an enduring situation, where the utilization and diffusion of indigenous building materials for prefabricated component is slowly adopted in the Nigerian building sector, even though evidence in other countries shows that it offers more benefits economically, socially and culturally compared to its counterparts. However, a particular focus will be to develop a framework that facilitates the understanding of the use of local building materials in the provision of offsite prefabrication low-cost house building in Nigeria. Innovation theory has been identified as helpful in guiding and asking systematic questions comprehensively, to guide the researcher to understand and determine the actual work that needed to be done. Some innovation theories considered include; business model innovation, social construction of technology, actor network theory and Rogers's diffusion of innovation theory.

Business model innovation involves the design and management of innovation at the organizational and system levels of businesses (Kapeleris, 2012). Kapeleris (2012) further opined that, "*Innovation requires constant thinking; planning, experimentation and learning by doing, to create new capabilities and to successfully implement a new business model*". This model is not suitable for this study because the research aims to investigate why prefabrication technology using local building materials fail to make headways in Nigeria even though it promises a superior performance to the conventional methods. Therefore, this research requires a theory that involves understanding how diffusion and utilization of an innovation takes place within a society.

Another theory often use when trying to understand innovation is the social construction of technology (known as SCOT theory) which generally claims that technology does determine human action, rather human action shapes technology. SCOT theory usually helps improve our understanding of technology. According to Klein and Kleinman (2002), the social construction of technology theory sometimes offers attractive propositions of use in a largely structural analysis; this avenue has been ignored in favour of a method that offers no means to evaluate the relative capacity of actors in shaping artefact construction. Klein and Kleinman (2002, p.50) further opined that, "*With a conceptual focus on groups and social interactions, scholarship in this field has made little progress toward identifying structural influences on technological change. Both the need and the opportunity exist for a broader research project*". Another theory considered is the Actor Network Theory (ANT). According to Ritzer, (2004, p.1), "*actor network theory is a conceptual frame for exploring collective sociotechnical processes, whose spokespersons have paid particular attention to science and technologic activity, stemming from a science and technologies studies interest in the elevated status of scientific knowledge and counter to heroic accounts or innovation models*". This study did not adopt the actor network theory but it did use an element of the theory from Ligny and Erkelens (2009) research on actor network in construction innovation system to help guide the researcher on potential opinion leaders within the Nigerian building industry (see figure 5.4).

Nevertheless, many researchers also use Rogers's diffusion of innovation theory to investigate technology diffusion and adoption (Medlin, 2001). Egmond and Erkelens (2008), successfully uses the same theory to identify the construction technology diffusion in developing countries. Therefore, an extensive literature review on Roger's diffusion of innovation theory will be carried out to investigate the particularities of diffusion mechanism that may possibly have an impact on the successful exploitation of innovative solution for the use of prefabricated local building materials for low cost house building in Nigeria. The theory will provide the basis for developing research question; data analysis and can help to identify the weakness to be addressed in this study and draw a theoretical comparison to the findings of this research. This chapter will study meticulously the theory of diffusion of innovation and how the theory will be applied to the overall research. The chapter is divided in to six sections. The first section examines the diffusion of innovation trend and explains why Rogers's diffusion of innovation theory is adopted in this research. The second section examines the main components in Rogers's diffusion of innovation theory. The third section investigates the Rogers's approaches to identifying opinion leaders. The fourth section examines Rogers's innovation decision process. The fifth section explores the Rogers' attributes of innovation and adoption rate, and the last section examines the Rogers' adopter categories.

5.2 The Diffusion of Innovation Trend

The Diffusion of Innovation was first discussed in 1903 by Gabriel Tarde a French sociologist who plotted the S-shaped Diffusion curve, see figure 5.3 (Couros, 2003; Toews, 2003). Adopting Tarde's approach, Couros (2003), argues that innovations with a comparatively quick adoption rate and those with a slower rate can be recognized using S-Curve. According to Rogers' (1995) and Rogers' and Scot, (1997), a study conducted by Ryan and Gross at Iowa State University in 1943 provided the origin of contemporary diffusion research. Rogers' further added that the study conducted by Ryan and Gross, from the subject of rural sociology, "*use interviews with adopters of an innovation to examine a number of factors related to adoption*". The study uses interview-based methodology which ever since remained the main methodology used in diffusion research. Moreover, in 1957 Katz introduced the notion of opinion leaders, opinion followers and how the media interrelate to persuade both groups.

Numerous researchers from rural sociology and other fields have built on the Ryan and Gross study to develop theories related to the diffusion of innovations, but the researcher who has done the most to produce all of the most important findings and persuasive theories related to diffusion is Everett M. Rogers'. Rogers's first book on diffusion of innovation was published in 1960 (Sherry & Gibson, 2002). According to Surry (1997), it, is the closest any researcher has come to presenting a unified theory of diffusion. The four theories of diffusion discussed by Everett M. Rogers' includes: Innovation Decision Process, Individual Innovativeness, Rate of Adoption and Perceived Attributes (Rogers', 2003).

Surry (1997) further argues that, the major significant fact to be considered in discussing diffusion theory is that it is not one distinct, combined, and complete theory. Diffusion of Innovation Theory is frequently considered as a valuable change model for technological innovation guidance where the innovation is adapted and presented in ways that meet the requirements of all adopter's categories (Kaminski, 2011).

Diffusion Theory signifies a complex number of sub-theories that jointly study the process of adopting an innovation (Couros, 2003). Researchers investigate implementation processes and diffusion outcomes for innovation to both understand and improve their market acceptance rates (Taylor and Levitt, 2007). One of the most widely held theories of communication in marketing is diffusion theory. According to Wright and Charlett (1995), diffusion is a type of communication in which the messages are concerned with a new initiative to the members of the population. According to Rogers' (1983), the diffusion process consists of four key elements, which include: an innovation, the social system on which the innovation impacts, the communication channels of that social system, and time. Wright and Charlett further added that diffusion theory mainly focuses on ways of disseminating information about an innovation to or within a social system.

According to Couros (2003) "*the common lens through which theorists study the adoption and development of new ideas*" is known as Innovation Theory or Diffusion Theory. Diffusion is the process "*in which an innovation is communicated through certain channels over time among the members of a social system*" (Rogers', 2003, p.5). Couros (2003) further defined Diffusion as "*the process by which an innovation is adopted and gains acceptance by individuals or members of a community*". Therefore, diffusion may possibly be considered as a sequence of adoptions (Hartmann, 2006). Through these processes "*an individual passes from first knowledge of an innovation, to the formation of an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and to confirmation of this decision*" (Rogers', 2003). According to Froese and Rankin (2009), to advance from a new initiative to one that is standard in practice, the steps are usually attributed to demand and supply. The supply side includes: research, develop, and deploy and the demand side includes: adoption, implementation, and acceptation (Froese and Rankin, 2009).

So many researchers from a wide range of disciplines have utilized the diffusion of innovation model as a framework. These disciplines include; public health, political science, technology, education, economics, history and communication (Rogers' and Scot, 1997; Stuart, 2000; Salveron *et al*., 2006; McLaren *et al*., 2008). Stuart (2000) further added that Rogers's theory is one of the most widely used theoretical frameworks in technology diffusion and adoption. According to Medlin (2001), Rogers's theory of diffusion innovation is the most appropriate for examining the adoption of new technology. Rogers's model could help a researcher to consider the basic forces, which affect both adoption rates and the factors that could lead to the negative response to an innovation. Therefore this study uses Rogers's theory to investigate and develop a framework that facilitates the use of local building materials in the production of offsite-prefabricated components for low-cost housing in Nigeria. The key objective of this research is to identify and understand the reasons why the diffusion of local building materials for prefabricated low-cost housing fail to be fully adopted even though they promise a superior performance compared to incumbent technologies.

5.3 Main components in Diffusion of Innovation

As expressed above by Rogers's definition of diffusion: innovation, communication channels, time, and social system are the four key components of the diffusion of innovations.

5.3.1 Innovation

According to Rogers' (2003, p.12) "*An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption*". However, an innovation could be invented a long time ago, but it depends on people's awareness. If people perceive it as new, then it may still be an innovation for them (Sahin, 2006). According to Froese and Rankin (2009), an innovation is the mechanism at the center of the key strategic goal of continuous development. An innovation system is seen as different institutions that individually contribute to innovation i.e., the development, diffusion and implementation of new competitive technologies (Ligny and Erkelens, 2008). Ligny and Erkelens, (2008) further added that, it offers the framework in which the government form and implement policies to influence the innovation process.

5.3.2 Communication Channels

According to Rogers' (2003, p.5), *Communication is "a process in which participants create and share information with one another in order to reach a mutual understanding*". Communication takes place via channels between sources. Thus, according to Rogers' (2003, p.204), "*source is an individual or an institution that* *originates a message*". Rogers' further defines Channel, as "*the means by which a message gets from the source to the receiver*".

Diffusion is a particular kind of communication that includes these communication elements: Mass media and Interpersonal communication (Rogers', 2003). Mass media channel includes mass medium such as TV, Newspaper and radio. An interpersonal channel involves a two-way communication between two or more individuals. Rogers' further added that diffusion is a social process that engages interpersonal communication relationships. As a result, interpersonal channels are more powerful to create or alter strong attitude held by individuals (Sahin, 2006; Bates *et al*., 2007; Kaminski, 2011). It is argued that distant marketing methods like advertising and media stories may spread information about new innovations, but it's conversations that spread adoption (Agarwal and Prasad, 1998; Lee *et al*., 2002; Rogers', 2003; Robinson, 2009). According to Bero *et al.,* (1998), current research suggests that face-to-face communication strategy is the most effective way of passing information.

Communication features that are seen to play a vital position in raising awareness and developing insight into innovation attribute includes; the source, the mode and the quality of communication (Lee *et al*., 2002). According to Frambach and Schillewaert (2002) the communication quality within a social system strongly affects whether a potential adopter becomes aware of an innovation and how this organisation or individual perceives the attributes of the innovative solution. The key source of information include stakeholders such as clients, suppliers or business partners, independent third parties such as government agencies or research institutions, and personal sources such as friends or near peers (Lee *et al*., 2002).

5.3.3 Time

According to Rogers' (2003), the time aspect is ignored in most behavioural research. Roger's argues that including the time dimension in diffusion study demonstrates one of its strengths. The innovation diffusion process, adopter categorization, and rate of adoptions all include a time dimension. This detail of Rogers's theory will be discussed later in more detail. According to Rogers' and Scot (1997), time dimension is involved in few ways in the diffusion process, which includes; in the innovation decision process and in the innovativeness of an individual or other unit of adoption.

5.3.4 The Social System

According to Hartmann (2006), communication features and insight of innovation attributes show that the adoption route is nested within a specific social context or system (Hartmann. 2006). The social system members or units may be individuals, informal groups or organizations. Rogers' (2003, p.23) defined the social system as "*a set of interrelated units engaged in joint problem solving to accomplish a common goal*". Sahin (2006) stated that, since diffusion of innovations takes place within the social system, it is influenced by the social structure of the social system. Rogers further noted that the nature of the social system affects individuals' innovativeness, which is the main criterion for categorizing adopters. Thus, the social systems form a frontier within which an innovation diffuses. At different phases in the diffusion of the innovation, individuals are regarded as either leaders or followers (Perry, 2003). Rogers' (2003) stated that, Opinion leaders are capable of exerting a positive influence over their contacts and to promote the utilization of an innovation. Support from opinion leaders is significant for encouraging change. According to Rogers' (2003), an innovation is more liable to gain fame within a social system when opinion leaders are supportive; on the other hand, opinion leaders can prevent the dispersal of innovations they see negatively. According to Walker (2006), influence can play an important part in the diffusion of innovation.

Opinion leadership is the extent to which an individual is capable of influencing casually other individuals' outlook or unconcealed behaviour in a required way with relative frequency (Rogers' and Scot, 1997). Rogers (1995) argues that, Opinion leaders with higher status and who are fairly more innovative than their peers play a very important role in convincing the sceptical majority of their peers. They help to overcome concern about the risks and expense of adoption by taking up the innovation by themselves (Rogers', 1995). However, opinion leaders are usually sought out by the change agents. A change agent is an individual who tries to persuade clients' innovation decisions in a path that is considered pleasing by a change agency (Rogers and Scot, 1997). According to Rogers' (1995), change agents create demand for innovation by decreasing barriers to adoption, convincing adopters and supporting adoption decision. However, Rogers' further argued those change agents are mainly effectual when they work affiliated with opinion leaders (Rogers', 1995). According to Rogers' (2003), during the social comparison process, the opinion of some individual or organization is stronger than others. These individuals or organizations are known as opinion leaders (Rogers', 1995; 2003). Opinion leaders are people who are respected for their knowledge and reputation on some particular topic (Bertrand, 2004). Opinion leaders usually are prestigious and reputable, thus have the ability to influence decision shift towards adoption or rejection (Rogers', 2003).

According to Rogers' (2003) Interpersonal communications between professionals and the public, opinion leaders and the community, and amid family and friends are evenly as vital as mass communications in the technology adoption process. Rogers' further added that knowing the perspective of opinion leaders and others (friends, family etc.) is a significant element of the social comparison procedure leading to choice change. Sometimes, structure and culture must change considerably to adopt and the public requires assurances from opinion leaders to make such a change (Rogers', 2003).

5.4 Change Agent

The communication between change agent and individual is usually supported by similarity in socio-economic features and it is also hindered by difference socio-economic characteristics. Understanding and working within communication networks of potential adopters may perhaps assist the change agent in terms of personal persuasion.

5.4.1 Five Approaches to Identifying Opinion Leaders

According to Rogers' (2003) there are five approaches on how change agents can identify opinion leaders. The approaches listed below are drawn from Rogers' (2003) and differ in their cost of implementation and correctness in locating opinion leaders.

5.4.1.1 Positional

In terms of positional approach individuals in elected or appointed positions in the community are regarded to be opinion leaders. This approach is economical, but the approach can be extremely imprecise because rather than through respect, it assumes opinion leadership based upon position.

5.4.1.2 Self Designating

In this approach, selected individuals are being asked to identify themselves as being influential on particular issue. The approach has the benefit of getting input on influence from community members and as a result is better than the positional approach. This approach is a bit more expensive; in this the change agent usually travels around a particular community to interview individuals for the needed information. A potential drawback of the self-designating approach is that individuals might over or under estimate their influence on others.

5.4.1.3 Reputational

This approach relies on selected individuals within a community. It's usually based on nomination for instance choosing the ten most influential people in the community regarding a related particular issue. Using this approach usually improves the precision of recognizing opinion leaders because one is getting information from more than one source about the influence of others in the community. Usually, individuals using the reputational approach will "snow ball" their nominations from key informants. Key informants are individuals who have a comprehensive knowledge of the community and how it works.

5.4.1.4 Sociometric

In sociometry, opinion leaders are chosen from a list of potential opinion leaders using sophisticated network analysis software (Rogers', 2003). The change agent uses the socio-metric system to locate the right opinion leaders about a certain issue area.

5.4.1.5 Observation

According to Rogers' (2003) some opinion leaders choose by their persona to be located a bit outside the everyday communication pattern instead of being at the centre of communication network. However, the problem with this type of approach is that status could sometimes be deceptive.

5.5 Innovation Decision Process

Innovation decision process can be defined as "*an information seeking and information processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation*" (Rogers', 2003, p.436). The innovation decision process involves five steps: knowledge, persuasion, decision, implementation, and confirmation (Rogers', 2003). See figure 5.1.

5.5.1 Adoption process

The adoption process aims at seeking and dispensing information to reduce the uncertainty about the benefits and barriers of an innovation (Rogers', 2003). Thus, the factors that drive the adoption of innovation require explanation (Walker, 2006). Hartmann (2006) stated that the possibility of adoption increases if benefits and standards of a new invention or service surpass that of alternative. According to Wolfe (1994) innovation diffusion is concerned with the diffusion of innovation through a population of potential adopter organizations over time.

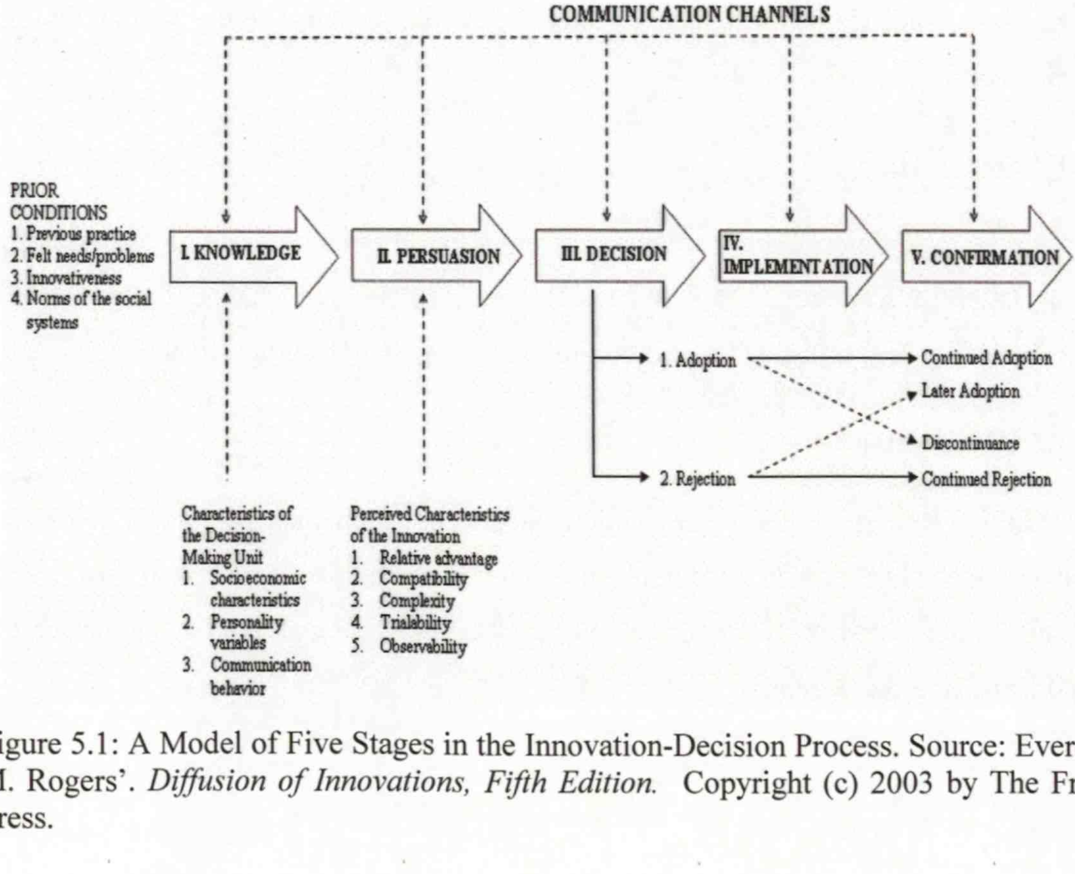

Figure 5.1: A Model of Five Stages in the Innovation-Decision Process. Source: Everett M. Rogers'. *Diffusion of Innovations, Fifth Edition.* Copyright (c) 2003 by The Free Press.

5.5.2 Knowledge Stage

The knowledge stage is the first in the Innovation decision process. During the knowledge stage individual learns about the existence of innovation and looks for information concerning the innovation. Unless potential adopters know about an innovation and its potential benefits, the new initiative is not likely to be put into practice (Hartmann, 2006). The critical questions in the knowledge phase are usually "What?" "How?" and "why*?"* (Sahin, 2006). According to Rogers' (2003, p.21), during this stage, individuals try to find out "*what the innovation is and how and why it works*". According to Rogers', the query outlines three type of knowledge: awareness knowledge, how to knowledge, and principles knowledge.

5.5.2.1 Awareness knowledge

This type of knowledge characterizes the knowledge of the innovation's existence. Awareness knowledge can stimulate the individual to learn more regarding the innovation and adopt it in due course. Furthermore, it could persuade an individual to learn about other two types of knowledge.

5.5.2.2 How to knowledge

This type of knowledge, deals with how to utilize an innovation correctly. In order to boost the chances of innovation adoption, an individual must have a satisfactory level of how to knowledge before the trial of the innovation.

5.5.2.3 Principles knowledge

The last type of knowledge is the principle knowledge, it deals with the performance values describing how and why an innovation works. Rogers' (2003) stated that an innovation can be adopted without this type of knowledge, but the abuse of the innovation may possibly cause its discontinuance. Knowledge about purpose and usage of an innovation is imperative to achieving a positive attitude towards an innovation (Hartmann, 2006). Understanding the functional values of a new idea and the way to utilize it appropriately increases the chances of adoption, as the adopter is able to evaluate the effectiveness of the idea (Rogers', 2003). Many studies indicate that the adoption rate grows exponentially as the knowledge of a product increases (Hartmann, 2006).

5.5.3 The Persuasion Stage

The persuasion stage happens when the individual has a different perception (negative or positive attitude) towards the innovation, but *"the formation of a favourable or unfavourable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection"* (Rogers', 2003, p.176). The persuasion stage comes after the knowledge stage in the innovation decision process. In the persuasion stage, the individual already has an idea about the innovation; thus, the individual characterizes their attitude towards the innovation. According to Rogers' the persuasion stage is more effective. Therefore the individual is more sensitively involved with the innovation at this stage. Sahin (2006) stated that the level of uncertainty regarding the innovations performance and the social support from other individuals affect the beliefs and opinions about the innovation.

5.5.4 The Decision Stage

During the decision stage, the individual decides to adopt or reject the innovation. However, according to Rogers' (2003, p.177), adoption is defined as the *"full use of an innovation as the best course of action available,"* whereas rejection signifies *"not to adopt an innovation".* Sahin (2006) stated that if an innovation has a "partial trial basis", it is generally adopted more rapidly, since most individuals prefer to try the innovation in their own circumstances before deciding whether to adopt or not. The explicit trial could help in the decision process. However, rejection is likely in every step of the innovation decision process.

5.5.5 The Implementation Stage

The Implementation stage is where an innovation is put into practice. According to Rogers' (2003, p.6), an innovation brings the newness in which *"some degree of uncertainty is involved in diffusion".* The doubts about the performance of an innovation could still be a problem at this stage. Therefore, Individuals may need technical support from change agents to decrease the level of uncertainty concerning the consequences (Sahin, 2003). Furthermore, the new decision process will end, given that the innovation loses its unique quality as the detached characteristic of the innovative initiative disappears (Rogers', 2003).

During the implementation stage, the idea of reinvention usually occurs; therefore it is a significant part of this phase. Rogers' (2003) defines Reinvention as "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation". Rogers' further argues that the more reinvention takes place, the more quickly an innovation is accepted and becomes institutionalized.

5.5.6 The Confirmation Stage

The innovation-decision has already been made in this stage. However at this stage the individuals seek support for the decision. According to Rogers' (2003), this decision can be inverted if the individual has uncovered some sort of contradictory messages about the innovation. Nevertheless, the individual chooses to stay away from the conflicting messages and tries to find encouraging messages that validate his or her decision. According to Rogers' (2003), attitude becomes crucial at this stage. Later adoption or discontinuance takes place at this stage, depending on the individual attitude and support for adoption of the innovation (Sahin, 2006).

During this stage, individual may decide to discontinue in two ways. The individual may decide to reject the innovation and adopt another one to replace it. This type of discontinuance decision is called Replacement discontinuance (Rogers', 2003; Sahin, 2006). The other type of discontinuance decision is known as Disenchantment discontinuance. In Disenchantment discontinuance, the individual decides to reject the innovation due to lack of satisfaction with the performance of the Innovation (Rogers', 2003; Sahin, 2006).

5.6 The Attributes of Innovation and Adoption Rate

Diffusion of Innovations takes a completely different approach to most other theories of change. Instead of focusing on persuading individuals to change, it sees change as being primarily about the evolution or reinvention of products and behaviours so they become better fits for the needs of individuals and groups (Robinson, 2009).

The innovation diffusion process is defined as an "*uncertainty reduction process*" (Rogers', 2003, p.232). Thus, negative barriers influence how individuals perceive the characteristics of an innovation and the speed with which it is diffused (Hubbard and

Sandmann, 2007). Rogers' proposes attributes of innovations to help reduce uncertainty about the innovation. According to Rogers' 2003 there are five elements of new or alternative established actions that will each fairly determine whether adoption or diffusion of a new innovation will occur. These five stages may possibly be utilized to conceptualize the adoption process and make reality simpler to a certain level (Hartmann, 2006). They include; Relative advantage, Compatibility, Complexity, Trial-ability and Observability (Rogers', 1995; 2003). According to Rogers' (2003, p.219), "*individual's perception of these characteristics predicts the rate of adoption of innovations*".

Rate of adoption is the "*relative speed with which an innovation is adopted by members of a social system*" (Rogers' 2003, p.221). According to Rogers', relative advantage is the strongest forecaster of the adoption rate of an innovation. Although other elements such as the innovation decision type, social system, communication channels, and change agents may enhance the certainty of the adoption rate of innovations as well.

5.6.1 Relative advantage

Rogers' (2003, p.229), defined relative advantage as "*the degree to which an innovation is perceived as being better than the idea it supersedes*". This definition is supported by (Greenhalgh *et al.*, 2004 and Robinson, 2009). Innovations that have a clear, unambiguous advantage in either effectiveness or cost effectiveness are more easily adopted and implemented (Greenhalgh *et al.*, 2004). If potential users see no relative advantage in the innovation, they generally will not consider it further (Rogers', 1995). According to Sahin (2006), the cost and social status motivation aspects of innovations are elements of relative advantage. Sahin further added that to boost the adoption rate of an innovation and to make relative advantage more effective, incentives may be used to support the individuals of a social system in adopting an innovation. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption is likely to be (Robinson, 2009). Rogers' and Scot (1997) argue that, the extent of relative advantage may be measured in economic stipulations, but social status, expediency, and contentment are also important factors. Rogers' and Scot (1997) further added that it does not matter how advantageous an innovation is what matters the most is if an individual perceives the innovation to be advantageous. According to Denis et al., (2002), Fitzgerald *et al*., (2002) Grimshaw *et al*., (2004) Relative advantage alone will not assure wide spread adoption. Thus, other elements of innovation diffusion should be included.

5.6.2 Compatibility

According to Rogers' (2003, p.15) compatibility is the "*degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters*". This definition is further supported by (Robinson, 2009). Innovations that are compatible with the intended adopter's principles, standards, and perceived needs are adopted more readily (Rogers', 1995; Denis et al. 2002). If an innovation is compatible with an individual's needs, then uncertainty will decrease and the rate of adoption of the innovation will increase. Rogers' (2003) further argues that, an idea that is incompatible with individual standards, norms or practices will not be adopted as rapidly as an innovation that is compatible.

5.6.3 Complexity

According to Rogers' (2003, p.15), complexity can be defined as "*the degree to which an innovation is perceived as relatively difficult to understand and use*". As Rogers' stated, opposite to the other attributes, complexity is negatively linked with the adoption rate. Simple and straightforward innovations are more easily understood and adopted more rapidly when compared to complicated innovation that requires the adopter to develop new skills and understanding (Rogers' 1995; Meyer, Johnson, and Ethington 1997; Denis *et al*. 2002; Robinson, 2009). Rogers' (1995) further added that organizational innovation with less response disadvantages is more easily incorporated. Intervention to reduce the rate and amount of such response barriers may perhaps ameliorate the adoption rate.

5.6.4 Trialability

According to Rogers' (2003, p.16), trial-ability can be defined as "*the degree to which an innovation may be experimented with on a limited basis*". Robinson (2009, p.2) further defines trialability as "*an innovation that is trialable represents less uncertainty to the individual who is considering it*". Moreover, trialability is positively linked with the adoption rate. Plsek (2003) argues that, innovations that permit the intended users to experiment on a limited basis are more easily understood and adopted. Trial-ability helps reduce the uncertainty of an innovation and may possibly boost the rate of adoption. However, Rogers' (2003) stated that earlier adopters see the quality of trial-ability of an innovation as more significant than later adopters.

5.6.5 Observability

According to Rogers' (2003, p.16), observability can be defined as "*the degree to which the results of an innovation are visible to others*". According to Denis *et al*., (2002) if the benefits of an innovation are clearly visible to intended adopters, it will be more easily and quickly adopted. If an innovation results is visible the uncertainty will be lowered and also stimulate peer discussion of a new idea (Robinson, 2009).

The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Such visibility stimulates peer discussion of a new idea, as friends and neighbours of an adopter often request innovation evaluation information about it (Rogers' and Scot, 1997). According to Harder (2009), relative advantage and compatibility are considered to have the most influence on the adoption rate. Rogers' (1995) stated that reinvention could also help in speeding up the adoption rate of an innovation.

5.6.6 Reinvention

The Degree at which an innovation is changed and modified as the adoption and implementation process is executed is referred to as Reinvention (Kaminski, 2011). Rogers' (1995) stated that, innovation could be easily adopted if potential adopters can adapt, refine or modify the innovation. Reinvention is among the key standards in the innovation diffusion process. The accomplishment of an innovation depends on how well it develops to meet up the desires of more challenging and unwilling risk of individuals of the population (Robinson, 2009). Robinson (2009) further stated that the best way to improve innovation is to make users partners in a continuous process of redevelopment. Robinson (2009) further added other companies; institutes and corporations make users active partners in ameliorating innovation by supporting user community.

5.7 Adopter Categories

According to Rogers' (2003, p.22) the adopter categories can be defined as "*the classifications of members of a social system on the basis of innovativeness*". This classification comprises innovators, early adopters, early majority, late majority, and laggards (Rogers' and Scot, 1997). Rogers' (2003) further stated that in each adopter category, individuals are alike in terms of their innovativeness. Thus Innovativeness "*is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system*" (Rogers', 2003, p. 22). Diffusion researchers believe that people can be categorised into five different sections, based on their tendency to adopt a specific innovation (Robinson, 2009).

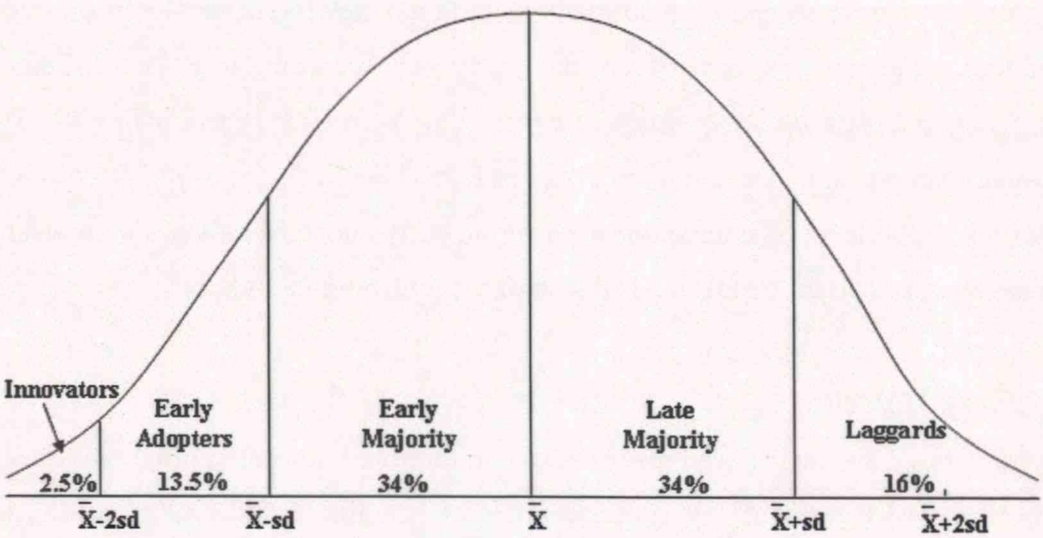

Figure 5.2: Adopter Categorization on the Basis of Innovativeness (Source: *Diffusion of Innovations, fifth edition* by Everett M. Rogers'. Copyright (c) 2003 by The Free Press.

5.7.1 Innovators

According to Rogers' (2003), innovators were keen to experience with new ideas. Therefore, they have to be ready to cope with running at loss and unsuccessful innovations, and a firm stage of ambiguity about the innovation. Rogers further added that innovators are the key actors bringing the innovation in from outside of the system. Robinson (2009) stated that the process of adoption starts with a little number of creative thinkers and inventive innovators. Robinson further added that innovators often spend a lot of time, energy and creativity on developing new ideas and gadget. Therefore, the innovator must be able to deal with a high level of uncertainty about an innovation at the time of adoption (Kaminski, 2011; Schuler, 2002).

5.7.2 Early Adopters

Early adopters are not too far ahead of the average individual in innovativeness; therefore, they are perceived as leaders for many other members of a social system (Kaminski, 2011; Rogers', 2003; Schuler, 2002). Rogers' (2003) stated that since early adopters are more liable to become leaders in the social system, other members come to them for advice on information about the innovation. Rogers', further argues that, early adopters leadership in adopting the innovation reduces doubt about the innovation in the diffusion process. This adopter category is usually sought after by a change agent as a messenger for speeding up the process of diffusion (Kaminski, 2011; Rogers', 2003; Schuler, 2002). According to Robinson, (2009) early adopters jump in once the benefits start to become obvious and they normally have the money to spend. Robinson further stated that social status is one of their major drivers. According to Rogers', (2003, p. 283), "*early adopters put their stamp of approval on a new idea by adopting it*". They are usually simple audience and do not require a great deal of persuasion. According to Perry (2003), the level of interpersonal power an early adopter holds in the innovation decision process will influence the diffusion of the innovation to others.

5.7.3 Early Majority

Early majorities are realist who are usually comfortable with fairly progressive ideas, but won't proceed without any concrete proof of benefits (Schuler, 2002; Robinson, 2009; Kaminski, 2011). Robinson, (2009) further noted that most of the early majorities are sensitive to cost, unwilling to take risk and hate complexity. According to Rogers' (2003), although the early majorities have good relationship with other members of the social system; they do not have the leadership position that early adopters have. However, their networks are still significant in the innovation diffusion process and they are neither the first nor the last to adopt an innovation (Rogers', 2003). Therefore, their decision on innovation usually takes more time in comparison to innovators and early adopters.

5.7.4 Late Majority

The late majority comprise of one third of all members of the social system who wait until majority of their social class adopt the innovation (Rogers', 2003). Basically their only driver is the fear of not fitting in; that's why they will follow normal style and established standards (Robinson, 2003). Though they are cynical about the innovation and its end result, economic necessity and peer pressure may well lead them to adopt the innovation (Rogers', 2003). Moreover, attention should be focused on encouraging social standards rather than product benefits alone. Robinson further noted that the late majorities are often influenced by the doubts and views of laggards. The burdens of system norms have to positively favour an innovation before the late majority are persuaded (Schuler, 2002; Kaminski, 2011).

5.7.5 Laggards

According to Rogers' (2003), laggards are more cynical about innovations and change agents than the late majority. Rogers' further noted that due to limited resources and the lack of knowledge-awareness of innovations, the laggards want to be positive about the quality and standard of a particular innovation before they adopt. According to Sahin (2006), laggards take a longer period of time before deciding to adopt an innovation. Laggards are those who see a high risk in adopting a particular innovation (Robinson, 2009). Robinson, (2009, p.8) further suggested that "*laggards should be giving high levels of personal control over when, where, how and whether they do the new behaviour and maximise their familiarity with new products or behaviours*".

According to Rogers' (2003), the five categories of adopters can be separated into two focal groups: earlier adopters and later adopters. Earlier adopters consist of innovators, early adopters, and early majority, while the later adopters consist of late majorities and laggards.

5.8 Rate of Adoption

According to Rogers' (1995, p. 37) the, "*rate of Adoption is the relative speed with which an innovation is adopted by members of a social system. The theory states that innovations are diffused over time in a pattern that resembles an s-shaped curve*" (Rogers', 1995). The theory further stated that an innovation goes via an era of slow, steady growth before going through a period of quite dramatic and hasty growth. The theory also states that subsequent after the period of rapid growth, the innovation's rate of adoption will gradually remain steady and ultimately decline (Surry, 1997). The path the cumulative adoption of an innovation takes between introduction and saturation is generally modelled by an S curve (Meade and Islam, 2006).

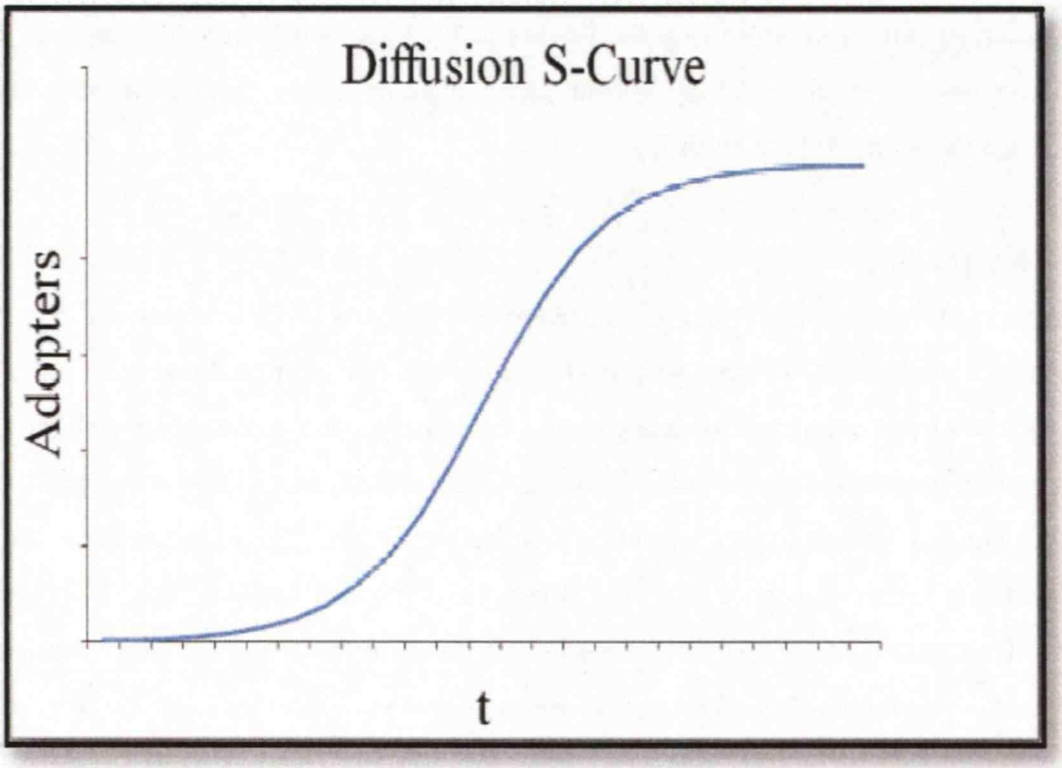

Figure 5.3: S-Shaped Innovation Curve (Source; Sheffer and Levitt, 2010).

5.9 Actor Network Diagram of Construction Innovation System

The terms actor and network are interconnected in an effort to avoid the distinction between agency and structure, an essential concern within sociology (as well as other disciplines) (Ritzer, 2004). According to Cressman (2009), everything can be considered both an actor and a network it is simply a matter of viewpoint. The aim of this research is to identify and understand the reasons why the diffusion and utilization of offsite prefabrication construction techniques using local building materials fail in Nigeria, even though they promise a superior performance compared to traditional techniques of construction. Therefore, the study will involve communication with the individuals and organizations that are familiar with the proposed innovation techniques. Diffusion is accomplished through human interactions and communication between members of a community of Practice (Rogers', 1995).

In the usual course of events, the public and the private sector of the Nigerian building industry are the main actors within the housing sector. The public and private sector of Nigerian building industry usually comprises of interconnected organisations that work closely to affect change within the building industry. According to Ligny and Erkelens (2008), innovation-supplying actors (opinion leaders) within construction industry of developing countries usually involves designers (architect, engineers and quantity surveyors), building materials suppliers, construction companies/organisation and Research and development institutes. The knowledge and perceptions of these actors in the diffusion and utilization of prefabrication techniques of construction using local building materials within the Nigerian building industry will be vital to achieving the main aim and objectives of the study. Nevertheless, opinion leaders involve in innovation supporting and regulating are financing organization, national, regional and local government and public agencies, R&D, education institutes, information centres. See figure 5.4. The stakeholder network was adopted to assist in guiding the researcher to identify the innovation opinion leaders within the building industry of Nigeria.

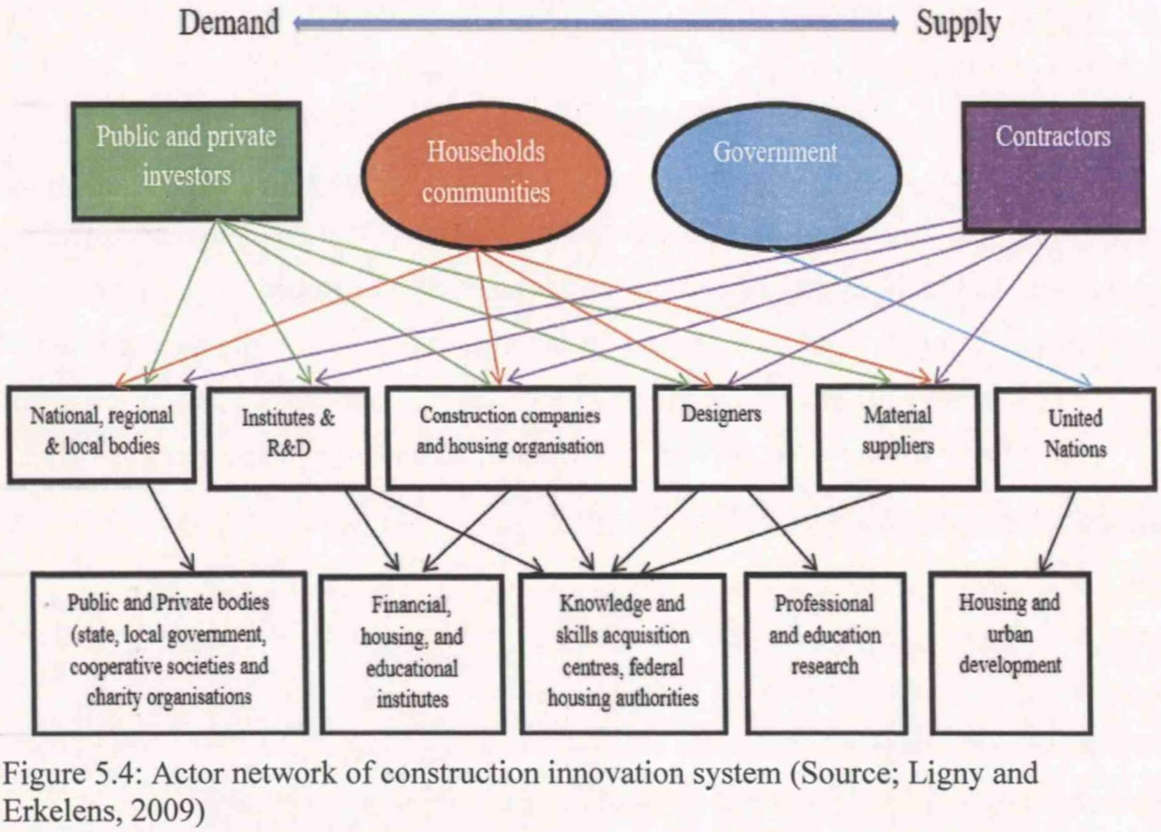

Figure 5.4: Actor network of construction innovation system (Source; Ligny and Erkelens, 2009)

5.10 Conclusion

The above Theories adopted provide the basis for developing the questions and analysing data. It helps identify weakness to be address when improving products or behaviours. These five attributes of innovation make an important checklist to structure interview discussion or research evaluations. However the Rogers' diffusion of innovation theory will be used as a guide to setting the research question by concentrating on the important elements of the study as well as focusing on the right target individuals. The diffusion of innovation theory will be applied to help investigate some of the objectives of the study.

Rogers' theory helped tremendously in developing a pattern through which some of the research questions are developed and it helped in narrowing the target respondents within the building industry of Nigeria. Rogers's theory help to inform the communication channels through which the research should be carried out. A particular focus will be giving to the Rogers's innovation decision process. In the innovation decision process, Rogers's identified some factors (such as, relative advantage of an innovation, trial-ability of an innovation, complexity of an innovation, observe-ability of an innovation and compatibility) that affect the diffusion and utilization of an innovation within a society.

The stakeholders network diagram adopted from Erkelens and Lingy on actor network has help to identify the key individuals and organizations that are considered opinion leaders as well as the target respondents for this research. The Rogers' theory adopted in this chapter is useful to this study especially in terms of preparations for data collection. The next chapter will examine the methodology used for this research. The chapter will also identify the theoretical framework that will help to underpin this research as well as determine the philosophical stand of the research.

CHAPTER SIX

RESEARCH METHODOLOGY

6.1 Introduction

The comprehensive literature review carried out in the previous chapters helped to understand and stimulate the conceptual issues that seek to ascertain why local building materials are not utilized in the production of offsite prefabricated components for low cost house building provision within the building industry of Nigeria. The literature review carried out also formed the basis for determining the appropriate theory adopted to underpin the work. This research is dealing with an on-going problem concerning an innovative method of construction within the building industry of Nigeria. However, it is appropriate from the beginning to recap what the aim and objectives of the research are.

The aim of this research is to examine the utilization of local building materials in the production of offsite-prefabricated components for low-cost house building in Nigeria through the formal building sector.

The objectives of the study are:

1. To examine the degree to which local building materials have been utilized in offsite prefabrication construction methods.
2. To identify the factors that affect the diffusion and use of local building materials for offsite prefabrication components.
3. To explore the potential for the utilization and diffusion of local building materials for prefabricated low-cost house building.
4. To develop a framework for understanding the utilization and diffusion of offsite prefabricated local building materials towards the provision of low-cost house building in Nigeria.

6.2 Philosophical underpinning

Many researchers have argued about research strategies and methods (how knowledge is generated and acquired and which method is best in acquiring that knowledge) for a very long time (Krauss, 2005; Creswell, 2003). Despite the argument on qualitative and quantitative methods of research, each method is based on a particular paradigm, a patterned set of assumptions concerning ontology (reality), Epistemology (Knowledge of that reality) and Methodology (which is a way of knowing that reality) (Guba, 1990). Every study is a link to a set of philosophical assumptions and stances (Greene and Garacelli, 1997). Creswell (1998), define paradigm as a "*basic set of beliefs or assumptions that guide a researcher's inquiry*" (p. 74).

In the paradigm of the positivists (and post-positivist), the object of study is independent of the researchers; the discovery and verification of knowledge is through direct measurement and observation of phenomena and facts are determined by taking apart a phenomenon to study its elementary parts (Krauss, 2005). Positivism prevails in science and assumes that science quantitatively measures independent facts about one comprehensible reality (Healy and Perry, 2000). In this case data and its analysis are value free and it does not change because they are observed (Krauss, 2005). Positivists researchers isolate themselves from the world they study, whereas, researchers from other paradigm participate in the real world to have a better understanding of a certain phenomena and express it's growing characteristics and properties (Healy and Perry, 2000).

Positivism is also linked to "post-positivism", which refers to the thinking after positivism, challenging the view of the total truth of knowledge and realizing that we cannot be constructive about our claims of knowledge when examining the actions and behaviour of humans (Phillips and Burbules, 2000). According to Creswell (2003), the problems studied by the post-positivism reflect a need to examine causes that influence outcomes, such as issues examined in experiments. "*It is also reductionist in that the intent is to reduce the ideas into a small, discrete set of ideas to test, such as variables that constitute hypotheses and research questions*"

Constructionism or naturalist view, regard knowledge establishment through the connotations attached to the phenomena studied; in this case they believe reality to be socially constructed and only knowable from multiple and subjective points of view. The knower and the known are seen as inseparable (Rocco *et al.*, 2003). Constructionism assumes that individuals develop subjective meaning of their experience, meanings directed towards certain objects or things (Cresswel, 2003). Constructivists rely on participant's views of the situation being studied.

Rossman and Wilson (1985) stated that, in pragmatist's worldview, researchers highlight the research problems and utilize all methods available to understand the problem. As a philosophical underpinning for mixed methods research, pragmatist views focus on the research problem in social science research and then uses mixed methods to derive knowledge concerning the problem (Morgan, 2007; Patton, 1990). "*There are many forms of philosophy, but for many, pragmatism as a world view arises out of actions, situations, and consequences rather than antecedent conditions as in postpositivism*" (Cresswell, 2014, p10).

Therefore, in order to investigate the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria, there is the need to systematically seek for the appropriate philosophical assumption to better understand the phenomena within the context of the building industry of Nigeria. The research philosophy adopted in this study is the pragmatic worldview. Pragmatism is not committed to anyone system of philosophy and reality (Cherryholmes, 1992). According to Morgan (2007) and Cherryholmes (1992), researchers have a freedom of choice to choose the techniques, methods and procedures of research that best suit their needs and purposes. Mixed method researchers seek for different approaches to collect and analyse data rather than subscribing to a single way, because pragmatists do not see the world as an absolute unity (Morgan, 2007; Cherryholmes; 1992). The philosophical approaches are important in understanding and providing a framework for any research study. Thus, it is vital to clarify how these philosophical considerations (Epistemology, Ontology and Axiology) helped in shaping and underpinning this research.

6.3 Research Philosophical Considerations (Epistemology and Ontology)

6.3.1 Ontology

The ontological assumption between many qualitative and quantitative researchers differs. "*Many qualitative researchers do not assume that there is a single unitary reality apart from our perception*" (Krauss, 2005, p.760). Therefore, the phenomena of many realities exist since everyone experiences different realities from their point of view. Consequently, based on the relativists and constructivists ontology of qualitative research, there is no single reality (Krauss, 2005; Sale et al., 2002; Berger and Luckmann, 1966). However, the ontological assumption of the quantitative paradigm is that there is only one truth, an objective reality that exists independent of human perception (Sale *et al*., 2002).

According to Lincoln and Guba (2011), the ontological spectrum comprises of methods whose subjects of knowledge differs and can be very different. There are numerous types of knowledge claims, but the ontological position adopted is pragmatism. Pragmatists researchers look to the "what" and "how" to research based on its intended consequences, where they want to go with it (Cherryholmes, 1992). Cherryholmes further stated that, pragmatists also agree that research always occurs in social, historical, political and other context. The underlying assumption for the dialectic position is that it calls for the mixture of research paradigms in order to yield a stronger outcome and help gain a fuller understanding of the phenomenon (Rocco *et al*., 2003). Therefore, this study depicts the dialectic perspective of pragmatic philosophy, which mixes the constructivists and post-positivists paradigm to achieve better and realistic findings for this research.

The significance of this ontological consideration is that it guides and informs the actual research strategy and the research tools. This research focuses on the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. The key issues involves examining the degree to which these techniques of construction are diffused and utilized within the building industry of Nigeria, to investigate the factors that affect the utilization of prefabricated techniques of construction using local building materials and explore their potentials within the building industry of Nigeria.

6.3.2 Epistemology

The term Epistemology comes from the Greek word episteme, which is the term referred to as knowledge (Krauss, 2005). Trochim (2000) define epistemology as the philosophy of knowledge. However, epistemology is closely connected to ontology and methodology; as ontology comprises of the philosophy of reality, epistemology addresses the knowledge of reality while methodology identifies the specific practices that is utilized to achieve the knowledge of the reality (Krauss, 2005). According to Krauss (2005), the common questions posed by epistemology are: "What is the relationship between the knower and the known? How do we know what we know? What counts as knowledge"? Various factors that prevent the utilization and diffusion of local building materials in the production of prefabricated components are being investigated. The pragmatists approach has been selected so that rich and interesting data can be collected through both qualitative and quantitative methods. Indeed, this is the most appropriate approach to be used for any meaningful data to be collected within the building industry of Nigeria.

6.3.3 Axiology

Axiology is the third philosophical approach that helps in guiding the research process. In philosophy, axiology usually refers to the philosophy of value. This approach can be either value-laden or value-free. The desire to understand the factors affecting the utilization and diffusion of prefabricated local building materials towards low cost house building provision has brought about this research. An example of how axiology can influence this research process is the choice of one specific data collection method instead of the other, such as the use of questionnaire survey instead of an in depth interview or case study. In this study, a high priority is given to both the questionnaire survey and the personal communication that would essentially take place.

The value-laden approach focuses on the development of theory that takes into account the researchers views on learning about the research through multifaceted situations. In contrast, the value free approach highlights that the researcher has to keep at a reasonable distance and as such not offer any valued decisions. Some of the information to be obtained is sensitive, such as the issue of corruption challenges within the building industry of Nigeria. Therefore, in order to obtain this sort of information, a more sensitive approach is proposed which is to work closely and engage in an in depth discussion with the participants.

Positivists advocated that the role of the researcher had to be detached and unbiased in order to reveal facts naturally. The strength of this approach was that precise and accurate measurements could be obtained when conducting research or carrying out empirical surveys and these could be repeated and were considered valid. However, the constructivist's researcher is not usually a detached researcher. The goal of a constructivist's is to rely as much as possible on the participant's views of the situation. In terms of practice, the questions become broad and general so that the participants can construct the meaning of a situation, a meaning typically forged in discussions or interaction with other individuals, and the more open ended the questioning the better, as the researcher listens carefully to what participants say or do in their life setting (Cresswell, 2007).

6.4 The Relationship Between Theory And Research

The term theory is used in a variety of different ways, but its common meaning is as an explanation of observed regularities (Bryman, 2008). According to Kerlinger's (1979), a theory is "*a set of interrelated constructs (variables), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining natural phenomena*" (p.64). However, a theory may appear in the study as discussion, argument, or a rational, and it helps to explain or predict phenomena that occur in the world (Creswell, 2009).

The two main methodological approaches adopted in this research are deductive and inductive approach. According to Creswell (2008), in order to bridge the gap between theory that is being used and the real research findings, deductive and inductive processes are used.

6.4.1 Deductive Process

Deductive process represents the commonest view of the nature of the relationship between theory and social research (Bryman, 2008). Bryman further stated that, the deductive theory construction advocated by positivists is when a researcher on the basis of what is known in a particular domain and of theoretical considerations in relation to that domain deduces a hypothesis that must then be subjected to empirical scrutiny (Bryman, 2008). Deductive process is used to hypothesize theories that can be tested. Therefore, we may discover that the theory does not fit the truths well and so the theory must be revised to understand better and forecast reality (Krauss, 2005).

The researcher usually advances a theory, collects data to test it, and reflects if the result confirms or refutes the theory. The theory becomes a frame for the entire research and a base or model for the research hypotheses or questions and the procedure for collection data. The deductive model of thinking used in this research is presented in Figure 6.1.

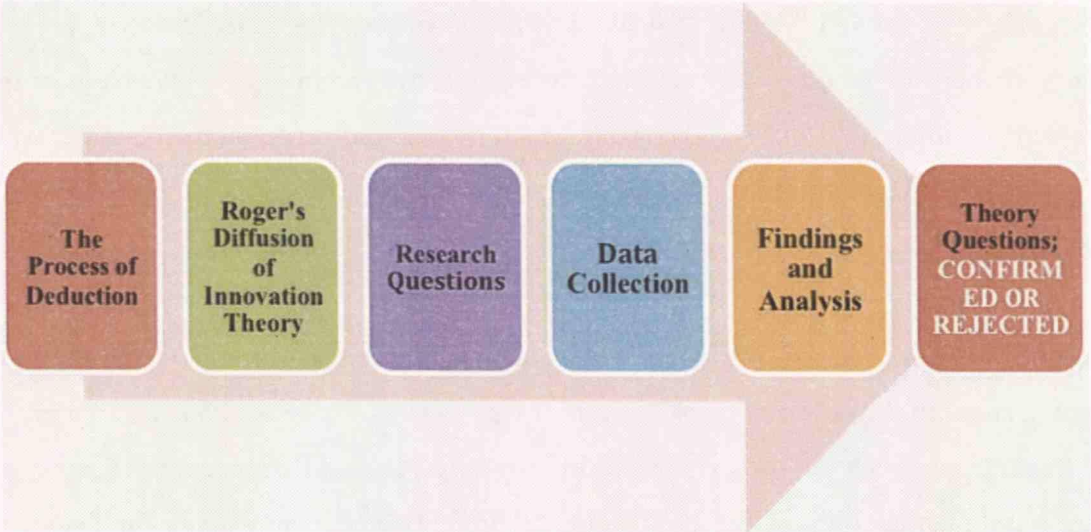

Figure 6.1: Deductive Theory (*Source; Bryman 2008*)

6.4.2 Induction Process

In induction process, the researcher infers the implication of his or her findings for the theory that prompted the whole exercise (Bryman, 2008). The findings are fed back into the stock of theory and the research findings associated with a certain domain of enquiry. According to Rocco (2003), inductive logic and qualitative methods of data collection is usually adopted in the constructivism paradigm with the aim of understanding a certain phenomenon within a social context. Inductive theory is carried out in the opposite manner as the deduction process.

Researchers use qualitative theories in many ways. According to Wolcott (1999), "*it is used as a broad explanation for behaviour and attitudes, and it may be complete with variables, constructs, and hypotheses*" (p.113). Creswell (2009) stated that, researchers increasingly use a theoretical lens or perspective in qualitative research, which provides an overall orienting lens for the study of questions of race, gender and class. Creswell further noted that, this lens becomes an advocacy perspective that shapes the type of questions asked, informs how data is collected and analyzed and provides a call for action or change. Some qualitative studies do not employ any explicit theory. Creswell further noted that, in these studies, the inquirer constructs a rich detailed description of the central phenomenon.

Therefore, the inductive and deductive process can also be used in a single research. According to Creswell (2009), "*Theory use in mixed methods research may include theory deductively in quantitative theory testing and verification, or inductively as an emerging qualitative theory or pattern*" (p.66). Creswell further noted that, another way to think about theory in mixed method research is as theoretical lens or perspective to guide the study.

Rogers's diffusion of innovation theory (innovation decision process) was used to develop some of the research questions and it was used as a base to shape and underpin the research. As such the theory was used to investigate the diffusion and utilization of local building materials in the production of prefabricated components for low-cost house building provision in Nigeria.

6.5 Theory Adopted

Many researchers have tried to clarify the phenomena of innovation for quite some time now by using innovation theories, that are entrenched in the wide field of evolutionary and institutional economics, and the sociology of technology (Metcalfe, 1995; Edquist, 1997). "*Innovation implies change, which can take many forms. There are various classifications of innovation that include product, process, position (of the products,* *processes and services in the socio-economic context) and paradigm innovation*" (Ligny and Erkelens, 2008). Therefore, from this viewpoint, innovation is viewed as a recurrent process, which involves the growth, diffusion and implementation of innovative, competitive technologies (Ligny and Erkelens, 2008).

Therefore, this study adopted the Rogers's diffusion of innovation theory to aid in finding out the reasons behind the lack of wider adoption of prefabricated local building materials in house building provision in Nigeria. These actors could also be the opinion leaders, because they have higher status within the Nigerian building industry and their level of influence could affect any sort of innovation change. These opinion leaders involve individuals and organizations from both public and private sectors of the Nigerian building industry.

There are different ways of identifying opinion leaders within a society. They include; Positional, self-designating, reputational, sociometric and observational (Rogers, 2003). All of which were applied in identifying the opinion leaders within the Nigeria building industry prior to the commencement of this study. The actor network within the Nigerian building industry consist of interrelated individuals and organization including; designers, general contractors, building material suppliers, prefabrication companies, construction companies, financial institutes, non governmental organizations, R&D and government bodies/authorities. Thus, the actor's influence is vital to the diffusion and utilization of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. Their perception, experience and influence are vital to the success of this study. Which is why the adoption of actor network is paramount in this research.

The theoretical framework illustrated in figure 6.2 is a combination of the network of stakeholder's diagram of construction innovation system and Rogers's diffusion of innovation theory (innovation decision process). The framework shows how technology decision processes takes place among the opinion leaders within the building industry of Nigeria. It shows the actors communication channels on the technology demand and supply sides within the building industry and how the innovation can be diffused from the knowledge stage to the implementation stage using Rogers' theory of innovation decision process. The theoretical consideration was used to underpin different mechanism that was used in this study, from the selection of target participant to coming up with ways of shaping the type of questions that were targeted at the participants.

The knowledge stage of Rogers's innovation decision process was adopted to examine the degree of awareness of local building materials in the production of prefabricated components for low cost house buildings. According to Rogers' (2003) the knowledge of the innovation characteristics in terms of the decision making unit must include; socio-economic characteristics, personality variable and communicator behaviour. Since the opinion leaders strongly influence adoption and rejection of an innovation, the actors are certainly the right subject to promote innovative change in the country. However, in order to influence the opinion leaders regarding the use of local building materials to produce prefabricated components towards the delivery of low cost housing in urban Nigeria, the individuals/organization identified from the actor network must be convinced about any uncertainties regarding the innovation.

A particular focus of the Rogers's theory of innovation-decision process is the persuasion stage. The persuasion stage includes some key perceived characteristics of innovation (such as relative advantage, compatibility, complexity, trial-ability and observe-ability) that usually affect the technology diffusion within a society (refer to figure 5.1). These key factors of Rogers's theory was used as a lens to understand diffusion and utilization of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. Rogers' (2003) stated that the persuasion stage is the most effective stage during the adoption process. Therefore, the diffusion of innovation uncertainty factors mentioned in the persuasion stage was brought up in both the survey and interview questions of this research. The actors such as; clients, suppliers, government agencies, research institutes are classified to be the key sources of information in the diffusion of innovation process (Lee *et al.*, 2002). The persuasion stage systematically addressed the second objective of the study, which is to identify the factors that affect the diffusion and use of local building materials for offsite prefabrication components in the provision of low cost house building in Nigeria.

The decision stage systematically addressed the third objective of the study, which is to explore the potential for the utilization and diffusion of local building materials for prefabricated low-cost house building in Nigeria. The implementation stage addressed the last objective of the study, which is to develop a framework for understanding the utilization and diffusion of offsite prefabricated local building materials towards the provision of low-cost house building in Nigeria. The last objective of the study is based on the overall analysis of the entire outcome of the research.

The theoretical consideration illustrated below draw attention to diverse mechanism of a general theoretical framework, which may help in analysing the diffusion and adoption of innovative technologies in the Nigerian building industry. According to Rogers' (2003) diffusion is accomplished through human interaction and communication between members of a community of Practice. Figure 6.2, shows the processes of how prefabricated local building materials may perhaps be disseminated using the actor network.

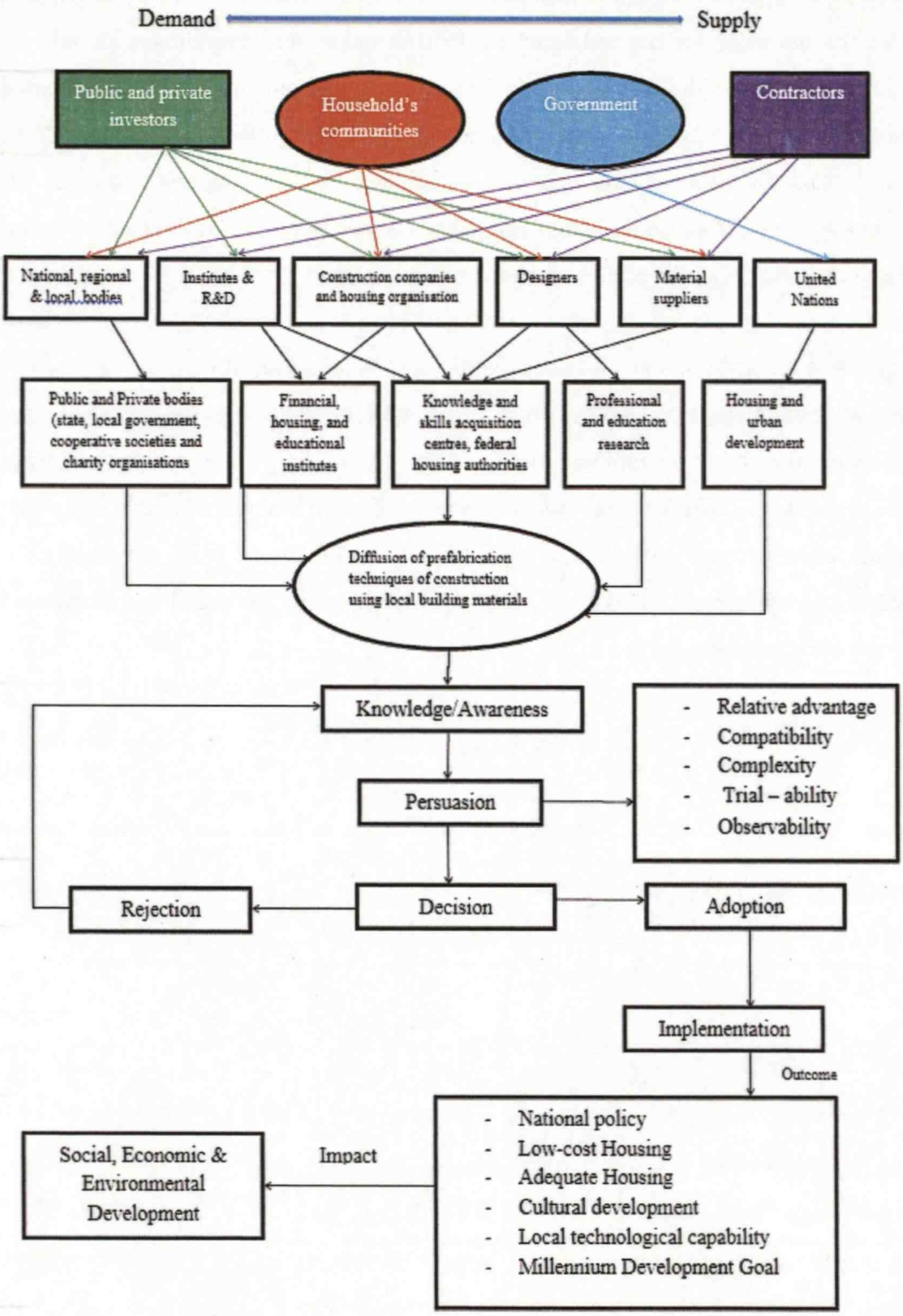

Figure 6.2: A theoretical framework for the diffusion of prefabricated low-cost housing using local building materials in Nigeria (*Source; adapted from Rogers' theory and Ligny and Erkelens actor network*).

6.6 Research Strategy

Research strategies of inquiry are methods of designs or models that provide specific direction for procedures in a research design (Creswell, 2009). There are three types of research design strategy used in social science research. They are qualitative, quantitative and mixed method research.

Qualitative research strategy is defined as the research strategy that usually emphasizes words rather than quantification in the collection and analysis of data that: predominantly emphasizes an inductive approach to the relationship between theory and research, in which the emphasis is placed on the generation of theories; has rejected the practices and norms of the natural scientific model and positivism in particular in preference for an emphasis on the ways in which individuals interpret their social world; and embodies a view of social reality as a constantly shifting emergent property of individuals creation (Bryman, 2008). The key qualitative research methods used today in social sciences research are; Phenomenology, Case study, Narrative, Grounded Theory.

Phenomenology research recognizes the essence of human understandings concerning a phenomenon as described by participants in a study (Creswell, 2003). Thus, phenomenology qualitative research method was adopted in this study because in order to understand the diffusion and utilization of prefabricated local building materials in Nigeria, there is the need to recognize the essence and opinion of the actors within the building industry of Nigeria. Case study would have been suitable for this research. Case study research explores in depth a program an occasion, an action, a manner, or one or more individual. But there are only two companies who were currently executing prefabricated house building projects at the time of the fieldwork and only one company agreed to invite the researcher to the building site. Narrative research is a form of study that includes studying the lives of individuals and asks one or more individuals to provide stories about their lives (Creswell, 2003). The researcher in a narrative sequential order usually reiterates the information gathered. In grounded theory research, this method seeks to develop theory that is grounded in data systematically gathered and analyzed (Myers, 1997). In ethnography, the researcher studies an intact cultural group in a natural setting over a prolonged period of time by collecting primarily observational data (Creswell, 1998). Phenomenological method of qualitative research was used for investigation in this research.

Quantitative research strategy is defined as a research strategy that emphasizes quantification in the collection and analysis of data and that: entails a deductive approach to the relationship between theory and research, in which the accent is placed on the testing of theories; has incorporated the practices and norms of the natural scientific model and of positivism in particular; and embodies a view of social reality as an external, objective reality (Bryman, 2008). Quantitative Strategy is usually objective in nature and focuses on the collection of numerical data and on investigating the relationship between theory and research. The quantitative strategy for data collection adopted in this study is known as survey method of research (Creswell, 2009).

6.6.1 Mixed Method

The combination of two different strategies of data collection (qualitative and quantitative study) in a single research is known as a mixed method (Creswel, 2009; Johnson and Onwuegbuzie, 2004; Patton, 1990; Brewer and Hunter, 1989). The research adopts a mixed method strategy and a triangulation technique to help pin the two methods together. Triangulation is a process of integration of quantitative and qualitative data sources to help inform and improve one another (Creswell, 2003). Researchers use mixed methods in their studies because they *"need to know and use variety of methods to be responsive to the nuances of particular empirical questions and idiosyncrasies of specific stakeholder needs"* (Patton, 2002, p. 585).

The strategy adopted in this study is known as sequential procedure. In sequential procedures the researcher gets to develop and elaborate the findings of one method with another method (Creswell, 2003). Other research start with qualitative method before adopting the quantitative method at a later stage depending on the method the researcher deemed suitable. Other key method commonly used in mixed procedures is the concurrent procedures, which allows the researcher to collect both qualitative and quantitative data at the same time (Creswell, 2003). Refer to figure 6.4 for the strategies used in conducting this research.

Having discussed some of the basic philosophical assumptions of the two paradigms (epistemology and ontology), there is the need to develop a better understanding and justify why mixed method is feasible to this research. According to Reichardt and Rallis (1994), the two paradigms are thought to be compatible because they are combined by a shared commitment to understanding and enhancing the human condition, a mutual aim of diffusing knowledge for practical use, and a shared obligation for diligence, and critique in the research process.

The combination of qualitative and quantitative method offers huge potential for practicing researchers who would like to see methodologists define and develop methods that are closer to what researchers truly utilize in practice (Johnson and Onwuegbuzie, 2004). "*By combining multiple observers, theories, methods, and data sources, researchers can hope to overcome the intrinsic bias that comes from single-methods, single-observer, and single-theory studies*" (Denzin, 1989, p. 307). Therefore, all the philosophical considerations, theories depicted and the research strategies adopted in this study were deemed suitable when investigating innovation diffusion.

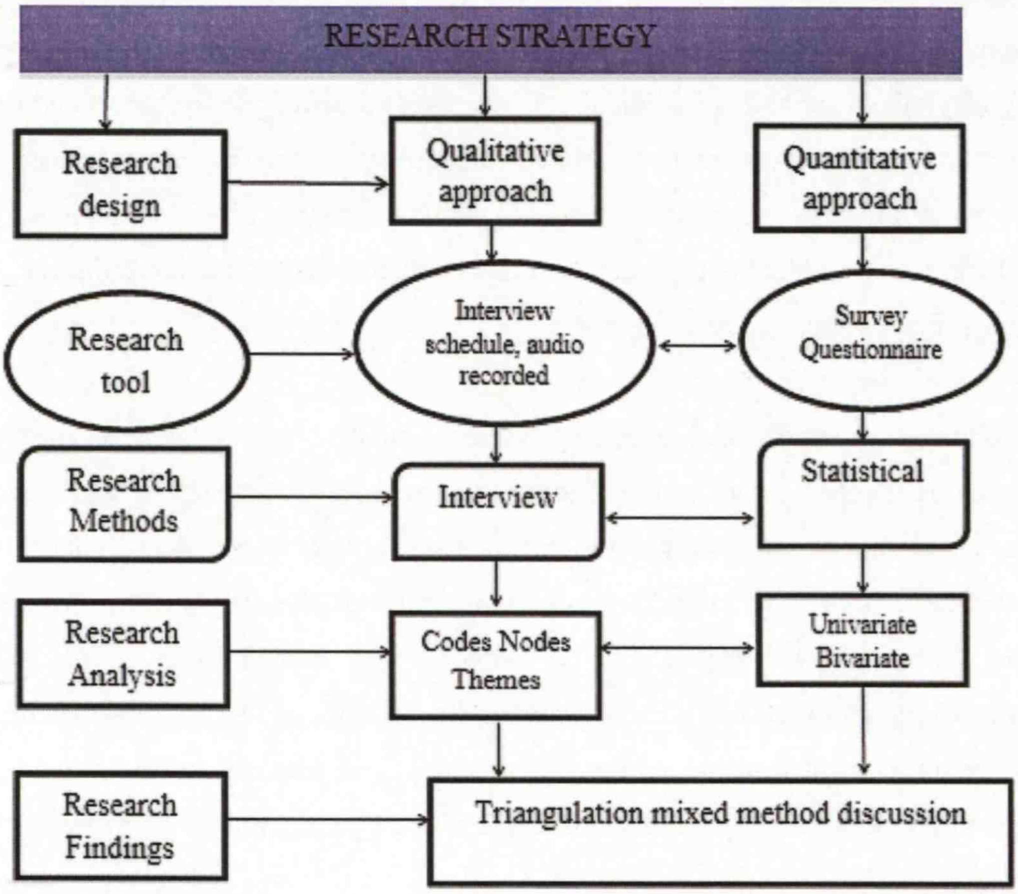

Figure 6.3 Research Strategy

6.7 Research Design

Bryman (2008) define research design as a framework for the collection and analysis of data. In addition, the choice of research design reflects decisions about the priority being given to various dimensions. These dimensions include; expressing causal links between variable, generalization of groups of individuals, contextualization and understanding of behaviour and temporal appreciation of social phenomena and their interconnections (Bryman, 2008). The research design is usually a complex procedure because it represents a structure that guides the implementation of the research method and analysis of the data gathered from this study. The entire design process is structured in order to undertake the primary and secondary data collection during the fieldwork to investigate the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building delivery in Nigeria. An in-depth knowledge of Nigeria's building industry with an unbiased viewpoint is essential for this study. However, the researcher has no control over the building environment in

Nigeria. Thus, an appropriate research design method will be the use of self-administered survey questionnaire and face-to-face audio recorded interview.

The theoretical framework adapted for this study informed a detailed questionnaire design as well as questions that were used for an in-depth interview. The research uses a combination of quantitative and qualitative approaches allowing for a strong analysis of interrelationships among factors that affect the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. Data collected would help in understanding the utilization and diffusion of prefabricated local building materials in the building industry of Nigeria and aid in the development of a framework to improve the understanding of how prefabricated local building materials are utilized and diffuse within the building industry of Nigeria, especially towards low-cost housing delivery.

6.7.1 Background, Methods of Data Collection and Analysis

Sample refers to the segment of the population that is selected for investigation. However, there are two methods of sample selection in quantitative method of social science research. The sample selection may be based on the probability or non-probability approach. Thus, the probability sampling approach involves the use of random method of sample selection so that each unit or individual in the population has an equal chance of been selected, whereas non-probability sample approach implies that some units or individuals in the population are more suited and more likely to be selected than others (Bryman, 2008). Therefore, because of the low population sample and cognizance of the individuals who were suited for this study, this research used the non-probability method of sampling to select the population sample and sample frame for this study. Sampling frame refers to "the listing of all units in the population from which the sample will be selected" (Bryman, 2008). However, main purpose of sampling in a research study is to provide a practical and viable means of enabling the data collection and processing components of the research to be carried out whilst ensuring that the sample provides a good representation of the population (Fellows and Liu, 1998). The primary task is to define the target group's population clearly and correctly. Population refers to the universe of units or individuals from which sample is to be selected (Bryman, 2008).

6.7.2 Participants and Company selection Process

The researcher approached each organization by visiting their office headquarters in Abuja. The researcher introduced himself to the right people in charge of the research departments of each organization. Where there are no research departments, the researcher was introduced to the company/organizational heads. These individuals were asked to grant access to some experts from their organization, representing different roles/professions (e.g. architect, engineers, builders, quantity surveyor, project manager, chief executives or managing directors) who would be willing to participate in the study. The researcher clearly explained to the participants selected from each organization that no one is to be forced into taking part in the study. Each of the participants was briefed about the research and were handed a copy of the information sheet to read through before deciding whether to take part or not.

Sixty-three formal construction companies/organizations are identified by the Federal Housing Authority, Federal Control Development Authority and verified by Corporate Affairs Commission of Nigeria. Out of the sixty-three house building companies/organizations identified, only fifty-nine agreed to participate in this study. Therefore, the researcher decided to use all the fifty-nine population size since it is viable within the limited time it took to complete the fieldwork. 59 (93.6%) agreed to participate out of the initial 63 companies/organizations identified. However, at the end of the fieldwork only 54 companies/organizations participated, with a total number of 222 participants (respondents) see table 6.1.

Table 6.1: Number of participants and their profession

Profession	Frequency (%)
Project manager	44 (20)
Builder	25 (11)
Architect	39 (18)
Civil Engineer	43 (19)
Quantity Surveyor	43 (19)
C.E.O	28 (13)

Total	222 (100)

These individuals are the opinion leaders within the building industry of Nigeria. The researcher made sure that the respondents chosen must be able to provide valid and reliable information regarding the use of prefabricated local building materials for low-cost house building delivery in Nigeria. Therefore, the respondents are only those who have extensive knowledge and understanding of prefabricated methods house building delivery in Nigeria. The study comprised of actors (professionals) within the Nigeria's building industry. Their categories are registered Engineers of the Council for the Regulation of Engineering in Nigeria (COREN), registered Architects from the Nigeria's Institute of Architect (NIA), registered Quantity surveyors from the Nigeria Institute of Quantity Surveyors (NIQS), registered Builders of The Nigeria Institute of Builders (NIOB), projects managers and professional Chief Executive Officers in the building industry. Therefore, each of these actors was approached from each of the 54 formal companies/organizations available. However, because the companies/organizations were categorized into small, medium and large organizations, the researcher expected the larger organizations to provide more participants than the medium and smaller ones. However, 29 out of the 54 companies that participated were identified as small organizations, 16 were identified as medium and 9 were identified as Large organizations.

Sixteen (16) participants volunteered to participate for the in-depth interview after the questionnaires were filled and returned. All of the sixteen participants were identified from different organizations within the building industry of Nigeria. Therefore, since there is no category of companies (small, medium and large) in Nigeria, the researcher categorized the companies based on the United Kingdom's company categorization. Small companies were categorized as companies with less than 50 workforces; medium companies were categorized with workforces between 50-250 and large companies were categorized with the workforces above 250 (SME, 2014; DETI, 2006). Thus, out of the sixteen participants who participated for the interview, 7 participants were identified as small, five mediums and four from large companies/organizations. Other data were collected to increase the validity of this research. The data sources include; articles, organization reports, papers, magazines and thesis.

The geographical location of the study was considered important to obtaining representatives of the target population. Therefore, this study has mainly focused on Abuja the federal capital territory of Nigeria. According to UN Habitat (2008), it is one of the fastest growing and one of the most urbanized city in Africa. Moreover, it's where the housing institute and most of the construction company's headquarters are located.

6.7.3 Questionnaire Survey

A questionnaire refers to forms, which contains some sets of questions that the respondent completes and returns to the researcher (Aldridge and Levine, 2001). A self-administered survey questionnaire was used as the primary source of data collection technique. Although the initial plan was to carry out interviewer-administered questionnaire techniques, due to the limited availability of time from the participant side, the researcher decided to use the self-administered method. The self-administered questionnaire allows the participants to complete the questionnaire at their own convenient time. In addition, it also enables coverage of a larger population and is therefore cheaper, quicker and more convenient to use (Bryman, 2008).

The questionnaires were dropped off to the participants at each organization, and a collection date was scheduled. The use of email could have saved transportation cost for the distribution and collection of the questionnaires, but due to the low level of computer literacy among the participants the researcher decided the self-administered technique is the most viable way of obtaining data within the building industry of Nigeria.

Therefore, the main aim behind the selection of self-administered questionnaire as the primary source for data collection in this study was to cover a large group of participants with a little amount of time and cost. The rating system was used almost throughout the questionnaire allowing the respondents to tick or circle the most appropriate answer. The entire questionnaire was closed ended questions apart from few questions that asked the respondents to list and rank (from 1-5) some answers. However, some questions also allowed the room for response opportunities such as 'other, or please specify'. A minimum of at least two rows was created at the end of each section having a matrix layout for any other factors to be included by the respondents. The advantages of using matrix questions format in a questionnaire where that, respondents tend to complete them faster.

However, a potential problem was that there was no personal communication between the researcher and the respondents. Thus, there would be no clarification and discussion of the question in case the respondent finds one of the questions complicated or if the researcher wants to seek further details on a particular answer from the respondent. Additionally, due to the large number of questions on each section of the questionnaire, the response rate could be low, and the returned dates could be quite late. To overcome most of these limitations, the researcher conducted a pilot study prior to the start of the main data collection, which was discussed in more detail in the next section.

6.7.3.1 Pilot Study

A pilot study can be defined as a "*small scale version or trial run in preparation for a major study*" (Polit *et al.*, 2001, p. 467). A pilot study was conducted in order to refine the research questionnaire and make sure it was set in a terminology that the actors within the building industry would simply understand. Therefore, the pilot questionnaires were not included in this thesis. It was only conducted to get the questionnaire ready before the fieldwork commences. The questionnaires were addressed to some randomly selected actors within the building industry of Nigeria. The researcher notified the respondent that the pilot study was purposely arranged to try and enhance the research questions and will not be used as part of the study. However, it took at least 4 weeks to amend the questions and submit the amended questionnaire for final approval. Only few sections of the questionnaire were amended, and some questions were rewritten to suit the Nigerian building industry's experts. The overall outcome of the pilot study was a success because it helped to eliminate complicated questions and made the questionnaire more straightforward during the main study, including acting on all comments given by the respondents.

In addition, the pilot study feedback helped the researcher to come up clearly with the type of coding method and analysis that was used for this study. All the participants of the study were contacted over the telephone and asked whether they would be willing to take part in a pilot study. The aim of the research was explained to each one of the participants and why their participation is important to the success of the study. The most common questions asked by most of the respondents were about the technical terminology used in the questionnaires, which was later on amended and made into a layman's vocabulary. An example of such amendment was inclusion of Expanded polystyrene among the local building materials stated and the categorization of offsite prefabrication into high technology, medium technology and low technology so expert within the building industry would understand.

6.7.3.2 Questionnaire Design

The survey questionnaire (see Appendix E) was categorized into four sections. Section 1: consists of information about the respondents and their company/organization. Section 2: (The Knowledge and Awareness) was designed to investigate the extent to which prefabricated local building materials is utilized towards housing provision in Nigeria. Section 3: (The Persuasion stage) was designed to investigate factors that influence the diffusion and utilization of prefabricated local building materials towards low-cost house building delivery. Section 4: (The Decision stage) was designed to explore the potential for the utilization and diffusion of local building materials for prefabricated low-cost house building in Nigeria. Whereas, the interview questions were categorized into three sections (Knowledge/awareness, persuasion and decision stage) based on Rogers' diffusion of innovation theory communication channels. There are 18 questions for the interview phase, with six questions investigating each objective (1,2 and objective 3) of the study.

6.7.3.3 Level of Measurement and Statistical Methods Used

The levels of measurements adopted for this study are the Likert scale ordinal type of measurement and the response scale. According to Holt (2014), many researchers do not differentiate Likert scale and response scale in their studies. The Likert Scale is an ordinal psychometric measurement of attitudes, beliefs and opinions presented in form of a statement to allow respondents indicate their level of agreement of disagreement in multiple types format (Lamarca, 2011). Lamarca (2011) opined that, Likert scale is the most universal method for survey collection and the responses are easily quantifiable and subject to computation of some mathematical analysis. Unlike yes or no options, the likert scale ordinal method of measurement does not force the respondent to take a stand on a particular topic, but allows them to respond in a degree of agreement; this makes question answering easier on the respondent (Lamarca, 2011). Holt (2014) further stated that, Likert scales are usually statement that respondents are being asked to offer an opinion about; and response scales are represented as numbered options spaced a long a horizontal stem (Holt, 2014). According to Abeyasekera (2001), open scoring method where each item to be scored can be given any significance within a specific range (such as 1 to 5) is the most flexible because it leads to observations that are independent of the other. "*The availability of a meaningful measurement scale also means that the resulting scores usually correspond easily to the objectives of the study, and can usefully be summarised across respondents*" (Abeyasekera, 2001, p.6).

The options for each survey questions were coded using the following numerical numbers: (1-5), as shown in table 6.1

Table 6.2: Numerical coding of questionnaire

S/N	Ranking	Usage	Level agreement	Level satisfaction
1	Very low	Never	Strongly disagree	Highly unsatisfied
2	Low	Rarely	Disagree	Unsatisfied
3	Medium	Sometimes	Neither disagree nor agree	Neither unsatisfied nor satisfied
4	High	Mostly	Agree	Satisfied
5	Very high	Always	Strongly agree	Highly satisfied

6.7.3.4 Method of Analysis

There are three levels of analysis; univariate, bivariate and multivariate. Univariate analysis is the analysis of one variable at a time; bivariate refers to the analysis of two variables at a time in order to discover a relationship between the variables; whereas multivariate refers to the analysis of more than two variables at a time (Bryman, 2008). However, the questions that were developed in this study allow the use of univariate and bivariate levels of analysis. Therefore, any additional level of analysis might seem unnecessary, because the two levels of analysis adopted is enough to produce the required answers needed to understand the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building in Nigeria.

The quantitative data was analysed using SPSS. SPSS is an acronym for statistical package for social sciences. According Bryman (2008), SPSS is possibly the most widely used statistical computer software for the analysis of quantitative data for social science research. Counts and proportions in the categories of the responses from the questions were summarized. Some key questions were identified and Chi-Squared method was used to determine the relationships among the groups and categories of respondents on those key questions. Chi-square allows us to establish how confident we can be that there is a relationship between the two variables in the population (Bryman, 2008).

Chi-square method is preferred among other methods because it is the most feasible method to use when investigating the relationship between two variables (Bland, 1993). "*It can be quite difficult to measure the strength of the association between two variables, but it is easy to test the null hypothesis that there is no relationship or association between the two variables*" (Bland, 1993, Pp.241). For each hypothesis testing; the null and alternative hypotheses were defined. The null hypothesis is the hypothesis of no relationship or association between the two variables whereas the alternative hypothesis is that there is an association of any kind. The alternative hypothesis will be accepted when the null hypothesis is rejected. Chi-squared value and significance level were reported from the package results of output.

The Chi-squared distribution is a family of distributions, like the Normal and t-distribution. Theoretically, Chi-squared test for association using contingency table, the 2 variables to compare constitute the rows and columns of the contingency table, from the observed frequencies marginal (rows and columns) total expected frequencies are derived for each cell by multiplying the corresponding rows and columns total and then divide by the grand total (Bland, 2006). Chi-squared value is obtained by comparing the observed and expected frequencies then compare the results with the table value.

6.7.4 Interview

There are three types of interviews commonly used in qualitative social science research namely: structured, semi-structured and narrative interviews (Stuckey, 2013). Structured interviews have chronological and clear order in the questioning, where semi-structured interviews have a focus, but are flexible in order based upon the direction of the subject's responses. Narrative interviews are unstructured and normally start with a wide open-ended question about a subject's experience, where the subject is rarely interjected in the telling of their story. This research adopted the semi-structured type of interview. According to Stuckey (2013 p.2), "*the semi-structured interview guide and provides a clear set of instruction for interviewers and can provide reliable, comparable qualitative data*".

The type of interview used in this study is the semi-structured face-to-face interview. The research involves investigating the diffusion and utilization of local building materials in the production of prefabricated components for low-cost house building provision in Nigeria. Therefore, in order to develop a better understanding into the use of local building materials for prefabrication techniques of construction in Nigeria, there is the need for a one on one interview with the experts of the country's building sector. Interviews allow people to convey to others a situation from their own perspective and in their own words (Kvale, 1996).

In qualitative interviews the researcher tries to understand a phenomenon from the subject viewpoint and to reveal the meaning of their experiences (Silverman, 2004). Other interview method such as focus group is also possible to be used in gathering the required data needed, but due to the lack of flexibility of the participants in terms of movement to a required venue for the focus group as well as rivalry among some experts, the researcher decided a one on one interview is the right choice of data collection. The interview method of data collection is probably the most employed method used in qualitative research (Bryman, 2008). According to Bryman (2008), it is the flexibility of interview that makes it so attractive to use for data collection in a research.

Face to face interview was used in order to have an in-depth conversation with the participants on prefabrication techniques of construction in Nigeria. According to McGivern, (2006) this method of data collection will give the room for open-ended questions that could not be achieved through questionnaires. Therefore, a one on one interview was scheduled with some of the participants who showed interest in partaking further after completing the research survey questionnaire. The face-to-face interview technique for data collection created an environment for the researcher and the participants to discuss thoroughly and explore deeper into the factors that affects the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria.

6.7.4.1 Analysis of Qualitative Data

The use of software for qualitative analysis can be beneficial for researchers. According to Jones (2007), Suitable software's such as Nvivo can reduce analysis timeframes, can provide more detailed and rigorous coding and interpretation, and offer researchers with improved data management. The benefits of using Nvivo software are that; large sums of data can be managed relatively easily, categories and nodes can be altered or re-rearranged at will, therefore as new data re-focussed the study the old data could be simply redesigned to fit into the emerging framework (Jones, 2007). Therefore, this research used Nvivo software to transcribe, code, interpret and organize the interview data.

6.7.5 Appendices

The appendix section consists of many useful documents, which largely contributed to the overall completion of this research. The appendix sections include;

The letter of research approval by the Oxford Brookes research ethics committee is presented in Appendix A, the transfer approval from MPhil to PhD is presented in Appendix B, the Participant information letter is presented in Appendix C, the consent form is presented in Appendix D, the research questionnaire is presented in Appendix E, the research interview questions are presented in appendix F and the qualitative interview data is presented in Appendix G. All of which will be found at the Appendices section of this Thesis.

6.8 Ethical Consideration

Social sciences research that involves participant's response is usually accompanied with a lot of ethical issues. As part of the ethical consideration, the researcher made sure ethical issues were being addressed before the commencement of the fieldwork. The Oxford Brookes University Ethics Committee has approved the ethical processes before the research fieldwork commences. Each participant was given the participant information sheet to read before they decide whether to take part or not. The participant sheet contains the purpose of this study, why the participants were invited to take part and that their participation was voluntarily. Apart from the participant information sheet, consent form was also provided to the participants. The participants were giving enough time for both the survey questionnaire as well the interview.

The research fieldwork was intended to be carried out in six months. However, due to the amount of time giving to the respondent so there will not be pressure on them, the researcher requested an additional six weeks extension and it was granted. This additional time helped the researcher to collect back more than 200 survey questionnaire and created enough time for the interviews to be carried out without rush. The overall process was successful because the participants were kind and like the idea of the research topic. In fact they are curious to find out the overall findings of the study. There wasn't any unethical behaviour from the participant's side or the researchers side as both the parties conducted themselves in a professional manner throughout the fieldwork.

6.9 Research Questions

The questions that were answered in the course of this research were categorized into three sections based on the Roger's Theory of innovation decision process:

6.9.1 Knowledge and Awareness

1. What is the level of knowledge and awareness of offsite prefabricated techniques of construction among the experts of Nigerian building industry?
2. What are the types of locally sourced building materials mostly used within the building industry of Nigeria?
3. How often are locally sourced building materials used in the production of prefabricated components especially towards low-cost house building provision in Nigeria?
4. Which among the prefabricated components is more used within the building industry of Nigeria, is it locally produced or imported prefabricated components?

5. Which type of prefabricated techniques of construction is mostly utilized within the building industry of Nigeria?

6.9.2 Persuasion Stage

6. What are the factors that affect the diffusion and utilization of local building materials in the production of prefabricated components for low-cost house building provision?
7. Are prefabricated methods of construction using local building materials consistent with the existing values and needs of Nigerians?
8. Are prefabricated methods of construction using local building materials visible and economically viable when utilized towards low-cost house building provision?
9. Are prefabricated methods of construction using local building materials complex when utilized towards low-cost house building?
10. Does corruption affect the utilization and diffusion of prefabrication techniques of construction using local building materials for low-cost house building in Nigeria?

6.9.3 Decision Stage

11. Are local building materials promoted towards the production of prefabricated components for low-cost house building provision within the building industry of Nigeria?
12. Are prefabricated techniques of construction using local building materials cheaper than the prefabricated imported components?
13. Which among the prefabricated local building components offer greater potential for low-cost house building provision in Nigeria?
14. Are there any policies that support and encourage the utilization of local building materials in the production of prefabricated components for low-cost house building provision in Nigeria?
15. Will the utilization and diffusion of prefabricated techniques of construction using local building materials increase or diminish?

16. How would the utilization and diffusion of local building materials in the production of prefabricated components for low-cost house building improve within the building industry of Nigeria?
17. Are there any similarities or difference among the response of participants from the categories of their companies/organizational coverage?
18. Are there any similarities or differences among the response of participants by the categories of their jobs?

6.10 Summary of Research methodology

There is a need to adopt a feasible research methodology in order to investigate the levels and factors that affect utilization and diffusion of prefabrication techniques of construction using local building materials for low cost house building provision in Nigeria. Because the research deals with an on-going issues that will involve interaction with some professionals of the Nigerian building industry, the pragmatist philosophical stand point deem right because it accepts all the other philosophical views. Therefore, the research must represent the world as seen by the Nigerian building industry by using the pragmatic ontological approach.

Nevertheless, the research adopted both the quantitative and qualitative approach in order to have a more holistic understanding of why prefabrication techniques of construction using local building materials fail in Nigeria even though it promises a superior performance compared to the conventional methods. In order to gather valid data, the research uses survey questionnaire as a primary source of data collection. The second source of data collection adopted was face-to-face audio-recorded interview, which followed immediate after the completion of survey questionnaire. The interview helped tremendously towards reaching for a more in-depth results which would not have been achieved using survey questionnaire alone. The integration of the two methods of data collection added more substance and validity to this study.

Both the quantitative and qualitative data was analysed using computer software's such as SPSS and Nvivo. SPSS was used to analyse the survey questionnaire data. The methods of quantitative analysis adopted include; univariate, bivariate and Chi-Squared analysis. Furthermore, Nvivo software was used for the qualitative analysis. The software, helped enormously in coding and interpretation of the face-to-face interview conducted. The findings of the quantitative and qualitative data was separately presented in chapter 7 and systematically discussed in chapter 8 using triangulation methods.

CHAPTER SEVEN

QUANTITATIVE AND QUALITATIVE DATA ANALYSIS AND DISCUSSION OF THE FINDINGS

7.1 Introduction

This chapter presents the data collected during the course of this study and the methods of analysis adopted to produce a comprehensive result for discussion. This chapter reveals the findings of this research through both the quantitative and qualitative research methods. The quantitative approach was achieved using a survey questionnaire and the qualitative approach was achieved through an in-depth face-to-face interview with the respondents. The quantitative data was collected and analysed using the Statistical Package for Social Sciences (SPSS). While the interview responses were transcribed before it was entered in to an Nvivo (software used for qualitative analysis) where it was coded and analysed as shown below.

7.2 Quantitative Data

7.2.1 Information of Company/Organisation

In this study, 63 formal building companies/organization were identified by the Federal Housing Authority, Federal Control Development Authority and verified by Corporate Affairs Commission of Nigeria. Out of the 63 house building companies/organizations identified, only 59 agreed to participate in this study. Therefore, the researcher decided to use all the 59 (93.6%) population size since it is viable within the limited time it took to complete the fieldwork. However, at the end of the fieldwork only 54 companies/organizations participated, with a total number of 222 participants. All of the 54 companies have used prefabricated techniques of construction in some of their projects but only 3 out of the 54 companies/organization are fully into prefabrication.

The 54 companies whose staff completed the questionnaires included 172 (77.5%) participants conducting their building projects at the national level, 16 (7.2%) at regional, 33 (14.8%) within state level and 1 (0.5%) at local level. The profession of the 222 staff who completed the questionnaires included; project managers 44 (20%), civil engineers and quantity surveyors 43 (19%) each, Architects 39 (18%), chief executive officers 28 (13%) and builders 25 (11%) (refer to figure 7.1 for the graphical summary of the above findings).

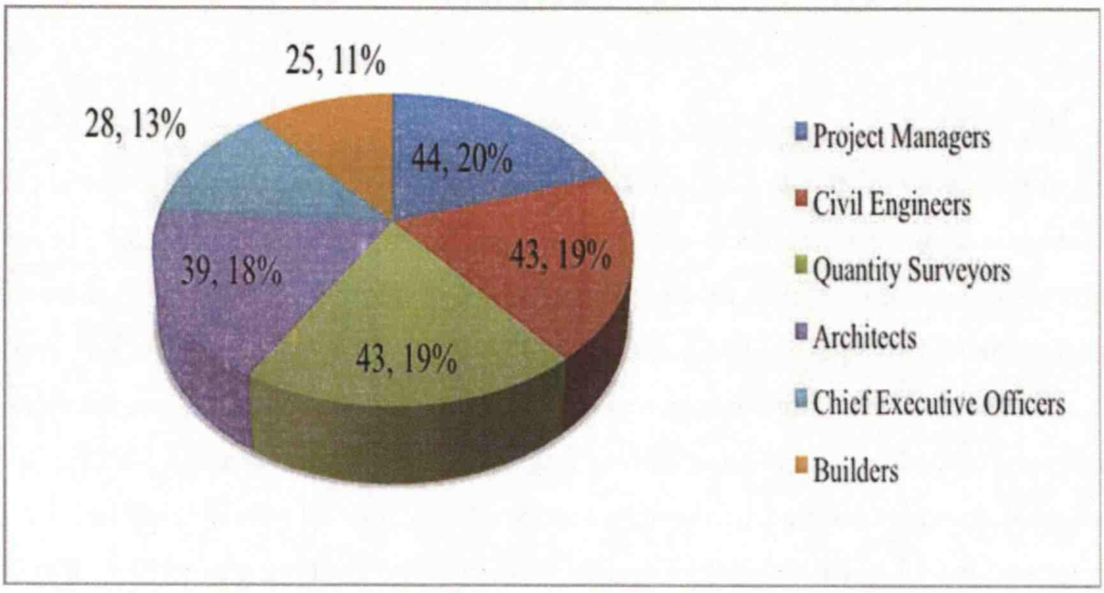

Figure 7.1: Professions of the Research Participants

Numerous categories of companies/organisations have participated in this study as indicated in Figure 7.2. The majority of participants were from construction or building companies constituted 189/222 (85.1%). Private sector housing institute firms or agencies constituted 32/222 (14.4%). Public sector housing institute firms or agencies with 25/222 (11.3%). Local building materials (LBM) suppliers constituted 20/221 (9.0%). Housing or building authorities constituted 17/221 (7.7%). Prefabrication/Offsite manufacturing companies constituted 14/222 (6.3%). However, there were no participants from any charity housing.

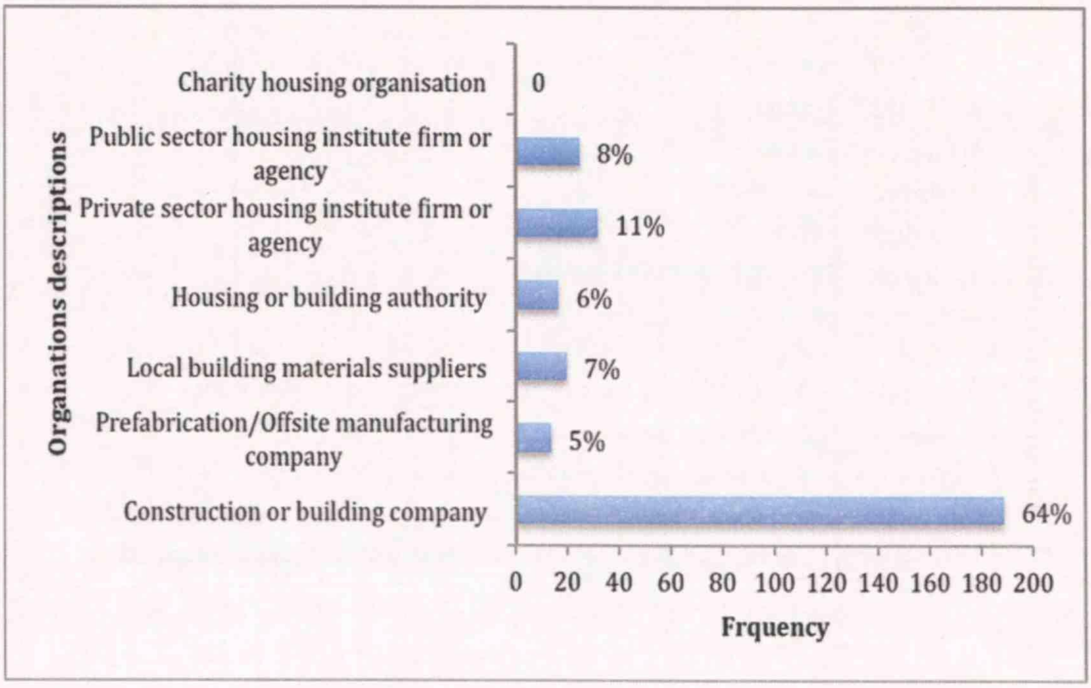

Figure 7.2: Company/Organisational description

7.2.2 Knowledge/Awareness Section of the Questionnaire

7.2.2.1 Building Materials Generally Used

An open ended question was asked on which of the local building materials (LBM) within the Nigeria's building industry are mostly used for house building. Spaces were provided for the respondents to list the materials they used the most for house building in Nigeria. Two hundred and fifteen (98.6%) of the respondents completed this section. The list from all the respondents constituted 13 different types of building materials overall. The building material names, frequencies and percentages were as follows: timber 175 (82.8%), Sandcrete 165 (76.7%), Gravel/stones 142 (66.0), Bamboo 107 (49.8%), Clay 102 (47.4), Cement 80 (37.2%), Burnt bricks 58 (27.0%), Metal/steel 38 (17.7%), Thatch 22 (10.2%), EPS 22 (10.2%), Earthen 20 (9.3%), Aluminium 20 (9.3%) and PVC 10 (4.7%) refer to figure 7.3.

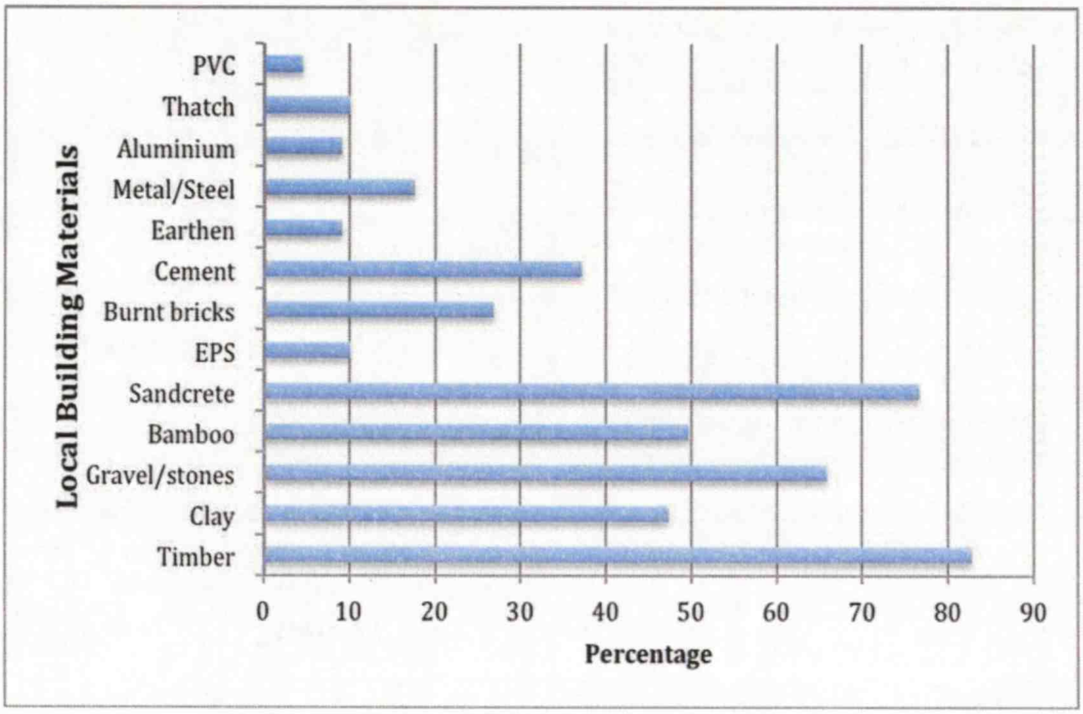

Figure 7.3: List of Building materials generally used for house building in Nigeria

7.2.2.2 Local Building Materials Ranking Based on Their Usage for Prefabricated Low Cost House Building

A list of some selected local building materials were presented in the questionnaire and the respondents were asked to rank them (from very low to very high) based on their level of usage for prefabricated low cost house building. Table 7.1 summarised the materials with the counts and proportions of their responses. The materials ranking in order of highly (high plus very high) utilised included; Sandcrete – 150/175 (85.7%), Timber - 112/174 (64.4%), Stones – 59/166 (35.5%), clay - 33/160 (30.6%), Earthen elements – 21/135 (15.3%), Bamboo – 13/163 (8.0%) and five respondents mentioned the use of Expanded Polystyrene (EPS) of which 4 (80%) of them ranked it as very highly utilised.

Table 7.1: Ranking of local building materials mostly utilized for prefabricated low cost house building – Counts (n) and Percentages (%)

Local Building Materials	Very Low n (%)	Low n (%)	Medium n (%)	High n (%)	Very High n (%)
Timber (n=174)	7 (4.0)	13 (7.5)	42 (24.1)	50 (28.7)	62 (35.6)
Clay (n=160)	33 (20.6)	58 (36.3)	36 (22.5)	23 (14.4)	10 (6.3)
Bamboo (n=163)	47 (28.8)	65 (39.9)	38 (23.3)	6 (3.7)	7 (4.3)
Stones (moulded stones) (n=166)	18 (10.8)	33 (19.9)	56 (33.7)	34 (20.5)	25 (15.1)
Sand (Sandcrete element) (n=175)	11 (6.3)	6 (3.4)	8 (4.6)	51 (29.1)	99 (56.6)
Earthen elements (n=137)	79 (57.7)	26 (19.0)	11 (8.0)	10 (7.3)	11 (8.0)
Other: EPS(n=5)	0	0	1 (20.0)	0	4 (80.0)

7.2.2.3 Extent to the Use of Local Building Materials in House Building In Nigeria

The study seeks to investigate the extent to which local building materials are used for house building in Nigeria. The study reveals that majority of the respondents have utilized local building materials for house building provision, with 66 respondents (30%) sometimes, 63 (28%) mostly, 49 (22%) always and 41(19%) rarely. Only 1% of the respondents never used local building materials for house building (refer to figure 7.4).

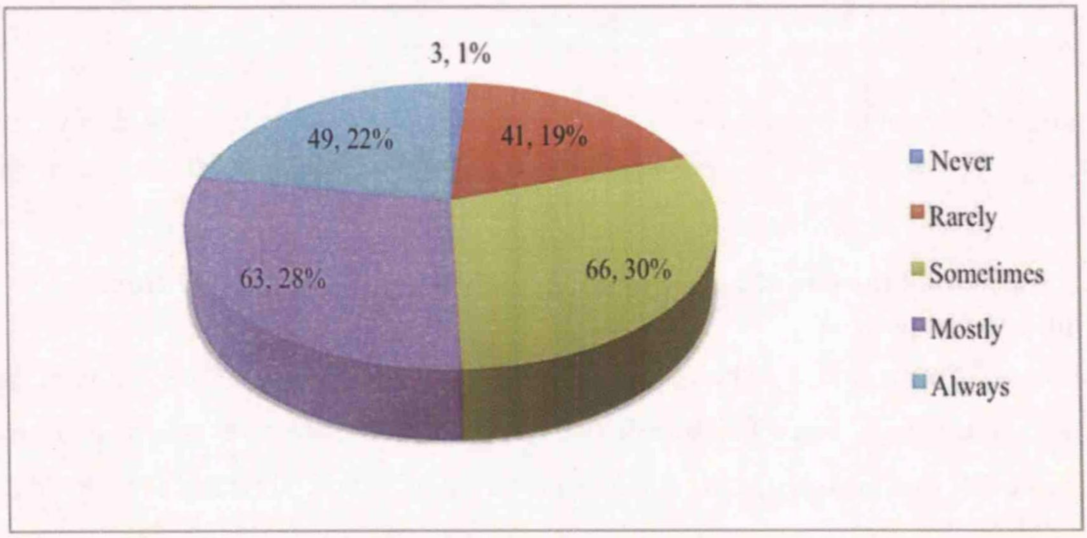

Figure 7.4: Extent to which local building materials are used for house building in Nigeria.

7.2.2.4 Extent to the Use of Local Building Materials in Low Cost House Building In Nigeria

The study tries to find out the extent to which local building materials are used for prefabricated low cost house building delivery in Nigeria. Therefore, the study reveals that majority of the respondents have utilised prefabricated local building materials for low cost house building provision, with 72 respondents (33%) rarely, 64 (29%) sometimes, 45 (20%) mostly and 14 (6%) always. However, 26 (14%) respondents have never used prefabricated local building materials for low cost house building delivery in Nigeria (refer to figure 7.5).

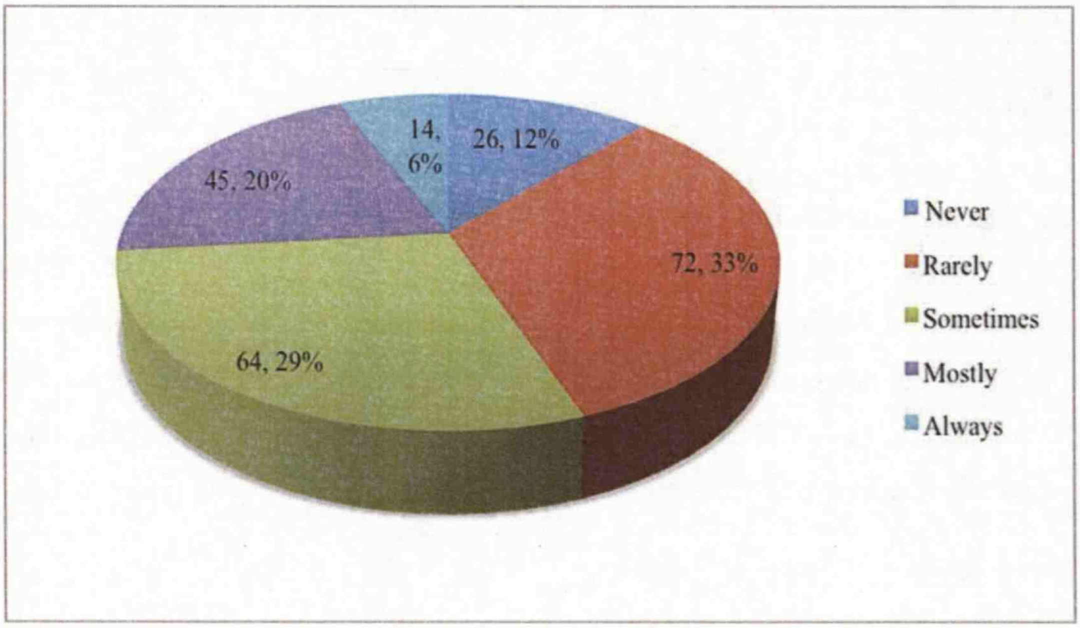

Figure 7.5: Extent to which local building materials are used for prefabricated low cost house building in Nigeria.

7.2.2.5 Extent to the Use of Local Building Materials in Prefabricated House Building In Nigeria

The study tries to find out the extent to which local building materials are used for prefabricated general house building delivery in Nigeria. The study reveals, as indicated in Figure 7.6, that majority of the respondents have utilised prefabricated local building materials for general house building provision, with 71 (32%) sometimes, 65 (29%) rarely, 53 (24%) mostly, and 24 (11) always. However, 8 (4%) of the respondents have never used prefabricated local building materials for general house building provision in the country.

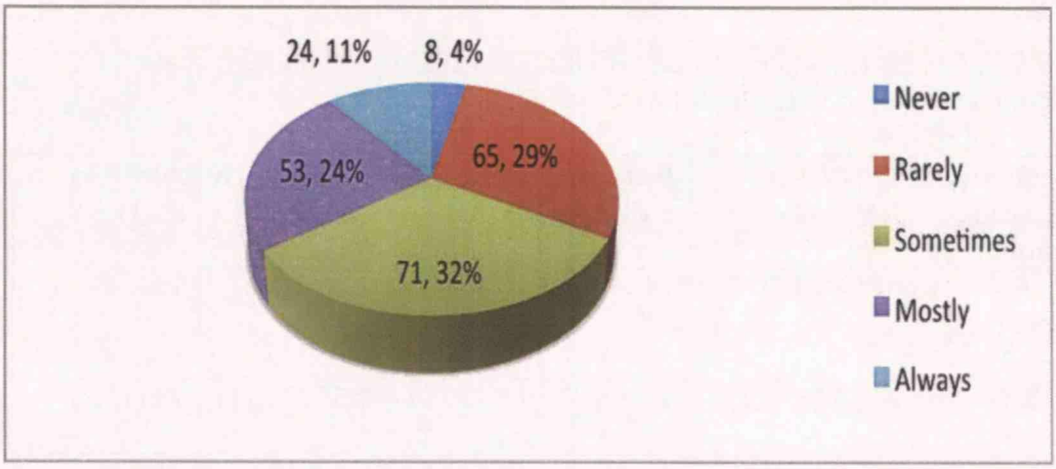

Figure 7.6: Extent to which local building materials are used for prefabricated general house building in Nigeria.

7.2.2.6 Frequency of Use of Selected Local Building Components in Low Cost House Building

Some selected local building material components were listed and respondents were asked to rate how often they use them (from never to always) for low cost house building, the counts and proportions of their usage is summarised in Table 7.2. It can be seen from Table 7.2 majority 175/212 (83.3%) rate sandcrete blocks as mostly or always used similarly for timber as roof components 152/212 (71.7%) while 81/210 (38.6%) said they never use timber as floor elements. Clay bricks are rarely or sometimes used 127/209 (60.8%), however 49/209 (23.4%) never used it. Over 50% (105/201) never use adobe for wall. Similarly, bamboo is not commonly used; majority of the respondents never use it for: roofing-123/208 (59.1%), truss-102/209 (48.8%), beam/column-131/209 (62.7%), panel-135/209 (65.2%) and floors-144/209 (69.9%).

Table 7.2: Counts (n) and proportions (%) of how often local building material components are used in low cost house building

Local Building Materials Components	**Never n (%)**	**Rarely n (%)**	**Sometimes n (%)**	**Mostly n (%)**	**Always n (%)**
Timber Roof components (n=212)	9 (4.2)	14 (6.6)	37 (17.5)	48 (22.6)	104 (49.1)
Timber frames (n=211)	22 (10.4)	43 (20.4)	63 (29.9)	55 (26.1)	28 (13.3)
Timber panels (n=205)	35 (17.1)	40 (19.5)	71 (34.6)	48 (23.4)	11 (5.4)
Timber floor elements (n=210)	81 (38.6)	83 (39.5)	31 (14.8)	12 (5.7)	3 (1.4)
Clay Bricks (n=209)	49 (23.4)	60 (28.7)	67 (32.1)	21 (10.1)	12 (5.7)
Adobe Wall (n=201)	105 (52.2)	48 (23.9)	39 (19.4)	7 (3.5)	2 (1.0)
Bamboo roofing (n=208)	123 (59.1)	64 (30.8)	12 (5.8)	8 (3.8)	1 (0.5)
Bamboo truss (n=209)	102 (48.8)	74 (35.4)	23 (11.0)	4 (1.9)	6 (2.9)
Bamboo Beam/Column (n=209)	131 (62.7)	58 (27.8)	12 (5.7)	5 (2.4)	3 (1.4)
Bamboo panels (n=207)	135 (65.2)	55 (26.6)	15 (7.2)	2 (1.0)	0
Bamboo floors (n=207)	144 (69.6)	48 (23.2)	13 (6.3)	2 (1.0)	0
Stone plate roof (n=205)	94 (45.9)	43 (21.0)	46 (22.4)	15 (7.3)	7 (3.4)
Stone for wall (n=209)	43 (20.6)	67 (32.1)	79 (37.8)	17 (8.1)	3 (1.4)
Stone for wall finishes (n=210)	21 (10.0)	52 (24.8)	101 (48.1)	30 (14.3)	6 (2.9)
Stones for flooring (n=204)	53 (26.0)	79 (38.7)	43 (21.1)	17 (8.3)	12 (5.9)
Sandcrete Blocks (n=210)	6 (2.9)	6 (2.9)	23 (11.0)	56 (26.7)	119 (56.7)
Rammed earth wall (n=207)	83 (40.1)	60 (29.0)	36 (17.4)	19 (9.2)	9 (4.3)
Others: Please specify EPS (n=10)	1 (10.0)	3 (30.0)	1 (10.0)	2 (20.0)	3 (30.0)

7.2.2.7 Frequency of Use of Selected Local Building Components in General House Building

The responses are similar in the use of these materials for general house building, from Table 7.3 it can be seen that sandcrete blocks were mostly or always used 188/221 (85.1%) just slightly higher than its usage for low cost house building, timber for roofing components 182/222 (82.0%), timber as floor elements never used as rated by 75/219 (34.1%), clay bricks are used rarely or sometimes by 140/219 (63.9%) and 42/219 (19.2%) never use clay bricks for general house building materials. More than half of the respondents never used adobe wall for general house building in Nigeria 116/206 (56.3%), similarly, bamboo roofing, trust, beam/column, panels and floors were not used by 61.3%, 55.5%, 68.7%, 70.3% and 74.8% respectively. Refer to table 7.3 for other numerical details on the use of local building materials components for general house building in Nigeria.

Table 7.3: Counts (n) and proportions (%) of how often local building material components are used for general house building

Local Building Materials Components	Never n (%)	Rarely n (%)	Sometime n (%)	Mostly n (%)	Always n (%)
Timber Roof components (n=222)	8 (3.6)	7 (3.2)	25 (11.3)	81 (36.5)	101 (45.5)
Timber frames (n=218)	18 (8.3)	41 (18.8)	52 (23.9)	62 (28.4)	45 (20.6)
Timber panels (n=218)	30 (13.8)	400 (18.3)	81 (37.2)	51 (23.4)	16 (7.3)
Timber floor elements (n=220)	75 (34.1)	70 (31.8)	55 (25.0)	15 (6.8)	5 (2.3)
Clay Bricks (n=219)	42 (19.2)	58 (26.5)	82 (37.4)	19 (8.7)	18 (8.2)
Adobe Wall (n=206)	116 (56.3)	58 (28.2)	27 (13.1)	3 (1.5)	2 (1.0)
Bamboo roofing (n=212)	130 (61.3)	55 (25.9)	20 (9.4)	7 (3.3)	0
Bamboo truss (n=218)	121 (55.5)	59 (27.1)	26 (11.9)	7 (3.2)	5 (2.3)
Bamboo Beam/Column (n=214)	147 (68.7)	45 (21.0)	18 (8.4)	2 (0.9)	2 (0.9)
Bamboo panels (n=212)	149 (70.3)	42 (19.8)	18 (8.5)	2 (0.9)	1 (0.5)
Bamboo floors (n=210)	157 (74.8)	38 (18.1)	10 (4.8)	4 (1.9)	1 (0.5)
Stone plate roof (n=212)	91 (42.9)	40 (18.9)	50 (23.6)	24 (11.3)	7 (3.3)
Stones for wall (n=213)	43 (20.2)	70 (32.9)	75 (35.2)	25 (11.7)	0 (0.0)
Stone for wall finishes (n=215)	14 (6.5)	44 (20.5)	94 (43.7)	55 (25.6)	8 (3.7)
Stones for flooring (n=214)	56 (26.2)	61 (28.5)	55 (25.7)	25 (11.7)	17 (7.9)
Sandcrete Blocks (n=221)	4 (1.8)	12 (5.4)	17 (7.7)	60 (27.1)	128 (57.9)
Rammed earth wall (n=220)	111 (50.5)	50 (22.7)	37 (16.8)	6 (2.7)	16 (7.3)
Others: EPS = 7	0	1 (14.3)	1 (14.3)	1 (14.3)	4 (57.1)

7.2.2.8 Extent of Use of Offsite Prefabrication Techniques

Offsite prefabricated techniques/materials are not often used for house building in Nigeria, where only 27 (13%) reported using them from mostly to always but they are sometimes used by 101 (46.0%) and rarely 72 (33.0%) and only 18 (8.0%) reported as never used offsite prefabricated materials (refer to figure 7.7). These responses are in agreement with answers to question does Nigerian Building Industry use more traditional methods of construction for low cost house building over offsite prefabrication techniques with 169/222 (76.0%) respondents selected agree and strongly agree options, only 27/222 (12.0%) selected disagree and strongly disagree options and the remaining 12.0% neither disagree or agree (refer to figure 7.8).

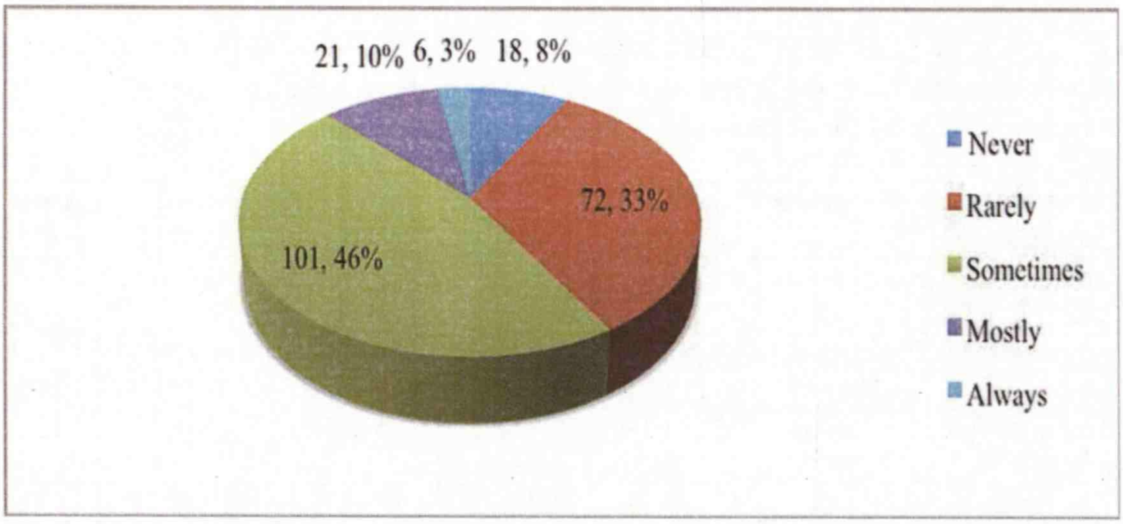

Figure 7.7: How often Offsite prefabricated techniques are used for house building in Nigeria.

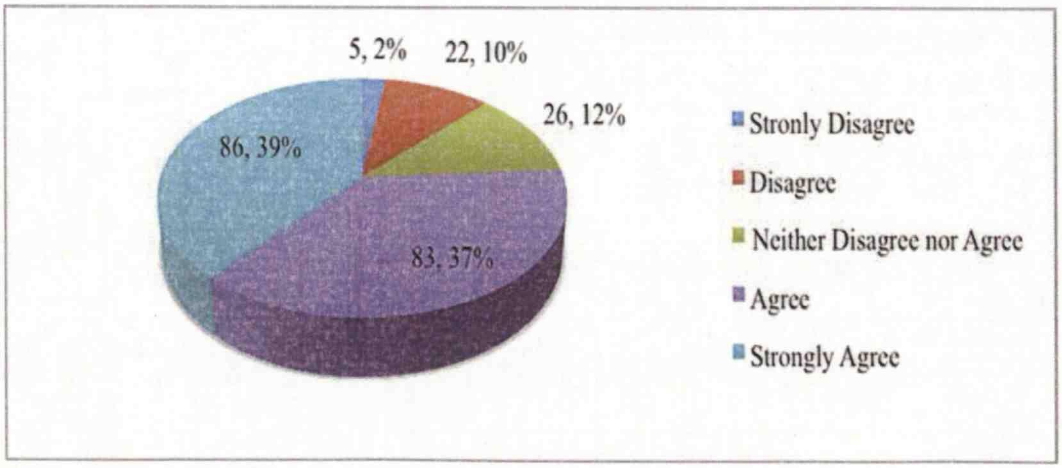

Figure 7.8: Level of agreement on traditional methods of construction is more prevalent towards low cost house building than offsite prefabricated techniques.

7.2.2.9 Comparison on the Level of Agreement of Use of Prefabrication Techniques in General and Prefabricated local Building Materials

In addition, 14/221 (7.0%) strongly agreed and 89 respondents (40.0%) agreed that even where the prefabricated techniques are utilised the local building materials are not utilised while 36 (16.0%) neither disagreed nor agreed, 73 (33.0%) disagreed and 9 (4.0%) strongly disagreed (refer to figure 7.9). The professionals in the house building industry agreed that in order to reduce the housing shortage in Nigeria, the building industry must increase the diffusion and utilisation of the techniques of prefabricated local building materials for low cost house building provision where 154/221 (70.0%) strongly agreed or agreed and only 38 (17.0%) strongly disagreed or disagreed and the remaining 13.0% neither disagreed nor agreed (refer to figure 7.10).

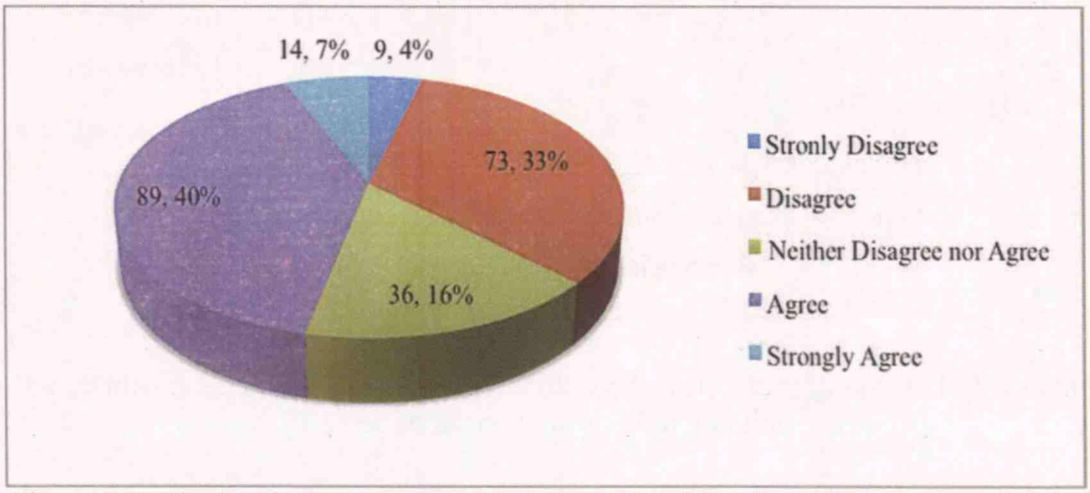

Figure 7.9: The level of agreement on where prefabricated components are used for house building, local building materials are not used to produce the components.

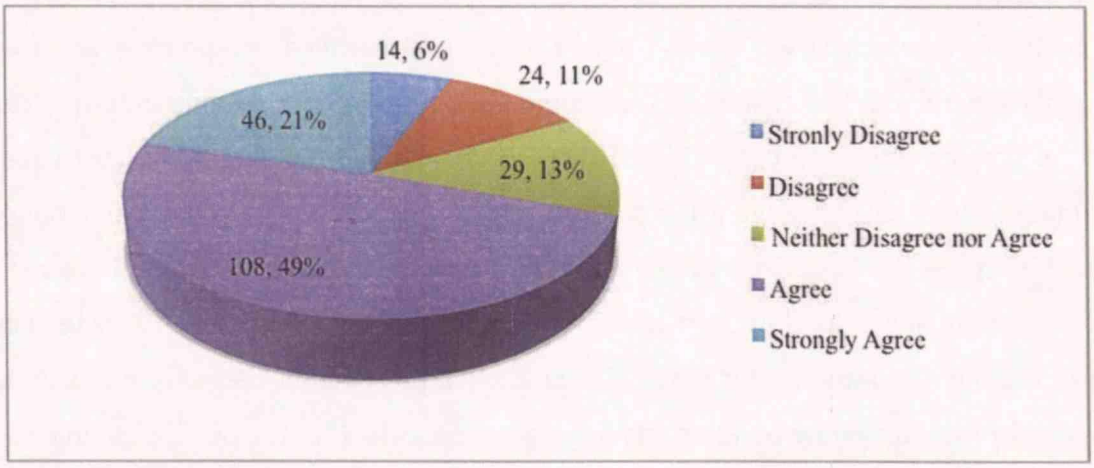

Figure 7.10: Level of agreement on whether the diffusion and utilisation of prefabricated local building materials for low cost house building to be increased within the building industry of Nigeria, in order to reduce the housing shortage in the country

7.2.2.10 Level of Prefabrication Construction Techniques Application

The findings shows the level of prefabricated construction techniques application within the building industry's sector of Nigeria as follows; 31.5%, 45.7%, 40.8% replying as mostly and always, 37.6%, 25.7%, 37.4% sometimes and 31.9%, 28.6%, 21.8% never and rarely for residential, industrial and commercial respectively (refer to figure 7.11).

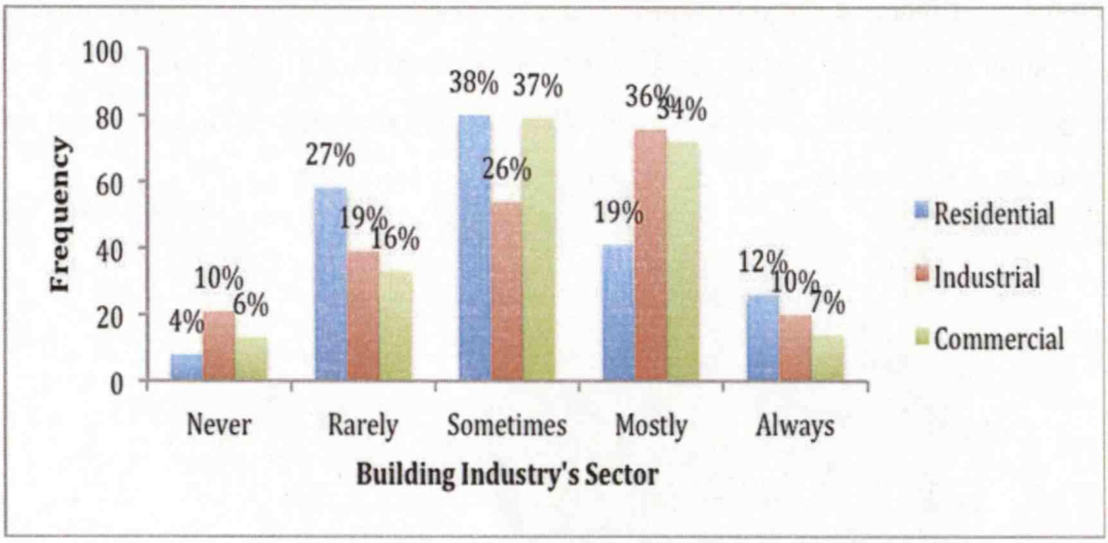

Figure 7.11: Level of prefabricated construction techniques application within the building industry's sector of Nigeria.

7.2.2.11 Rate of Usage of Selected Prefabricated Components in General and in Low Cost House Building

In addition, questions were asked for how often prefabricated components are used towards general and low cost house building within the Nigerian building industry. The lists of components are presented in Table 7.4 and 7.5 for general and low cost house building. The levels of usage differ in many of the components for general and that of low cost house building. For example, 45.9% never use prefabricated volumetric / modular component for low cost house building while for general 29.1% said they never use them. Similarly, for prefabricated kitchen pods 11.6% use it from mostly to always for low cost house building and for general up to 16.1%. The detailed counts and proportions of responses from never – always for all the components are presented in tables 7.4 and 7.5 for general and low cost house building.

Table 7.4: Application of prefabricated components for general house building

Prefabricated Components (General house building)	Never n (%)	Rarely n (%)	Sometimes n (%)	Mostly n (%)	Always n (%)
Volumetric/Modular (n=203)	59 (29.1)	66 (32.5)	45 (22.2)	20 (9.9)	13 (6.4)
Kitchen pods (n=205)	74 (36.1)	57 (27.8)	41 (20.0)	24 (11.7)	9 (4.4)
Bathroom/Toilet pods (n=206)	74 (35.9)	45 (21.8)	34 (16.5)	34 (16.5)	19 (9.2)
Pre-assembled roof (n=211)	53 (25.1)	52 (24.6)	60 (28.4)	26 (12.3)	20 (9.5)
Interlocking blocks (n=211)	7 (3.3)	25 (11.8)	77 (36.5)	54 (25.6)	48 (22.7)
Interlocking bricks (n=210)	18 (8.6)	37 (17.6)	75 (35.7)	49 (23.3)	31 (14.8)
Internal wall panels (n=210)	24 (11.4)	46 (21.9)	85 (40.5)	43 (20.5)	12 (5.7)
External wall panels (n=209)	32 (15.3)	55 (26.3)	85 (40.7)	20 (9.6)	17 (8.1)
Pre-assembled doors/windows (n=210)	6 (2.9)	14 (6.7)	39 (18.6)	86 (41.0)	65 (31.0)
Timber cassette (n=209)	46 (22.0)	73 (34.9)	52 (24.9)	29 (13.9)	9 (4.3)
Timber frame (n=208)	35 (16.8)	51 (24.5)	66 (31.7)	39 (18.8)	17 (8.2)
Precast concrete frame (n=210)	18 (8.6)	47 (22.4)	79 (37.6)	49 (23.3)	17 (8.1)
Traditional structure steel frame (n=209)	18 (8.6)	43 (20.6)	85 (40.7)	41 (19.6)	22 (10.5)
Light steel frame (n=208)	20 (9.6)	52 (25.0)	60 (28.8)	54 (26.0)	22 (10.6)
Pre-assembled drainage (n=209)	30 (14.4)	60 (28.7)	66 (31.6)	35 (16.7)	18 (8.6)
Pre-assembly formwork (n=210)	36 (17.1)	57 (27.1)	59 (28.1)	42 (20.0)	16 (7.6)
Offsite prefabricated foundation (n=210)	118 (56.2)	43 (20.5)	27 (12.9)	11 (5.2)	11 (5.2)
Precast piles (n=210)	86 (41.0)	52 (24.8)	36 (17.1)	18 (8.6)	18 (8.6)
Interlocking floors (n=210)	28 (13.3)	26 (12.4)	57 (27.1)	58 (27.6)	41 (19.5)
Pre-assembly drainage & underground services	52 (24.8)	59 (28.1)	47 (22.4)	33 (15.7)	19 (9.0)

(n=210)					
Prefabricated Stairs (n=210)	58 (27.6)	66 (31.4)	58 (27.6)	10 (4.8)	18 (8.6)

Table 7.5: Application of prefabricated components for low cost house building

Prefabricated Components (Low cost house building)	Never n (%)	Rarely n (%)	Sometimes n (%)	Mostly n (%)	Always n (%)
Volumetric/Modular (n=172)	79 (45.9)	39 (22.7)	37 (21.5)	8 (4.7)	9 (5.2)
Kitchen pods (n=173)	82 (47.4)	42 (24.3)	29 (16.8)	14 (8.1)	6 (3.5)
Bathroom/Toilet pods (n=173)	70 (40.5)	41 (23.7)	27 (15.6)	19 (11.0)	16 (9.2)
Pre-assembled roof (n=175)	37 (21.1)	61 (34.9)	55 (31.4)	13 (7.4)	9 (5.1)
Interlocking blocks (n=175)	20 (11.4)	49 (28.0)	52 (29.7)	35 (20.0)	19 (10.9)
Interlocking bricks (n=176)	30 (17.0)	60 (34.1)	59 (33.5)	17 (9.7)	10 (5.7)
Internal wall panels (n=176)	34 (19.3)	66 (37.5)	49 (27.8)	20 (11.4)	7 (4.0)
External wall panels (n=176)	45 (25.6)	63 (35.8)	37 (21.0)	20 (11.4)	11 (6.3)
Pre-assembled doors/windows (n=177)	24 (13.6)	55 (11.3)	34 (29.4)	49 (27.7)	32 (18.1)
Timber cassette (n=175)	64 (36.6)	55 (31.4)	34 (19.4)	18 (10.3)	4 (2.3)
Timber frame (n=176)	39 (22.2)	38 (21.6)	55 (31.3)	37 (21.0)	7 (4.0)
Precast concrete frame (n=176)	33 (18.8)	58 (33.0)	54 (30.7)	22 (12.5)	9 (5.1)
Traditional structure steel frame (n=176)	36 (20.5)	47 (26.7)	58 (33.0)	19 (10.8)	16 (9.1)
Light steel frame (n=176)	47 (26.7)	38 (21.6)	57 (32.4)	16 (9.1)	18 (10.2)
Pre-assembled drainage (n=175)	66 (37.7)	46 (26.3)	31 (17.7)	23 (13.1)	9 (5.1)
Pre-assembly formwork (n=175)	67 (38.3)	39 (22.3)	40 (22.9)	19 (10.9)	10 (5.7)
Offsite prefabricated foundation (n=175)	111 (63.4)	34 (19.4)	15 (8.6)	9 (5.1)	6 (3.4)
Precast piles (n=176)	90 (51.1)	40 (22.7)	25 (14.2)	12 (6.8)	9 (5.1)
Interlocking floors (n=175)	31 (17.7)	46 (26.3)	45 (25.7)	35 (20.0)	18 (10.3)
Pre-assembly drainage & underground services (n=176)	61 (34.7)	52 (29.5)	34 (19.3)	17 (9.7)	12 (6.8)
Prefabricated Stairs	82 (46.9)	49 (28.0)	25 (14.3)	10 (5.7)	9 (5.1)

(n=175)					

7.2.2.12 Level of Satisfaction of the Use of Selected Prefabricated Components in House Building in Nigeria

Respondents were asked to indicate their level of satisfaction with the application of prefabricated components used in house building. Among the prefabricated components presented in Table 7.6, pre-assembled doors and windows have the highest proportion of (70.2%) satisfaction level in the application of prefabricated components for house building where 51/208 (24.5%) respondents were highly satisfied and 95 (45.7%) satisfied. Then followed by Interlocking blocks 60.6% satisfaction level with 32/208 (15.4%) and 94 (45.2%) highly satisfied and satisfied respectively. The third, fourth and fifth on top of the satisfied (satisfied + very satisfied) list were interlocking bricks 59.6% (45.7% + 13.9%), Interlocking floors 56.3% (37.5% +18.8%) and light steel frame 54.1% (44.9% + 9.2%).

The prefabricated components application can overall be considered satisfactory by the respondents although there are some components with high level of unsatisfied responses such as offsite prefabricated foundation where 127/201 (63.2%) users were unsatisfied with 49 (24.4%) highly unsatisfied and 78 (38.8%) unsatisfied. Then followed by volumetric/modular components 91/194 (46.9%) with 35 (18%) highly unsatisfied and 56 (28.9%) unsatisfied responses. Then Kitchen pods and Bathroom/Toilet pods each with 87/196 (44.4%) unsatisfied where 42 (21.4%) each highly unsatisfied and 45 (23.0%) unsatisfied but 28.1% and 25.5% neither unsatisfied nor satisfied and 27.6% and 30.1% who are satisfied for Kitchen pods and Bathroom/Toilet pods respectively. Table 7.6 contained the details of all satisfaction levels in counts and proportions for each level from highly unsatisfied to highly satisfy. Refer to figure 7.12 for a graphical presentation on the respondent's level of satisfaction of some of the major prefabricated components used for house building in Nigeria.

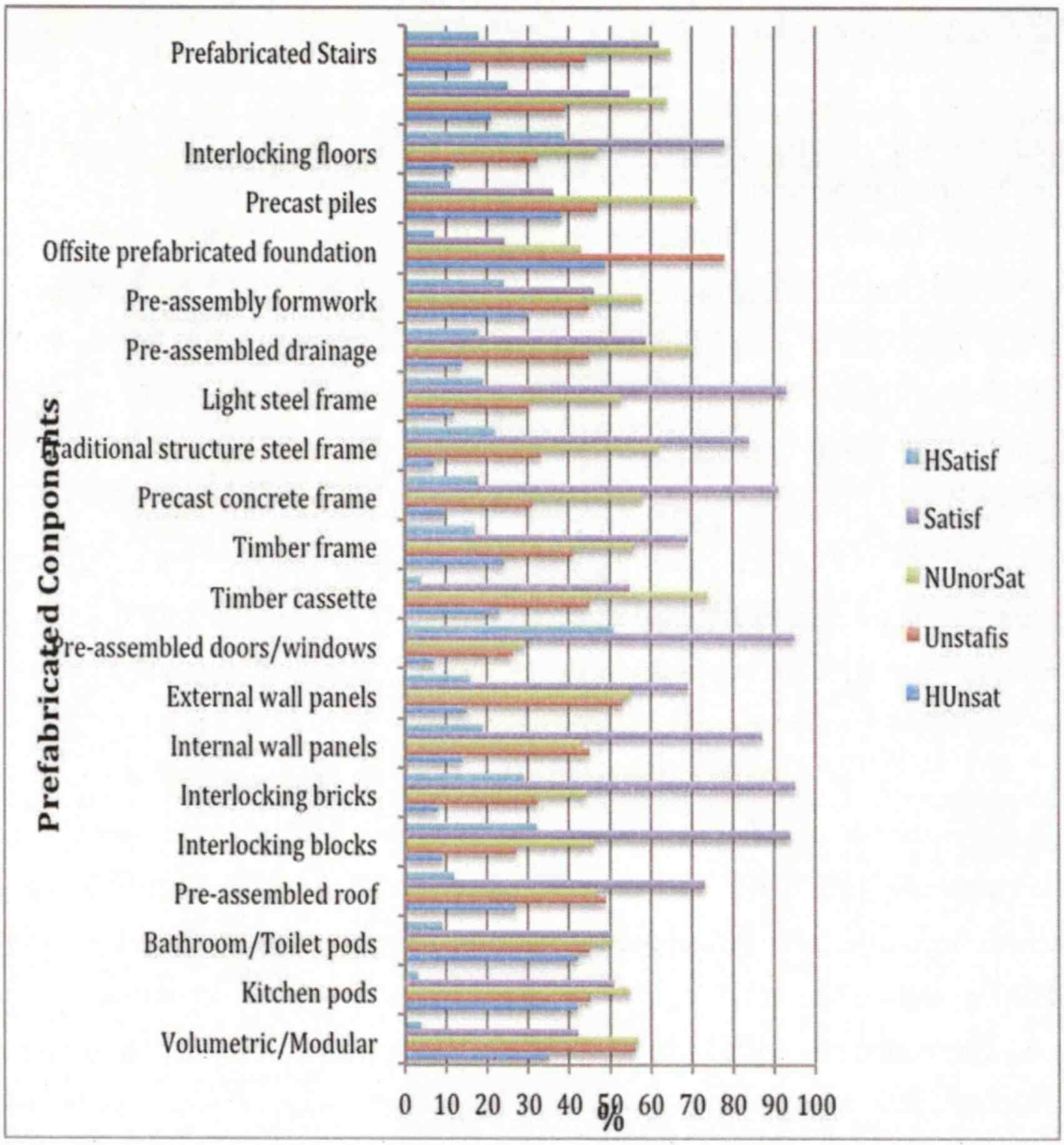

Figure 7.12: Level of satisfaction in the application of prefabricated components used for house building in Nigeria.

Table 7.6: Level of satisfaction in the application of prefabricated components used for house building in Nigeria

Level of Satisfaction	**Highly Unsatisfied n (%)**	**Unsatisfied n (%)**	**Neither Unsatisfied nor Satisfied n (%)**	**Satisfied n (%)**	**Highly Satisfied n (%)**
Volumetric/Modular (n=194)	35 (18.0)	56 (28.9)	57 (29.4)	42 (21.6)	4 (2.1)

Kitchen pods (n=196)	42 (21.4)	45 (23.0)	55 (28.1)	51 (26.0)	3 (1.5)
Bathroom/Toilet pods (n=196)	42 (21.4)	45 (23.0)	50 (25.5)	50 (25.5)	9 (4.6)
Pre-assembled roof (n=208)	27 (13.0)	49 (23.6)	47 (22.6)	73 (35.1)	12 (5.8)
Interlocking blocks (n=208)	9 (4.3)	27 (13.0)	46 (22.1)	94 (45.2)	32 (15.4)
Interlocking bricks (n=208)	8 (3.8)	32 (15.4)	44 (21.2)	95 (45.7)	29 (13.9)
Internal wall panels (n=208)	14 (6.7)	45 (21.6)	43 (20.7)	87 (41.8)	19 (9.1)
External wall panels (n=208)	15 (7.2)	53 (25.5)	55 (26.4)	69 (33.2)	16 (7.7)
Pre-assembled doors/windows (n=208)	7 (3.4)	26 (12.5)	29 (13.9)	95 (45.7)	51 (24.5)
Timber cassette (n=201)	23 (11.4)	45 (22.4)	74 (36.8)	55 (27.4)	4 (2.0)
Timber frame (n=207)	24 (11.6)	41 (19.8)	56 (27.1)	69 (33.3)	17 (8.2)
Precast concrete frame (n=208)	10 (4.8)	31 (14.9)	58 (27.9)	91 (43.8)	18 (8.7)
Traditional structure steel frame (n=208)	7 (3.4)	33 (15.9)	62 (29.8)	84 (40.4)	22 (10.6)
Light steel frame (n=207)	12 (5.8)	30 (14.5)	53 (25.6)	93 (44.9)	19 (9.2)
Pre-assembled drainage (n=206)	14 (6.8)	45 (21.8)	70 (34.0)	59 (28.6)	18 (8.7)
Pre-assembly formwork (n=203)	30 (14.8)	45 (22.2)	58 (28.6)	46 (22.7)	24 (11.8)
Offsite prefabricated foundation (n=201)	49 (24.4)	78 (38.8)	43 (21.4)	24 (11.9)	7 (3.5)
Precast piles (n=203)	38 (18.7)	47 (23.2)	71 (35.0)	36 (17.7)	11 (5.4)
Interlocking floors (n=208)	12 (5.8)	32 (15.4)	47 (22.6)	78 (37.5)	39 (18.8)
Pre-assembly drainage & underground services (n=204)	21 (10.3)	39 (19.1)	64 (31.4)	55 (27.0)	25 (12.3)
Prefabricated Stairs (n=205)	16 (7.8)	44 (21.5)	65 (31.7)	62 (30.2)	18 (8.8)

7.2.3 Persuasion (Influencing Factors)

7.2.3.1 Level of Agreement and Disagreement on Some Factors That Might Influence the Adoption of Prefabricated Local Building Materials for Low Cost House Building

The Respondents were asked to indicate the extent to their level of agreement or disagreement on the consistency of prefabrication techniques of construction to the existing values and needs of potential adopters in Nigeria. The respondents strongly agreed or agreed that prefabrication technique of construction are not consistent with the existing values and needs of potential adopters, with overall agreement of 53.4% for values and 33.8% needs. The overall disagreement is 28% for values and 48.6% for needs, whereas 18.6% and 17.6% neither agree nor disagree for values and needs respectively.

The level of agreement is slightly higher in the responses on difficulty of applying prefabricated construction techniques towards low cost house building in Nigeria, with 58.6% either strongly agreeing or agreeing that the techniques are difficult to apply towards low cost house building compared with the traditional methods. Similarly, the level of disagreement was slightly lower where 27.0% strongly disagree/disagree and 14.4% choose to be neutral.

The responses on; prefabricated construction techniques are not economically viable or achievable when utilised towards low cost house buildings questions recorded 14.9% as strongly agree, 36.7% agree with only 9.5% strongly disagree and 19.5% each disagree and neither disagree nor agree. The respondents agreed that prefabricated construction techniques are not as visible to the Nigerian populace as traditional methods with up to 70% selecting strongly agree 30.6% and agreed 39.6% and only 18% disagreed with the statement and the remaining 12% were neutral. Details of the counts and proportions of responses on persuasion are summarised in Table 7.7. Refer to figure 7.13 for the graphical summary of some major questions on the factors that affect the diffusion and use of prefabricated local building materials towards low cost house building delivery.

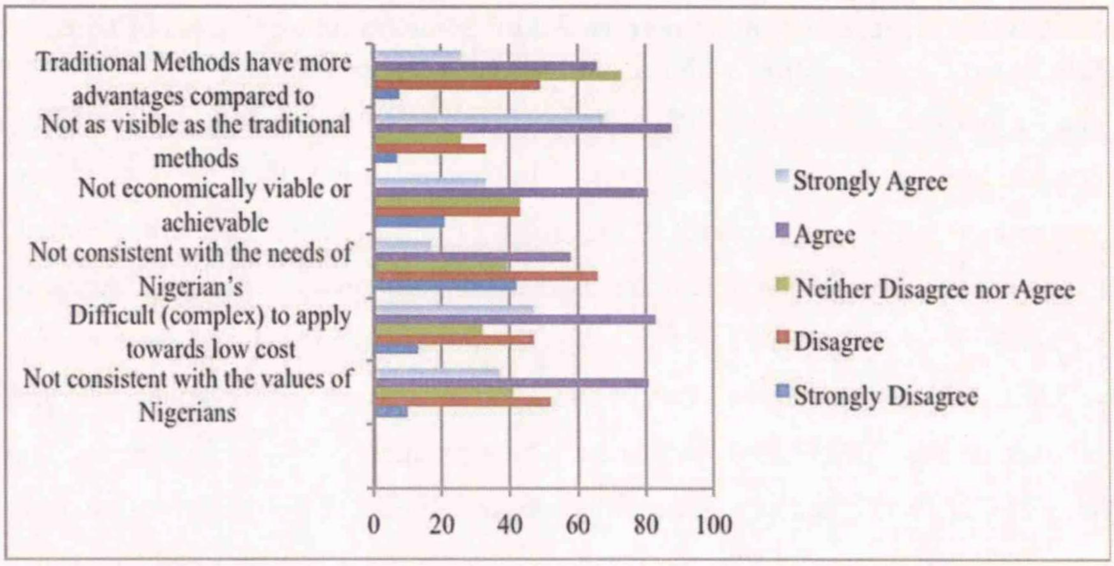

Figure 7.13: The factors that affect the diffusion and use of prefabricated local building materials towards low cost house building delivery.

Table 7.7: Level of agreement on questions of Persuasion

Persuasion	**Strongly Disagree n (%)**	**Disagree (%)**	**Neither Disagree nor Agree n (%)**	**Agree n (%)**	**Strongly Agree n (%)**
Not consistent with the values of Nigerians (n=221)	10 (4.5)	52 (23.5)	41 (18.6)	81 (36.7)	37 (16.7)
Difficult (complex) to apply towards low cost (n=222)	13 (5.9)	47 (21.2)	32 (14.4)	83 (37.4)	47 (21.2)
Not consistent with the needs of Nigerian's (n=222)	42 (18.9)	66 (29.7)	39 (17.6)	58 (26.1)	17 (7.7)
Not economically viable or achievable (n=221)	21 (9.5)	43 (19.5)	43 (19.5)	81 (36.7)	33 (14.9)
Not as visible as the traditional methods (n=222)	7 (3.2)	33 (14.9)	26 (11.7)	88 (39.6)	68 (30.6)
Traditional Methods have more advantages (n=222)	8 (3.6)	49 (22.1)	73 (32.9)	66 (29.7)	26 (11.7)

7.2.3.2 Level of Agreement and Disagreement on Some Enabling Factors of Using Prefabricated Local Building Materials in Low Cost House Building

On the factors that could drive the utilisation of offsite prefabricated local building materials in low cost house building provision in Nigeria, over 50% of the respondents agreed (strongly agree or agree) with all the factors (Table 7.8) listed apart from limited company policies and revision of building regulations questions, where only 33.8% and 47.5% agreed respectively. The counts and proportions of the responses are shown in Table 7.8. It can be seen that reduction of construction duration has the highest number of respondents 184/222 (82.9%) who agreed (strongly agree 37.4% and agree 45.5%) and only 21/222 (9.5%) neither agree nor disagree and 17/222 (7.7%) disagree (strongly disagree 3.2% and disagree 4.5%). Then followed by the use of prefabricated technique to reduce environmental impact during construction with 182/221 (82.4%) respondents who agreed (strongly agree 22.6%, agree 59.7%), 13.1% neither agree nor disagree and the remaining 4.5% disagree (strongly disagree 3.2% and disagree 1.5%). Refer to figure 7.14 for the graphical summary of factors that drive individuals and companies within the building industry of Nigeria to use prefabricated local building materials for low cost house building in Nigeria.

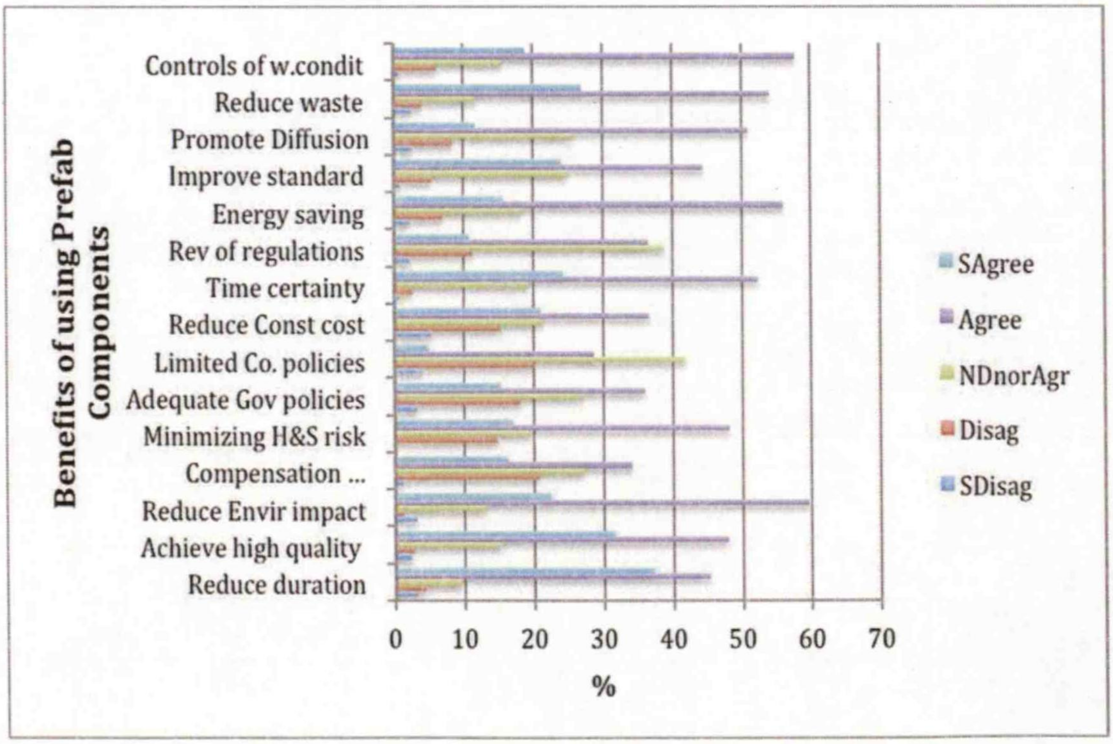

Figure 7.14: Factors that drive individuals or organisations to use prefabricated techniques using local building materials for low cost house building in Nigeria.

Table 7.8: (Enablers) Level of agreement on factors that drive individuals or organisations to use prefabricated techniques using local building materials for low cost house building in Nigeria.

Enablers	**Strongly Disagree n (%)**	**Disagree n(%)**	**Neither Disagree nor Agree n (%)**	**Agree n (%)**	**Strongly Agree n (%)**
Reduce duration (n=222)	7 (3.2)	10 (4.5)	21 (9.5)	101 (45.5)	83 (37.4)
Achieve high quality (n=221)	5 (2.3)	6 (2.7)	34 (15.4)	106 (48.0)	70 (31.7)
Reduce Environmental impact (n=221)	7 (3.2)	3 (1.4)	29 (13.1)	132 (59.7)	50 (22.6)
Compensation … (n=220)	3 (1.4)	46 (20.9)	60 (27.3)	75 (34.1)	36 (16.4)
Minimizing H&S risk (n=222)	1 (0.5)	33 (14.9)	43 (19.4)	107 (48.2)	38 (17.1)
Adequate Gov policies (n=221)	7 (3.2)	40 (18.1)	60 (27.1)	80 (36.2)	34 (15.4)
Limited Co. policies (n=219)	9 (4.1)	44 (20.1)	92 (42.0)	63 (28.8)	11 (5.0)
Reduce Const cost (n=222)	12 (5.4)	34 (15.3)	47 (21.2)	82 (36.9)	47 (21.2)
Time certainty (n=221)	2 (0.9)	6 (2.7)	43 (19.5)	116 (52.5)	54 (24.4)
Rev of regulations (n=221)	5 (2.3)	25 (11.3)	86 (38.9)	81 (36.7)	24 (10.9)
Energy saving (n=221)	5 (2.3)	16 (7.2)	41 (18.6)	124 (56.1)	35 (15.8)
Improve standard (n=220)	2 (0.9)	12 (5.5)	55 (25.0)	98 (44.5)	53 (24.1)
Promote Diffusion(n=221)	6 (2.7)	19 (8.6)	57 (25.8)	113 (51.1)	26 (11.8)
Reduce waste (n=221)	6 (2.7)	9 (4.1)	26 (11.8)	120 (54.3)	60 (27.1)
Controls of Working condition (n=221)	2 (0.9)	14 (6.3)	35 (15.8)	128 (57.9)	42 (19.0)

7.2.3.3 Level of Agreement and Disagreement on Some Restraining Factors of Using Prefabricated Local Building Materials in Low Cost House Building

Therefore, on the factors that restrain expert's decision within the Nigerian building industry in utilising offsite prefabricated local building materials towards low cost house building provision including; lack of enough factories that produce components, lack of adequate knowledge and awareness of the construction techniques, lack of motivation from professionals within the Nigerian building industry questions all recorded over 60% as agreed (strongly agree and agree). Similarly, lack of building policy that supports the use of prefabrication techniques and attitude of public and house builders towards offsite prefabrication each has 56.5% agreed level. While the remaining questions have between 30 and 50% agreed level. The counts and proportion of responses are summarised in Table 7.9. It can be seen that the disagreed (strongly disagree and disagree) level in all the questions were between 10% and 30% apart from increase in construction cost and previous negative perception of historical context from other industries with 41.6% and 31.1% respectively. However, refer to figure 7.15 for the graphical presentation of each of the statement on the above question with the level of agreement response for each statement mentioned.

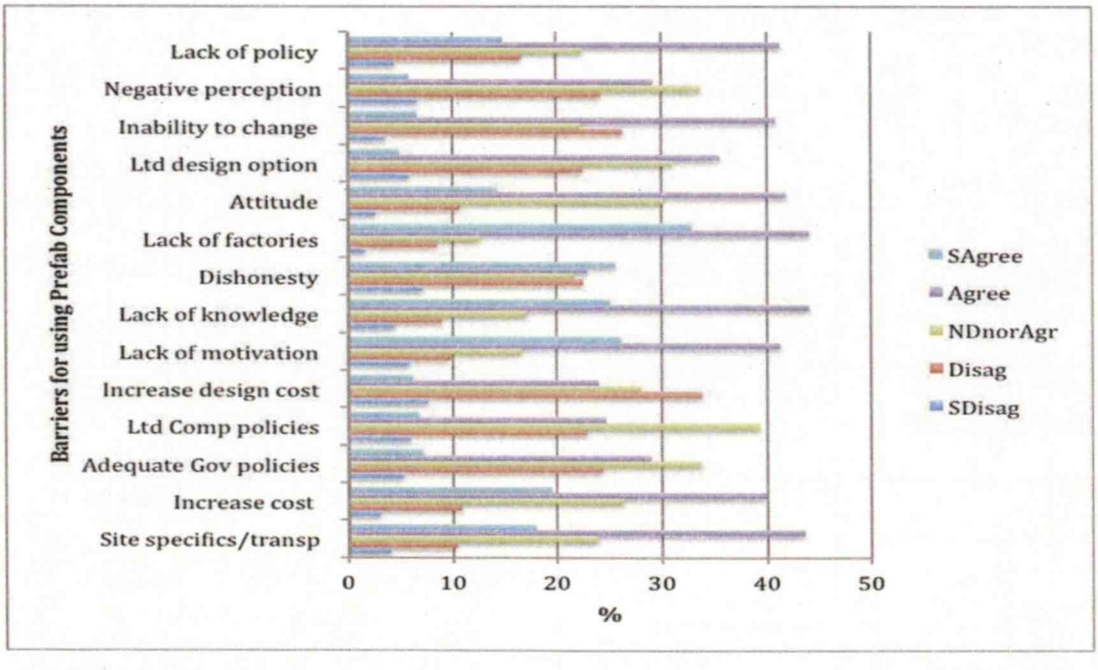

Figure 7.15: Factors that restrain individual or organisations to use prefabricated techniques using local building materials for low cost house building in Nigeria.

Table7.9: Level of agreement on restraining factors on the use prefabricated techniques using local building materials for low cost house building in Nigeria.

Barriers	**Strongly Disagree n (%)**	**Disagree n (%)**	**Neither Disagree nor Agree n (%)**	**Agree n (%)**	**Strongly Agree n (%)**
Site specifics and transport restraint (n=222)	9 (4.1)	23 (10.4)	53 (23.9)	97 (43.7)	40 (18.0)
High cost (n=220)	7 (3.2)	24 (10.9)	58 (26.4)	88 (40.0)	43 (19.5)
Adequate Govt. policies (n=221)	12 (5.4)	54 (24.4)	75 (33.9)	64 (29.0)	16 (7.2)
Ltd Comp policies (n=218)	13 (6.0)	50 (22.9)	86 (39.4)	54 (24.8)	15 (6.9)
Increase design cost (n=221)	17 (7.7)	75 (33.9)	62 (28.1)	53 (24.0)	14 (6.3)
Lack of motivation from professionals (n=222)	13 (5.9)	22 (9.9)	37 (16.7)	92 (41.4)	58 (26.1)
Lack of knowledge and awareness (n=222)	10 (4.5)	20 (9.0)	38 (17.1)	98 (44.1)	56 (25.2)
Dishonesty (corruption) (n=222)	16 (7.2)	50 (22.5)	48 (21.6)	51 (23.0)	57 (25.7)
Lack of factories (n=222)	4 (1.8)	19 (8.6)	28 (12.6)	98 (44.1)	73 (32.9)
Attitude of people (n=222)	6 (2.7)	24 (10.8)	67 (30.2)	93 (41.9)	32 (14.4)
Ltd design option (n=222)	13 (5.9)	50 (22.5)	69 (31.1)	79 (35.6)	11 (5.0)
Inability to change (n=220)	8 (3.6)	58 (26.4)	49 (22.3)	90 (40.9)	15 (6.8)
Negative perception(n=222)	15 (6.8)	54 (24.3)	75 (33.8)	65 (29.3)	13 (5.9)
Lack of policiess (n=222)	10 (4.5)	37 (16.7)	50 (22.5)	92 (41.4)	33 (14.9)

7.2.4 Potential for Prefabricated Local Building Materials

This section of the research questionnaire tries to explore the potential for the utilisation and diffusion of local building materials for prefabricated low cost house building in Nigeria.

7.2.4.1 Potential for Prefabricated Local Building Materials in Low Cost House Building

Responses to the question about the potential of prefabricated local building materials becoming the dominant method for low cost house building in Nigeria, shows that 48.0% (106/222) of the respondents agreed (strongly agree – 12.0% and agree – 36.0%)

with the statement, 25.0% of the respondents neither disagree nor agree that the use of locally produced prefabricated components using local building materials might become the dominant method of building. However, the remaining 27.0% respondents disagreed (strongly disagree – 5.0% and disagree – 22.0%). Refer to figure 7.16 for the graphical presentation of the responses on the potential for prefabricated local building materials to become the dominant method of construction for low cost housing delivery in Nigeria.

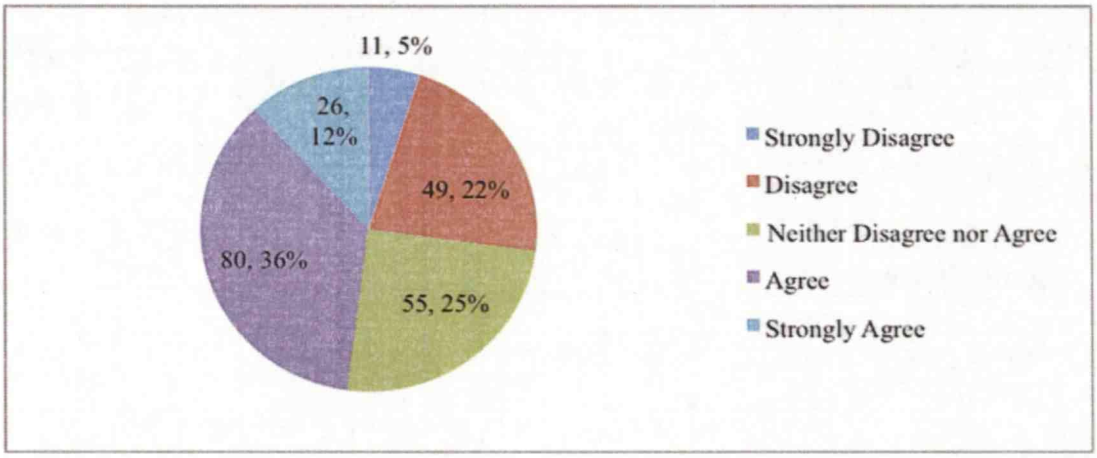

Figure 7.16: potential for prefabricated local building materials to become the dominant method of construction for low cost housing delivery in Nigeria.

7.2.4.2 Reasons Why People Utilize Prefabricated Local Building Materials for Low Cost House Building

The responses to questions about what might influence people to adopt prefabricated local building materials towards low cost house building are summarised in Table 7.10. It can be observed that overall the level of agreement (agree and strongly agree) on all questions is high ranging from 60.4% to 77.0% and the level of disagreement is very low ranging from only 8.1% on successful examples of applications in the Nigerian building question to 18.0% on the question that prefabricated local building materials are more environmental friendly compared to prefabricated important building materials. Refer to figure 7.17 for the graphical presentation of the findings in table 7.10.

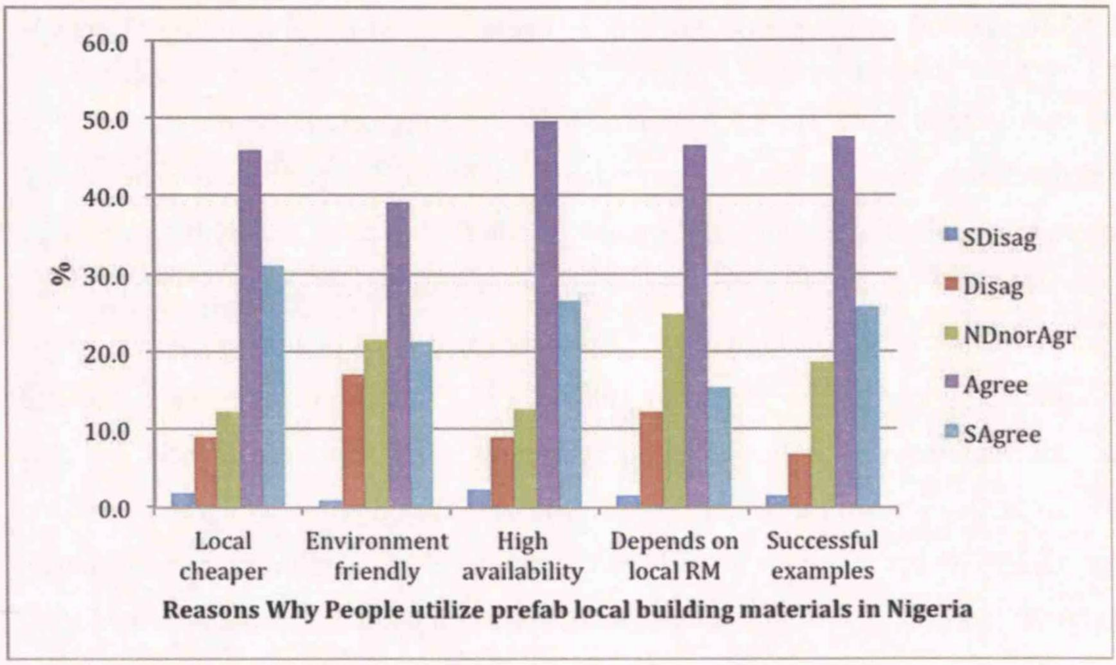

Figure 7.17: Level of agreement or disagreement on factors that might influence people to adopt and utilise prefabricated local building materials for low cost house building.

Table 7.10: level of agreement or disagreement on what might influence people to adopt and utilize prefabricated local building materials towards low cost house building

Statements	**Strongly Disagree n (%)**	**Disagree n (%)**	**Neither Disagree nor Agree n (%)**	**Agree n (%)**	**Strongly Agree n (%)**
Prefab LBM are cheaper compared to imported (n=222)	4 (1.8)	20 (9.0)	27 (12.2)	102 (45.9)	69 (31.1)
Prefab LBM More Environmentally friendly (n=222)	2 (0.9)	38 (17.1)	48 (21.6)	87 (39.2)	47 (21.2)
LBM are readily available (n=222)	5 (2.3)	20 (9.0)	28 (12.6)	110 (49.5)	59 (26.6)
Availability of prefab factories depends solely on local raw materials (n=222)	3 (1.4)	27 (12.2)	55 (24.8)	103 (46.4)	34 (15.3)
Successfully application of prefab in the industry (n=221)	3 (1.4)	15 (6.8)	41 (18.6)	105 (47.5)	57 (25.8)

7.2.4.3 Reasons Why People Do Not Utilize Prefabricated Local Building Materials for Low Cost House Building

In terms of the reasons why prefabricated local building materials are not adopted or utilised towards low cost housing provision, inability of the construction industry to encourage the diffusion and utilisation of local building materials for offsite prefabricated techniques had the highest proportion of agreement 172/222 (77.5%), followed by lack of proper knowledge of prefabricated local building materials within the building industry of Nigeria with 168/222 (75.7%) level of agreement. Lack of codes of practice and proper building standards for prefabricated local building materials is also a reason in which 134/222 (60.4%) agreed (strongly agree 18.0% and agree 42.3%). Other reasons with 50% and below level of overall agreement included: dishonesty (corruption) within building industry; incompatibility of prefabricated local building materials to both existing values and needs of potential adopters. Table 7.11 has the detailed counts and proportions of the level of agreement, disagreement and neutral from the respondents. Also refer to Figure 7.18 for the graphical presentation of all the details in Table 7.11.

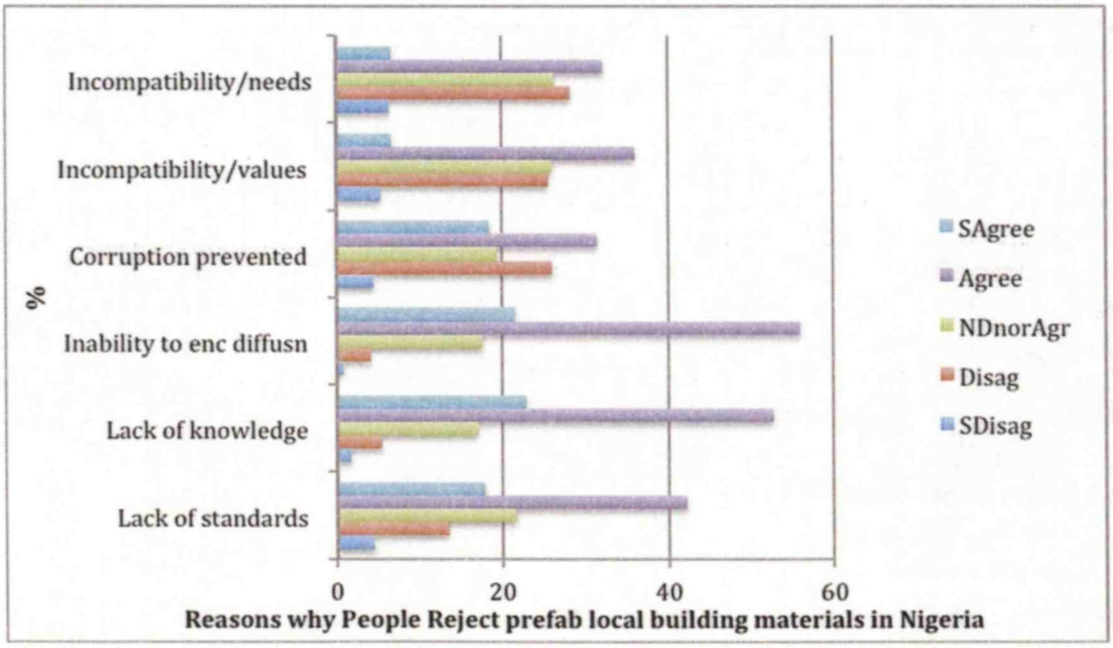

Figure 7.18: Reasons why people do not adopt or use prefabricated local building materials for low cost house building delivery in Nigeria.

Table 7.11: level of agreement or disagreement on the reasons why people do not adopt and utilize prefabricated local building materials towards low cost house building

Statements	Strongly Disagree n (%)	Disagree n (%)	Neither Disagree nor Agree n (%)	Agree n (%)	Strongly Agree n (%)
Lack of building codes and proper building standards for prefabricated LBM (n=222)	10 (4.5)	30 (13.5)	48 (21.6)	94 (42.3)	40 (18.0)
Lack of knowledge of prefabricated LBM (n=222)	4 (1.8)	12 (5.4)	38 (17.1)	117 (52.7)	51 (23.0)
Inability to encourage diffusion and use of prefabricated LBM (n=222)	2 (0.9)	9 (4.1)	39 (17.6)	124 (55.9)	48 (21.6)
Corruption (n=222)	10 (4.5)	58 (26.1)	43 (19.4)	70 (31.5)	41 (18.5)
Incompatibility of prefab to the existing values (n=219)	12 (5.5)	56 (25.6)	57 (26.0)	79 (36.1)	15 (6.8)
Incompatibility of prefab to the existing needs (n=220)	14 (6.4)	62 (28.2)	58 (26.4)	71 (32.3)	15 (6.8)

7.2.4.4 Ranking of Local Building Materials With the Greatest Potential For Application Towards Prefabricated Low Cost House Building

Among the local building materials components listed in Table 7.12 the material that offer the greatest potential towards the application of offsite prefabricated low cost house building with 50% or more respondents categorized them as high and very high were: Sandcrete blocks 191/219 (87.2%), Timber roofing components 147/219 (67.1%), Timber frames 130/219 (59.4%), Clay bricks 125/220 (56.8%), Timber floor elements 122/218 (55.7%) and Stones for wall finishing (54.1%). Some of the components recorded by the respondents with lowest (very low and low) potentials from the list included: Bamboo floors 130/217 (59.9%), Bamboo panels 118/217 (54.4%), Rammed earth wall 107/207 (51.7%), Bamboo beam/column 50.5%. Refer to figure 7.19 for the graphical presentation of the findings in table 7.12.

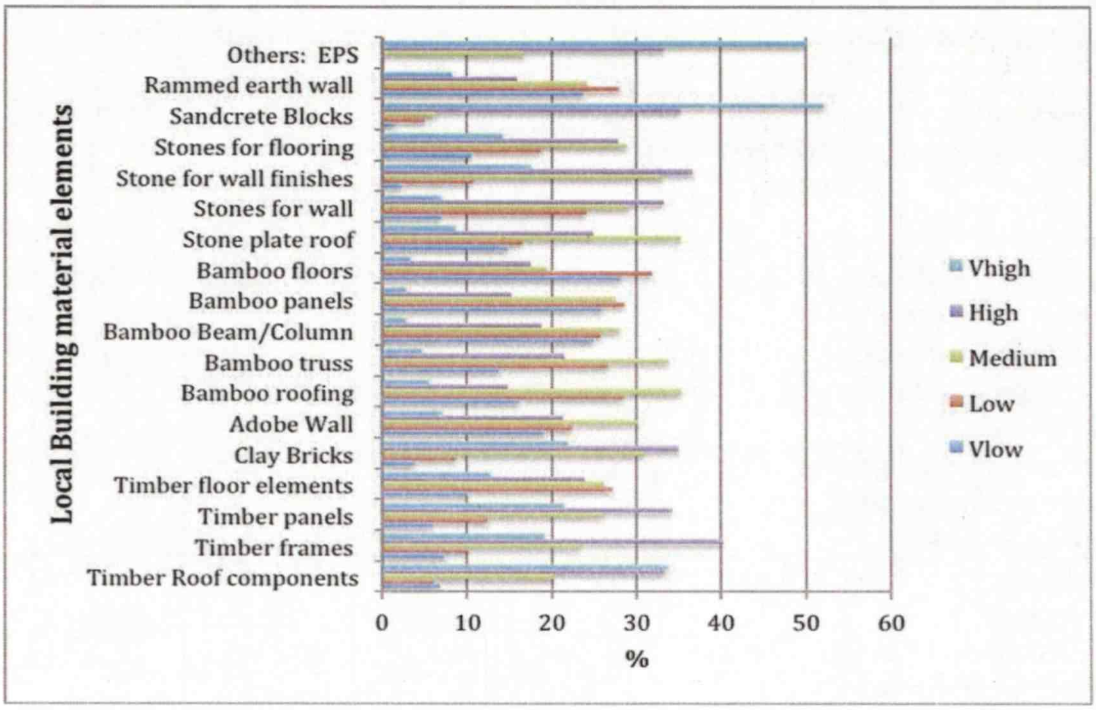

Figure 7.19: Responses on the potentials for local building materials components used for house building.

Table 7.12: The potentials for local Building materials components used for house building in Nigeria.

Local Building Components	**Very low n (%)**	**Low n (%)**	**Medium n (%)**	**High n (%)**	**Very high n (%)**
Timber Roof components(n=219)	15 (6.8)	13 (5.9)	44 (20.1)	73 (33.3)	74 (33.8)
Timber frames (n=219)	16 (7.3)	22 (10.0)	51 (23.3)	88 (40.2)	42 (19.2)
Timber panels (n=218)	13 (5.9)	27 (12.3)	57 (26.0)	75 (34.2)	47 (21.5)
Timber floor elements (n=218)	22 (10.1)	59 (27.1)	57 (26.1)	52 (23.9)	28 (12.8)
Clay Bricks (n=220)	8 (3.6)	19 (8.6)	68 (30.9)	77 (35.0)	48 (21.8)
Adobe Wall (n=211)	40 (19.0)	47 (22.3)	64 (30.3)	45 (21.3)	15 (7.1)
Bamboo roofing (n=218)	35 (16.1)	62 (28.4)	77 (35.3)	32 (14.7)	12 (5.5)
Bamboo truss (n=219)	30 (13.7)	58 (26.5)	74 (33.8)	47 (21.5)	10 (4.6)
Bamboo Beam/Column (n=218)	54 (24.8)	56 (25.7)	61 (28.0)	41 (18.8)	6 (2.8)
Bamboo panels (n=217)	56 (25.8)	62 (28.6)	60 (27.6)	33 (15.2)	6 (2.8)
Bamboo floors (n=217)	61 (28.1)	69 (31.8)	42 (19.4)	38 (17.5)	7 (3.2)
Stone plate roof (n=218)	32 (14.7)	36 (16.5)	77 (35.3)	54 (24.8)	19 (8.7)
Stones for wall (n=217)	15 (6.9)	52 (24.0)	63 (29.0)	72 (33.2)	15 (6.9)
Stone for wall finishes (n=218)	5 (2.3)	23 (10.6)	72 (33.0)	80 (36.7)	38 (17.4)
Stones for flooring	23 (10.5)	41 (18.7)	63 (28.8)	61 (27.9)	31 (14.2)

(n=219)					
Sandcrete Blocks (n=219)	3 (1.4)	11 (5.0)	14 (6.4)	77 (35.2)	114 (52.1)
Rammed earth wall (n=207)	49 (23.7)	58 (28.0)	50 (24.2)	33 (15.9)	17 (8.2)
Others: (n=6) EPS	0	0	1 (16.7)	2 (33.3)	3 (50.0)

7.2.4.5 Ranking of Prefabricated Components With the Greatest Potential For Application Towards Low Cost House Building

Table 7.13 has the list of some prefabricated components. The components were used to assess the level of potentials they have towards the provision of low cost house building in Nigeria. From the counts and proportions of participants' responses in Table 7.13 as each component was ranked from low to high. Pre-assembled doors/windows were ranked with highest (high and very high) potential with 155/217 (71.4%) respondents. Interlocking bricks, interlocking blocks and interlocking floors also ranked as having high potentials by 64.1%, 63.1% and 61.8% respondents respectively. However, the prefabricated components that were ranked with low potential towards the provision of low cost house building were off site prefabricated foundation 124/216 (57.4%), precast piles 102/216 (47.2%) and volumetric/modular component 94/211 (44.5%). The counts and proportions of how the respondents ranked all the components are reported in Table 7.13.

Table 7.13: The potentials for offsite-prefabricated components use in house building.

Prefabricated components	**Very low n (%)**	**Low n (%)**	**Medium n (%)**	**High n (%)**	**Very high n (%)**
Volumetric/Modular (n=211)	37 (17.5)	57 (27.0)	68 (32.2)	32 (15.2)	17 (8.1)
Kitchen pods (n=215)	34 (15.8)	59 (27.4)	82 (38.1)	31 (14.4)	9 (4.2)
Bathroom/Toilet pods (n=215)	33 (15.3)	46 (21.4)	78 (36.3)	44 (20.5)	14 (6.5)
Pre-assembled roof (n=216)	10 (4.6)	37 (17.1)	69 (31.9)	63 (29.2)	37 (17.1)
Interlocking blocks (n=217)	9 (4.1)	20 (9.2)	51 (23.5)	83 (38.2)	54 (24.9)
Interlocking bricks (n=217)	4 (1.8)	15 (6.9)	59 (27.2)	77 (35.5)	62 (28.6)
Internal wall panels (n=216)	8 (3.7)	26 (12.0)	66 (30.6)	75 (34.7)	41 (19.0)
External wall panels	9 (4.2)	36 (16.7)	81 (37.5)	61 (28.2)	29 (13.4)

(n=216)					
Pre-assembled doors/windows (n=217)	5 (2.3)	15 (6.9)	42 (19.4)	91 (41.9)	64 (29.5)
Timber cassette (n=216)	14 (6.5)	44 (20.4)	89 (41.2)	57 (26.4)	12 (5.6)
Timber frame (n=216)	11 (5.1)	28 (13.0)	71 (32.9)	84 (38.9)	22 (10.2)
Precast concrete frame (n=217)	12 (5.5)	25 (11.5)	58 (26.7)	81 (37.3)	41 (18.9)
Traditional structure steel frame (n=217)	6 (2.8)	36 (16.6)	58 (26.7)	94 (43.3)	23 (10.6)
Light steel frame (n=218)	9 (4.1)	37 (17.0)	53 (24.3)	86 (39.4)	33 (15.1)
Pre-assembled drainage (n=218)	15 (6.9)	46 (21.1)	65 (29.8)	66 (30.3)	26 (11.9)
Pre-assembly formwork (n=217)	21 (9.7)	51 (23.5)	56 (25.8)	63 (29.0)	26 (12.0)
Offsite prefabricated foundation (n=216)	60 (27.8)	64 (29.6)	54 (25.0)	31 (14.4)	7 (3.2)
Precast piles (n=216)	37 (17.1)	65 (30.1)	58 (26.9)	36 (16.7)	20 (9.3)
Interlocking floors (n=217)	4 (1.8)	28 (12.9)	51 (23.5)	76 (35.0)	58 (26.7)
Pre-assembly drainage & underground services (n=216)	22 (10.2)	30 (13.9)	75 (34.7)	65 (30.1)	24 (11.1)
Prefabricated Stairs (n=215)	18 (8.4)	39 (18.1)	86 (40.0)	49 (22.8)	23 (10.7)

7.2.4.6 Ranking of Some Factors that Influence the Utilization of Selected Local Building Materials for Prefabricated House Building

In respect of cost saving, sand recorded the highest proportion among respondents who agreed that it has from high to very high cost saving with 158/222 (71.2%) respondents, followed by timber 153/222 (68.9%), then earthen elements with 138/214 (64.5%), then clay with 141/222 (63.5). Bamboo and stones recorded a much lower percentage of 119/221 (53.8%) and 45.5% (100/220) respectively.

In respect of quality, sand with the highest proportion among respondents who agreed from high to very high 179/222 (80.6%) that quality influence their decision to use sand in the production of prefabricated components for house building, followed by Timber

152/222(68.4%), then stones with 142/221(64.2%), then Bamboo 97/221(43.9%). Earthen recorded a lowest percentage of 93/214 (43.4%).

In respect of time saving, Table 7.14 shows sand with the highest proportion of 155/222(69.8%) from high to very high, followed by timber 145/220(65.9%), then clay with 98/222(44.3%), bamboo and stones level on 96/219(43.8%) and 97/221(43.8%) respectively. Earthen building materials recorded the lowest percentage with 91/214 (42.5%).

In respect of availability, Table 7.14 also shows sand with the highest proportion 194/222(87.3%) from high to very high among the participants who use it for prefabricated house building because of it's availability, timber and clay with 175/222(78.8%) and 175/222(78.8%) respectively, then stones 132/221(59.7%). Bamboo recorded the lowest proportion 109/220(49.6%) in terms of availability. In respect of ease of usage, Table 7.14 shows sand with the highest proportion among the respondents 182/221(82.4%) from high to very high, followed by timber with 174/221(78.7%), then clay with 138/219(63%), then earthen with 129/213(60.5%). Bamboo and stones levelled with the lowest proportion of 119/221(53.4%) and 118/221(53.4%) respectively.

The materials in Table 7.14 also reveals that when it comes to social acceptability of local building materials, sand has the highest proportion 192/217(88.5%), from high to very high in terms of its application for prefabricated components for house building, followed by timber with 150/221(67.9%), then stones with 131/220(59.6%), then clay with 102/222(45.9%), then earthen with 92/212(43.4%). Bamboo recorded the lowest percentage 81/221(36.7%) from high to very high ranking in terms of being socially acceptable for prefabricated components for house building in Nigeria.

Table 7.14: Factors that influence local building materials usage in Nigeria

Local Building materials	**Very low n (%)**	**Low n (%)**	**Medium n (%)**	**High n (%)**	**Very high n (%)**
Timber					
Cost saving (n=222)	5 (2.3)	19 (8.6)	45 (20.3)	92 (41.4)	61 (27.5)
Quality (n=222)	3 (1.4)	11 (5.0)	56 (25.2)	86 (38.7)	66 (29.7)
Time saving (n=220)	2 (0.9)	16 (7.3)	57 (25.9)	87 (39.5)	58 (26.4)

Availability (n=222)	1 (0.5)	7 (3.2)	39 (17.6)	89 (40.1)	86 (38.7)
Ease of use (n=221)	0 (0.0)	9 (4.1)	38 (17.2)	82 (37.1)	92 (41.6)
Social acceptability (n=221)	3 (1.4)	19 (8.6)	49 (22.2)	81 (36.7)	69 (31.2)
Clay					
Cost saving (n=222)	12 (5.4)	25 (11.3)	44 (19.8)	68 (30.6)	73 (32.9)
Quality (n=222)	14 (6.3)	35 (15.8)	62 (27.9)	55 (24.8)	56 (25.2)
Time saving (n=222)	15 (6.8)	44 (19.8)	65 (29.3)	59 (26.6)	39 (17.7)
Availability (n=222)	10 (4.5)	24 (10.8)	32 (14.4)	73 (32.9)	83 (37.4)
Ease of use (n=219)	9 (4.1)	32 (14.6)	40 (18.3)	73 (33.3)	65 (29.7)
Social acceptability (n=222)	20 (9.0)	44 (19.8)	56 (25.2)	54 (24.3)	48 (21.6)
Bamboo					
Cost saving (n=221)	15 (6.8)	31 (14.0)	56 (25.3)	61 (27.6)	58 (26.2)
Quality (n=221)	11 (5.0)	41 (18.6)	72 (32.6)	48 (21.7)	49 (22.2)
Time saving (n=219)	11 (5.0)	33 (15.1)	79 (36.1)	53 (24.2)	43 (19.6)
Availability (n=220)	14 (6.4)	37 (16.8)	60 (27.3)	58 (26.4)	51 (23.2)
Ease of use (n=221)	9 (4.1)	34 (15.4)	60 (27.1)	65 (29.4)	53 (24.0)
Social acceptability (n=221)	15 (6.8)	56 (25.3)	69 (31.2)	34 (15.4)	47 (21.3)
Stones					
Cost saving (n=220)	12 (5.5)	36 (16.4)	72 (32.7)	56 (25.5)	44 (20.0)
Quality (n=221)	4 (1.8)	14 (6.3)	61 (27.6)	73 (33.0)	69 (31.2)
Time saving (n=221)	10 (4.5)	36 (16.3)	78 (35.3)	58 (26.2)	39 (17.6)
Availability (n=221)	8 (3.6)	20 (9.0)	61 (27.6)	67 (30.3)	65 (29.4)
Ease of use (n=221)	10 (4.5)	37 (16.7)	56 (25.3)	71 (32.1)	47 (21.3)
Social acceptability (n=220)	9 (4.1)	18 (8.2)	62 (28.2)	86 (39.1)	45 (20.5)
Sand					
Cost saving (n=222)	5 (2.3)	5 (2.3)	54 (24.3)	91 (41.0)	67 (30.2)
Quality (n=222)	0	10 (4.5)	33 (14.9)	97 (43.7)	82 (36.9)
Time saving (n=222)	0	12 (5.4)	55 (24.8)	93 (41.9)	62 (27.9)
Availability (n=222)	0	4 (1.8)	24 (10.8)	84 (37.8)	110 (49.5)
Ease of use (n=221)	2 (0.9)	4 (1.8)	33 (14.9)	76 (34.4)	106 (48.0)
Social acceptability (n=217)	0	4 (1.8)	21 (9.7)	70 (32.3)	122 (56.2)
Earthen elements					
Cost saving (n=214)	9 (4.2)	17 (7.9)	50 (23.4)	73 (34.1)	65 (30.4)
Quality (n=214)	21 (9.8)	24 (11.2)	76 (35.5)	51 (23.8)	42 (19.6)
Time saving (n=214)	11 (5.1)	36 (16.8)	76 (35.5)	52 (24.3)	39 (18.2)
Availability (n=214)	7 (3.3)	22 (10.3)	44 (20.6)	73 (34.1)	68 (31.8)
Ease of use (n=213)	9 (4.2)	23 (10.8)	52 (24.4)	81 (38.0)	48 (22.5)
Social acceptability (n=212)	16 (7.5)	33 (15.6)	71 (33.5)	50 (23.6)	42 (19.8)

7.2.5 Groups comparisons using Chi-Squared method

The respondents that participated in filling the survey questionnaire include different categories of professionals or organizational area of coverage within the building industry, whose sometimes independently work separately from one another and might have different experience of prefabrication techniques of construction. Therefore, Chi-Square method of analysis will be use to identify if there are differences on the responses within the categories of professionals or their area of coverage within the building industry of Nigeria. Some key questions were selected and analysed using qi-squared method to identify if there is any significant difference in the responses among different categories as shown in Table 7.15 to 7.25.

7.2.5.1 Utilization of Prefabricated LBM for Low Cost Within Company Coverage

Null hypothesis: There is no difference in the utilization of prefabricated local building materials for low cost house building within the categories of Companies coverage (which are national, regional and state) in Nigeria.

Alternative hypothesis: There is a difference in the utilisation of prefabricated local building materials for low cost house building within the categories of Companies coverage (which are national, regional and state) in Nigeria.

Table 7.15: The utilisation of prefabricated local building materials for low cost within the categories of companies' coverage

Coverage * Prefab low-cost Cross tabulation

								Total
			Never	Rarely	Sometimes	Mostly	Always	
Coverage	National	Count	21	57	48	33	12	171
		% within Coverage	12.3%	33.3%	28.1%	19.3%	7.0%	100.0%
	Regional	Count	1	5	8	1	1	16
		% within Coverage	6.3%	31.3%	50.0%	6.3%	6.3%	100.0%
	State	Count	4	10	8	11	0	33
		% within Coverage	12.1%	30.3%	24.2%	33.3%	0.0%	100.0%
Total		Count	26	72	64	45	13	220

% within Coverage	11.8%	32.7%	29.1%	20.5%	5.9%	100.0 %

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.950[a]	8	.269
Likelihood Ratio	11.721	8	.164
Linear-by-Linear Association	.022	1	.882
N of Valid Cases	220		

a. 6 cells (40.0%) have expected count less than 5. The minimum expected count is .95.

Pearson Chi square Value = 9.950 and the P-Value = 0.269 which is greater than 0.05. Thus, there is no significant difference among the company categories of respondents. According to Chi-Square method of analysis, the P-Value must be less than 0.05 to prove any significant difference among the categories trying to determine if there is any differences in their answers. It can be clearly seen from Table 7.15 the proportions of the responses from the companies' area of coverage for each category (ranging from never to always) are not significantly different.

7.2.5.2 Utilization of Prefabricated LBM for General House Building Within Company Coverage

Null hypothesis: There is no difference in the utilisation of prefabricated local building materials for general house building within the categories of companies coverage (which are national, regional and state) in Nigeria.

Alternative hypothesis: There is difference in the utilisation of prefabricated local building materials for general house building within the categories of companies coverage (which are national, regional and state) in Nigeria.

Table 7.16: The utilisation of prefabricated local building materials for general house building within the categories of companies' coverage

Coverage * Prefab general Cross tabulation

		Total

			Never	Rarely	Sometimes	Mostly	Always	
Coverage	National	Count	6	51	52	44	18	171
		% within Coverage	3.5%	29.8%	30.4%	25.7%	10.5%	100.0%
	Regional	Count	0	2	8	4	2	16
		% within Coverage	0.0%	12.5%	50.0%	25.0%	12.5%	100.0%
	State	Count	2	12	11	5	3	33
		% within Coverage	6.1%	36.4%	33.3%	15.2%	9.1%	100.0%
Total		Count	8	65	71	53	23	220
		% within Coverage	3.6%	29.5%	32.3%	24.1%	10.5%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.388[a]	8	.604
Likelihood Ratio	7.225	8	.513
Linear-by-Linear Association	.889	1	.346
N of Valid Cases	220		

a. 6 cells (40.0%) have expected count less than 5. The minimum expected count is .58.

Pearson Chi square Value = 6.388 and the P-Value = 0. 604 which is greater than 0.05. Therefore, there is no significant difference to the responses among the company categories on the extent to which local building materials are used for prefabrication in general house building in Nigeria. It can be clearly seen from Table 7.16 the proportions of the responses from the companies' area of coverage for each category (ranging from never to always) are not significantly different.

7.2.5.3 Level of Prefabrication Techniques Usage For House Building in Nigeria

Null hypothesis: There is no difference on how often offsite prefabricated techniques are used for house building within the categories of companies' coverage (which are national, regional and state) in Nigeria.

Alternative hypothesis: There is difference on how often offsite prefabricated techniques are used for house building within the categories of companies' coverage (which are national, regional and state) in Nigeria.

Table 7.17: Level of prefabricated techniques usage towards house building

Coverage * Use of Prefab Cross tabulation

			Never	Rarely	Sometimes	Mostly	Always	Total
Coverage	National	Count	14	56	81	14	4	169
		% within Coverage	8.3%	33.1%	47.9%	8.3%	2.4%	100.0%
	Regional	Count	0	6	9	0	1	16
		% within Coverage	0.0%	37.5%	56.3%	0.0%	6.3%	100.0%
	State	Count	4	10	11	7	0	32
		% within Coverage	12.5%	31.3%	34.4%	21.9%	0.0%	100.0%
Total		Count	18	72	101	21	5	217
		% within Coverage	8.3%	33.2%	46.5%	9.7%	2.3%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.176[a]	8	.144
Likelihood Ratio	14.135	8	.078
Linear-by-Linear Association	.068	1	.794
N of Valid Cases	217		

a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .37.

Pearson Chi square Value = 12.176 and the P-Value = 0.144 which is greater than 0.05. Therefore, there is no significant difference to the responses among the company categories on how often offsite prefabricated techniques are used for house building in Nigeria. It can be clearly seen from Table 7.17 the proportions of the responses from the companies' area of coverage for each category (ranging from never to always) are not significantly different.

7.2.5.4 Where Prefabrication Techniques are Utilize Local Building Materials Are Not Used

Null hypothesis: There is no difference on the question; where prefabricated techniques are used local building materials are not utilised for house building within the categories of companies coverage (which are national, regional and state) in Nigeria.

Alternative hypothesis: There is difference on the question; where prefabricated techniques are used local building materials are not utilised for house building within the categories of companies coverage (which are national, regional and state) in Nigeria.

Table 7.18: Prefabricated local building components are not used in prefabricated house buildings

Coverage * LMB not use for Prefab Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Coverage	National	Count	6	51	26	75	13	171
		% within Coverage	3.5%	29.8%	15.2%	43.9%	7.6%	100.0%
	Regional	Count	1	6	5	3	1	16
		% within Coverage	6.3%	37.5%	31.3%	18.8%	6.3%	100.0%
	State	Count	1	16	5	11	0	33
		% within Coverage	3.0%	48.5%	15.2%	33.3%	0.0%	100.0%
Total		Count	8	73	36	89	14	220
		% within Coverage	3.6%	33.2%	16.4%	40.5%	6.4%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.958[a]	8	.204

Likelihood Ratio	12.731	8	.121
Linear-by-Linear Association	5.696	1	.017
N of Valid Cases	220		

a. 5 cells (33.3%) have expected count less than 5. The minimum expected count is .58.

Pearson Chi square Value = 10.958 and the P-Value = 0.204 which is greater than 0.05. Therefore, there is no significant difference to the responses among the company categories on the question, where prefabricated techniques are used local building materials are not utilised for prefabricated house building in Nigeria. It can be clearly seen from Table 7.18 the proportions of the responses from the companies' area of coverage for each category (ranging from never to always) are not significantly different.

7.2.5.5 Level of Agreement or Disagreement on Factors that Influence Diffusion and Utilization of Prefabrication LBM in Low Cost House Building

7.2.5.5.1 Prefabricated Inconsistency With the Existing Values of Potential Adopters Among the Professional Participants

Null hypothesis: There is no difference on the question; prefabricated construction techniques are not consistent with the existing values of potential adopters in Nigeria.

Alternative hypothesis: There is difference on the question; prefabricated construction techniques are not consistent with the existing values of potential adopters in Nigeria.

Table 7.19: Prefabricated inconsistency with the existing values of potential adopters among the professional participants

Job title * Prefab not consistent with values Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Job title	Project manager	Count	3	10	7	15	8	43
		% within Job title	7.0%	23.3%	16.3%	34.9%	18.6%	100.0%
	Builder	Count	1	6	4	9	5	25
		% within Job title	4.0%	24.0%	16.0%	36.0%	20.0%	100.0%
	Architect	Count	2	8	8	16	5	39

		% within Job title	5.1%	20.5%	20.5%	41.0 %	12.8%	100.0 %
	Civil Engineer	Count	0	12	10	13	7	42
		% within Job title	0.0%	28.6%	23.8%	31.0 %	16.7%	100.0 %
	Quantity Surveyor	Count	3	8	7	20	5	43
		% within Job title	7.0%	18.6%	16.3%	46.5 %	11.6%	100.0 %
	C.E.O	Count	0	8	5	8	7	28
		% within Job title	0.0%	28.6%	17.9%	28.6 %	25.0%	100.0 %
Total		Count	9	52	41	81	37	220
		% within Job title	4.1%	23.6%	18.6%	36.8 %	16.8%	100.0 %

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.749[a]	20	.924
Likelihood Ratio	14.195	20	.820
Linear-by-Linear Association	.101	1	.751
N of Valid Cases	220		

a. 9 cells (30.0%) have expected count less than 5. The minimum expected count is 1.02.

Pearson Chi square Value = 11.749 and the P-Value = 0.924 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; prefabricated construction techniques are not consistent with the existing values of potential adopters in Nigeria. It can be clearly seen from Table 7.19 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.2.5.5.2 Difficulty of Prefabricated Techniques Application Towards Low Cost House Building

Null hypothesis: there is no difference on the question; prefabricated construction techniques are difficult to apply towards low cost house buildings compared to traditional methods.

Alternative hypothesis: there is difference on the question; prefabricated construction techniques are difficult to apply towards low cost house buildings compared to traditional methods.

Table 7.20: Difficulty of prefabricated techniques application towards low cost house building among the professional participants

Job title * Prefab is difficult to apply for low-cost Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Job title	Project manager	Count	1	9	8	20	6	44
		% within Job title	2.3%	20.5%	18.2%	45.5 %	13.6%	100.0 %
	Builder	Count	1	8	5	7	4	25
		% within Job title	4.0%	32.0%	20.0%	28.0 %	16.0%	100.0 %
	Architect	Count	4	9	5	13	8	39
		% within Job title	10.3%	23.1%	12.8%	33.3 %	20.5%	100.0 %
	Civil Engineer	Count	1	9	2	20	10	42
		% within Job title	2.4%	21.4%	4.8%	47.6 %	23.8%	100.0 %
	Quantity Surveyor	Count	4	5	6	15	13	43
		% within Job title	9.3%	11.6%	14.0%	34.9 %	30.2%	100.0 %
	C.E.O	Count	1	7	6	8	6	28
		% within Job title	3.6%	25.0%	21.4%	28.6 %	21.4%	100.0 %
Total		Count	12	47	32	83	47	221
		% within Job title	5.4%	21.3%	14.5%	37.6 %	21.3%	100.0 %

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.483[a]	20	.491
Likelihood Ratio	20.327	20	.438

Linear-by-Linear Association	.620	1	.431
N of Valid Cases	221		

a. 8 cells (26.7%) have expected count less than 5. The minimum expected count is 1.36.

Pearson Chi square Value = 19.483 and the P-Value = 0.491 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; prefabricated construction techniques are difficult to apply towards low cost house buildings compared to traditional methods. It can be clearly seen from Table 7.20 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.2.5.5.3 Prefabricated Inconsistency With the Existing Needs of Potential Adopters

Null hypothesis: there is no difference on the question; prefabricated construction techniques are not consistent with the existing needs of potential adopters in Nigeria.

Alternative hypothesis: there is difference on the question; prefabricated construction techniques are not consistent with the existing needs of potential adopters in Nigeria.

Table 7.21: Prefabricated inconsistency with the existing needs of potential adopters among the professional participants

Job title * Prefab Inconsistency with Needs Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Job title	Project manager	Count	10	14	6	12	2	44
		% within Job title	22.7%	31.8%	13.6%	27.3%	4.5%	100.0%
	Builder	Count	1	13	2	8	1	25
		% within Job title	4.0%	52.0%	8.0%	32.0%	4.0%	100.0%
	Architect	Count	7	11	9	7	5	39
		% within Job title	17.9%	28.2%	23.1%	17.9%	12.8%	100.0%
	Civil	Count	9	12	6	13	2	42

	Engineer	% within Job title	21.4%	28.6%	14.3%	31.0 %	4.8%	100.0 %
	Quantity Surveyor	Count	9	8	12	11	3	43
		% within Job title	20.9%	18.6%	27.9%	25.6 %	7.0%	100.0 %
	C.E.O	Count	6	7	4	7	4	28
		% within Job title	21.4%	25.0%	14.3%	25.0 %	14.3%	100.0 %
Total		Count	42	65	39	58	17	221
		% within Job title	19.0%	29.4%	17.6%	26.2 %	7.7%	100.0 %

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.493[a]	20	.369
Likelihood Ratio	22.108	20	.335
Linear-by-Linear Association	.568	1	.451
N of Valid Cases	221		

a. 9 cells (30.0%) have expected count less than 5. The minimum expected count is 1.92.

Pearson Chi square Value = 21.493 and the P-Value = 0.369 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; prefabricated construction techniques are not consistent with the existing needs of potential adopters in Nigeria. It can be clearly seen from Table 7.21 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.2.5.5.4 Prefabricated Techniques not Economically Viable Towards Low Cost House Building

Null hypothesis: there is no difference on the question; prefabricated construction techniques are not economically viable and achievable when utilised towards low cost house building in Nigeria.

Alternative hypothesis: there is difference on the question; prefabricated construction techniques are not economically viable and achievable when utilised towards low cost house building in Nigeria.

Table 7.22: Perception of professional participant on prefabricated techniques not economically achievable or viable towards low cost house building

Job title * Prefab not economically viable for low cost Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Job title	Project manager	Count	3	9	9	13	10	44
		% within Job title	6.8%	20.5%	20.5%	29.5 %	22.7%	100.0 %
	Builder	Count	1	9	4	9	2	25
		% within Job title	4.0%	36.0%	16.0%	36.0 %	8.0%	100.0 %
	Architect	Count	3	7	7	16	6	39
		% within Job title	7.7%	17.9%	17.9%	41.0 %	15.4%	100.0 %
	Civil Engineer	Count	5	9	5	20	3	42
		% within Job title	11.9%	21.4%	11.9%	47.6 %	7.1%	100.0 %
	Quantity Surveyor	Count	4	5	13	12	8	42
		% within Job title	9.5%	11.9%	31.0%	28.6 %	19.0%	100.0 %
	C.E.O	Count	4	4	5	11	4	28
		% within Job title	14.3%	14.3%	17.9%	39.3 %	14.3%	100.0 %
Total		Count	20	43	43	81	33	220
		% within Job title	9.1%	19.5%	19.5%	36.8 %	15.0%	100.0 %

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.579[a]	20	.485
Likelihood Ratio	19.285	20	.503

Linear-by-Linear Association	.075	1	.784
N of Valid Cases	220		

a. 10 cells (33.3%) have expected count less than 5. The minimum expected count is 2.27.

Pearson Chi square Value = 19.579 and the P-Value = 0.485 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; prefabricated construction techniques are not economically viable and achievable when utilised towards low cost house building in Nigeria. It can be clearly seen from Table 7.22 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.2.5.5.5 The Visibility of Prefabricated Techniques Compared to the Traditional Methods of Construction

Null hypothesis: there is no difference on the question; prefabricated construction techniques are not as visible to the Nigerian populace as the traditional methods.
Alternative hypothesis: there is difference on the question; prefabricated construction techniques are not as visible to the Nigerian populace as the traditional methods.

Table 7.23: Perception of professional participant on the visibility of prefabricated techniques compared to the traditional methods

Job title * Prefab not visible compared to traditional methods of Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Job title	Project manager	Count	1	6	5	16	16	44
		% within Job title	2.3%	13.6%	11.4%	36.4%	36.4%	100.0%
	Builder	Count	1	7	2	8	7	25
		% within Job title	4.0%	28.0%	8.0%	32.0%	28.0%	100.0%
	Architect	Count	1	9	3	15	11	39
		% within Job title	2.6%	23.1%	7.7%	38.5%	28.2%	100.0%

	Civil Engineer	Count	3	4	8	14	13	42
		% within Job title	7.1%	9.5%	19.0%	33.3%	31.0%	100.0%
	Quantity Surveyor	Count	0	5	4	22	12	43
		% within Job title	0.0%	11.6%	9.3%	51.2%	27.9%	100.0%
	C.E.O	Count	0	2	4	13	9	28
		% within Job title	0.0%	7.1%	14.3%	46.4%	32.1%	100.0%
Total		Count	6	33	26	88	68	221
		% within Job title	2.7%	14.9%	11.8%	39.8%	30.8%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.587[a]	20	.549
Likelihood Ratio	18.863	20	.531
Linear-by-Linear Association	.866	1	.352
N of Valid Cases	221		

a. 12 cells (40.0%) have expected count less than 5. The minimum expected count is .68.

Pearson Chi square Value = 18.587 and the P-Value = 0.549 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; prefabricated construction techniques are not as visible to the Nigerian populace as the traditional methods. It can be clearly seen from Table 7.23 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.2.5.5.6 Traditional Methods to Have More Advantages Over Prefabrication Techniques

Null hypothesis: there is no difference on the question; the traditional construction methods have more advantages economically and socially compared to the prefabricated techniques.

Alternative hypothesis: there is no difference on the question; the traditional construction methods have more advantages economically and socially compared to the prefabricated techniques.

Table 7.24: Perception of the professional participants on traditional methods to have more advantages over prefabrication techniques

Job title * Traditional construction methods have more advantages over prefab Cross tabulation

			Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree	Total
Job title	Project manager	Count	1	9	14	17	3	44
		% within Job title	2.3%	20.5%	31.8%	38.6%	6.8%	100.0%
	Builder	Count	1	8	5	8	3	25
		% within Job title	4.0%	32.0%	20.0%	32.0%	12.0%	100.0%
	Architect	Count	3	9	10	12	5	39
		% within Job title	7.7%	23.1%	25.6%	30.8%	12.8%	100.0%
	Civil Engineer	Count	0	10	20	5	7	42
		% within Job title	0.0%	23.8%	47.6%	11.9%	16.7%	100.0%
	Quantity Surveyor	Count	3	5	13	18	4	43
		% within Job title	7.0%	11.6%	30.2%	41.9%	9.3%	100.0%
	C.E.O	Count	0	7	11	6	4	28
		% within Job title	0.0%	25.0%	39.3%	21.4%	14.3%	100.0%
Total		Count	8	48	73	66	26	221
		% within Job title	3.6%	21.7%	33.0%	29.9%	11.8%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.142[a]	20	.196
Likelihood Ratio	28.321	20	.102

Linear-by-Linear Association	.091	1	.763
N of Valid Cases	221		

a. 10 cells (33.3%) have expected count less than 5. The minimum expected count is .90.

Pearson Chi square Value = 25.142 and the P-Value = 0.196 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; the traditional construction methods have more advantages economically and socially compared to the prefabricated techniques. It can be clearly seen from Table 7.24 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.2.5.5.7 Potential of Prefabrication Techniques Becoming Prevalent

Null hypothesis: there is no difference on the question; low cost house building using prefabricated local materials has the potential to become a dominant method of building in Nigeria.

Alternative hypothesis: there is difference on the question; low cost house building using prefabricated local materials has the potential to become a dominant method of building in Nigeria.

Table 7.25: Perception of the professional participants on the potential of prefabrication techniques becoming prevalent

Cross tabulation

			Strongly disagree	Disagre e	Neither disagree nor agree	Agree	Stron gly Agree	Total
Job title	Project manager	Count	1	8	9	21	5	44
		% within Job title	2.3%	18.2%	20.5%	47.7%	11.4 %	100.0%
	Builder	Count	2	7	2	9	5	25
		% within Job title	8.0%	28.0%	8.0%	36.0%	20.0 %	100.0%

	Architect	Count	1	9	10	16	3	39
		% within Job title	2.6%	23.1%	25.6%	41.0%	7.7%	100.0%
	Civil Engineer	Count	4	9	11	13	5	42
		% within Job title	9.5%	21.4%	26.2%	31.0%	11.9 %	100.0%
	Quantity Surveyor	Count	2	10	15	12	3	42
		% within Job title	4.8%	23.8%	35.7%	28.6%	7.1%	100.0%
	C.E.O	Count	1	6	8	9	4	28
		% within Job title	3.6%	21.4%	28.6%	32.1%	14.3 %	100.0%
Total		Count	11	49	55	80	25	220
		% within Job title	5.0%	22.3%	25.0%	36.4%	11.4 %	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.494[a]	20	.747
Likelihood Ratio	15.946	20	.720
Linear-by-Linear Association	1.683	1	.195
N of Valid Cases	220		

a. 11 cells (36.7%) have expected count less than 5. The minimum expected count is 1.25.

Pearson Chi square Value = 15.494 and the P-Value = 0.747 which is greater than 0.05. Therefore, there is no significant difference to the responses among the categories of participants on the question; low cost house building using prefabricated local materials has the potential to become a dominant method of building in Nigeria. It can be clearly seen from Table 7.25 the proportions of the responses within the professional participants for each category (ranging from never to always) are not significantly different.

7.3 Interpretation of Qualitative Interview Data

7.3.1 Section 1: (Awareness and Usage) Degree to Which Prefabricated Local Building Materials Have Been Used For Low Cost House Building in Nigeria.

This section of the qualitative data interpretation contains answers for questions 1-6 of the qualitative interview. This section aims to examine the degree to which local building materials have been utilised in offsite prefabrication construction techniques in low cost house building provision in Nigeria. The interview data was transcribed, coded and interpreted as discussed in the ensuing paragraphs.

There is a high level of knowledge of offsite-prefabricated techniques among the experts of the building industry of Nigeria. However, in terms of offsite prefabrication usage, prefabricated techniques of construction are being used within the building industry of Nigeria. 11 out of the 16 respondents interviewed have used prefabricated techniques of construction in low cost house building; refer to table 2 (In appendix G) for full summary of the responses. According to respondent 2, "*Yes. We use prefabricated construction techniques, mostly expanded polystyrene components. We use them in general house building not just low cost*" (Question 2). The major reasons attributed to the utilisation of these techniques of construction are mainly time saving and construction speed compared to other techniques. According to respondent 10, *"We use prefabrication to speed up construction, to reduce cost and to save time". (Question 2).*

Nine out of the sixteen respondents interviewed stated that, there is a limited use of local building materials for prefabricated components in Nigeria. Some of the major reasons identified are low level of awareness within the Nigerian building industry and among the public, high importation of building materials and the lack of readily available prefabricated local building materials within the building industry, refer to Table 3 (In appendix G) for the summary of the remaining responses to this question.

However, when they were asked if locally produced prefabricated components are used in low cost house building provision in Nigeria. 13 out of the 16 respondents interviewed have one-way or the other used prefabrication techniques of construction using local building materials in their building projects. The major reasons stated were; cost effectiveness of local building materials, availability of local building materials and time savings when prefabricated local components are utilised compared to imported building materials which mostly takes time to get it into the country, refer to Table 4 (In appendix G) for the summary of the remaining interview responses. According to respondent 2, *"Prefabricated local building materials are used for low cost house buildings in Nigeria, because it is low cost and saves construction time" (Question 4).*

The study further reveals that majority (10 out of the 16 respondents) of the prefabricated components used in house building provision in Nigeria are produced locally, even though the importation of building materials is at the high end in the country. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials. Local prefabricated components are mostly used because local building materials are readily available*" (Question 5). The major reasons why prefabricated local building materials are used more for house building delivery over the prefabricated imported building materials are; local building materials are readily available for prefabrication, ease of access to locally prefabricated components compared to imported ones and the cost of prefabricated components produced locally using local building materials in Nigeria is cheaper than the imported prefabricated building components; refer to table 5 (In appendix G) for the full summary of the responses.

Twelve out of the sixteen respondents interviewed stated that majority of prefabrication techniques used within the building industry of Nigeria are the low and medium technology such as, pre-assembled components and panels system but not the high technology. According to respondent 2 "*The low and medium technology prefabricated techniques of construction are mostly used within the building sector of Nigeria. The components are easy to work with. High technology requires heavy lifting's which is expensive*" (Question 6).

Several reasons were attributed to the higher usage of the low and medium technology methods of prefabricated construction. However, some of these reasons stated were that the low and medium technologies are affordable, the technology is available compared to the high technology, and it does not require heavy lifting and high use of machineries when used for house building. Refer to Table 6 (In appendix G) for the summary of responses on prefabricated techniques of construction mostly used within the building industry of Nigeria. There is still an insignificant use of high technological techniques of prefabrication construction in Nigeria. According to respondent 12, "*The high technology requires heavy lifting and it is expensive. The medium and smaller companies are the majority and can only afford the medium and low technology*" (Question 6). The major reasons attributed to the very low level of high technology usage include; high cost and requirement for heavy lifting.

7.3.2 Section 2: Factors that Affect the Diffusion and Utilisation Prefabricated Local Building For Low Cost House Building in Nigeria.

This section of the qualitative data interpretation contains answers for questions 7-12 of the qualitative interview. These questions aim to identify the factors that affect the diffusion and utilization of local building materials for offsite prefabrication techniques for low cost house building provision in Nigeria.

The major reasons that influenced experts within the Nigerian building industry to use prefabricated local building materials for low cost housing delivery in the country are; prefabricated local building materials are cost effective when they are used for low cost house building provision, it saves an incredibly amount of time compared to other techniques and local building materials are readily available in the country. According to respondent 16, "*You want to talk of speed when you are talking about the provision of low cost housing for populace, people want to see in time what you deliver for them. So speed of construction is what will make me use these methods and that's what we are into, it also gives us the opportunity to use less labour for more work. A house that we are going to use 20 people to lay blocks over a month, we can use 4people to complete within two weeks using prefabrication, so when you compare the two you will see that it's of advantage in terms of speed and reduction of construction cost*" (Question 7). Refer to table 7 (In appendix G) for the full summary of the responses.

The study also reveal's many factors that restrain expert's decision within the Nigerian building industry to use prefabricated local building materials for low cost house building provision. Refer to table 8 (In appendix G) for the full summary of the responses. The major factors are; high cost of the prefabricated local components. Although majority of the respondents argue that they use locally produced prefabricated components in their house building projects because it is low cost, but others still argues that prefabrication techniques of construction is expensive regardless of it being produced locally or imported when compared to the traditional method. Some respondents believe that the initial cost of using prefabricated techniques is usually high, especially when the contract awarded for house building requires only a few number of houses. It sometime depends on the type of building material used or the number of units awarded. According to respondent 1, *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; If it is not functional compared to alternatives, high cost and if it is not durable quality wise" (Question 8).* Some experts argue that cost can only be reduced when large number of housing units is to be built. However, the issue of cost of prefabrication techniques of construction is debatable among the experts of the Nigerian building industry. One can construct his or her argument based on experienced. But these participants are mostly from different company categories (such as small, medium and large companies) and their level of prefabrication usage differs. Therefore, if a large prominent company have the resources and manpower to produce large number of components or even cut down their cost in the process, it is possible that a small company won't find it cheaper to fabricate and build. Therefore, the issue of cost of prefabrication techniques of construction is debatable depending on each expert's experience and viewpoint.

The study shows that 10 out of the 16 respondents interviewed agree that the use of locally produced prefabricated components using local building materials is consistent with the existing values and needs of Nigerians. According to respondent 1 "*"Majority of average Nigerians are classified as low income earners and prefabricated techniques of construction is expensive and far beyond an average citizen. Therefore, it is out of the average Nigerian needs. In terms of values, it is well within their values" (Question 9).* Respondent 4 argues that, *"Prefabricated local building materials are consistent with the values and needs of Nigerians. The low technology prefabricated local building materials has been in use for a very long time and it is used to deliver affordable houses. Therefore, it is consistent with the Nigerian values and needs"* (Question 9).

Many reasons were mentioned as to why it is consistent with the needs and values of the Nigerian citizens. Refer to table 9 (In appendix G) for the summary of responses on the consistency of prefabricated techniques of construction.

However, the major reasons are; there is a high demand for houses in Nigeria and prefabricated methods of construction is the fastest way to reduce the housing deficit within a short period of time, many Nigerians are aware of the low technology (preassemble elements such as interlocking blocks and bricks) types of prefabricated techniques, so they are consistent with the existing needs and values of Nigerians, and average Nigerian needs a standard house building and do not care if it prefabricated or not and prefabrication techniques demonstrate high level of standard. About 5 of the respondents emphasised the inconsistency of local prefabricated techniques of construction to the existing socio-cultural values and needs of Nigerians. Respondent 13 stated, "*The Nigerian culture doesn't like changes we are used to the traditional system of blocks and timber, Nigerians do not have the knowledge of this prefabricated methods, it is new to them and they don't like change*" (Question 9). The major reasons are; lack of wider knowledge of prefabrication techniques, prefabricated techniques reduce the number of labourer's onsite and increases unemployment in the country and people prefers what they are use to and do not want to be engage with something new.

Visibility and viability of prefabricated techniques of construction using local building materials have a significant effect on its diffusion and utilization within the building industry of Nigeria, especially towards the provision of low cost house building in Nigeria. Refer to Table 10 (In appendix G) for the summary of all the responses on the effect of visibility and viability. According respondent 1, "*Successful application of these techniques of construction within the building industry will definitely influence it uptake. If they are cheap and within my client's budget, yes it will affect my decision definitely, positively*" (Question 10). 15 out of 16 respondents interviewed highly stressed that visibility and viability will definitely affect their decision to utilise prefabricated local building materials for low cost house building delivery. Respondent 7, stated that, "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria*". *It has to be viable economically and the more these techniques of building are visible, it will not only increase the uptake but it will also improve our company's* *reputation*" (Question 10). However, the major reasons as to how visibility and viability affect the experts decisions are; The technology has to be viable cost wise, when low cost houses are built using prefabricated local building materials it will definitely encourage people and expert to adopt it more within the Nigerian building industry, flexibility in design and appearance of prefabrication construction techniques using local building materials will have a huge impact on its utilisation within the building industry of Nigeria and awareness of the benefits of prefabricated construction techniques using local building materials will definitely increase it's utilisation in the Nigerian building industry.

Twelve out of the sixteen respondents interviewed agreed that corruption is among the major factors that affect the use of local building materials in the production of prefabricated components for low cost house buildings provision in Nigeria. According to respondent 5, "*Corruption affects everything in Nigeria, including low cost housing delivery and prefabrication. Sometimes you have to pay few people to get a contract and at the end it affects the entire concept of prefabricated low cost house building. Corruption affects investors from coming into the country to start up prefabricated company*". (Question 11). Respondent 11 argues that, "*Corruption does affect the use of local building materials for prefabricated low cost house building delivery in Nigeria. The inflation of prices for local prefabricated materials is also an issue. Due to the level of corruption, the government does not monitor the high inflation of building materials which at the end affects the entire concept of low cost house buildings in the country*" (Question 11).

The major reasons influencing corruption are; many professionals within the building industry are eager to get rich quicker even if it means doing something unethical, prices of local building materials are not regulated due to the high level of corruption within the building industry, following due process for licensing or acquiring some sort of approval to run a building or prefabricated local building materials company is also an issue because of the channels, procedures and corruption that is involved along the process which at the end affects the concept of prefabricated low cost house building, the big companies have enough resources and money to bribe and acquire a contract and the government officials find it easier to do unethical business with them because of their resources and influence. The level of corruption among the professionals within other sectors of the country have also affected the improvement and use of local technological capabilities, especially using local building materials in the production of offsite prefabricated components for low cost house building provision in Nigeria. Refer to table 11 (In appendix G) for the full summary of the responses.

7.3.3 Section 3: Potentials for the Utilisation and Diffusion of Local Building Materials for Prefabricated Low Cost House Building in Nigeria.

This section of the qualitative data interpretation contains answers for questions 12-17 of the qualitative interview. These questions aim to explore the potential for the utilisation and diffusion of local building materials for prefabricated low cost house building in Nigeria.

The study aimed to identify the effort being made by the Nigerian building industry's expert and government to promote the use of prefabricated local building materials for low cost house building provision in the country. Refer to Table 12 (In appendix G) for the summary of responses on promoting prefabricated techniques in Nigeria. However, 11 out of the 16 respondents interviewed have promoted the use of prefabrication techniques of construction. Although, it is not promoted formally through media or research and development, but the professional participants interviewed claim to have promoted it either to their clients or by using a fair quantity of prefabricated components on their building projects. According to respondent 5, "*We have promoted the use of prefabricated local building materials for low cost house buildings provision and we are still doing it. We promoted the techniques by using it and by advising our clients on the benefits of it. The reasons include, bringing down cost and speeding up construction*". (Question 12). Therefore, when they were asked why they promote this techniques of construction, the answers given are; prefabrication techniques of construction using local building materials is cost effective when applied towards low cost house building, prefabrication techniques of construction using local building materials saves construction time compared to it alternatives and prefabricated local building materials are promoted in order to enhance the Nigerian building industry's local technological capabilities. However, 5 out of the 16 respondents stated that they have never promoted the use of prefabricated local building materials. The major reasons why they never promoted these techniques of construction are, they are small-scale company and most of the contracts they are involved with were mainly for little number of units, which they find no motivation to go for prefabrication.

To try and find out the reasons behind higher importation of building components in Nigeria, the researcher tries to compare the cost of locally produced prefabricated building components and imported prefabricated building components base on the experiences of the building expert's. 14 out of the 16 respondents interviewed agreed that there is definitely cost savings when prefabricated local building materials are used for house buildings over the prefabricated imported building materials. Refer to Table 13 (In appendix G) for summary of responses to this question. According to respondent 4, *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. It's readily available and you don't have to pay for any duties or shipping cost"* (Question 13). However, Majority of the reasons given are; prefabricated local building materials are cheaper even from a logical point, because the materials are readily available and they are sourced and produced locally. The cost of imported building materials are usually higher because of the transportation and import duties that is attached to it, and the cost of labour in Nigeria is cheap.

The study reveals that Timber, Clay, Expanded Polystyrene, Sandcrete and granite stones among the major local building materials that could offer greater potential for prefabricated low cost house building in Nigeria. See Table 14 (In appendix G) for the summary of the local building materials with greater potential for prefabrication. The reasons stated are; availability of local building materials in Nigeria and the prevalence of these local materials within the Nigerian building industry.

Nine out of sixteen respondents interviewed stated that there are no policies set out by the Nigerian government to encourage the use of prefabricated local building materials for low cost house building provision in the country. See Table 15 (In appendix G) for the summary of responses on policy. According to respondent 1, "*I am not aware of any policy that supports the higher use of prefabricated local building materials. This issue also goes back to corruption. I don't think there are any. Even if there is, I have never come across one. Why they are not promoting this policy is because they encourage importation, because they are involved in all this importation and they have their stakes* *in the imported materials through all the big foreign firms that are available in the country. So by the time they bring about the issue of using local building materials that means they are discouraging importation and that means its bad business for them. But when they are no policies, the importation keeps on, that means it keeps them in business, so corruption also comes in here as an issue*" (Question 15).

The major reasons as to why there are no policies to support prefabrication usage are; lack of awareness of local prefabricated building materials technique of construction. Lack of proper support and encouragement from government professional bodies and housing institutes in the country to promote the use of local technology, and due to the corruption and selfish interest surrounding many government sectors in the country, the Nigerian government lack the zeal to stop importation and encourage the use of local building materials for affordable house buildings. Respondent 12 argues that, "*Even the ministry of land and housing the kind of development they are doing all over the ministries of this country, none of them is considering the use of local building materials. As of today the government of this country have no policy that support or encourage the use of prefabricated local building materials for the sole aim of having a low cost housing*" (Question 15).

However, 6 out of the 16 respondents interviewed stated that there are a few policies that support these techniques of construction in Nigeria. One of the respondent argues that, "*there are policies but the implementation process is very poor*". The policies mentioned were the higher importation duty which is the Nigerian custom policy set up to generate more revenue for the government, and some of them mentioned the national building code which is mostly directed towards building standards and specifications.

The researcher tries to forecast the future of offsite prefabrication in Nigeria. Fourteen out of sixteen respondents interviewed stated that the utilization and diffusion of prefabricated techniques of construction using local building materials would definitely increase within the building industry of Nigeria. Refer to Table 16 (In appendix G) for summary of responses on the future of prefabrication in Nigeria. According to respondent 6, *"It will certainly increase. The awareness is increasing so as the demand for prefabricated local building materials. There is currently about 16million housing deficit in Nigeria and housing prices is increasing. Therefore, we are looking for ways* *to bring down cost and meet the housing demand. So all of these will propel the need for prefabrication techniques"* (Question 16). Some of the major reasons attributed to the increase in the use of prefabricated local building materials are; the awareness of prefabricated techniques of construction using local building materials is growing among the society. The increase in housing demand is soaring in Nigeria, and prefabrication techniques have proven to be an efficient way of delivering house building. Cost can be saved when local building materials are used to produce prefabricated components for house building.

The professionals interviewed for this study, have strongly emphasized that so many factors must be in place in order for the adoption and utilization of prefabrication techniques using local building materials to be improved in Nigeria, especially towards the provision of house building for all. Refer to Table 17 (In appendix G) for the summary of answers to this question. The major factors are; prefabricated local building material components must be made cheap in order for people to rush into adopting the techniques and use the components for low cost house building. The Nigerian government must provide a vibrant policy and legislation to support these techniques of construction. The standard of locally produced components must be enhanced for it to be acceptable by the Nigeria society. The level of awareness and promotion must be increased within the building industry of Nigerian. There is the need for the government to strengthen its education and research institutes. The issue of infrastructure must be addressed in order to increase the adoption rate of prefabricated local building materials for low cost house building provision in Nigeria.

7.4 Conclusion

This chapter presents the findings from both questionnaire survey and the data obtained from the face-to-face interview conducted during the course of this research. The first section of the chapter comprehensively presents the analysis of the questionnaire data using SPSS software. The other section of the chapter comprehensively presents the interview data using Nvivo software. The two findings are presented separately to show how each method was driven and what each finding represents. The survey questionnaire findings was initially analysed and presented before it was complimented with the interview questions to give room for open-ended conversation. This chapter only tries to present the findings with a very limited input to the discussion of the actual data analysed. The study reveals many factors, as the reason to why utilization and of diffusion prefabricated local building materials is not widely accepted in Nigeria. Some of the most emphasized factors from this chapter includes; awareness, corruption, policy, infrastructure, cost, standard, accessibility, promotion, motivation, knowledge transfer, training, laxity of the professionals within the industry, institution, relative advantage, trial-ability, compatibility, complexity and observe-ability The next chapter will thoroughly triangulate the findings together with the literature in order to come up with a more meaningful discussion of the findings. This would help look at how the two findings complement or dispute each other. It is also aimed to examine how the new findings are compared to what is on the literature. Some of the content from this chapter may be largely employed on the next chapter in order to draw a meaningful discussion without referring back to this chapter. The general conclusion of the findings will be drawn on the next chapter after a comprehensive and systematic discussion.

CHAPTER EIGHT

DISCUSSION OF FINDINGS

8.1 Introduction

This chapter will systematically discuss and summarize the findings revealed from both the quantitative and qualitative data obtained during the course of this research. The triangulation method was adopted in order to draw a systematic and holistic discussion on the factors that affect the utilization and diffusion of local building materials in the production of prefabricated components for low cost house buildings in Nigeria. The triangulation method involves discussion of the findings revealed from this study while drawing comparisons from the literature reviewed.

The questions that were answered in this research are categorized into three sections based on Rogers's Theory of innovation-decision process. The innovation-decision process is defined as "*an information seeking and information processing activity, where an individual is motivated to reduce uncertainty about the advantages or disadvantages of an innovation*" (Rogers', 2003, p.436). The Rogers's innovation decision process adopted in this study includes; Knowledge, persuasion, decision and implementation. The knowledge stage questions systematically answered the first objective of the study, which is to examine the degree to which local building materials have been utilized in offsite prefabrication construction methods in low cost house building provision in Nigeria.

The persuasion stage questions systematically answered the second objective of the study, which is to identify the factors that affect the diffusion and use of local building materials for offsite prefabrication components in the provision of low cost house building in Nigeria. However, a particular attention was given to some perceived characteristics of the persuasion stage of the innovation-decision process. These perceived characteristics includes; relative advantage of the innovation, compatibility of the innovation, complexity of the innovation, trial-ability of the innovation and the observe-ability of the innovation (refer to figure 5.1 from chapter 5 of the literature review for more detailed explanation). The decision stage questions systematically answered the third objective of the study, which is to explore the potential for the utilization and diffusion of local building materials for prefabricated low-cost house building in Nigeria.

The implementation stage addressed the last objective of the study, which is to develop a framework for understanding the utilization and diffusion of offsite prefabricated local building materials towards the provision of low-cost house building in Nigeria. The last objective of the study is based on the overall analysis of the entire outcome of the research. This study revealed and confirmed some themes as the factors that affected the diffusion and utilization of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. The systematic discussion of the themes will help in determining and development of the appropriate model that could help facilitate the understanding of the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building in Nigeria.

8.2 Knowledge and Awareness

8.2.1 What is the level of knowledge and awareness of offsite prefabricated techniques of construction among the experts of Nigerian building industry?

Knowledge and Awareness

The qualitative interview reveals that there is a very high level of knowledge and awareness of offsite prefabrication techniques of construction among the respondents in the building industry of Nigeria. All of the participants interviewed have knowledge of offsite prefabrication techniques of construction, regardless of their company's workforce or coverage. Although, the entire participants interviewed from different categories of organizations within the building industry of Nigeria have the knowledge of prefabrication techniques of construction. The participants further highlighted the lack of awareness of prefabrication techniques of construction using local building materials among the factors, which affects it utilization and diffusion within the building industry of Nigeria. This finding partially support the literature where authors such as; (Nawi *et al.*, 2011; Qays *et al.*, 2010; Mohamad *et al.*, 2009; Windapo and

Balogun, 2009) acknowledged the lack of awareness among some experts within the building industry and their clients to be among the major factors that affect the utilization and diffusion of offsite prefabrication techniques of construction in many of the African building industry, including Nigeria.

Level of usage and application of offsite prefabrication towards low cost house building provision in Nigeria

The study further reveals that offsite prefabricated techniques of construction have been used towards low-cost house building in Nigeria. To determine the level of offsite prefabrication construction techniques application within the building sector, the respondents were asked to choose which among the building industry's sector do they mostly apply these techniques of construction in Nigeria. These sectors include; residential, industrial and commercial building sectors. However, the survey data reveals that it is mostly applied within the industrial and commercial sectors of the building industry compared to the residential sector. Thus, it's level of application for house building is less compared to other sectors of the Nigerian building industry.

Off-site prefabrication technique is often regarded as a modern method of construction within the building industry of Nigeria, but it has been used and applied in house building provision for over three decades in Nigeria. Prefabricated techniques of construction can be traced in Nigeria since the early 1970's when the need for urgent house building soared at an alarming rate as a result of urbanization and population growth in the newly created states of the country (Personal Communication, 2014).

Some of the mass housing prefabrication projects in the 70's and 80's were; "*NNPC estates in Kaduna, Warri, and Port Harcourt they did a lot of prefabricated structures. Even in the early 1970's a lot of university units were prefabricated, in Kaduna ABU teaching hospital, professorial quarters in ABU Zaria were all prefabricated. Then we had prefabricated structures in (UPE) Universal Primary Education Scheme 1976 during Obasanjo's tenure, they had a lot of prefabricated classrooms all over the country. But I don't know why these days the traditional methods are preferred. Crème Etalo in Minna the first set of houses that were built immediately after the creation of Niger state, Creme etalo were all prefabricated units fully*" (Respondent 3). The previous prefabricated housing projects in Nigeria were mostly built using concrete structures and steel elements, and these buildings still stand firm around the country.

The current noticeable prefabrication mass housing project in Nigeria is the construction of over 2800-house buildings by CITEC International Limited in Mboura District Abuja using Expanded Polystyrene components (CITEC, 2014). Other companies actively promoting the diffusion and utilization of prefabricated techniques of construction in Nigeria include; Cubic Homes Limited and Millpond Properties. These techniques of construction are still regarded as a new technology when compared to the traditional methods, even though the technology has been in existence for few decades in Nigeria.

Level at which offsite prefabrication techniques are being currently used

The survey data reveals that offsite prefabricated techniques of construction are not used very often for house building in Nigeria, with only 27 (13%) reported using them from mostly to always (refer to figure 7.7). The low level of usage of prefabrication techniques was also complimented with the answers to the comparison with between traditional methods of construction and prefabrication techniques usage. When asked if traditional methods of construction are more used compared to prefabrication techniques, based on the respondent level of agreement or disagreement.

The data reveals that 169/222 (76.0%) of the respondents agree and strongly agree that traditional construction methods are more adopted within the building industry of Nigeria compared to prefabrication techniques of construction (refer to figure 7.8). The finding further proves that there is still limited use of offsite prefabrication techniques of construction in Nigeria when compared traditional methods of construction, which is the mainstream construction method. This is in agreement with Wahab and Lawal, (2011) and Windapo and Balogun, (2009), that there is still limited use of offsite prefabrication in Nigeria, especially towards low cost house building provision when compared to the traditional methods.

8.2.2 What are the types of locally sourced building materials mostly used within the building industry of Nigeria?

The survey data revealed some of the most used local building materials within the building industry of Nigeria. The building material names, frequencies and percentages were as follows: timber 175 (82.8%) and Sandcrete 165 (76.7%), these figures reveal that timber is the most used building material in Nigeria. Although, this research shows timber came first ahead of Sandcrete elements in second, but is in agreement with Baiden and Tuuli (2004) statement that more than 85% of Nigerian house buildings used sandcrete blocks. Then followed by Gravel/stones 142 (66.0%) in third position. This could be due to the increase in the use of granite stones for block production in the country. The house builders within the Nigerian building industry uses granite stones particles as a replacement for sand in most of the areas where there is abundant deposit of granite stones. Then followed by Bamboo with 107 (49.8%), which partially confirms Nwoke and Ugwuishiwu (2011) statement that bamboo is mostly used in the rural eastern parts of Nigeria. Then followed by Clay 102 (47.4%).

This proves that there is a limited clay usage within the building industry of Nigeria even though authors like Ojo *et al.*, (2009) argue that clay deposits are available in almost every region of the country. Refer to figure 7.3 for the summary of all the local building materials listed by the respondents. Most of these local indigenous building materials are in agreement with what authors such as (Anosike and Oyebade, 2012; Yar'adua and Aliyu, 2012; Ojo *et al.*, 2009; Kabir, 2005; Baiden and Tuuli, 2004; Olotuah, 2002; Oruwari *et al.*, 2002) classified from the literature as local building materials in Nigeria.

Some of the most generally utilized local building materials in Nigeria were identified from the literature review and the participants were asked to rank them from (1-5) low to high based on their level of application in prefabricated components for low cost house building provision. The ranking further shows sandcrete and timber in the fore front interchangeably. Followed by stones, then clay, then earthen elements, then bamboo and expanded polystyrene which was included and ranked by some respondents. The percentages are 85.7% for sandcrete, 64.4% for timber, 35.5% clay, 30.6% earthen elements, 15.3% bamboo and four respondents mentioned the use of

Expanded Polystyrene (EPS) of which 4 (80%) of them ranked them as very highly utilised.

Extent to which local building materials are used for house building delivery in Nigeria

The survey data reveals that majority of the respondents have utilized local building materials for house building provision, with 66 respondents (30%) sometimes, 63 (28%) mostly, 49 (22%) always and 41(19%) rarely. Only 1% of the respondents never used local building materials for house building (refer to figure 7.4). Therefore, this proves that the local building materials mentioned in the literature are indeed available and are still being used for house building in the country. However, with only about 50% of the respondents mostly and always used local building for house building provision. This figure further exposed the limited usage of local indigenous building materials in the country.

The most commonly used local building materials (timber, clay, sandcrete elements, granite stones, bamboo and adobe) were identified according to their components in order to determine their level of application towards low cost and general house building in Nigeria. The survey data reveals that for low cost house building provision, the respondent's (83.3%) rate sandcrete blocks as mostly or always used similarly for timber (71.7%) in roof components. Majority of the respondents (38.6%) said they never use timber as floor elements. Clay bricks are rarely or sometimes used (60.8%). Over 50% of the respondents never used adobe for wall. Bamboo components are the least applied components in low cost house building in Nigeria. Refer to table 7.2 for the summary of all the result for this question.

In general house-building provision, the responses are similar to that of low cost. The study shows sandcrete blocks as mostly or always used (85.1%) just slightly higher than its usage for low cost house building. Majority of the respondents (82.0%) uses timber for roofing components. Some respondents (34.1%) never used timber as floor elements. While clay bricks are used rarely or sometimes by (63.9%) and (19.2%) never use clay bricks for general house building materials. More than half of the respondents (56.3%) never used adobe wall for general house building in Nigeria. Similarly, bamboo roofing, trust, beam/column, panels and floors were not used by 61.3%, 55.5%, 68.7%, 70.3% and 74.8% respectively, see Table 7.3.

The above findings shows that local building elements overall level of usage in low cost is similar to the level of usage in medium and high-income house building provision in Nigeria. The study further reveals that, sandcrete blocks and timber elements are mostly applied in building areas compared to other building materials. However, it is clear that sandcrete blocks are commonly used for wall section and the timber elements are used for the internal sections of the roof (such as ceilings and trusses). Building materials such as adobe and Bamboo elements are not frequently applied in both general and low cost house building with more than 50% of the respondents claimed they never used it towards house building application even though authors like Yar'adua and Aliyu (2012) and Ukoba *et al*., (2011) stated that they have the most potential to be used for low cost house building because of there cost effectiveness. The above findings and discussion further confirm Oruwari *et al*., (2002), that local building materials are underdeveloped in Nigeria thereby calling the experts and the government to improve the acquisition and application of local technological capabilities in the country.

8.2.3 How often are locally sourced building materials used in the production of prefabricated components especially towards low-cost house building provision in Nigeria?

In order to ascertain how often local building materials are used in the production of prefabricated components for house building provision in Nigeria, the above question was asked during the qualitative face-to-face interview. However, the study reveals that local building materials are not used very often in the production of prefabricated building component in Nigeria. According to respondent 9, "*Prefabricated local building materials are not used too often in Nigeria"*. Any Reason Why? *"High importation of prefabricated building materials affects the realization of locally produced prefabricated materials" (Question 3).*

Some of the major reasons identified were low level of awareness in terms of using local building materials for prefabricated components, high importation of building materials and poor level of concentration on the enhancement of local building materials, and unavailability of enough locally produced prefabricated components. Refer to Table 3 (In appendix G) for the summary of the remaining responses to this question. The high level of importation of building components and unavailability of enough locally produced prefabricated components is in agreement with what Abdullahi, (2011) and Opara (2011) stated as to why prefabricated techniques are not highly adopted in Nigeria.

Level of prefabricated local building materials usage in low cost house buildings

In order to ascertain the level at which locally produced prefabricated components are used in low-cost house building provision and why? This question was repeated in both the interview and a questionnaire. The survey data reveals that majority of the respondents (55%) have utilized prefabricated local building materials for low cost house building provision (from sometimes, mostly and always). However, (14%) respondents have never used prefabricated local building materials for low-cost house building delivery in Nigeria (refer to figure 7.5).

Thus, the face-to-face interview further confirms that prefabrication techniques of construction using local building materials are being used in low-cost house building projects in Nigeria. According to the respondent 6, "*We are talking about affordability of housing, being able to bring down the cost of housing. Now a typical house in Nigeria, say 60% of the cost comes from building materials and 40% comes from labour, when you use prefabricated local building materials because of the technology that is involved you speed up the process. What 10 men can usually do, with the aid of machinery one man would be able to do alone. So when you prefabricate, you are able to bring down the labour content or if you look at that 40% content for instance, with prefabrication you can bring it down to 20%. And when you look at the speed of construction with the aid of machinery you can produce blocks much faster*" (Question 4). The major reasons stated were; cost effectiveness of local prefabricated building materials, ease of access to prefabricated local building materials and time savings when prefabricated local components are utilized compared to imported building materials which mostly takes time to get it into the country. Refer to Table 4 (In appendix G) for the summary of the remaining interview responses.

A similar question was raised to find out the level at which local building materials are used in the production of prefabricated components for house building in general, not just towards low-cost house building provision. The survey data reveals that majority

(64%) of the respondents have utilized prefabricated local building materials for general house building provision in Nigeria (from sometimes, mostly and always). Refer to figure 7.6 for a graphical presentation on this question.

The differences of those that used and those who never used locally produced prefabricated components in low cost and general house building in Nigeria differs. Those that used it sometimes, mostly and always are 55% for low cost house building and 64% in general house building in Nigeria. Although, the differences are not very much, but it can be seen that there is a difference of about 10% on the extent to which prefabricated local building materials are applied in low cost and general house building provision in Nigeria. This reveals that prefabricated local building materials are more applied towards general house buildings than in low cost.

8.2.4 Which among the prefabricated components is more used within the building industry of Nigeria, is it locally produced or imported prefabricated components?

Face-to-face interview was used to obtain an in-depth insight to this question. The study reveals that prefabricated components used in house building provision in Nigeria are produced locally, even though there is an argument on the high level of importation of prefabricated components in the country. This study refutes Abdullahi (2011) and Opara (2011) statements, that most of the prefabricated building materials used within the building industry of Nigeria are imported.

However, the reasons why prefabricated local building materials are used more in house building delivery over the prefabricated imported building materials are; local building materials are readily available for production of prefabricated components, ease of access to local prefabricated components compared to imported ones and the cost of prefabricated local building materials are cheaper compared to the imported prefabricated building components. Refer to table 5 (In appendix G) for the full summary of the responses. According to respondent 16, "*The reasons are embedded in the question, cost; before you import something from UK, US, India, China or wherever, it will include the purchase, the freights, and the clearance and then moving to site compared to something that is produced at the nearest town. The cost of freights* *from that place to your site will be far cheaper. So in terms of cost, in terms of delivery when you put a cargo on the water it will take one or two months, but if you go to the nearest town you can easily get the materials you want to use in your site and get it to site faster*" (Question 5).

The survey respondents were asked to indicate their level of agreement or disagreement with the statement, where prefabricated components are utilized for house building, local prefabricated building materials are not utilized? The survey data reveals that, more than 50% of the respondents disagree, strongly disagree and neither agrees nor disagrees. However, majority (70.0%) of the respondents agreed that in order to reduce the housing shortage in Nigeria, the building industry must increase the diffusion and utilization of prefabrication construction techniques using local building materials for low cost house building. This is in agreement with Opara (2011), that in order to keep pace and compete with other countries towards construction innovation, there is the need to reposition and revitalize the Nigerian building industry towards embracing the modern techniques of construction to help overcome the housing dilemma in Nigeria.

8.2.5 Which type of prefabricated techniques of construction is mostly utilized within the building industry of Nigeria?

A survey question was raised in order to have a better understanding of the type of prefabricated techniques of construction used within the building industry of Nigeria and how often are they applied for house building. The lists of components are presented in Table 7.4 and 7.5 for general and low-cost house building respectively. The levels of usage differ in majority of the components for general and that of low-cost house building. For example, 45.9% never use volumetric / modular component for low-cost house building while for general 29.1% said they never use them. Similarly, for prefabricated kitchen pods, 11.6% use it from mostly to always for low-cost house building and for general up to 16.1%. This shows that, the complicated components that require high level of technology are rarely applied in low cost.

In order to find out which type of prefabrication techniques are mostly used in house building and why? Interview was used to develop an in-depth and better understanding of this question. The study reveals that, majority of prefabrication techniques used within the building industry of Nigeria are the low and medium technology such as, pre-assembled components and panel system but not the high technology (refer to table 4.1 from the literature review on the types and classification of offsite prefabrication techniques in Nigeria). According to respondent 16 "*In terms of volumetric and pods we don't use it more often, because of the technical knowhow, the cost of equipment, the complexity of the structure, the cost of the technology itself and accessibility and low demand for the component. In terms of medium technology, that one is widely used and is under which this company falls, the use of panels, frames etc. our walls are made of Expanded Polystyrene (EPS), and so it falls within the medium. We also produce doors and windows here, which is the low technology and we have many other companies that do the same, so in Nigeria, I can say that the medium and low technology prefabrication is more used in the level we are now*" (Question 6). Both the qualitative and quantitative findings compliment one another.

Several reasons were attributed to the higher usage of the low and medium technology methods of prefabricated construction. Majority of the respondents stated that the low and medium technologies are affordable compared to high technology, the technology is available compared to the high technology, and most of the low and medium technology do not require heavy lifting and high use of machineries when applied in house buildings. Refer to 6 (In appendix G) for the summary of responses on type of prefabricated techniques of construction mostly used within the building industry of Nigeria. Both the qualitative and quantitative findings show a very limited application of high technology type of prefabrication techniques of construction within the Nigerian building industry. It is also in agreement with Windapo and Balogun, (2009) that there is a very limited level of offsite techniques of construction application in Nigeria.

Respondent 14 stated that, "*the high technology requires special skills and in terms of providing a low-cost housing we want to minimize the importation of high skilled artisans and use the local labour instead. And when we talk of high technology we have to think about precision as well. But for the medium and low technology the precision is been taken care of. You just put up your blocks or bricks and use mortar to bind them together or just lock the interlocking materials together without thinking about so much precision like the high technology*" (Question 6). The major reasons attributed to the very low level of high technology usage are; high cost and requirement for heavy lifting.

To determine the level of satisfaction of the prefabricated components used in Nigeria, the respondents were asked to rate the components from highly unsatisfied to highly satisfied based on their previous application of the components on house building provision. The survey data shows that, pre-assembled doors and windows have the highest proportion of (70.2%) satisfaction level in the application of prefabricated components for house building. Then followed by Interlocking blocks (60.6%) satisfaction. The third, fourth and fifth on top of the satisfied list were interlocking bricks (59.6%), Interlocking floors (56.3%) and light steel frame (54.1%) see Table 7.6. This further proves that the respondents are satisfied with the low technology types of prefabrication construction techniques, followed by medium technology components. The high technology type is rarely used, and the few respondents who used it before are mostly unsatisfied with it. The reasons for the lack of satisfaction were mostly attributed to the cost of the high technology components, the involvement of heavy lifting, use of machineries and lack of awareness of the techniques of construction among potential adopters.

The respondents are aware of prefabrication techniques of construction using local building materials in Nigeria, yet many still emphasised the need to improve the level of awareness within the building industry of Nigeria in order to possibly increase the adoption rate. This is also in agreement with the Rogers's diffusion of innovation theory, which comprehensively stated the importance of knowledge and awareness of an innovation. Rogers's mention that for any innovation diffusion to take place within a society, the uncertainties of the innovation most be reduced. These uncertainties will include diffusing the knowledge as well as creating the awareness of an innovation. According to respondent 1, *"The utilization of prefabricated local building materials in Nigeria can be improved if there is more awareness" (Question 17).* Some of the respondents feel the awareness is still lacking within both the experts and the clients within the Nigerian building industry. According to respondent 6, *"It can be improved by creating more awareness within the building industry and among Nigerians" (Question 17).*

8.3 Persuasion Stage

8.3.1 What are the factors that affect the diffusion and utilization of local building materials in the production of prefabricated components for low-cost house building provision?

This question tries to investigate the benefits for and barriers against the use of offsite prefabricated local building materials towards the provision of low-cost house building in Nigeria. Therefore, the question was raised in both the survey and the interview. The respondents were asked to rate (from strongly disagree to strongly agree) some enabling factors to why they use prefabricated local building materials in low-cost house building. The study reveals that over 50% of the respondents agreed (strongly agree or agree) with all the factors listed (Table 7.8) apart from limited company policies and revision of building regulations questions, where only 33.8% and 47.5% agreed respectively. The counts and proportions of the responses are shown in Table 7.8.

It can be seen that reduction of construction duration has the highest number of respondents (82.9%) who agreed and strongly agreed and only (9.5%) neither agree nor disagree. Then followed by the use of prefabricated techniques to reduce environmental impact during construction with (82.4%) respondents who agreed and strongly agreed and 13.1% neither agreed nor disagreed Refer to figure 7.14 for the graphical summary of factors that drive individuals and companies within the building industry of Nigeria to use prefabricated local building materials for low-cost house building in Nigeria.

The finding of the interview reveals that, the reasons that influence experts within the Nigerian building industry to use prefabricated local building materials for low-cost housing delivery are; prefabricated local building materials are cost effective when used for low cost house building provision, it saves time compared to other techniques and local building materials are readily available to produce prefabricated components in the country. The major enabling factors stated in the questionnaire data differs from the interview data, apart from the time saving due to construction speed of offsite prefabrication techniques of construction. Which is why this research encouraged open-ended questions as well, instead of just the questionnaire method of data collection.

The interview gave a more holistic insight into other issues that could not have been achieved using questionnaire alone. According to respondent 16, "*You want to talk of speed when you are talking about the provision of low-cost housing for populace, people want to see in time what you deliver for them. So speed of construction is what will make me use these methods, and that's what we are into, it also gives us the opportunity to use less labour for more work. A house that we are going to use 20people to lay blocks over a month, we can use 4people to complete within two weeks using prefabrication, so when you compare the two you will see that it's of advantage in terms of speed and reduction of construction cost*" (Question 7). Refer to table 7 (In appendix G) for the full summary of the responses.

Awareness, accessibility and motivation

The survey finding reveals the restraining factors against the utilization and diffusion of prefabricated local building materials for low-cost house building provision in Nigeria. Some of the question on restraining factors are; lack of enough factories that produce components, lack of adequate knowledge and awareness of the construction techniques, lack of motivation from professionals within the Nigerian building industry. All of these questions recorded over 60% as agreed and strongly agreed. Similarly, lack of building policy that supports the use of prefabrication techniques and attitude of public and house builders towards offsite prefabrication each has 56.5% level of agreement among the respondents. While the remaining questions have between 30% and 50% level of agreement. The counts and proportion of responses are summarized in Table 7.9. It can be seen that the level of disagreement in all the questions were between 10% and 30% apart from increase in construction cost and previous negative perception of historical context from other industries with 41.6% and 31.1% respectively. Refer to figure 7.15 for the graphical presentation of each of the statements on the above question with the level of agreement and disagreement for each statement mentioned.

Cost

The interview data reveals the main factor against the utilization of prefabricated local building materials for low-cost house building provision in Nigeria as; high cost of the prefabricated local components. The majority (59.5%) of survey respondents agreed and strongly agreed that high cost of prefabrication techniques of construction using local building materials affects it adoption rate in Nigeria. According to respondent 8, *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; high cost, if it is not easily accessible and also complexity of technology" (Question 8).*

Although the respondents argued that they use locally produced prefabricated components in their house building projects because it is low cost, others still argue that prefabricated techniques of construction is expensive regardless of it being produced locally or imported when compared to the traditional method. Some experts argue that the cost can only be reduced when large number of housing units is to be built. This confirms the statement of Alinaitwe et al., (2006), that there is up to 30% reduction of construction cost when there is increase in productivity.

The issue of cost of prefabrication techniques of construction is debatable among the experts within the building industry of Nigeria. This sometimes seems contradictory especially to individuals who are willing to use prefabrication techniques in order to cut down cost. These participants often build their argument based on their experiences. These participants are mostly from different company categories (such as small, medium and large companies) and their level of prefabrication usage differs. Therefore, if the large prominent companies have the resources and manpower to produce large number of units or even cut down their cost in the process, it is arguable that a small company won't find it cost effective when building just two or three houses.

The respondents were also asked if prefabrication construction techniques are not economically viable or achievable when utilized towards low-cost house buildings. More than 50% of the respondents agreed and strongly agreed to the statement. This further raises an argument to the issue of cost. The small and some medium organizations who are not into mass housing projects argue that prefabrication techniques of construction is not viable economically towards low-cost house building projects. While some medium and large organizations always argue that prefabrication techniques is cheaper and can be applied towards low cost especially when local building materials are used for the components. The issue of cost of prefabrication techniques of construction is debatable depending on each participant's experience and viewpoint. Other negative factors include; lack of infrastructure and lack of mass housing projects.

Infrastructure

The issue of infrastructural provision severely threatens the provision of low-cost house building in Nigeria not just offsite prefabrication. According to respondent 3, *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Lack infrastructural facilities such as electricity and water supply" (Question 8).* Lack of infrastructural provision (such as, electricity, good roads access to sites or factories and availability of water supply to produce local components) has created a major setback on housing delivery. According to Adewale (2010), companies have relocated to the neighbouring countries because of the lack of basic infrastructural provision to assist their business operations in Nigeria. The issue of infrastructural provision is in agreement with Adewale (2010), Akinmoladum and Oluwale, (2007) and Andrew (2007) stated among the major factors affecting housing provision in Nigeria, especially low cost house building.

Some of the participants argue that the cost of providing infrastructure will end up increasing the building price beyond affordability rate. Makinde (2014) opined that the cost of infrastructure amount to about 30% of the overall housing expenditure. Makinde (2014) further stated that high cost of infrastructure significantly influences the final cost of house buildings and land. Therefore, in order to improve the utilization and diffusion of prefabricated local building materials towards low cost house building, the issue of infrastructure must be addressed among other issues.

8.3.2 Are prefabricated methods of construction using local building materials consistent with the existing values and needs of Nigerians?

Compatibility

The issue of consistency of innovation with the values and needs of potential adopters is among the key elements to the successful utilization and diffusion of any technology according to the compatibility perceived characteristics of innovation in the persuasion stage of Roger's theory adoption decision process. Therefore, this question aims to examine the compatibility of prefabricated local building materials to the existing values and needs of the Nigerian society. However, the above question was asked in both the survey and the interview methods of data collection used in this study.

The survey data reveals that, majority of the respondents either strongly agreed or agreed that prefabricated construction techniques are not consistent with the existing values and needs of potential adopters with overall agreement of 53.4% for values and 33.8% needs. However, the respondent's overall disagreement is 28% for values and almost half of the respondents 48.6% disagree with the statement on the existing needs of the Nigerians. While the remaining 18.6% and 17.6% neither disagree nor agree with the statements for values and needs respectively. The interview reveals that prefabricated techniques of construction are not compatible to the existing values of the potential adopters. According to Rogers' diffusion of innovation theory, if an innovation is compatible with an individual's needs or values then uncertainty will decrease and the rate of adoption of the innovation will increase.

Prefabricated techniques of construction are not compatible with the existing values of potential adopters in Nigeria, because it is often regarded as modern methods of construction that encompasses many imported components. Therefore, people's perception of prefabricated techniques needs to change from the techniques that uses mostly imported components to the techniques that will utilize local indigenous building materials. However, prefabricated techniques of construction are compatible with the existing needs of the potential adopters. This could be because of the housing deficit in Nigeria and the fact that prefabricated techniques of construction is arguably the fastest method of construction that could be utilize to reduce the housing deficit in the country within a short period of time.

The interview data reveals that the use of locally produced prefabricated components using local building materials is consistent with the existing values and needs of Nigerians. According to respondent 16, "*it is something that is welcome by the urban community. The only hitch we are having is the lack of awareness from local community, but it is a hurdle that will be overcome by time. At the rate at which the Nigerian population is growing, I think our best bet will be to use prefabricated local* *building materials such as EPS*" (Question 9). Respondent 6 argued that, "*when you look from the perspective of needs, there is a need for housing. I have also mentioned a moment ago that the shortfall in housing delivery in Nigeria is about 16million, so to be able to meet these needs we must look at methods and ways to fast track the process of meeting the needs*" (Question 9).

Many reasons were mentioned as to why it is consistent with the needs and values of the Nigerian citizens. Some of the reasons are; there is a high demand for houses in Nigeria and prefabrication techniques of construction is the fastest way to reduce the housing deficit within a short period of time, many Nigerians are aware of the low technology (preassemble elements such as interlocking blocks and bricks) types of prefabrication techniques so they are consistent with the existing needs and values of Nigerians, and the average adopter in Nigerian needs a standard house building and do not care if it's prefabricated or not. Refer to table 9 (In appendix G) for the summary of responses on the consistency of prefabricated techniques of construction. Respondent 4 argued that, "*An average Nigerian is not interested in substandard housing; if it is standard they will go for it. So I know one of the advantages of using prefabrication methods of construction is to be able to finish your house with high standard and specification. For you to be able to achieve better than what you usually achieve using traditional methods. Everybody will be interested in that especially when it is cheaper compared to traditional methods of construction, so the bottom line is quality and affordability, it is not in variance with the needs and values of Nigerians*" (Question 9).

Rogers' (2003) argues that, the adoption rate of the innovation will increase when it is compatible with an individual's needs, and the uncertainty will reduce. The issue of compatibility definitely has an effect on innovation diffusion. This could be among the reasons why the utilization and diffusion of local building materials in the production of prefabricated components is relatively low in Nigeria compared to the traditional methods. Many other generic factors need to be in place in order to improve the diffusion of an innovation and increase it adoption. However, in the case of Nigeria the compatibility for prefabrication techniques of construction using local building materials is there, but the adoption rate is still not high.

8.3.3 Are prefabricated methods of construction using local building materials visible and economically viable when utilized towards low-cost house building provision?

Visibility and viability

This question tries to examine how observe-ability (visibility and viability) affect the utilization and diffusion of prefabrication techniques of construction. According to Observe-ability is among the key elements to the successful utilization and diffusion of any technology according to the Observe-ability perceived characteristics of innovation in the persuasion stage of Rogers's theory adoption decision process.

The survey data reveals that, majority (70.0%) of the respondents agreed and strongly agreed that prefabricated construction techniques are not as visible to the Nigerian populace as traditional methods of construction. Only 18% disagreed with the statement and the remaining 12% were neutral. Details of the counts and proportions of responses on persuasion are summarized in Table 7.7. Refer to figure 7.13 for the graphical summary of some major questions on the factors that affect the diffusion and use of prefabricated local building materials towards low-cost house building delivery. The finding is also in agreement with Rogers' (2003) and Denis *et al*., (2002) that when an innovation is not visible to the potential adopters the uncertainty will increase and the adoption rate will be low.

Interview was used to gather in-depth data into how visibility and viability affect the diffusion and utilization of prefabricated local building materials in Nigeria. The data reveals that, visibility and viability of prefabricated techniques of construction using local building materials have a significant effect on its diffusion and utilization within the building industry of Nigeria, especially towards the provision of low cost house building in Nigeria. Refer to Table 10 (In appendix G) for the summary of all the responses on the effect of visibility and viability. According to respondent 10, "*when you see it more you will like to use it more. It is what people see that entices them to use and to some extent it is viable too because once you are sure that you have continuous and repeated patronage as a businessperson, it makes your business viable*" (Question 10).

The findings are also in agreement with Robinson (2009) and Rogers's (2003) that, the more the result of technology is visible the more likely for people to adopt it. The respondents that were interviewed highly stressed that visibility and viability will affect their decision to utilize prefabricated local building materials for low-cost house building delivery. Respondent 6 stated that, "*anybody who goes into the building practice is not for charity; you are into business to make a profit or to make that business sustainable. If a particular project is not visible I will not venture it, if it is not viable I will not venture it, if you have to use prefabrication construction on a project and your check reveals it is not viable it will be foolishness to go ahead with it*" (Question 10).

The reasons as to how and why visibility and viability affect the participant's decisions are; the technology has to be viable cost wise, because when low cost houses are built using prefabricated local building materials it will definitely encourage people to use it more in Nigeria. Secondly, flexibility in design and appearance of prefabricated construction techniques using local building materials will have a huge impact on its utilization within the building industry of Nigeria and awareness of the benefits of prefabricated construction techniques using local building materials will definitely increase its utilization in the Nigerian building industry.

Both survey and interview finding reveals that observe-ability of prefabrication techniques of construction using local building materials can influence its level of diffusion and utilization in Nigeria. Rogers' theory further validates the findings to this question that when an innovation is visible to the potential adopters, the utilization and diffusion is more likely to increase. It is also in agreement with Denis *et al*., (2002) that when an innovation is clearly visible to the potential, it will be more quickly and easily adopted. In order to increase the uptake of prefabrication techniques of construction using local building materials, the technology and its benefits must be visible to Nigerians.

8.3.4 Are prefabricated methods of construction using local building materials complex when utilized towards low-cost house building?

Complexity

This question tries to examine if complexity of prefabricated construction techniques affects its production using local building materials for low-cost house building in Nigeria. The survey data reveals that 58.6% of the respondents agreed and strongly agreed that prefabricated techniques are difficult to apply towards low cost house building compared with the traditional methods. Therefore, this confirms the Rogers' theory that the complexity of an innovation does influence its adoption rate. The finding is also in agreement with Johnson and Ethington (1997) and Rogers' (1995) that, simple and straightforward innovations are more easily understood and adopted compared to complicated innovation that requires the adopter to develop new skills and understanding. According to Respondent 16 "*In terms of volumetric and pods we don't use it more often, because of the technical knowhow, the cost of equipment, the complexity of the structure, the cost of the technology itself and accessibility and low demand for the component"*. Thus, the techniques of prefabrication construction using local building materials must be made simple and straightforward in order to increase its utilization and diffusion within the building industry of Nigeria.

8.3.5 Does corruption affects the utilization and diffusion of prefabrication techniques of construction using local building materials for low-cost house building in Nigeria?

Corruption

The interview finding reveals that, corruption is among the major factors that affect the utilization of local building materials in the production of prefabricated components for low-cost house buildings provision in Nigeria. The survey finding reveals that 48.7% of the respondents agreed or strongly agreed and 21.6% neither disagree nor agree that corruption does affect the utilization and diffusion of prefabricated local building materials in low cost house building in Nigeria. According to respondent 1, "*Corruption definitely is a factor and a strong one in our society here. Because prefabrication involves some level of technology and the technology available to us here is the low technology, but the few big firms in Nigeria use the higher technology and it is with this big firms that our government officials can siphon funds. Because they are going to import everything from abroad where we can't confirm what price the materials or equipment was procured, and what duties were paid and all that. We can't really do a comprehensive check up on their prices as they are imported and for every contract giving to all these big firms, all the government officials have their percentages, they have their stakes in them. So it is only through these big companies that they can siphon fund. So they have not encouraged us the smaller companies available; they have not encouraged the growth and the use of local prefabricated building materials*" (Question 11).

Respondent 16 further argues that, "*Corruption has indeed affected a lot of things in Nigeria especially the provision of prefabricated low-cost housing. The government isn't doing enough to encourage the use of indigenous building materials and the issues going on the country such as lack of electricity has affected the production of prefabricated local building materials in the country. A lot of times we use generators 24/7 for the electricity supply and when the generator is down it affect the production and delivery, so we have to have generators on standby at all our factories around the country. If the nation would have been healthy and no one siphoned our resources, I think the electricity problem would have been dealt with and this would have helped the delivery of prefabricated local building for low cost housing at a cheaper rate*" (Question 11). Refer to table 11 (In appendix G) for the full summary of the responses.

The reasons influencing corruption are; the political and institutional structure in Nigeria lacks transparency and does not allow for sufficient monitoring and it is prone to corruption. Many professionals within the building industry are eager to get rich quicker even if it means doing something unethical. Prices of local building materials are not regulated due to the high level of corruption within the building industry. Following due process for licensing or acquiring some sort of approval to run a building or prefabricated local building materials company is also an issue because of the channels, procedures and corruption that is involved along the process which at the end affects the concept of prefabricated low cost house building, the big companies have enough resources and money to bribe and acquire a contract and the government officials find it easier to do unethical business with them because of their resources and influence. This finding is in agreement with Olayiwola *et al*., (2005) and Marshal and Onyekachi (2014) that corruption does exist within the building industry of Nigeria and it contribute to the housing paucity in the country.

The study reveals that corruption is among the major factors that affected the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building in Nigeria. The issue of corruption had also influenced the lack of infrastructural provision in the country. Therefore, both the issue of corruption and lack of adequate infrastructure would potentially contribute to the research framework and knowledge regarding why prefabricated local building materials are not highly adopted towards low cost housing provision.

8.3.6 How do the major factors that affect the diffusion and utilization of prefabricated local building components influence the adoption or rejection of offsite construction techniques especially toward low-cost house building provision?

The survey responses to questions about what might influence people to adopt prefabricated local building materials towards low-cost house building are summarized in Table 7.10. It can be observed that overall the level of agreement (agree and strongly agree) on all questions is high ranging from 60.4% to 77.0% and the level of disagreement is very low ranging from only 8.1% on successful examples of applications in the Nigerian building question to 18.0% on the statement that prefabricated local building materials are more environmental friendly compared to prefabricated important building materials. Also refer to figure 7.17 for the graphical presentation of all the data's in table 7.10.

Therefore, In terms of the question about what might influence people to reject prefabricated local building materials towards low cost house building, it includes; inability of the construction industry to encourage the diffusion and utilization of local building materials for offsite prefabricated techniques had the highest proportion (77.5%), of agreement. According to respondent 13, "*My organisations have no power to promote these techniques. We only make suggestion but government decide*". Then followed by lack of proper knowledge of prefabricated local building materials within the building industry of Nigeria with (75.7%) level of agreement. Then followed by lack of codes of practice and proper building standards for prefabricated local building materials with 60.4% level of agreement. Other reasons with 50% and below the level of the overall agreement included: dishonesty (corruption) within the building industry; incompatibility of prefabricated local building materials to the existing values and needs of potential adopters. Table 7.11 has the detailed counts and proportions of the level of agreement, disagreement and neutral from the respondents. Also refer to figure 7.18 for the graphical presentation of all the details in table 7.11.

8.4 Decision Stage

8.4.1 Are local building materials promoted towards the production of prefabricated components for low-cost house building provision within the building industry of Nigeria?

<u>Promotion</u>

The study tries to find out the effort that has been made by the Nigerian building industry's professionals to promote the use of prefabricated local building materials for low cost house building provision in the country. Refer to Table 12 (In appendix G) for the summary of responses on promoting prefabricated techniques in Nigeria. The interview finding reveals that the professionals within the building industry of Nigeria have promoted the use of prefabrication techniques of construction. Although, it is not promoted formally through media or research and development, but majority (11 out of 16) of the professional participants interviewed claim to have promoted it either to their clients or by using a fair quantity of prefabricated components on their building projects. According to respondent 12, "*We have not done it in such a way that we advertise it on air, we have not done any flyer about it but we have used them for people to see in half of our projects. A lot of people have seen us use them in one or two ways, so in some way we have promoted it, just that is not on a global scale, we have not* *advertised it on TV but by using it and people are already occupying those houses I think we have promoted it in some way*" (Question 12).

Therefore, when they were asked why they promote this techniques of construction, majority of the answers given were mostly; prefabrication techniques of construction using local building materials are cost effective when applied towards low cost house building, prefabrication techniques of construction using local building materials saves construction time compared to it alternatives and prefabricated local building materials are promoted in order to enhance the Nigerian building industry's local technological capabilities.

However, there are professionals that have never promoted the use of prefabricated local building materials before, and their major reasons are; they are small scale company and most of the contracts they are involved with were mainly for few number of units which they find no motivation to go for prefabrication. According to respondent 7, "*We do not promote these techniques of construction. Because we have not secured a big housing contract that will make economic sense for us to adopt prefabrication techniques. Prefabrication is more advantageous when large number of units is to be delivered*". This finding reveals that prefabrication techniques of construction using local building materials are not highly and professionally promoted within the building industry of Nigeria. This could also be attributed to the less awareness among the Nigerian populace and some professionals in the building sector.

8.4.2 Are prefabricated techniques of construction using local building materials cheaper than the prefabricated imported components?

To try and find out the reasons behind higher importation of building components in Nigeria, the researcher tries to compare the cost of locally produced prefabricated building components and imported prefabricated building components based on the experiences of the building experts. The interview data reveals that there is definitely cost savings when prefabricated local building materials are used for house buildings over the prefabricated imported building materials. Refer to Table 13 for a summary of responses to this question. This statement is in agreement with Ogundiran and Adedeji

(2014) study which shows that the locally produced expanded polystyrene system (EPS) fascia saved about 50% cost savings compared to the concrete fascia. According to respondent 7, "*Cost of labour is not expensive here, so I will go for locally produced prefabricated components. Because I have control over it, it is cheaper for me to use, it is faster and being faster is also cost savings as well. Importation will be more expensive*" (Question 13). Respondent 6 argue that, *locally sourced materials are cheaper. The only problem with locally produced components is standard. They are not up to standard. Components that are produced locally are cheaper in terms of maintenance compared to imported materials" (Question 13).*

The reasons given are; prefabricated local building materials are cheaper even from a logical point because the materials are readily available, and they are sourced and produced locally. The cost of imported building materials are usually higher because of the transportation and import duties that are attached to it, and the cost of labour in Nigeria is cheap. This proves that, locally produced prefabricated components using local building materials are cheaper to use towards low-cost house building provision in Nigeria compared to the use of imported building components. The finding further emphasized the need for the Nigerian building industry to boycott the importation of building materials and focus on improving and usage of the local building materials in order to achieve an affordable low cost house building for the teeming population, especially the urban low-income earners.

8.4.3 Which among the prefabricated local building components offer greater potential for low-cost house building provision in Nigeria?

The survey finding reveals that, among the local building materials components listed in Table 7.12 the materials that offer the greatest potential towards the application of offsite prefabricated low cost house building with 50% or more respondents categorized them as high and very high were: Sandcrete blocks (87.2%), Timber roofing components, Timber frames (59.4%), Clay bricks (56.8%), Timber floor elements (55.7%) and Stones for wall finishing (54.1%). Some of the components recorded by the respondents with lowest (very low and low) potentials from the list included: Bamboo floors (59.9%), Bamboo panels (54.4%), Rammed earth wall (51.7%), Bamboo beam/column 50.5%. Refer to figure 7.19 for the graphical presentation of all the responses on table 7.12.

The interview reveals that Timber, Clay, Expanded Polystyrene, Sandcrete and granite stones are among the key local building materials that could offer greater potential for prefabrication low cost house building in Nigeria. See Table 14 (In appendix G) for the summary of the local building materials with greater potential for prefabrication. According to respondent 2, *"The local building materials that offers greater potential for prefabricated low cost house building includes; expanded polystyrene, timber, bamboo, sand and cement. They are readily available" (Question 14).* However, the reasons given were; availability of local building materials in Nigeria and their level of usage compared to other local building materials within the Nigerian building industry. The local building materials chosen by the quantitative respondents are the same as those listed by the qualitative interview participants. Therefore, a particular focus must be given to the utilization and improvement of the above local building materials for prefabricated components to deliver affordable low-cost house buildings in Nigeria.

Table 7.13 has the list of some prefabricated components. The components were used to assess the level of potentials they have towards the provision of low-cost house building in Nigeria. From the counts and proportions of participants' responses in Table 7.13, each component was ranked from low to high. Pre-assembled doors/windows were ranked with highest (high and very high) potential (71.4%). Interlocking bricks, interlocking blocks and interlocking floors also ranked as having high potentials by 64.1%, 63.1% and 61.8% respondents respectively. However, the prefabricated components that were ranked with low potential towards the provision of low cost house building were off-site prefabricated foundation (57.4%), precast piles (47.2%) and volumetric/modular component (44.5%).

The counts and proportions of how the respondents ranked all the components are reported in Table 7.13. The study reveals that, most of the components with the highest potential to be used towards low cost house building are the low technology and those with less potential were identified to be the high technology types of prefabricated components. This further proves that, the medium and high technology prefabricated techniques of construction in general have not been widely accepted within the building industry of Nigeria regardless of its benefits compared to the traditional mainstream construction.

The generally used local building materials in Nigeria (sand, timber, clay, bamboo, stones and earthen elements such as adobe) were listed and the respondents were being asked to rate them base on their cost saving, quality, availability, time saving, ease of usage and social acceptability. The survey finding reveals that, in respect of cost saving, sand recorded the highest proportion among respondents who agreed that it has from high to very high cost saving with (71.2%) respondents, followed by timber (68.9%), then earthen elements with (64.5%), then clay with (63.5). Bamboo and stones recorded a much lower percentage of (53.8%) and (45.5%) respectively.

The survey finding reveals that, in respect of quality; sand with the highest proportion among respondents who agreed from high to very high 80.6% that quality influence their decision to use sand in the production of prefabricated components for house building, followed by Timber 68.4%, then stones with 64.2%, then Bamboo 43.9%. Earthen recorded a lowest percentage of 43.4%.

The survey finding reveals that, in respect of time saving; Table 7.14 shows sand with the highest proportion of 69.8% from high to very high, followed by timber 145/220 65.9%, then clay with 44.3%, bamboo and stones level on 43.8% and 43.8% respectively. Earthen building materials recorded the lowest percentage with 42.5%.

The survey finding reveals that, in respect of availability, Table 7.14 also shows sand with the highest proportion 87.3% from high to very high among the participants who use it for prefabricated house building because of it's availability, timber and clay with 78.8% and 78.8% respectively, then stones 9.7%. Bamboo recorded the lowest proportion 49.6% in terms of availability.

The survey findings further reveals that, in respect of ease of usage, Table 7.14 shows sand with the highest proportion among the respondents 82.4% from high to very high, followed by timber with 78.7%, then clay with 63%, then earthen with 60.5%. Bamboo and stones levelled with the lowest proportion of 53.4% and 53.4% respectively.

The materials in Table 7.14 also reveal that when it comes to social acceptability of local building materials, sand has the highest proportion 88.5%, from high to very high in terms of its application for prefabricated components for house building, followed by timber with 67.9%, then stones with 59.6%, then clay with 45.9%, then earthen with 43.4%. Bamboo recorded the lowest percentage 36.7% from high to very high ranking in terms of been socially acceptable for prefabricated components for house building in Nigeria.

The study reveals that, sand has been used the most, followed by timber, then granite stones and the remaining local building materials followed interchangeably in terms of factors such as; cost saving, quality of the building material, time saving, availability, ease of use and social acceptability of materials. This proves that, sand is the most promising local building material in Nigeria. It could also be the reason Baiden and Tuuli (2004) state that, about 90% of buildings in Nigeria uses sand element. Thus, sand as a building materials must be explored to further improve it's feasibility and affordability towards low cost housing application, especially that of prefabrication techniques of construction. Another material that needed attention is timber, which is also readily available in Nigeria. All of these materials revealed could be improved and utilized for affordable prefabricated house building in Nigeria.

8.4.4 Are there any policies that support and encourage the utilization of local building materials in the production of prefabricated components for low-cost house building provision in Nigeria?

<u>Policy</u>

The interview finding reveals that the experts within the Nigerian building industry have emphasized the lack of support from the government to be among the key factors confronting the use of prefabricated techniques of construction using local building materials in the country. See Table 15 (In appendix G) for the summary of responses on policy. Respondent 3 argues that, *"All the housing policies out there are just paper jargons. They are not at all effective in any way. Even the government bodies that are suppose to promote these techniques are not making any impact. So I am not aware of* *any policy that encourages the use of prefabricated local materials in Nigeria" (Question 15).*

The experts within the building industry stated that there are no policies set out by the Nigerian government to encourage the use of prefabricated local building materials for low-cost house building provision in the country. According respondent 7, *"No, there isn't. There isn't any policy that speaks, motivates or enforces you to use prefabrication because the national housing plan does not take into consideration modularization as well as mass production of building. A lot of policies are geared towards traditional processes and no thought was giving to cost savings as well as time saving. So is totally lack of focus from the government bodies. Because a country that lacks housing units like Nigeria ought to look at prefabrication as a viable means of bridging that gap"* (Question 15).

The reasons attributed to the lack of vibrant policies are; lack of awareness of prefabricated local building materials techniques of construction, lack of proper support and encouragement from government, poor support from professional bodies and housing institutes to promote the use of prefabricated local building materials. Furthermore, the Nigerian government lack the zeal to stop the importation and encourage the use of prefabricated local building materials for affordable low-cost house building. Therefore, this study reveals that there is no policy in place or any proper support from the government that is aimed at encouraging the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. Thus, there is the need for proper support from the Nigerian government to encourage prefabrication techniques of construction using local building materials. This support could be in form of a vibrant policy, which would aim at solely promoting and encouraging the acquisition of local technological capabilities. The findings revealed in this study could possibly assist in informing policy on offsite prefabrication techniques of construction using local building materials in Nigeria.

8.4.5 Will the utilization and diffusion of prefabricated techniques of construction using local building materials increase or diminish in Nigeria?

The study tries to forecast the future of offsite prefabrication in Nigeria. Therefore, the respondents were asked if the use of prefabrication techniques of construction would increase or even become the mainstream construction method within the building industry of Nigeria. The survey finding shows that, (48.0%) of the respondents agreed and strongly agreed with the statement and (25.0%) of the respondents neither disagree nor agree that the use of locally produced prefabricated components using local building materials would soon become the dominant method of house building. However, the remaining 27.0% respondents disagreed and strongly disagreed. Refer to figure 7.16 for the graphical presentation of the responses on the potential for prefabricated local building materials to become the dominant method of construction for low-cost housing delivery in Nigeria.

The interview reveals that, the future of prefabrication techniques of construction will increase within the building industry of Nigeria. Although, some experts argued that the prefabrication trend in Nigeria has dwindled over the past few decades. According to Respondent 3, "*NNPC estates in Kaduna, Warri, and Port Harcourt they did a lot of prefabricated structures. Even in the early 1970's a lot of university units were prefabricated, in Kaduna ABU teaching hospital, professorial quarters in ABU Zaria were all prefabricated. Then we had prefabricated structures in (UPE) Universal Primary Education Scheme 1976 during Obasanjo's tenure, they had a lot of prefabricated classrooms all over the country. But I don't know why these days the traditional methods are preferred. Crème Etalo in Minna the first set of houses that were built immediately after the creation of Niger state, Creme etalo were all prefabricated units fully*" (Question 4). Most of the buildings were built using the medium to high technology types of prefabricated components of which majority are imported materials such as cement, aluminium, steel and precast concrete structures. These buildings still exist today.

Thus, majority of the professional (14 out of 16) within the building industry of Nigeria highly forecast the use of prefabrication techniques to increase within the industry, especially that of locally produced local building materials. Refer to Table 16 (In appendix G) for summary of responses on the future of prefabrication in Nigeria. According to respondent 4, "*I think the forecast is quite good. Nigeria is reported to have a housing deficit of about 15 to 17 million nationwide and prefabrication has proven to be the fastest method of construction and you can manufacture the whole component ahead of time, now you have a lot of private players in the real estate, a lot of private developers developing one estate or the other and of course the developers are in the business to make profit, once everybody realizes prefabrication is the best way to achieve the targeted housing unit, the developers will start leaning toward prefabrication and before you know it, it will take off and more factories will be built*" (Question 16). Respondent 12 argue that, *"I think it will take a little longer for prefabrication techniques to pick up, because the government does not support it. The level of poverty in the country is too high that an average person cannot afford to use even raw materials in their raw form to build. When government becomes more active and keen to provide more houses in the country, then they will think about how to use locally available building materials for house buildings" (Question 16).* Some of the reasons attributed to the potential increase in the use of prefabricated local building materials are; the awareness of prefabrication techniques of construction using local building materials is growing among the society. The increase in housing demand is soaring in Nigeria, and prefabrication techniques have proven to be an efficient way of delivering house building. Cost can be saved when local building materials are used to produce prefabricated components for house building.

The overall findings of the study reveals that, the decision stage of Roger's theory of innovation adoption decision process to be positively inclined towards the adoption of offsite prefabricated local building materials for low cost house building provision in Nigeria. The study shows that, majority of the experts within the building industry of Nigeria are willing to adopt offsite prefabrication techniques of construction using local building materials, and majority of the experts forecast the increase in the utilization and diffusion of prefabrication techniques using local building materials. Therefore, there is a need to develop a strategic framework that will aim to inform policy on the effective implementation of local building materials in the production of prefabricated components for low-cost house building provision in Nigeria.

8.4.6 How could the utilization and diffusion of local building materials in the production of prefabricated components for low-cost house building improve within the building industry of Nigeria?

Affordability, Awareness and legislation

The interview finding reveals that, many factors must be in place in order to effectively diffuse and utilize prefabrication techniques of construction using local building materials to provide affordable low cost and general house building in Nigeria. Refer to Table 17 (In appendix G) for all the summary of answers to this question. The factors mentioned are; prefabricated local building material components must be made very cheap in order for people to rush into the adoption of the techniques and the level of awareness must be increased among the experts and the Nigerian society at large. According to respondent 6, *"It can be improved by creating more awareness within the building industry and among Nigerians. The government must put down a legislation to encourage and monitor the cost of prefabricated local building materials. The cost of prefabrication techniques must be affordable in order to increase its uptake" (Question 17).*

The Nigerian government must provide a vibrant policy to support prefabrication techniques of construction using locally sourced building materials. According to respondent 7. *"The government have to support these techniques policy wise. The policy must include high utilization of prefabricated components in Nigeria and creation of prefabrication centres such as technical colleges and skill development centres to train local artisans. It will then become like a movement that is geared towards low cost house building delivery" (Question 17).*

Standard and availability

The standard of locally produced components must be enhanced for it to be widely accepted or even compete with the standards of imported materials. According to respondent 8, "*It can be improved by making the components readily available, and training local artisans. The quality, reliability, availability and affordability of any* *product is important when it comes to its marketing and promotion. It is paramount to improve all of the criteria in order to increase its diffusion" (Question 17).*

Infrastructure

Another important issue highlighted by the respondents, is the creation of an enabling environment by the government. These should include providing infrastructural provision, financial support, encouragement through incentives, and necessitating the application of these techniques in most of the Nigerian governments housing projects. According to respondent 3, "*To improve prefabrication, infrastructural facilities must be in place. Respondent 14 stated that, "Infrastructural facilities such as power supply must be in place in order to increase the utilization of prefabrication" (Question 17).*

Research and development and training

Another important issue revealed by the respondents is the need to financially support the institution and bodies' in charge of promoting these techniques of construction. According to respondent 2, *"One of the best ways to improve prefabricated techniques of construction using local building materials is through research and development. We need to increase research and development within the building industry of Nigeria" (Question 17). Respondent 16 stated that "More research institute must be involved and companies must promote these techniques in order to increase their usage" (Question 17).* Thus, these are some of the significant factors raised by the experts within the building industry of Nigeria on how to enhance and spread the utilization and diffusion of offsite prefabrication techniques using local building materials for low cost house building in Nigeria.

8.5 Group's Comparisons Using Chi-Squared Method

Some key questions were selected from the questionnaire to test the differences between their variables as shown in Table 7.15 to 7.25. The tables contained in the rows are the groups of the participants and in the columns are the categories of the responses. The main variables used for the Chi-square analysis include; the differences on the categories of companies area of coverage (national, regional and state) and the differences in the opinion of the professional respondents (architects, engineers, quantity surveyors, project managers, builders and chief executives) who participated in this research. Some of the key questions asked were: are there any differences among the response of participants from the categories of their companies/organizational coverage? Are there any differences among the response of participants by the categories of their jobs?

The study reveals that, there are no significant differences among the job categorization of the respondents and their area of work coverage in all of the key questions from the questionnaire. Please refer to figure 7.15 to 7.25. This shows that the professionals within the building industry of Nigeria faces similar challenges in the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building delivery, regardless of their jobs or company's coverage.

8.6 Strategies for an Effective Enhancement of Low Cost Prefabricated Housing Systems in Nigeria

The emerging themes that have been revealed in this research are vital to the development of this framework and it also help to improve the theoretical framework that was initially used to underpin this study. Apart from the factors adopted from Roger's innovation decision process, which were used as a checklist, other factors were identified during the course of this research. The emerging factors highlighted by the respondents would be used to inform the effective implementation strategy on how low cost house building can perhaps be effectively delivered using prefabricated local building materials in Nigeria. The model developed would help identify the key actors from the building industry of Nigeria (see figure 8.1). The model incorporated the Roger's diffusion of innovation theory to help understand how prefabrication is utilized and diffused within the Nigerian building industry. The emerging factors identified from the research were integrated in the model. These emerging factors together with the existing factors identified prior to the research would serve as a framework that will assist the Nigerian building industry to improve the diffusion and utilization of prefabricated local building materials. The overall goal of the model is to assist and facilitate the understanding of prefabricated local building materials to satisfy the social, economic and environmental housing problems confronting the building industry of Nigeria.

8.6.1 Awareness

Awareness is among the major factors revealed by this research as to why prefabrication techniques of construction using local building materials fail in Nigeria. Therefore, it is among the major factors that need to be addressed in order to improve the utilization and diffusion of prefabricated local building materials in low cost house building provision in Nigeria. The participants highly emphasized the need for the Nigerian building industry to improve the awareness of prefabricated techniques of construction using local building materials in order to increase its application towards low cost house building in Nigeria. The respondents interviewed highlighted that awareness must be created not only within the professionals within the Nigerian building industry but among the common individuals as well. The professionals must inform and showcase locally produced prefabricated components to the common individuals and explain to them some of the benefits of prefabrication techniques of construction over what they are used to, which is the traditional methods. The professionals themselves have to be confident in promoting it to their clients and using it in their projects. The professionals have to rise to the occasion only then the common individuals can see it, experience it and promote it among themselves. The research further reveals that with a high level of awareness among the professionals of the Nigerian building industry and the common individuals or clients, the diffusion and utilization of local building materials in the production of prefabricated components for low cost house building will increase. When people are aware and use to something, they usually feel more comfortable around it, just like the traditional method of construction.

8.6.2 Infrastructure

The research reveals that the provision of infrastructures such as adequate power supply, water supply and roads would assist in increasing the utilization and diffusion of prefabricated techniques of construction using local building materials in low-cost house building provision in Nigeria. The respondents agreed that lack of adequate infrastructural provision largely affected the diffusion and utilization of prefabricated local building materials in Nigeria. The respondents stated that the developers have to use generators because of the lack of electricity and boreholes are drilled in sites because there is no water and roads are being constructed because there is no access to many building sites in the country. The repercussion is that the cost of production of components or house buildings will be very high. This lack of infrastructural provision has inadvertently affected the concept prefabricated local building materials for low-cost house building in Nigeria. Unless these problems are being addressed, the problem will persist. The respondents highlighted that, if the government can act as an enabler in terms of providing the necessary infrastructure, the cost will be very affordable especially when it is aimed at low cost. Nevertheless, the research reveals that in order to encourage and improve the acquisition of local technological capabilities especially that of local building materials for prefabricated component towards low cost house building provision, the government must create an enabling environment where all the necessary infrastructures are made available.

8.6.3 Affordability (Cost)

This research reveals that cost of prefabrication techniques of construction has been the major issue for debate among the professionals within the Nigerian building industry. The professionals within the building industry of Nigeria argue that prefabrication techniques of construction using local building materials are cheaper to be applied in low cost house building, whereas others still argue that it is more expensive than the rational methods of construction. Nevertheless, prefabricated local building materials must be made cheaper in order to increase its utilization and diffusion within the building industry of Nigeria. The research also reveals that when large numbers of units are produced, the cost will be reduced. Therefore, there must be a collective effort from both the public and private sector of the Nigerian building industry in order to reduce the cost and make prefabrication techniques more affordable within the Nigerian populace. The more affordable it is, the more likely the cost uncertainty will reduce and the adoption rate will increase.

8.6.4 Corruption

This research reveals that the limited use of prefabricated local building materials for low cost house building is attributed to the high level of corruption within the building industry of Nigeria. The respondents highlighted that in order to effectively enhance the utilization and diffusion of prefabrication techniques of construction using local building materials for low-cost house building provision in Nigeria, there is the need abide by the codes of ethics of the building industry and avoid any unethical act that could lead to corruption. The respondents stated that the issue of corruption has affected different façade of the Nigerian building industry, from contract bidding to contract implementation process. The research reveals that, there is the need for the high, medium and low-income organization to come together and find a solution in moving the building industry and the country forward and corruption free. That ethical reorientation has to be there, but it has to start with self-reorientation. The respondents emphasized that corruption must be eliminated in order for the Nigerian building industry to increase the acquisition of local technological capabilities and find affordable ways of delivering house buildings in the country. There is also the issue of getting the right people at the right place at the right time to implement the right courses. Then good examples will be set, and people will start to rejuvenate the zeal, commitment and devotion to work.

8.6.5 Quality and Standards

This research further reveals that, lack of standard and good quality prefabricated components also affect it wider adoption within the building industry of Nigeria. The respondents emphasized that standards of locally produced components must be improved so people won't rely so much on imported building components. When standard of the local prefabricated component is improved, and it is produced at a very reasonable price then people will use it even more. The issue of quality must be address in order to reduce the uncertainty of local produce prefabricated components among the potential adopters.

8.6.6 Accessibility and Reliability of Product

The research reveals that, another major issue confronting the utilization and diffusion of prefabricated local building materials towards low cost housing provision is accessibility and reliability of the local components. The respondents highlighted that the lack of readily available prefabricated local building materials also affects their decision to use the traditional methods of construction. However, the respondents strongly suggest that accessibility to locally prefabricated components must be guaranteed within the Nigerian building industry. Making the local prefabricated materials readily available and accessible could improve its diffusion and utilization within the building of Nigeria. The respondents further emphasized that these components must also be reliable in terms of cost and standard. When the components are proven reliable in quality and cost, it will increase its utilization and diffusion.

8.6.7 Motivation (Through Incentives)

This research also reveals the lack of motivation from the government and professionals within the building industry of Nigeria as the reason why prefabricated local building materials isn't making headways as the traditional methods of construction. The respondents stated that utilization and diffusion of prefabrication construction techniques using local building materials could be improved through the full support of government. The respondents further emphasized that the motivation could be achieved through the creation of some incentives for those who use prefabrication techniques in their mass housing projects. It could also be achieved by necessitating the use of offsite prefabrication in must of government housing contracts so people can see and adopt it as well or by offering tax reduction or flexible financing (mortgage etc.) for people that adopt it.

8.6.8 Promotion

This research reveals that the utilization and diffusion of prefabricated local building materials is widely affected due to lack of promotion of the techniques of construction within the Nigerian building industry. The respondents suggested that prefabrication techniques of construction using local building materials could be promoted through several channels including showcasing the components and techniques of construction in seminars, television or conference. The respondents further emphasized that professional bodies and other relevant institutes must come together to help in terms of mobilizing the necessary force to enhance the diffusion and utilization of local building materials in the production of prefabricated components for affordable low-cost house building provision. The respondents stressed that research institutes should come up with viable methods of providing low cost house buildings, such as using local building materials for prefabricated house building and the housing finance institutes should support the techniques of construction financially. Whereas, the professional bodies which usually consist of the experts within the building industry, should champion the implementation process through promotion and application of the techniques.

8.6.9 Policy

The research reveals lack of policy among the major factors affecting the utilization and diffusion of prefabrication techniques of construction using local building materials for low cost house building provision in Nigeria. The respondents stressed that, in order to implement a vibrant policy for the adoption and diffusion of prefabricated local building components for low cost house building provision in Nigeria, there is the need to push for legislation. That can be achieved by ensuring that there are professionals within the congress at both the senate and the house of representative level. These professionals should be in form of individuals who are already familiar with the building and construction industry. There is also a need to have a lobbyist in the form of the companies and organization in the local and national level. Therefore, if there are professionals at the level of senate and house they can come up with legislature and that can be fast track through professional bodies such as Nigerian Institute of Architects, Society for the Regulation of Engineers etc. The respondents stressed that, in order to enhance and increase the utilization and diffusion of prefabrication techniques of construction using local building materials for low cost house building in Nigeria, an effective policy must be in place.

8.6.10 Training

This research has identified the lack of training of local builders among the factors affecting the wider adoption of prefabricated local building materials for low cost house building in Nigeria. The research reveals that the local builders are not being encouraged and trained on the application and use of local building materials in the production of prefabricated components for low cost house building in Nigeria. However, prefabrication techniques of construction using local building materials in Nigeria, can be improved through trainings and educating the local artisans. It could be achieved through the higher institutions or continual professional development for the professionals within the building industry of Nigeria. The respondents stressed that, relevant institutes, such as the Nigerian Building and Road Research institutes and the technical colleges, should carry out practical trainings in form of educating the local artisans on prototype buildings and trainings in form of the continual professional development (CPD) to the experts of the Nigeria building industry. The creation of the practical knowledge and awareness of local building materials for prefabricated low-cost house building would improve its uptake tremendously within the building industry. Therefore, there is the need for the professional and educational institutes to increase the level of trainings on the acquisition of local technological capabilities in Nigeria.

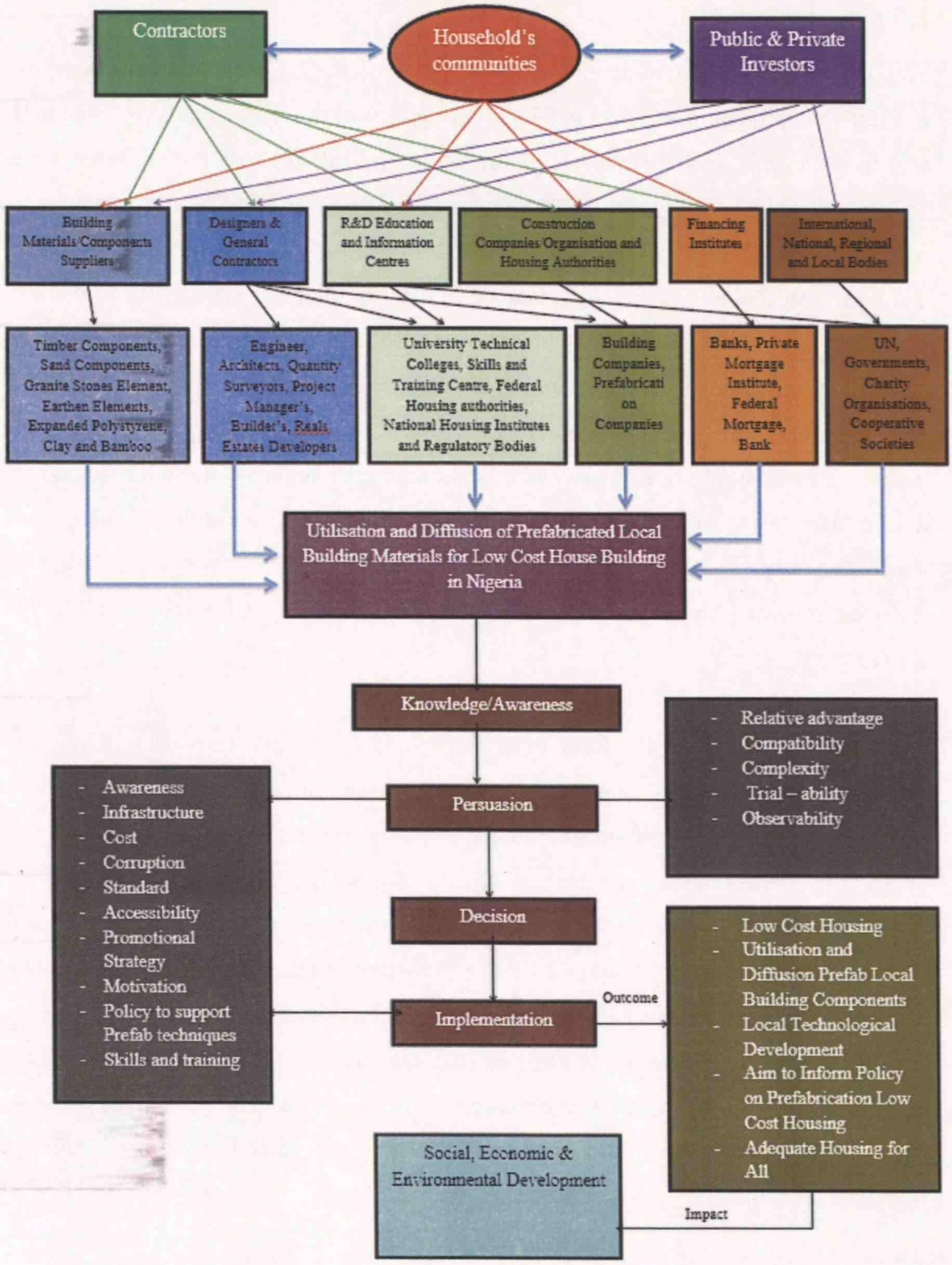

Figure 8.1: Model for utilization and diffusion of prefabricated local building materials in Nigeria

8.7 Conclusion

This chapter provides a comprehensive discussion of the findings and analysis of the qualitative and quantitative data gathered during the course of this research. The study reveals an insight in to the level of utilization and diffusion of prefabricated local building materials for low cost house building provision in Nigeria. Cross tabulation method was used to draw a strong and valid argument from the literature review to compare with the qualitative and quantitative data in order to refute or confirm some questions that were raised from the literature and Rogers' diffusion of innovation theory adoption decision process. The overall goal of the research is to try and answer the aim and objectives of the study. However, the aim and objectives of the study was achieved, because all of the questions that were raised under each objective were answered and have collectively contributed to the overall build up of the framework and the overall conclusion chapter of the study. The conclusion chapter will draw general conclusion of the overall research thesis and suggest some recommendation for future research in this area of work.

Assessment of the findings from quantitative and qualitative responses during the course of this study has helped to contextualize the sample of respondents. More importantly, many vital prominent themes have emerged and are discussed in this chapter. The emergence of the themes helped enormously to develop a framework for understanding and improving the utilization and diffusion of offsite prefabricated local building materials towards the provision of low-cost house building in Nigeria. The identification of the themes had led to the creation of a framework that when effectively implemented would possibly tackle both the quantitative and the qualitative house building problems in Nigeria. The development of the framework would also assist in the augmentation of the utilization and diffusion of prefabricated local building materials for affordable low-cost house building in Nigeria.

Rogers' diffusion of innovation theory was adopted and tested to confirm or reject the theory in terms of its application within the context of the Nigerian building industry. However, apart from the innovation decision process, which Rogers's theory claimed as the generic factor that could affect the diffusion and utilization of an innovation within a community, other new themes (such as; awareness, cost, policy, infrastructure, corruption, promotion, motivation, training and education.) were identified as factors that affect the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria.

CHAPTER NINE

CONCLUSION

9.1 Introduction

This research aims to identify and address the factors that affect the utilization and diffusion of local building materials in the production of offsite prefabricated techniques of construction for low-cost house building in Nigeria. In order to answer the research questions and to achieve the research aim and objectives, the research has undertaken a thorough literature review before a suitable methodology was selected. The previous eight chapters have discussed the problem statement; the rationale behind this study; comprehensive literature review, thorough discussion of theory adopted; justification of the methodology approach used for the research; analysis of the findings; discussion of the findings and finally a framework was developed to help facilitate the understanding of the use of local building materials in the production of offsite prefabrication for low-cost house building in Nigeria through the formal building sector.

The pragmatist philosophical approach was adopted for this research. Both quantitative questionnaire and qualitative face-to-face interview was used for data collection in order to gain an in-depth understanding of why local building materials are not utilized in the production of prefabricated components for low cost house building in Nigeria (refer to chapter 6 for more details). The analysis of the qualitative and quantitative data offers an opportunity to gather a more holistic understanding of diffusion and utilization of prefabricated local building materials within the building industry of Nigeria. The analysis has helped in identifying a pattern of promoting and constraining factors, which have an impact on the diffusion and utilization of local building materials in the production of prefabricated components for low cost house building in Nigeria.

9.2 Achieving the Aim and Objectives

The aim of this research is to examine the utilization of local building materials in the production of offsite-prefabricated components for low-cost house building in Nigeria through the formal building sector. The objectives are:

1. To examine the degree to which local building materials have been utilized in offsite prefabrication construction methods in low cost house building provision in Nigeria.
2. To identify the factors that affect the diffusion and use of local building materials for offsite prefabrication components in the provision of low cost house building in Nigeria.
3. To explore the potential for the utilization and diffusion of local building materials for prefabricated low cost house building in Nigeria.
4. To develop a framework for understanding the utilization and diffusion of offsite prefabricated local building materials towards the provision of low cost house building in Nigeria.

Therefore, the aim of this research was successfully achieved through fulfilment of the research objectives. In order to address each objective of the study, a series of research questions were identified from the knowledge gaps in the literature. Some of the key knowledge gaps identified include; the level of knowledge of prefabrication techniques of construction within the building industry of Nigeria, the factors that affect the utilization and diffusion of prefabrication techniques of construction in Nigeria and the potential in the utilization of local building materials in the production of prefabricated components for low cost house building in Nigeria. These questions were derived from the knowledge gaps identified from the extensive literature reviews conducted in chapter 1-5.

- ✓ The first approach of closing the knowledge gap was by conducting a critical and extensive literature review on house building delivery in Nigeria. These include; examining public and private intervention in housing provision in Nigeria, factors that aggravate housing demand in Nigeria and Factors affecting housing demand in Nigeria.

- ✓ The second approach used in closing the knowledge gap of this research was by conducting an extensive literature review on local building materials in Nigeria. These include; identifying the types of local building materials used for house building in Nigeria and how these materials can be enhanced and utilized efficiently for low-cost house building in Nigeria.

- ✓ The third approach for closing the Knowledge gap was achieved through conducting an extensive literature review on the use of offsite prefabrication techniques of construction within the Nigerian building industry and other building industries around the world. These include; exploring some case studies of prefabrication techniques of construction and the reasons why or why not these techniques of construction are adopted within the building industries of developed and developing nations.

- ✓ The fourth approach used in closing the knowledge gap was by creating a model that incorporates the Roger's theory and the actor's network as well as the new emergent factors from this study that could possibly be adopted when trying to understand the diffusion and utilization of prefabricated local building materials for low cost house building provision in Nigeria and other countries facing similar housing problems.

- ✓ The fifth approach used in closing the knowledge gap was through the development of a framework based on the emergent themes from the findings. These emergent themes helped in terms of revealing the strategic framework that would attempt to facilitate the adoption and diffusion of offsite prefabricated local building materials for low cost house building provision in Nigeria.

9.3 Have the Objectives Been Addressed?

9.3.1 To examine the degree to which local building materials have been utilized in offsite prefabrication construction methods in low-cost house building provision in Nigeria.

This objective was achieved using series of questions developed with the guidance of Rogers's diffusion of innovation theory. A particular focus on the questions asked was based on the knowledge/awareness stage on the adoption decision process of the Rogers's theory. This stage of the adoption decision process aims to examine the knowledge of an innovation within a society. These include; the level of awareness of the innovation and the degree to which the innovation is utilized or diffused. The achievement of this helped in understanding why, where and how prefabricated local building materials are utilized and diffused in house building within the building industry of Nigeria, especially towards low-cost house building provision.

The study reveals that there is knowledge of prefabrication construction techniques within the Nigerian building industry. The research further shows that prefabrication construction techniques using local building materials are being used for low-cost house building provision in Nigeria. According to the findings from this study, these techniques of construction are least applied in residential house buildings compared to other sectors of the building industry such as the commercial and industrial. The research also reveals that prefabrication techniques of construction has been in existence within the building industry of Nigeria since the early 1970s, but some experts argue that the use of prefabrication has dwindled within the building industry.

The quantitative finding shows that only about 13% of respondents mostly or always used prefabrication techniques. The study further reveals that about 76% of respondents agreed and strongly agreed that traditional methods of construction are mostly used towards low-cost house building provision compared to prefabrication techniques. This finding is in agreement with the argument from the literature review that prefabrication techniques of construction are not highly utilized and diffused within the building industry of Nigeria of Nigeria even though it promises better benefits compared to the traditional methods of construction.

The research reveals some of the most frequently used local building materials in Nigeria are; sand, timber, granite stones, bamboo, clay and earthen elements such as adobe. Therefore, this has indeed confirmed the literature review that Nigeria is endowed with abundant locally sourced building materials. The study reveals that even though these local building materials are readily available, they are not frequently used in the production of prefabricated components for low-cost house building provision in Nigeria.

Some of the major reasons identified were low level of awareness in terms of using local building materials for prefabricated components, high importation of building materials and less concentration on improving local building materials, and inaccessibility of enough locally produced prefabricated components. Majority of the respondents have used prefabrication techniques of construction using local building materials in their low cost and general house-building projects before, but not frequently. The major reasons stated were; cost effectiveness of local prefabricated building materials and time savings when prefabricated local components are utilized compared to imported building materials, which mostly takes time to get it into the country.

Many participants have attributed the lack of frequent utilization of local building materials for prefabricated low-cost house building provision to the higher importation of building components within the building industry. Authors such as Abdullahi (2011) and Opara (2011) have both opined that, majority of building materials used in Nigeria are imported. However, This study reveals that locally produced building components are mostly used in Nigeria compared to the imported. This finding somewhat refutes the statement of Abdullahi (2011) and Opara (2011). The major reasons why prefabricated local building materials are used more on house building delivery over the prefabricated imported building materials are; local building materials are readily available for prefabrication components, ease of access to locally prefabricated components compared to imported ones and the cost of prefabricated components that are produced locally using local building materials in Nigeria are cheaper than the imported prefabricated building components.

The study reveals that, majority of prefabrication techniques used within the building industry of Nigeria are the low and medium technology such as, pre-assembled components and panels system but not the high technology. Several reasons were attributed to the higher usage of the low and medium technology methods of prefabricated construction. Majority of the respondents stated that the low and medium technologies are affordable compared to high technology, the technology is available compared to the high technology, and most of the low and medium technology do not require heavy lifting and high use of machineries when applied in house building.

The level of satisfaction with the prefabricated components within the building industry of Nigeria reveals that the respondents were more satisfied with the low technology types of prefabrication construction techniques, followed by medium technology components. The high technology type is rarely used, and the few respondents who used it before are mostly unsatisfied with it. However, more than 70% of respondents have agreed that in order to reduce the housing shortage in Nigeria, the building industry must increase the diffusion and utilization of prefabrication construction techniques using local building materials for low cost house building provision.

Even though there is the knowledge of prefabrication techniques of construction within the building industry of Nigeria. Majority of respondents strongly stressed the need for more awareness among the experts of the Nigerian building industry as well as the potential adopters (clients). Therefore, this statement is in agreement with the Roger's diffusion of innovation theory that lack of knowledge/awareness of an innovation within a system could affect its adoption rate. Therefore, the issue of awareness must be among the key issues to address in order to improve the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria.

9.3.2 To identify the factors that affect the diffusion and use of local building materials for offsite prefabrication components in the provision of low-cost house building in Nigeria.

This objective was achieved using a series of questions developed with the guidance of Rogers's diffusion of innovation theory. A particular focus on the questions asked was based on the persuasion stage of the adoption decision process of the Rogers's theory. This stage of the adoption decision process aims to identify the factors that affect the utilization and diffusion of an innovation within a society. These include; the reasons why or why not an innovation is utilized and diffused within a society. This stage also involves understanding how perceived characteristics of Rogers's innovation diffusion (such as relative advantages of an innovation, compatibility of an innovation, complexity of an innovation, trial-ability and observe-ability of an innovation) and other factors affect the diffusion and utilization of prefabrication techniques of construction using local building materials for low cost house building in Nigeria. The achievement of this objective helped in finding out the reasons why prefabricated local building materials are not being frequently used for low cost housing even though it promises superior benefits compared to the conventional methods of house building.

The major reasons identified for the utilization of prefabrication techniques of construction using local building materials in Nigeria were; prefabricated local building materials are cost-effective when used towards low cost house building provision, it saves an incredible amount of construction time compared to other techniques, reduction of construction duration, and reduction of environmental impact during construction. However, some of the restraining factors are; lack of enough factories that produce components, lack of adequate awareness of prefabrication construction techniques, lack of motivation from professionals within the Nigerian building industry, high cost of prefabricated components, corruption lack of infrastructural provision (such as, electricity, good roads access to sites or factories and availability of water supply to produce local components), lack of adequate policy, lack of proper motivation and promotion of prefabrication techniques, cost and poor standard of locally produce prefabricated components.

The study shows that prefabrication techniques of construction using local building materials are indeed compatible with the needs of the potential adopters in Nigeria. Some respondents argued that Nigerian housing deficit is over 16million units and prefabrication techniques are the fastest way of delivering those units within a short period of time. Some respondents argue that it is not compatible with the existing values of the potential adopters' majority of who are the poor low-income earners. Majority of their reasons were attributed to cost. This finding somewhat agrees with the Roger's theory that, uncertainty such as compatibility of an innovation could influence its adoption and diffusion rate.

The study reveals that visibility and viability of prefabrication techniques of construction using local building materials has affected its level of diffusion and utilization in Nigeria. Therefore, the findings to this question is in agreement with Rogers's theory that when an innovation is visible to the potential adopters, the utilization and diffusion is more likely to increase. The finding is also in agreement with Denis *et al*., (2002) that when an innovation is clearly visible to the potential, it will be more quickly and easily adopted. Therefore, more houses are needed using prefabricated local building materials in order to convince the potential adopters that this technology is possible and it has to be viable as well economically.

The study reveals that prefabrication techniques of construction using local building materials are complex to apply towards low-cost house building provision, especially when compared to traditional methods of construction. The finding agrees with Roger's theory that the complexity of an innovation does negatively affect its adoption rate. The finding is also in agreement with Johnson and Ethington (1997) and Rogers' (1995), which stated that, simple and straightforward innovations are more easily understood and adopted compared to complicated innovation that requires the adopter to develop new skills and understanding. This statement is evidently supported with the prefabrication adoption rate in Nigeria, as majority of the respondents only used the low and medium technology because it is simple and straightforward. Whereas, majority of the respondents never used the high technology such as volumetric and pods because they complex.

The level of corruption within the building industry of Nigeria and other sectors of the country have also affected the utilization and diffusion rate of local technological potentials, especially using local building materials in the production of offsite prefabricated components for low cost house building provision in Nigeria. The effect of corruption comes in various ways; through bribery, through illegal bidding process where only the big companies get mass housing contracts, corruption through inflation of components prices and corruption through the reduction of quality of components.

9.3.3 To explore the potential for the utilization and diffusion of local building materials for prefabricated low-cost house building in Nigeria.

This objective was achieved using a series of questions developed with the guidance of Rogers's diffusion of innovation theory. A particular focus on the questions asked was based on the decision stage of the adoption decision process of Rogers's theory. This stage of the adoption decision process aims to determine the influential decision factors of an innovation within a society. These include; factors that might influence the continued adoption of an innovation and the potentials of an innovation within a society. The achievement of this objective helped in exploring some of the potentials for the utilization and diffusion of local building materials for prefabricated low-cost house building in Nigeria.

The study reveals that many respondents have in one way, or the other promoted the use of prefabrication techniques of construction using local building materials. But, it is not promoted formally through media or research and development, instead majority of the professional participants interviewed claim to have promoted it either to their clients or by using a fair quantity of prefabricated components in their building projects. Majority of the experts promoted it because; prefabrication techniques of construction using local building materials are cost effective when applied towards low cost house building, prefabrication techniques of construction using local building materials save construction time compared to their alternatives and prefabricated local building materials are promoted in order to enhance the Nigerian building industry's local technological proficiencies. The study further reveals that, there is cost savings when prefabricated local building materials are used for house buildings over the prefabricated imported building materials.

In terms of local building materials that offer the greatest potential for prefabricated components in low-cost house building provision; sandcrete elements, timber elements and granite elements are were all selected above other materials. The study further reveals that, sand is being used the most, followed by timber, then granite stones and the remaining local building materials followed interchangeably in terms of factors such as; cost saving, quality of the building material, time saving, availability, ease of use and social acceptability of material. The findings indicate that, sand, timber and granite stones are the most promising local building material to be used in the production of prefabricated components for low-cost house building provision in Nigeria. Nevertheless, the study reveals the low technology type of prefabrication techniques of components has the greatest potential for adoption compared to medium and high technology components. Therefore, these local building materials could be utilized to provide low cost house building in the country.

The study also reveals that there are no policies that support prefabrication techniques of construction using local building materials in Nigeria. However, majority of the respondents agreed that the future of prefabrication techniques of construction is very bright within the building industry of Nigeria and it will possibly become a mainstream construction method in the future when the diffusion and utilization is improved and implemented appropriately. The study reveals that, many driving factors must be in place in order to effectively diffuse and utilize prefabrication techniques of construction using local building materials in affordable low cost and general house building in Nigeria. The major factors mentioned are; prefabricated local building material must be made very cheap in order for people to rush into the adoption of the techniques. The Nigerian government must provide a vibrant policy to support prefabrication techniques of construction using locally sourced building materials. The standard of locally produced components must be improved for it to be widely accepted or even compete with the standards of imported materials. The level of awareness must be increased among the housing professionals and the Nigerian society at large.

The study reveals that, there are no significant differences among the job categorization of the respondents and their area of work coverage in all of the key questions from the questionnaire. This shows that majority of the experts within the building industry of Nigeria face similar challenges in the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building delivery, regardless of their jobs difference or company's coverage.

9.3.4 To develop a framework for understanding the utilization and diffusion of offsite prefabricated local building materials towards the provision of low-cost house building in Nigeria.

This objective is based on the implementation stage of the adoption decision process of the Rogers's theory. This stage of the adoption decision process is aimed at developing a framework that would attempt to understand and assist in the utilization and diffusion of an innovation within a society. This objective was achieved through the framework developed in chapter eight that would possibly inform policy on the utilization and diffusion of local building materials in the production of prefabricated components for low cost house building provision in Nigeria.

In conclusion, local building materials are used in the production of prefabricated components for low cost house building in Nigeria. But are not highly adopted and diffused compared to the traditional methods of construction. Many factors were identified as to why these techniques of construction are not being highly utilized and adopted within the building industry of Nigeria. Unlike other developing countries, prefabrication techniques of construction using local building materials in Nigeria have the potential to compete with the traditional methods when a vibrant policy is in place. The implementation of the framework developed in chapter eight is vital towards possibly pushing for legislation to inform policy on the effective diffusion and utilization of prefabrication techniques of construction using local building materials for low cost house building provision in Nigeria.

9.4 Contribution to Knowledge

This study contributes to knowledge by bridging the gap on why the utilization and diffusion of prefabrication techniques of construction using local building materials are not widely adopted in Nigeria, even though they promise a superior performance compared to traditional techniques of construction. The innovation-decision process of Rogers's theory has led to the identification of some major factor's that affect the diffusion and utilization of local building materials in the production of prefabricated components for low cost house building provision in Nigeria. Rogers's diffusion of innovation theory was used to underpin the theoretical framework for this study. Some key factors of the Rogers's innovation-decision process were adopted in order to understand the innovation diffusion within the Nigerian building industry. According to Rogers's theory, factors such as relative advantages of an innovation, compatibility of an innovation, complexity of an innovation, trial-ability of an innovation and observe-ability of an innovation affect the utilization and diffusion of an innovation within a society.

Many factors were identified, some of which was used to appraise the theoretical framework and validate the theory used in this study. Some of the themes identified (such as; awareness, cost, infrastructure, compatibility, relative advantage, oberve-ability and complexity) are in line with those found by other scholars (such as; Makinde, 2014; Adewale 2010; Windapo and Balogun, 2009; Akinmoladum and Oluwale, 2007; Alinaitwe *et al*., 2006) whereas the other factors (Policy, corruption, training and education, R&D, promotion, standard and quality, motivation) are entirely new in regard to innovation diffusion and the utilization of prefabricated local building materials for low cost house building provision in Nigeria. These new factors include; corruption, policy, motivation, infrastructure, training, accessibility and standards. These factors have not been identified in any previous study. In conclusion, the theoretical framework adapted from the combination of actor network and Roger's theory is useful. The framework developed is generic and can be applicable in many countries not just Nigeria. The findings of this research and the framework developed based on the emerging themes possibly will facilitate the enhancement and effective application of offsite prefabrication for low cost house building in Nigeria using local building material.

The research could inform policy changes that are expected to improve the acquisition of local technological proficiency in the Nigerian building industry, by strengthening of domestic technological ability to produce low cost prefabrication house buildings using local building materials. The implementation of the framework would improve the way local building materials are used in prefabricated low-cost house building delivery across the country. The successful implementation of the framework would also help other developing countries that face similar challenges to that of Nigeria, to adopt similar strategic framework and improve their housing challenges.

9.6 Recommendations

9.6.1 Low Cost

Prefabricated local building materials must be made cheaper through the creation of legislation that monitors the cost of components. Building materials in Nigeria are not regulated in terms of prices. Thus, the first step to take will be to form an institute that would monitor and control building materials price in Nigeria. Cost could be minimized when local building materials are used for prefabricated components as revealed from the finding of this study. There is the need for both public and private sectors of the Nigerian building industry to come together to promote the use of local building materials for affordable house building in the country. These could also be achieved through the creation of an enabling environment that promotes the creation of cooperative cottage small building components fabrication; e.g. Brickyard for the production of burnt bricks using biogas digestion plants.

9.6.2 Policy

A strong policy that supports local technological competences must be in place. This policy could be pushed and implemented through the appropriate legislation that would serve as a platform towards strategic and implementation of prefabricated local building materials for low cost house building in Nigeria. Ones there is a legislature then the relevant arm of government can supervise the implementation. The implementation process will then go down to the ministries and other relevant government bodies. At the federal level, there are ministries such the federal ministry of works, the federal ministry of land and housing and urban development. Political appointees usually head these ministries and majority of them are professionals within the building industry of Nigeria who are very well familiar with the industry. These professionals are the ones who are in charge of regulating and monitoring the building industry, and they are the same people who are in charge of implementing those policies. All the white papers that are developed before it goes through any round table for reading at the house of representative or the Nigerian senate is actually developed by those professional career civil servant within the ministries and housing organizations/authorities. Thus, they are among the foremost actors of the Nigerian building industries who can influence change within the industry.

There is a need to synergize the professional associations and the career civil servant who are professionals themselves. If the two can come together under one umbrella that will be promoted by the professional associations, then it will ease the policy implementation process. The professional associations can hold the career civil servant accountable that they are the ambassadors and if they do not implement those policies they will be held accountable. Penalties should include suspending or revoking their license to practice. When such serious penalties are put in place, it will be a huge step towards the push for the use of local building materials for offsite prefabrication policy implementation process in Nigeria. Such a policy support could also include leadership by example whereby students of vocational/technical colleges should be mandated to construct small and medium size projects ranging from block of toilets to pilot housing units in urban areas.

9.6.3 Standard

The standards of locally produced components must be improved so people won't rely so much on imported building components. When standard of the local prefabricated component is improved, and it is produced at a very reasonable price then people will use it even more. The best way to improve quality and standard is through the design of the building code that will ensure standard and quality is abided. Therefore, quality and standard must be enhanced through the introduction of a building standard and the establishment of a law that would support the building standards. This could be supervised by public organization such as; Council for Regulation of Engineers of Nigeria (COREN), Nigerian Building and Road Research Institute (NBRRI), Nigerian Institute of Builders (NIB), Nigerian Institute for Quantity Surveyors (NIQS), Nigerian Institute of Architects (NIA), Federal Housing Authority (FHA) and Federal Control Development Authority (FCDA). These organizations are capable of collectively or individually monitoring the standard of building materials or house building in Nigeria.

9.6.4 Awareness

The level of Awareness of offsite prefabricated local building materials must be increased within the building industry of Nigeria and the society itself. The best way to start marketing an innovation is first to create its awareness. The awareness can be achieved through continuing professional development (CPD), where every professional within the building industry is expected to attend. Professional bodies like NIA, NIQS, COREN and Chambers of commerce could come together with relevant research institutes, to fashion out prototype prefabricated low-cost housing units. Mandatory application of offsite prefabrication is feasible only when the Nigerian populous appreciates public enlightenment of the construction system. This professional development can be achieved through presentation of papers in seminars or conferences. These presentation papers are part of the papers that is put together to become blue papers or white papers for the policy implementation.

9.6.5 Education and Training

Prefabrication techniques of construction in Nigeria can be improved through trainings and educating the local artisans. It could be achieved through the higher institutions or continual professional development for the experts within the building industry of

Nigeria. The technical colleges are usually higher institution of Nigeria that mostly focused on educating students on the practical and industrial knowledge. This knowledge involves production of elements locally using local raw materials. These elements are mostly components made from timber, bamboo, clay as well as sandcrete components that are mostly used as house decoration or house building components. There is the need for both public and private sectors of the Nigerian building industry to capitalize on using such institutes towards the diffusion and creation of broader knowledge on the utilization of prefabrication techniques of construction using local building materials. Another way of focusing on the orientation of prefabrication techniques will be through the creation of vocational centres and skill development centres to be established purposely for the production, diffusion and creation of knowledge for prefabrication techniques of construction using local building materials.

9.6.6 Government Intervention

The utilization and diffusion of prefabrication construction techniques using local building materials can be improved through the full support of government. It could be achieved through the creation of some incentives for those who use prefabrication techniques in their mass housing projects. It could also be achieved by using offsite prefabrication in must of government housing contracts so people can see and adopt it as well or by offering tax reduction or flexible financing (mortgage etc.) for people that adopt it. Such a support could also include leadership by example whereby students of vocational/technical colleges should be mandated to construct small and medium size projects ranging from block of toilets to pilot housing units in urban areas. The private developers must sell the idea of prefabrication techniques of construction to the government by highlighting its benefits over the conventional methods of construction. The government could then chair the promotion of prefabrication techniques of construction using local building materials to provide affordable house building in Nigeria.

9.6.7 Accessibility

Accessibility to locally prefabricated components must be guaranteed through the setting up of yards for the purpose. It could be improved by making the local prefabricated materials readily available. This would be achieved through the improvement of production of prefabricated components locally using local building materials (such as, clay, granites, timber elements bamboo, Expanded polystyrene using local petroleum by-product etc.). The public and private sectors of the Nigerian building industry must make sure more prefabricated local building materials factories are created. This could be done through supporting and encouraging the local artisans such as builders and carpenters to register their own formal companies, which the government could then assist them by providing them with some sort of loan to start up their prefabrication company. The involvement of the local artisans and the small-scale organization would help increase the accessibility of prefabrication techniques of construction and it could increase it wider adoption in Nigeria.

9.6.8 Provision of Infrastructures

The use of locally produced prefabricated components especially for low-cost house buildings can be improved when there is adequate infrastructural provision in the country. The provision of infrastructures such as adequate power supply, water supply and roads would assist in increasing the utilization and diffusion of prefabrication techniques of construction using local building materials in low-cost house building provision in Nigeria. It still boils down to government, because the public sector is supposed to be in charge with the responsibilities of making low-cost house buildings available. Therefore, government must step up in terms of providing adequate infrastructures to the actors involve in the housing supply in Nigeria. The government should create a platform where they will encourage the developers to approach them and discuss their problems so they can reach a common ground with the developers in terms of infrastructural provision. This infrastructural development could also be achieved through public Private Partnership (PPP). PPP usually involves a collective effort from both public and private partnership to provide the necessary infrastructures needed for the wider adoption of prefabricated local building materials in low cost house building in Nigeria.

9.6.9 Promotion of prefabricated components

The utilization and diffusion of offsite-prefabrication techniques of construction using local building materials can be improved through promotion. The best way to promote it is by showcasing prototypes or by promoting it through media and building cheaper units using the techniques. Professional bodies like NIA, ARCON, COREN and Chambers of commerce could come together with relevant research institutes and house finance institutes to fashion out prototype prefabricated low-cost housing units. Promotions of Prefabricated local building components can also be achieved through thread fares and architect and engineering colloquium where the building professional associations invite people to come and showcase their technology. These kinds of events must be encouraged by the tiers of government and the building professional bodies to encourage and promote the acquisition of local technological capabilities such as the use of local building materials for prefabricated components. When events like these are encouraged and promoted say quarterly or twice a year, there is no doubt this will be a starting point of promoting local building materials for offsite prefabrication. The Nigerian government must start to showcase it through their mass housing projects and within the affordable rates, and then it will be just a matter of time before people start to crave for it. The promotion could also be achieved through television, papers or radio.

9.7 Further Research

The following recommendations were developed based on this research. These recommendations are made for future professional and academic research:

Further research is required to investigate the effect of the lack of infrastructural provision on diffusion of prefabrication techniques of construction using local building materials for house building in Nigeria. This research reveals that lack of infrastructural provision have a significant effect on the utilization and diffusion of prefabricated local building materials for low cost house building in Nigeria. The issue of infrastructural development triggers many issues including high cost of construction and high cost of building materials. Therefore, a further research is required to investigate how lack of infrastructure would affect prefabrication techniques of construction. This will help to understand how and which sort of infrastructures affects prefabrication techniques in Nigeria. This research reveals many infrastructures including; power supply (electricity), water supply, road access, factories and transportation. This could help the Nigerian government to focus on the actual infrastructures that have the most significant effect on diffusion and utilization of prefabricated local building materials in Nigeria.

When dealing with a problem, the sooner you identified the exact problem the more likely to tackle the on-going problem sooner.

Further research is required to investigate on construction using prefabrication techniques of construction and traditional methods of construction. This research could not investigate on the practical aspect of the two methods of house building because it will require a substantial amount of capital to fund the building of two separate identical houses using different techniques of construction. However, a further research that will investigate and compare prefabrication techniques and traditional method of construction using local building materials will be needed. The benefit of investigating these methods is that, issues such as sustainability, embodied energy, cost, speed, durability, health and safety could all be measured during the course of the construction of the two methods of house building. Therefore, instead of arguing on the cost and other benefits of prefabrication techniques using local building materials over the traditional methods, there is the need to investigate on the house building for research purpose and not commercial purpose.

In addition, there is the need to further investigate the significance of government intervention on house building using prefabricated local building materials. The government is an integral part of development in every country. The Nigerian government intervention in the past can be considered a total fiasco as most the house buildings in Nigeria are being delivered by the public sector. Therefore, it is essential to investigate how the intervention of government alone can realistically increase the wider adoption of prefabricated local building materials for low cost house building in Nigeria.

REFERENCES

Abdulhamid, Y., 2011. Nigeria: Millpond pioneers commercial prefab houses in Abuja. Available at: http://allafrica.com/stories/201108030506.html (accessed on 3rd June 2012).

Abdulkadir, M.R., Lee, W.P., Jaafar, M.S., Sapun, S.M and Ali, A.A.A., 2006. Construction performance comparison between conventional and industrialised building system in Malaysia. *Structural Survey Journal*, 24, Pp.412-424.

Abdullah, M R and Egbu, C., 2010. Selection criteria framework for choosing industrialized building systems for housing projects. In: Egbu, C. eds. Procs 26th Annual ARCOM Conference, 6-8 September 2010, Leeds, UK, Association of Researchers in Construction Management, 1131-1139.

Abdullah, M.R., 2010. *The role of knowledge management in improving the adoption and implementation practices of industrialised building system (IBS) in Malaysia*. CIB World Congress 2010. 10-13 May 2010. The Lowry, Salford Quays, UK.

Abdullahi, B.C and Abd Aziz, W.N.A.W., 2010. *Nigerian housing policy and public-private partnership (PPP) strategy: reflection in achieving home ownership for low-income group in Abuja Nigeria*. Urban dynamics and housing change-crossing into the 2nd Decade of the 3rd millennium. 22nd international housing Research conference, ENHR, 4-7 July 2010. Istanbul Turkey.

Abdullahi, M., 2005. Compressive strength of sandcrete blocks in Bosso and Shiroro Areas of Minna, Nigeria. *A.U.J.T*, 9(2), Pp.126-132.

Abeyasekera, S., 2001. Analysis Approaches in Participatory Work involving Ranks or Scores. Available at: http://www.reading.ac.uk/ssc/resource-packs/RUFORUM_DVD_2009-Aug/documents/Stats_Guides/ras.pdf (accessed on 15th august 2015).

Abimaje, J., Akingbohungbe, D.O and Baba, A.N., 2014. Housing affordability in Nigerian towns: A case study of Idah, Nigeria. International Journal of Civil Engineering, *Construction and Estate Management*, 1(2), Pp31-38.

Asian Development Bank, ADB., 2006. Accelerating infrastructure development in India. Regional workshop of chief secretaries on public private partnership. Workshop Report 2006. Available at: http://www.adb.org/documents/reports/consultant/39659-ind39659-ind-tacr.pdf (accessed on 10th September 2012).

Adebakin, I.H., Adeyemi, A.A., Adu, J.T., Ajayi, F.A., Lawal, A.A and Ogunrinola, O.B., 2012. Uses of sawdust as admixture in production of lowcost and light-weight hollow sandcrete blocks. *American Journal of Scientific and Industrial Research*, 3(6), Pp.458-463.

Adedeji, Y.M.D and Ajayi, B., 2008. *Cost-effective composite building panels for walls and ceilings in Nigeria. 11th int*. inorganic-bonded fiber composite conference. November 5-7, 2008, Madrid Spain, Pp.151-159.

Adedeji, Y.M.D and Fa, G., 2012. Sustainable Housing Provision: Preference for the Use of Interlocking Masonry in Housing Delivery in Nigeria. *Journal of Environmental Research and Management,* 3(1), Pp.9-16.

Adedeji, Y.M.D., 2008. Interlocking masonry: panacea for sustainable low-cost housing in Nigeria. *Pakistani Journal of Social Science*, 5(8), Pp.744-750.

Adedeji, Y.M.D., 2012. Sustainable housing provision: preference for the use of interlocking masonry in housing delivery in Nigeria. *Architecture Research*, 2(5), Pp.81-86.

Adejumo, A.A., 2008. Social housing in Nigeria - an imminent mass housing revolution? Available at: http: //www.nigeriavillagessquare.com/articles/akintokunbo-a-adejumo (accessed on 17th December 2010).

Adeloye, A.M., 2011. The implication of global recession on sustainable housing in Lagos megacity. *Journal of International Business Research*, 4(1), Pp.167-175.

Ademiluyi, I.A and Raji, B.A., 2008. Public and private developers as agent in urban housing delivery in sub-saharan Africa: The situation in Lagos state. Journal *Humanity and Social Science*, 3, Pp.143-150.

Ademiluyi, I.A., 2010. Public housing delivery strategies in Nigeria: A historical perspective of policies and programmes. *Journal of Sustainable Development in Africa,* 12(6), Pp.153-161.

Aderamo, A.J and Ayobolu, D.F., 2010. Spatial structure of housing quality in Ilorin, Nigeria. *Nigerian Research Journal of Social Sciences*, 1(5), Pp.12-21.

Adesogan, S.O., 2013. Wooden materials in building projects: Fitness for roof construction in southwestern Nigeria. *Journal of Civil Engineering Construction Technology,* 4(7), Pp217-223.

Adewale, A., 2010. The bane of affordable housing in Nigeria. Available at: http: //propertygateplc.com/Articles/the-bane-of-affodable-housing-in-nigeria.html (accessed on 11th January 2011).

Agarwal, R. and Prasad, J., 1998. The antecedents and consequents of user perceptions in information technology adoption. *Decision Support Systems*, 22, pp. 15-29.

Ahianba, J.E., Dimuna, K.O and Okogun, G.R.A., 2008. Built environment decay and urban health in Nigeria. *Journal of Human Ecol*, 23(3), Pp.259-265.

Ajanlekoko, J.S., 2001. *Sustainable housing development in Nigeria: the financial infrastructural implication*. International Conference on Spatial Information for sustainable Development, 2-5 October 2001, Nairobi, Kenya. Pp.1-13.

Akinkunmi, J.O., 2012. An appraisal of materials and construction methods of indigenous earth building in rural area of Nigeria. *Continental J. Sustainable Development*, 3(2), Pp.7-14.

Akinmoladun, O.I. and Oluwale, J.O., 2007. An Assessment of why the problems of housing shortage persist in developing countries: a case study of Lagos metropolis, Nigeria. *Pakistani Journal of Social Sciences*, 4(4), Pp.589-598.

Akinwumi, I., 2014. Earth building construction processes in Benin city Nigeria and engineering classification of earth materials used. *Indian Journal of Traditional Knowledge,* 13(4), Pp686-690.

Alagbe, O.A and Adeboye, A.B., 2005. *A traditional approach to the challenges of urban slums in Lagos State*. Planning and management of Lagos state, 2 Days National Conference on Lagos State Region. University of Lagos guest houses Main campus, 15th -16th June 2005, Akoka, Lagos.

Aldridge, A and Levine, K., 2001. *Surveying the social world: principle and practice in survey research.* Open University Press.

Alinaitwe, H.M. Mwakali, J and Hansson, B., 2006. Assessing the degree of industrialization in construction - a case of Uganda. *Journal of Civil Engineering and Management*, 12(3), Pp.221-229.

Aliu, I.R and Adebayo, A., 2010. Evaluating the influence of housing quality on urban residents wellbeing: The case study of Lagos, Nigeria. *International Journal of Academic Research*, 2(6), Pp.401-410.

Alkali, J.L.S., 2005. *Planning sustainable urban growth in Nigeria: challenges and strategies*. Proceedings of national conference on planning sustainable urban growth and sustainable architecture. United Nation headquarters New York, 6th June 2005. Pp.2-8.

Allen, E and Thallon, R., 2001. Fundamentals of residential construction. New York: John Wiley and Sons. In: Chandra Varun, Alternative construction system for residential construction. Available at: http://archnt2.tamu.edu/cgraham/student_project.htmp (accessed on 12th June 2011).

Anand, K.B and Ramamurthy, K., 2003. Development and performance evaluation of interlocking block masonry. *J. Archit. Eng*, 6(2), Pp.45-51.

Andrew, A.A., 2007. *Challenges to providing affordable housing in Nigeria*. 2nd emerging urban Africa international conference on housing finance in Nigeria. Held at Shehu Yar-Aduas Centre Abuja, October 17-19, 2007.

Anosike, M.N and Oyebade, A.A., 2012. Sandcrete blocks and quality management in Nigeria building industry. *Journal of Engineering Project and Production Management*, 2(1), Pp.37-46.

Anthony Nkem Ede, A.N., Alegiuno, V and Awoyera, P.O., 2014. Use of advanced plastic materials in Nigeria: performance assessment of expanded polystyrene building technology system. *American Journal of Engineering Research*, 3(4), Pp.301-308.

Anugwom, E., 2003. *Privatization of workers housing provision: the national housing fund scheme in Nigeria*. African Training and Research Centre in Administration for development.

Aribigbola, A., 2008. Housing policy formulation in developing countries: evidence of programme implementation from Akure, Ondo State of Nigeria. *Human Ecology Journal*, 23(2), Pp.125-134.

Arif, M and Egbu, C., 2010. Making a case for offsite construction in China. *Journal of Engineering and Architectural Management*, 17(6), pp.536-548.

Atolagbe, A.M.O., 2009. The third world option in a globalized building materials market: the Nigeria case study. *Ethiopian Journal of Environmental Management*, 2(2), Pp.84-91.

Ayedun, C.A and Oluwatobi, A.O., 2011. Issues and challenges militating against the sustainability of affordable housing provision in Nigeria. *Business Management Dynamics*, 1(4), Pp.1-8.

Ayeyemi, D., 2011. We have less than 10% low Income housing in Nigeria-expert. Available at: http://www.nationalmirroronline.net/interviews/6350.html
(accessed on 2nd July 2012).

Ayodele, O.S., Obafemi, F.N and Sabastine, A., 2013. Options for Sustainable Mortgage Finance in Nigeria. *British Journal of Economics, Finance and Management Sciences*, 8(2), Pp23-48.

Badir, Y. F., Kadir, M. R., A and Hashim, A. H., 2002. Industrialized building systems construction in Malaysia. *Journal of Architectural Engineering*, 8(1), Pp.19-23.

Bates, M., Manuel, S and Oppenheim, C., 2007. Models of early adoption of ICT innovations in higher education, issue 50 January 2007. Available at: http://www.ariadne.ac.uk/issue50/oppenheim-et-al/
(accessed on 4th October 2011).

Bayode, A.O., 2008. Towards the involvement of youths in housing provision in Nigeria. *International NGO Journal*, 3(6), Pp.104-107.

Bell, P., 2010. *Kiwi prefab: re-framing attitudes towards prefabrication in New Zealand*. 5th Conference of Australasian Housing Researchers, 17-19 November 2010, University of Auckland, New Zealand.

Berger, P.L and Luckmann, T., 1966. *The social construction of reality: a treatise in the sociology of knowledge*. Garden City, NY: Doubleday.

Bernard, A., 2014. Pension fund: a veritable source of financing real estate development in Nigeria. *International Letters of Social and Humanistic Sciences*, Vol 23, Pp23-40.

Bero, L., Grilli, R., Grimshaw, J.M., Harvey, E., Oxman, A.D., Thomson, M.A., 1998. Closing the gap between research and Practice: an overview of systematic reviews of intervention to promote the implementation of research findings by health care professional. *BMJ 1998*, 317, Pp.465-468.

Bertrand, J.T., 2004. Diffusion of innovations and HIV/AIDS. *Journal of Health Communication*, 9, Pp.113–121.

Braak, J.V., 2001. Individual characteristics influencing teachers class use of computers. *Journal of Educational Computing Research*, 25(2), Pp.141-157.

Brewer, J., & Hunter, A., 1989. *Multimethod research: A synthesis of styles*. Newbury Park, CA: Sage.

British Precast, 2006. Future for concrete is set firm. Available at: http://www.targetwire.com/targetwire/2006/08/29/tw256_uk.html (accessed on 16th August 2012).

Bryman, A., 2008. *Social research methods*. 3rd ed. Oxford University Press. United States.

Buntrock, D., 2001. *Japanese architecture as a collaborative process: opportunities in a flexible construction culture*. New York: Spon Press.

Burwood, S., Poul, J., 2005. *Modern methods of construction: evolution or revolution*? British urban regeneration association (BURA), steering and development forum report, October, 2005, London, Pp.1-29.

Cherryholmes, C.H., 1992. Notes on pragmatism and scientific realism. *Education Research Journal*, 13-17. In; Cresswell, J.W., 2014. *Research design. international student edition. Qualitative, Quantitative and Mixed Methods Approaches*. 4th ed. SAGE Publication Limited.

CIB report, 2010. New perspective in industrialization in construction – a state – of – the art report. *CIB Publication 329*, May, 2010.

CITEC International Estates LTD., 2013. *Brochure*. CITEC Abuja, Nigeria. Pp1-42.

Coll, R.K and Chapman, R., 2000. Choices of methodology for cooperative education researchers. *Asia Pacific Journal of Cooperative Education*, 1(1). Pp.1-8.

Concrete Centre, 2008. Modern Methods of Construction. Available at: http://www.concretecentre.com/main.asp?page=790 (accessed on 10th July 2011).

Constructing Excellence., 2004. Off-site production. [online press release] available at: http://www.constructingexcellence.org.uk/pdf/fact_sheet/preassembly.pdf (accessed on 10th March 2012).

CIDB, IBS Survey., 2003. *A survey on the usage of Industrialized building system in Malaysian Construction Industry*. Construction Industry Development Board, Kuala Lumpur, 2003.

Coll, R.K and Chapman, R., 2000. Choices of methodology for cooperative Education researchers. *Asia Pacific Journal of Cooperative Education*, 1(1). Pp1-8.

Corus Construction, 2008. Modular and light steel design. Available at: http://www.corusconstruction.com/en/design_guidance/modular/ (accessed on 2nd July 2012).

Couros, A., 2003. Innovation, change theory and the acceptance of new technologies: A literature Review. Available at: http://www.educationaltechnology.ca/couros/publication_files/unpublishedpapers/change_theory.pdf (accessed on 22nd October 2011).

Cressman, D., 2009. A brief overview of actor-network theory: punctualization, heterogeneous engineering & ranslation. ACT Lab/Centre for Policy Research on Science & Technology (CPROST) School of Communication, Simon Fraser University□April 2009. Pp1-17.

Creswell, J., 2009. *Qualitative, quantitative, and mixed methods approaches*. 3rd ed. SAGE Publications, Inc. Pp.1-260.

Cresswell, J.W., 2007. *Qualitative inquiry and research design*: Choosing among five approaches. SAGE publication limited.

Creswell, J. W., 1998. *Qualitative inquiry and research design: choosing among five traditions*. Thousand Oaks, CA: Sage.

Creswell, J. W., 1998. *Qualitative inquiry and research design: choosing among five traditions*. Thousand Oaks, CA: Sage.

Cresswell, J.W., 2014. *Research design. International student edition*. Qualitative, Quantitative and Mixed Methods Approaches. 4th ed. SAGE Publication Limited.

Creswell, J.W., 2003. *Research design: qualitative, quantitative and mixed methods approaches*. 2nd ed. Sage Publication.

Dannenmann, B.M.E., Choocharoen, C., Spreer, W., Nagle, M., Leis., H., Neef, A and Mueller, J., 2007. *The potential of bamboo as a source of renewable energy in northern Laos*. Conference on International Agricultural Research and Development, University of Kassel-Witzenhausen and University of Gottingham, October 9-11, 2007. Tropentag, 2007.

Daramola, A., 2006. Affordable and functional housing in a developing economy; A case study of Nigeria. *Journal of Land use and Development*, 2(1). Pp.1-9.

Denis, J.L., Y. Hebert, A. Langley, D. Lozeau, and L.H. Trottier., 2002. Explaining diffusion patterns for complex health care innovations. *Health Care Management Review*, 27(3), Pp.60-73.

Denzin, N. K., 1989. The research act: *A theoretical introduction to sociological methods*. 3rd ed. Englewood Cliffs, NJ. Prentice Hall.

Department of Enterprise Trade and Investment (DETI)., 2006. Small and medium enterprises Northern Ireland. Northern Ireland Statistics and Research Agency. Available at: http://www.detini.gov.uk/small_and_medium_enterprises.pdf (accessed on 2nd December 2014).

Dimuna, K.O and Omatsone, M.E.O., 2010. Regeneration in the Nigerian urban built environment. *Journal of Hum Ecol*, 29(2), Pp.141-149.

Ede, A.N and Ogundiran, A., 2014. Thermal behavior and admissible compressive strength of expanded polystyrene wall panels of varying thickness. *Current Trends in Technology and Science*, 3(2), Pp.110 -117.

Ejiga, A.O., Oyekunle, O.L and Oke, A.A., 2011. Sample analysis of correlation of cost inputs of timber products in roof construction. *Journal of Building Performance*, 2(1). Pp.1-7.

Eke, F., 2004. *Social housing in Nigeria*. Paper presented at IUT congress, University of Birmingham, August 7th 2004.

Ely, A., 2005. *Are modern methods of construction compatible with best practice urban design*. Waterfront Conference on MMC, December 2005.

Energy Saving Trust, 2005. Building energy efficient buildings using modern methods of construction. Available at: http://www.energysavingtrust.org.uk/uploads/documents/housingbuildings/CE139%20-%20modern%20methods%20of%20construction.pdf (acceesed on 1st January 2012).

Eni, D.D and Danson, T.P.K., 2014. Private Sector Participation in Urban Housing Supply in Calabar, Nigeria. *American International Journal of Contemporary Research*, 4(8), Pp130-141.

Fadahunsi, S.O., 1985. Fifty years of housing in Nigeria. In: P. Onibokun (ed.) *Housing in Nigeria*. Ibadan, Nigeria: Nigerian Institute of Social and Economic Research, pp. 105–132.

Fellows, R and Liu, A., 1998. *Research methods for construction*. Blackwell Publishing.

Femi, A.B and Khan, A.F., 2014. Bridging the Gap between Housing Demand and Housing Supply in Nigerian Urban Centres: A Review of Government Intervention So Far. *British Journal of Arts and Social Sciences*, 18(11), Pp94-107.

Festus, I.A and Amos, I.O., 2015. Housing Policy in Nigeria: An Overview. *American International Journal of Contemporary Research, 5(2), Pp53-59.*

FGN, Federal Government of Nigeria, 2004. *National Housing policy for Nigeria*. Federal Ministry of Works and Housing Abuja, 2004 Report, Nigeria.

FMBN., 2015. The Federal Mortgage Bank Of Nigeria; NHF – Benefits. Available at: http://www.fmbn.gov.ng/doc/Benefits (accessed on the1st November 2015)

Finn, D.W., 1992. Towards industrialized construction. *Construction Canada*, 34, Pp.25-28.

Fitzgerald, L., E. Ferlie, M. Wood, and C. Hawkins., 2002. Interlocking interactions, the diffusion of innovations in health care. *Human Relations*, 55(12), Pp.1429-49.

Frambach, R.T. and Schillewaert, N., 2002. Organizational innovation adoption: a multi-level Framework of determinants and opportunities for future research. *Journal of Business Research*, 55(2), Pp.163-176.

Froese, T and Rankin, J., 2009. Strategic roadmaps for construction innovation: assessing the state of research. *Journal of Information Technology in Construction*, 14, Pp.400-411.

Gabriel, F and Abraham, T., 2009. Urbanization housing and infrastructural facilities in Lagos Nigeria. *Journal of Architecture and Built Environment*, 37(1), Pp.9-14.

Gaze, C., Ross, K., Nolan, E., Novakovic, O and Cartwright, P., 2007. Modern methods of construction (MMC) in housing: drivers and barriers to their use. *BRE, IP 3/07*. Pp.1-6.

Gbadegesin, J.T and Aluko, B.T., 2010. The Programme of urban renewal for sustainable urban development in Nigeria: issues and challenges. *Pakistani Journal of Social Sciences*, 7(3), Pp.244-253.

Gbadeyan, R.A., 2011. Private sector's contribution to the development of the Nigerian housing market. *Journal of Social Sciences*, 3(2), Pp.104-113.

Gbolagade, M.O., 2005. *An appraisal of maintenance of privately owned and publicly owned multi tenanted estate in Lagos metropolis*. University of Ibadan, Ibadan Nigeria.

Gibb, A., 1999. *Offsite fabrication*. Whittles Publishing, Scotland, UK.

Gorgolewski, M., 2003. Offsite fabrication. Green building magazine United kingdom. Available at: http://www.buildingforafuture.co.uk/spring03/offsite_fabrication_SIPs.php (accessed on 5th of February 2012).

Goulding, J., Rahimian, F. P., Arif, M. and Sharp, M., 2012. Offsite construction: strategic priorities for shaping the future research agenda. *Journal of Architectoni.ca*, 1, Pp.62-73.

Greene, J. C and Caracelli, V. J., 1997. Defining and describing the paradigm issue in mixed-method evaluation. In: J. C. Greene & V. J. Caracelli (ed.), *Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms*. New Directions for Evaluation, 74, San Francisco: Jossey-Bass. pp.5-17.

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P and Kyriakidou, O., 2004. Diffusion of innovation in service organization: systematic review and recommendation. *The Milbank Quarterly*, 82(4), pp.581-629.

Grimshaw, J.M., Thomas, R.E., MacLennan, G., Fraser, C., Ramsay, C.R., Vale, L., Whitty, P., Eccles, M.P., Matowe, L., Shirran, L., Wensing, M., Dikstra, R., Donaldson, C and Hutchinson, A., 2004. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technology Assessment Report*, 8(6), Pp.1-72.

Guba, E.G and Lincoln, Y.S., 1994. Competing paradigms in qualitative research. In: N.K. Dezin and Y.S Lincoln (ed). *Handbook of qualitative research*. Thousand Oaks, CA: Sage, Pp.105-117.

Guba, E.G., 1990. The alternative paradigm dialogue. In: E.G. Guba (ed), *The paradigm dialogue*. Newbury park, CA:Sage, Pp.17-30.

Gwarinpa District of Abuja, GDA., 2012. Gwarinpa District. Available at; http://www.abuja-ng.com/gwarinpa.html (accessed on the 2nd November 2015).

Hamid, Z., Kamar, K. A. M., Zain, M., Ghani, K., & Rahim, A. H. A., 2008. Industrialized building system (IBS) in Malaysia: the current state and R&D initiatives. *Malaysia Construction Research Journal*, 2, Pp.1-13.

Hampson, K and Brandon, P., 2004. *Construction 2020: a vision for Australian property and construction industry*. Cooperative Research Centre for Construction Innovation for Icon. Brisbane Australia.

Hamzah, N. H., Nafi, M. A., Yacob, J., Ashari, A. H., Daud, Z and Sulain, A. S. B. A., 2010. *Study on the acceptance of IBS in construction industry in Kelantan: application of logistic regression analysis*. Proceedings of the Regional Conference on Statistical Sciences 10, June 2010, Pp.297-306.

Harder, A., 2009. *Planned behavior change: an overview of the diffusion of innovations*. WC098 Series. Department of Agricultural Education and Communication, Florida Extension Services, University of Florida. First Published July 2009. Pp.1-4.

Haron, N.A., Hassim, S., Kadir, M.R.A and Jaafar, M.S., 2005. Building cost comparison between conventional and formwork system: a case study on four-story school buildings in Malaysia. *American Journal of Applied Sciences*, 2, Pp.819-823.

Hartmann, A., 2006. *Understanding the innovation adoption process of construction clients*. Clients driving innovation: moving ideas into practice. 12-14 March 2006. Cooperative Research Centre (CRC) for Construction Innovation, Pp.1-11.

Hashemi, A., 2006. *Modern methods of construction (MMC) in the UK housing industry*. Proceedings of the Second Research Student Conference held at the Welsh School of Architecture Cardiff University on 24 November 2006, 29-41.

Hassim, S., Jaafar, M.S., Sazali, S.A.A.H., 2009. The contractor conception towers industrialized building system risk in construction projects in Malaysia. *American Journal of Applied Sciences*, 6, Pp.937-942.

Holt, G.D., 2014. Asking questions, analysing answers: relative importance revisited. Construction Innovation, 14(1), Pp.1-18.

Hornbostel, C., 1991. *Construction materials: types, uses and applications*. John Wiley & Sons Inc., USA.

Hubbard, W.G and Sandmann, L.R., 2007. Using diffusion of innovation concepts for improved program evaluation. *Journal of Extension*, 45(5). Available at: http://www.joe.org/joe/2007october/a1.php (accessed on 3rd July 2013).

Hussein, J., 2007. *Industrialized building system: the challenge and the way forward*. Keynote addressed at Construction Industry Research Achievement International Conference, CIDB, PWTC, Kuala Lumpur. Malaysia.

Ibem, E.O., 2010. An assessment of the role of government agencies in public private partnerships in housing delivery in Nigeria. *Journal of Construction in Developing Countries*, 15(2), Pp.23-48.

Ifasanya, S.O., 2007. Building materials production and use. *Housing Development and Management*. In: Tunde Agbola, Layi Ogunjobi and C.O. Olatubara (ed). Department of Urban and Regional Planing of Ibadan, Ibadan Nigeria, Pp.310-349.

Ikechukwu, U.F., 2012. Compressive strength and costs of sandcrete blocks and blocks made with quarry dust in Nigeria: a case study of Abakaliki quarry. *Journal of Chemical, Mechanical and Engineering Practice*, 2,(3), Pp.9-17.

Ikejiofor, U., 2005. Land issues in the new national housing policy for Nigeria. *Journal of International Development Planning and Review*, 27(1), Pp.99-111.

Isa, R.B., Jimoh, R.A and Achuenu, E., 2013. An overview of the contribution of construction sector to sustainable development in Nigeria. *Net Journal of Business Management,* 1(1), Pp1-6.

Jiboye, A.D., 2010c. Evaluating users household size and housing quality in Osogbo, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 3(2), Pp.77-85.

Jimoh, A.M and Onochie, B.C., 2015. Workers demand new minimum wage. Available at: http://www.ngrguardiannews.com/2015/07/workers-demand-new-minimum-wage/Accessed on 27th October 2015).

Johnson, R.B and Onwuegbuzie, A.J., 2004. Mixed methods research: a research paradigm whose time has come. *Educational Researcher*, 33(7), Pp.14-26.

Jones, M.L., 2007. Using software to analyse qualitative data. *Malaysian Journal of Qualitative Research,* 1(1), Pp64-76.

Kabir, K.O., 2006. Planning sustainable and livable cities in Nigeria. *Research Journal of Social Science*, 1(1), Pp.40-48.

Kabir, K.O., 2005. Mass housing through earth Construction technology in Nigeria. *Pakistan Journal of Social Sciences*, 3(5), Pp.755-760.

Kabir, K.O., 2004, Low-cost technology and mass housing system in the Nigerian housing. *Journal of Applied Sciences*, 4(4), Pp.565-567.

Kalu, I.E., Agbarakwe, H.U and Anowor, O.F., 2014. National housing policies and the realization of improved housing for all in Nigeria: an alternative approach. *Asian Developing Policy Review,* 2(3), Pp47-60.

Kamar, K. A.M., Hamid, Z. A., Azman, M. N. A and Ahamad, M. S. S., 2011. Industrialized building system (IBS): revisiting issues of definition and classification. *Int. J. Emerg. Sci*, 1, Pp.120-132.

Kamar, K.A.M., Alshawi, M and Hamid, Z., 2009. *Barriers to industrialized building system (IBS): the case study of Malaysia*. Proceedings of the 9th international postgraduate research conference, 29-30th January 2009. Salford Quays, Greater Manchester, UK. Pp.471-485.

Kamar, K.A.M., Hamid, Z.A and Alshawi, M., 2010. *The critical success factors (CSFs) to the implementation of industrialized building system (IBS) in Malaysia*. Proceedings of 18th CIB world building congress, May 2010, Salford, United Kindom. Pp.64-76.

Kaminski, J., 2011. Diffusion of innovation theory. *Canadian Journal of Nursing Informatics*, 6(2). Theory in Nursing Informatics column. Available at: http://cjni.net/journal/?p=1444 (accessed on 3rd of November 2011).

Kapeleris, J., 2012. Business model innovation drives competitive advantages. Available at: http://johnkapeleris.com/blog/?p=1515 (accessed on 12 July 2015)

Katz, E., 1957. The two-step flow of communication: an up to date report on a hypothesis. *The Public Opinion Quarterly*, 21(1), Pp.61-78.

Kayode, O and Olusegun, A.E., 2013. Local building materials: a tool towards effective low-income housing in Nigeria. *Middle-East Journal of Scientific Research,* 18(4), Pp492-497.

Kerlinger, F.N., 1979. *Behavioral research: a conceptual approach*. New York. Holt, Rinehart and Winston.

Kinyungu, A.N., 2004. Public private sector partnership in servicing of land and provision of housing for low income groups in Harare: experience and lessons learnt 1990-1996. Kenya: Foundation for Rural and Urban Development. Available at: http://www.rics-foundation.org (accessed on 15th February 2011).

Klein, H.K and Kleinman, D.L., 2002. The social construction of technology: structural considerations. *Science, Technology, & Human Values*, 27(1), Pp28-52.

Kolo, S.J., Rahimian, F.P and Goulding, J.S., 2014. Offsite manufacturing construction: a big opportunity for housing delivery in Nigeria. *Procedia Engineering* 85, Pp319-327.

Krauss, S.E., 2005. Research paradigms and meaning making: a primer. *The Qualitative Report*, 10(4), Pp.758-770.

Kvale, S., 1996. *Interviews: an introduction to qualitative research interviewing.* SAGE Publications, Thousand Oaks California.

Lamarca, N., 2011. The Likert scale: advantages and disadvantages. Available at: https://psyc450.wordpress.com/2011/12/05/the-likert-scale-advantages-and-disadvantages/ (accessed on 5th July 2015).

Lawson, R.M and Ogden, R.G., 2010. *Sustainability and process benefits of modular construction*. Proceedings of 18th CIB world building congress, May 2010 Salford, United Kingdom, Pp.38-51.

Leake, G., Toole., Divis, P and Torres-Sanchez, C., 2010. *Bamboo as a solution for low-cost housing and storage in Pabal (India)*. EWB-UK National Research Conference, hosted by the royal academy of engineering, 19th February 2010. Pp.1-5.

Lee, E.J., Lee, J. and Schumann, D.W., 2002. The influence of communication source and mode on consumer adoption of technological innovations. *Journal of Consumer Affairs*, 36(1), pp.1-27.

Ligny, E.V.E and Erkelens, P., 2008. Construction technology diffusion in developing countries: limitation of prevailing innovation systems. *Journal of Construction in Developing Countries*, 13(2), Pp.43-64.

Lincoln, Y and Guba, E., 2011. Paradigmatic controversies, contradictions and emerging confluences. In: N. Denzin and Y. Lincoln, edn. *The Landscape of Qualitative Research: Theories and Issues.* 2nd ed. London: SAGE.

Lucas, E., Olorunnisola, A and Adewole, N., 2006. Preliminary evaluation of guava (Psidium Guajava L.) tree branches for truss fabrication in Nigeria. CIGR *E-Journal*, 8, Pp.1-10.

Lukiantchuki, M.A., Caixeta, M.C.B.F and Fabricio, M.M., 2010. *Construction industrialization and use of prefabricated elements applied in hospital buildings production: case study in the technology center of the Sarah network of rehabilitation hospitals (Ctrs) Brazil*. Proceedings of 18th CIB world building congress May 2010, Salford, United Kindom, Pp.93-104.

Makinde, O.O., 2014. Housing delivery system, need and demand. *Environ Dev Sustain,* vol 16, Pp49–69.

Marshal, I and Onyekachi, O., 2014. Funding Housing Deficit in Nigeria: A Review of the Efforts, Challenges and the Way Forward. *International Journal of Business and Social Science, 5(13), Pp206-209.*

Marsono, A. K., Tap, M. M., Ching, N. S and Mokhtar, A. M., 2006. *Simulation of industrialized building system (IBS) components production*. Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006), Kuala Lumpur, Malaysia.

Mbamali, I and Okotie, O.J., 2012. An assessment of the threats and opportunities of globalization on building practice in Nigeria. *American International Journal of Contemporary Research*, 2(4), Pp.1-8.

MBS (Miller Building System), 2005. Steel frame building system. Available at: http://www.mbsionline.com/steel_frame.html (accessed on 10th August 2012).

McGraw, H., 1977. *Encyclopedia of science and technology*. New York. McGraw-Hill Book Company.

McLaren, H., Gibson, C., Arney, F., Scott, D and Brown, L., 2008. *Sowing the seeds of innovation: exploring the utility of diffusion of innovation theory*. The history and future of social innovation conference. The Hawke Centre, Adelaide, 19-21 June 2008. Pp.1-8.

Meade, N and Islam, T., 2006. Modelling and forecasting the diffusion of innovation – A 25-year review. *International Journal of Forecasting*, 22, Pp.519– 545.

Medlin, B.D., 2001. *The factors that may influence a faculty member's decision to adopt electronic technologies in instruction*. Doctoral Dissertation, Virginia Polytechnic Institute and State University, 2001. Pro-Quest Digital Dissertations. (UMI No. AAT 3095210).

Meyer, M., D. Johnson, and C. Ethington., 1997. Contrasting attributes of preventive health innovations. *Journal of Communication*, 47, Pp.112-31.

Miller, R.L., Acton, C., Fullerton, D.A and Maltby, J., 2002. *SPSS for social scientist. Palgrave*, Macmillan.

Mohamad, M. I., Zawi, M and Nekooie, M. A., 2009. Implementing industrialized building System (IBS) in Malaysia: acceptance and awareness level, problems and strategies. *Malaysian Journal of Civil Engineering*, 21, Pp.219-234.

Mordi, S.E.O., 2002. *Social policy and housing needs in Nigeria*. A paper presented at two day workshop on your right to own a house. Organized by the Delta State Ministry of Housing, Asaba 2002, Nigeria.

Morgan, D., 2007. *Paradigms lost and paradigm regained*: Methodological implications of combining qualitative and quantitative methods. Journal of Mixed Methods Research, 1(1), 48-76.

Mullens, M.A. and Arif, M., 2006. Structural insulated panel: impact on the Residential Construction Process. *Journal of Construction Engineering and Management*, 132(7), Pp.786-794.

National Audit Office, (NAO), 2007. *Using modern methods of Construction to build homes more quickly and efficiently*. NAO report 2005, London.

Nawi, M. N. M., Elias, E.M., Hamid, M. S. A. and Yusoff, M. N., 2005. *A Study of IBS formwork usage in the Malaysian construction industry*. Proceedings of national seminar on engineering support course. University Malaysia Perlis, Malaysia.

Nawi, M. N. M., Lee, A and Nor, K. M., 2011. Barriers to implantation of the industrialized building system (IBS) in Malaysia. *Built and Human Environment review*, 4, Pp.22-35.

Nawi, M.N.M., Nifa, F.A.A., Abdullah, S. & Yasin, F.M., 2007a. *A preliminary survey of the application of IBS in kedah and perlis Malaysian construction Industry*. Proceeding in Conference in Sustainable Building, Malaysia.

Nawi, M.N.M., Nifa, F.A.A., Musa, S. & Sudirman, M.D., 2007b. *A preliminary survey of the application of IBS in Malaysian construction industry: barriers to implement in kedah and perlis*. Proceeding in Conference ITB, Indonesia.

National Center for Excellence in Housing (NCEH)., 2006. Semi volumetric and hybrid system. Available at: http://www.homein.org/new/page.jsp?id=523 (accessed on 6th September 2012).

National Economic and Empowerment Development Strategy (NEEDS)., 2004. Federal republic of Nigeria. National Planning Commission, Abuja Nigeria.

Ndubueze, O., 2009. Urban housing affordability and the housing policy dilemmas in Nigeria. Unpublished PhD Thesis, University of Birmingham, UK.

Nduka, C.E., 2008. *Technological development: a veritable tool for technology, Akure*. Annual lecture series. Pp.1.

Nigeria Property Centre, 2015. Houses for sale in Mbora, Abuja. Available at: http://www.nigeriapropertycentre.com/for-sale/houses/abuja/mbora/showtype (Accessed on 28th October 2015).

Nigeria Vision 2020 Programme., 2009. Report of the Vision 2020. National Technical Working Group On Housing, July 2009.

Nnamdi, O.P., 2011. Low cost materials for building and construction: a case study of rice. *Journal of Sustainable Development and Environmental Protection*, 1(1), Pp.87-93.

Nnanna, U.J., 2010. Housing crises: a theoretical study of the home building industry in Nigeria. *Journal of International Business Research*, 3(3), Pp.16-20.

Nubi, T.O., 2000. Housing finance in Nigeria - need for re-engineering. Available at: http: //www.housingfinance.org/pdfstorage/Africa (accessed on 15th November 2010).

Nwaka, G.I., 2005b. *Using indigenous knowledge to strengthen local governance and to counter urban inequality in Nigeria*. Proceedings of 10th international conference on information and communication technologies (ICT), CORP and Geo Multimedia 2005.

Nwaka,G.I., 2005a. The urban informal sector in Nigeria: Towards Economic Development. Environmental health and social harmony. *Global urban development*, 1(1), PP.1-11.

Nwoke, O.A and Ugwuishiwu, B .O., 2011. Local bamboo and earth construction potentials for provision of affordable structures in Nigeria. *International Journal of Sustainable Construction Engineering & Technology*, 2(2), Pp.1-15.

Nwoye, U.J., Obiorah, J.N and Ekesiobi, C., 2014. Effect of Nigeria Macroeconomic Environment on the Performance of the National Economy: Implications. *International Journal of Academic Research in Business and Social Sciences*, 5(7), Pp42-51.

Nwude, E.C., 2013. Are building materials stocks a hedge against inflation in Nigeria. *Asian Journal of Empirical Research*, 3(10), Pp1343-1361.

Odebiyi, S.O., 2010. Sustainable housing development in Africa: Nigeria P perspective. *Journal of International Business Management*, 1(1), Pp.22-30.

Odeyale, T.O and Adekunle, T.O., 2008. *Innovative and sustainable local materials in traditional African architecture socio cultural dimension*. Structural Analysis of Historic Construction – D'Ayala &Fodde ed. Taylor and Francis Group, London.

Odunjo, O.O., 2013. Laterite building material and sustainable housing production in Nigeria. *Sustainable Building Conference 2013*, Coventry University. United Kingdom. Pp159-165.

Ogunbi,O., 1997. Cooperative housing in Nigeria. *Housing Today Journal*, 2, Pp.4-8.

Ogundiran, I.A and Adedeji, Y. M. D., 2014. Sustainable construction: comparative advantages of expanded polystyrene (EPS) fascia in housing delivery in Nigeria. *Civil and Environmental Research*, 6(10), Pp.66-75.

Ogunjinmi, A.A., Ijeomah, H.M and Aiyeloja, A.A., 2009. Socio-economic importance of bamboo (Bambusa Vulgaris) in Borgu local governemnt area of Niger State, Nigeria. *Journal of Sustainable Development in Africa*, 10(4), Pp.284-298.

Ojo, M.O., Adenodi, R.A., Alabi, O.O., Akinjogbin, I.O and Akinwale, B.F., 2009. Analysis of thermal and electrical properties of some clay samples: implications of residential building in Ondo town, Nigeria. E.J.G.E., 14, Pp.1-6.

Okunade, E.A., 2007. Engineering properties of lateritic adobe bricks for local building construction and recommendations for practice. *Journal of Engineering and Applied Sciences*, 2(9), Pp.1455-1459.

Oladapo, A.A., 2006. A study of tenants maintenance awareness, responsibilities and satisfaction in institutional housing in Nigeria. *International Journal of Strategic Property Management,* 10, Pp.217-231.

Olajide, E.O., 1992. The meaning and content of self help architecture. *Journal of Nigerian Institute of Architects*, 7(1). Pp.1.

Olawande, O.A. and Ayodele, A.C., 2011. Effect of property tax on sustainable H housing delivery in Lagos State, Nigeria. *Journal of Sustainable Development*, 4(1), Pp.173-192.

Olayeni, K.P., 2014. Informal activities delivering formal housing: A case study of house-building industry in Ile-Ife, Nigeria. *Ethiopian Journal of Environmental Studies & Management,* 7(3), Pp319-326□.

Olayiwola, L.M., Adeleye, O and Ogunshakin, L., 2005. *Public housing delivery in Nigeria: problems and challenges*. World congress on housing, transforming housing environments through the design, September 27-30th Pretoria, South Africa. Pp.1-5.

Olofa, S and Nwosu, A., 2015. Investigating the problems associated with public-private partnership in the process of housing delivery in Nigeria. *International Journal of Education and Research, 3(1), Pp123-130.*

Olotuah, A.O., 2000. The challenge of housing in Nigeria. Effective housing in 21st century Nigeria, environmental forum. Federal University of Technology Akure, Nigeria. Pp.16-21.

Olotuah, A.O and Ajayi, M.A., 2008. Repositioning women in housing development. *Indian Journal of Gender Studies*, 15(1), Pp.101-113.

Olotuah, A.O and Bobadoye, S.A., 2009. "Sustainable housing provision for the urban poor: a review of public sector intervention in Nigeria. *Journal of the Built and Human Environment Review*, 2, Pp.51-63.

Olotuah, A.O., 2002. Recourse to earth for low-cost housing in Nigeria. *Building and Environment*, 37. Pp.123-129.

Olotuah, A.O., 2005. *Urban housing and heritage of earth architecture in Nigeria.* Paper Presented at the international network for traditional building architecture and urbanism, 25-27th August 2005. London, UK. Pp.1-16.

Olotuah, A.O., 2009. *Demystifying the Nigerian urban housing question.* The 53rd inaugural lecture of the federal university of technology, Akure, Nigeria.

Olotuah, A.O., 2010. Housing development and environmental degeneration in Nigeria. *Journal of the Built and Human Environment Review*, 3, Pp.42-48.

Olujimi, J., 2009. Evolving strategy for managing urban sprawl in Nigeria. *Journal of Human Ecology*, 25(3), Pp.1-20.

Omatsone, M.E.O and Dimuna, K.O., 2010. Regeneration in the Nigerian urban built environment. *Journal of Human Ecology*, 29(2), Pp.141-149.

Omole, K.F., 2010. An assessment of housing condition and socio-economic lifestyles of slum dwellers in Akure Nigeria. *Contemporary Management Research journal*, 6(4). Pp273-290.

Omole, F.K and Bako, A.I., 2013. Analysis of the Problems and Prospects in the Use of Local Building Materials: Review of Literature. *Civil and Environmental Research*, 3(11), Pp1-8.

Onibokun, A.G and Agbola, T., 1990. Urban housing problem: implication for the construction industry in Nigeria. In: *Urban Housing in Nigeria*. Ibadan: NISER, Pp91-361.

Onyekachi, A.F., 2014. Effects of Governance and Policy Reforms on Affordable Housing in Nigeria. *International Journal of Innovation and Scientific Research*, 11(2), Pp413-419.

Opara, S., 2011. Modular housing system gaining popularity despite huge costs. Available at: http://www.nigerianbestforum.com/generaltopics/?p=98229 (accessed on 10th June 2012).

Opoko, A.P and Oluwatayo, A., 2014. Trends in Urbanisation: Implication for Planning and Low-Income Housing Delivery in Lagos, Nigeria. *Architecture Research,* 4(1), Pp15-26.

Oruwari, O., Jev, M and Owei, O., 2002. Acquisition of technological capability in Africa: a case study of indigenous building materials firms in Nigeria. *ATPS Working Paper Series*, No.33. Pp.1-49.

Owoeye, O.J and Adedeji, Y.M.D., 2015. Urban Land Acquisition for Sustainable Housing Delivery in Akure, Nigeria. *International Journal of Developing Societies, 4(1), Pp10-20.*

Oyekan, G.L and Kamiyo, O.M., 2011. A study on the engineering properties of sandcrete blocks produced with rice husk ash blended cement. *Journal of Engineering and Technology Research*, 3(3), Pp.88-98.

Oyetola, E.B and Abdullahi, M., 2006. The use of rice husk ash in low-cost sandcrete block production. Leonardo Electronic *Journal of Practices and Technologies*, 8, Pp.58-70.

Oyewole, M.O., 2010. Housing development finance through cooperate societies: the case study of Ogbomoso, Nigeria. *International Journal of Housing Markets and Analysis*, 3(3), Pp.245-255.

Pan, W., Gibb, A.F and Dainty, A.R.J., 2007. Perspectives of UK house builders on the use of offsite modern methods of construction. *Construction Management and Economics*, 25, Pp.183-194.

Parid, W., 1997. *Global trends in research, development and construction*. Proceedings of the international conference on industrialized building system, CIDB 2003, Malaysia.

Patton, M. Q., 1990. *Qualitative evaluation and research methods*. 2nd ed. Newbury Park, CA: Sage.

Patton, M. Q., 2002. *Qualitative research and evaluation methods*. 3rd ed. Thousand Oaks, CA: Sage.

Perry, R., 2006. Diffusion theories. *Encyclopedia of Sociology*. In: Ed Edgar F. Borgatta and Rhonda J.V. Montgomery. Vol. 1. 2nd ed. New York: Macmillan Reference USA, 2001. Pp.674-681.

Phillips, D.C and Burbules, N.C., 2000. *Postpositivism and educational research*. Lanham, MD: Rowman and Littlefield.

Plsek, P., 2003. *Complexity and the Adoption of Innovation in Health Care*. Paper presented at accelerating quality improvement in health care: strategies to accelerate the diffusion of evidence-based innovations. Washington, D.C.: National Institute for Healthcare Management Foundation and National Committee for Quality in Health Care.

Polit, D.F., Beck, C.T and Hungler, B.P., 2001. *Essentials of nursing research: Methods, appraisal, and utilization.* 5th ed. Philadelphia, Lippincott.

Polystyrene Industry Limited., 2013. *Polyslab Technical Manual*. Polystyrene Industry Limited, Abuja, Nigeria. Pp.1-27.

Public Private partnership (PPP)., 2003. An introduction to public private partnership. Available at: http://www.partnershipsbc.ca/pdf/An%20Introduction%20to%20p3%20-June03.pdf (accessed on 1st January 2011).

Punch, K.F., 2005. *Introduction to Social Research: Qualitative and Quantitative Approaches*. 2nd ed. London: SAGE.

Qays, M., Mustapha, K. N., Al-matterneh, H and Mohamad, B. S., 2010. *The constraints of industrialized building system from the stakeholders point of view*. Proceedings of ICSE, Melaka 2010, Malaysia.

Rahman, A.A.B and Omar, W., 2006. *Issues and challenges in the implementation of industrialised building system in Malaysia*. Proceedings of the 6th Asia Pacific Structural Engineering and Construction Conference 2006, 5-6 September 2006. Kuala Lumpur, Malaysia.

Raji, O., 2008. Public and private developers as agents in urban housing delivery in Sub-saharan Africa. The situation in Lagos State. *Humanity of Social Science journal*, 3(2). Pp.143-150

Reichardt, C.S and Rallis, S.F., 1994. Qualitative and quantitative inquiries are not incompatible. A call for new partnership. *New Directions for Program Evaluation*, 6, Pp.85-91.

Ritzer, A., 2004. Actor network theory. Available from: http://www.sagepub.com/sites/default/files/upm-binaries/5222_Ritzer__Entries_beginning_with_A__[1].pdf (accessed on 11th July 2015).

Robinson, L., 2009. A summary of diffusion of innovations. Enabling Change. Available at: http://www.enablingchange.com.au/Summary_Diffusion_Theory.pdf (accessed on 16th October 2011).

Rocco, T.S., Bliss, L.A., Gallagher, S and Perez-prado, A., 2003. Taking the next step: mixed methods research in organizational system. Information Technology, *Learning and Performance Journal*, 21(1), Pp.19-29.

Rodriguez de Sensale, G., Ribeiro, A.B and Goncalves, A., 2008. Effects of RHA on autogenous shrinkage of portland cement pastes. *Cement Concrete Composition*, 30(10), Pp.892-897.

Rogers, E., 2003. *Diffusion of innovations*. 5th ed. Free Press: New York.

Rogers, E.M and Scott, K.L., 1997. The diffusion of innovations model and outreach from the national network of libraries of medicine to native American communities. Available at: http://www.au.af.mil/au/awc/awcgate/documents/diffusion/rogers.htm (accessed on 13th of December 2011).

Rogers, E.M., 1983. *Diffusion of innovations*. 3rd ed. The Free Press, London.

Ross, K., 2005. *Modern methods of house construction: a surveyor's guide*. BRE Press. Watford.

Ross, K., Cartwright, P and Novakovic, O., 2006. *A guide to modern methods of construction*. BRE Press, London.

Rossman, G.B and Wilson, B.L., 1985. Numbers and words: combining quantitative and qualitative methods in a single large scale evaluation study. *Evaluation Review*, 9(5), 627-643.

Saad, H.T and Ogunsusi, V., 1996. *Unity in diversity, continuing in changes: the traditional architecture of Nigeria*. A colloquium on Nigerian traditional architecture at the second united nation conference on human settlements, (Habitat II), Istanbul Turkey. 3-14 June, 1996.

Sahin, I., 2006. Detailed review of roger's diffusion of innovation theory and educational technology-related studies based on Roger's theory. The Turkish Online *Journal of Education Technology*, 5(2).

Salam, K., 2008. Bamboo for economic prosperity and ecological security with special reference to northeast India. CBTC, Guwahati. Available at: www.indianfolklore.org/journals/index.php/Ish/article/download/452/520 (accessed on 10th January 2013).

Sale, J.E.M., Lohfeld, L.H., Brazil, K., 2002. Revisiting the quantitative-qualitative debate: implications for mixed-methods research. *Kluwer Academic Publishers*, 36, Pp.43-53.

Salveron M, Arney F & Scott D., 2006. Sowing the seeds of innovation: Ideas for child and family services. Australian Institute of Family Studies, *Family Matters*, 73, Pp.38-45.

Sarja, A., 1998. *Open and industrialized building*. International Council for Building Research: E & FN Spoon, London.

Schuler, A.J., 2002. Planning change management communication. Available at: http://www.schulersolutions.com/change_management_communicatio.html (accessed on 13th September 2011).

Scurlock, J.M.O., Dayton, D.C and Hames, B., 2000. Bamboo and overlook biomass resource? Available at: http://artsarchive.tripod.com/03sene/biomass/bamboo.pdf (accessed on 2nd December 2013).

Sengupta, U., 2005. Government intervention and public private partnerships in housing delivery in Kolkata. *Habitat International Journal*, 30(3), Pp.448-461.

Silverman, D., 2004. *Qualitative research: theory, method and practice*. 2nd ed. SAGE publication.

SME., 2014. What is an SME? Available at: http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm (accessed on 4th December 2014).

Smith, E.R., 2009. *History of prefabrication: a cultural survey*. Proceedings of the third international congress on construction history, May 2009. Cottbus.

Stuart, W.D., 2000. *Influence of sources of communication, user characteristics and innovation characteristics on adoption of a communication technology (Doctoral dissertation*. The University of Kansas, 2000. Pro-Quest Digital Dissertations. (UMI No. AAT 9998115).

Stuckey, H.L., 2013. Three types of interviews: Qualitative research methods in social health. *Journal of Social Health and Diabetes*, 1(2). Pp.156-59.

Surry, D.W., 1997. *Diffusion theory and instructional technology*. Paper presented at the annual conference of the association for educational communications and technology (AECT), Albuquerque, 1-15 February 1997, New Mexico. Available at: http://www2.gsu.edu/~wwwitr/docs/diffusion/ (accessed on 13th October 2011).

Taiwo, A and Adeboye, A., 2013. ustainable Housing Supply in Nigeria Through the Use of Indigenous and Composite Building Materials. *Civil and Environmental Research,* 3(1), Pp79-84.

Tashakkori, A and Teddlie, C., 1998. Mixed methodology: combining qualitative and quantitative approaches. *Applied Social Research Methods*, 46, Thousand Oaks, CA: Sage.

Taylor, J.E and Levitt, R., 2007. Innovation alignment and project network dynamics: Aan integrative model for change. *Project Management Journal*, 38(3), Pp.22-25.

Thanoon, W.A.M., Peng, L.W., Kadir, M.R.A., Jaafar, M. S. & Salit, M. S., 2003a. *The experiences of Malaysia and other countries in industrialized building system*. Proceeding of international conference on industrialized building systems, Kuala Lumpur, Malaysia.

Thanoon, W.A.M., Peng, L.W., Kadir, M.R.A., Jaafar, M. S. & Salit, M. S., 2003b. *The essential characteristics of industrialized building system*. Proceeding of international conference on industrialized building systems, Kuala Lumpur, Malaysia.

Toews, D., 2003. The new Tarde: sociology after the end of the social. *Theory Culture and Society*, 20(5), Pp.81-98.

Trikha, D.N., 1999. *Industrialized building systems: prospects in Malaysia*. Proceedings World Engineering Congress, Kuala Lumpur, Malaysia.

Trochim, W.M., 2000. The research methods knowledge based. Available at: http://www.socialresearchmethods.net/kb (accessed on 6th November 2013).

Udechukwu, C.E., 2008. Obstacles to individual home ownership in Nigeria. *International Journal of Housing Markets and Analysis*, 1(2), Pp.182-194.

Ukoba, O.K., Ogunkoya, A.K and Soboyejo, W., 2011. Development of an eco-friendly bamboo bicycle. *The Pacific Journal of Science and Technology*, 12(1), Pp.102-108.

Ukwayi, E.J., Eja, E.E., Ojong, F.E and Out, J.E., 2012. An assessment of housing delivery in Nigeria: federal mortgage bank scenario. *Canadian Social Science*, 8(6), Pp68-74.

United Kingdom Timber Frame Association., 2008. What is timber frame? Available at: http://www.timber-frame.org/index.php?page=46 (accessed on 3rd April 2011).

UN-Habitat., 2006. Public-private partnership in enabling shelter strategies. United Nations HABITAB Information Services: Nairobi. Available At: http://www.unhabitat.org (accessed on 20th November 2010).

Usman, N.D., Inuwa, I.I., Kolawole A.R., Kwari, J.M and Didel, J.M., 2014. Evaluating the impact of jousting delivery system on project performance within the building industry in Nigeria. *Journal of Environmental Sciences and Resources Management,* 6(1), Pp145-155.

Van der Lugt, P., Van den Dobbelsteen, A.A.J.F and Janssen, J.J.A., 2006. An environmental, economic and practical assessment of bamboo as a building material for supporting structures. *Journal of Construction and Building Materials*, 20(9), Pp.648-656.

Wahab, A.B and Lawal, A.F., 2011. An evaluation of waste control measures in construction industry in Nigeria. *African Journal of Environmental Science and Technology*, 5(3), Pp.246-254.

Wahab, A.K., 1988. *Housing cooperative studies in environmental design in West Africa*. Vol. 9 and 11. Coedited by University of Terieste, Italy and Faculty of Environmental Science Obafemi Awolowo University, Ile Ife, Nigeria.

Walker, M.R., 2006. Innovation type and diffusion: an empirical analysis of local government. *Public Administration Journal*, 84(2), Pp.311-335.

Warszawski, A., 1999. *Industrialized and automated building system*. E & FN Spon. London.

Windapo, A.O and Balogun, A.A., 2009. *Study of the utilization of modern methods and techniques of building construction in low cost housing provision in Nigeria*. RICS COBRA Research Conference, University of Cape Town, 10-11th September 2009. Pp.537-552.

Wolcott, H.T., 1999. *Ethnography: a way of seeing*. Walnut Creek, CA. Altamira.

Wolfe, R., 1994. Organizational innovation: review, critique and suggested research agenda. *Journal of Management Studies*, 31(3), Pp.405-431.

Wright, M and Charlett, D., 1995. New product diffusion model in marketing: an assessment of two approaches. *Marketing Bulleting*, 6, Pp.32-41.

Yar' adua, M.M and Aliyu, A.A., 2012. *An examination of the properties of literate and clay as construction materials for sustainable buildings in Kano and Kaduna metropolis Nigeria.* In: Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) Procs 4th West Africa Built Environment Research (WABER) Conference, 24-26 July 2012, Abuja, Nigeria, Pp.1-7.

APPENDICES

Appendix (A): Ethical Approval

OXFORD BROOKES UNIVERSITY

Professor Joseph Tah
Director of Studies
Department of Real Estate and Construction
Faculty of Technology, Design and Environment
Oxford Brookes University
Gipsy Lane
Headington

19 November 2012

Dear Professor Tah

UREC Registration No: 120676

The utilization of local building materials to provide offsite prefabricated components for low cost house building in urban Nigeria

Thank you for your email of 9 November 2012 outlining your response to the points raised in my previous letter about the PhD study of your research student Zaharaddeen Al-kaleel Ahamad, and attaching the revised documents. I am pleased to inform you that, on this basis, I have given Chair's Approval for the study to begin.

The UREC approval period for this study is two years from the date of this letter, so 19 November 2014. If you need the approval to be extended please do contact me nearer the time of expiry.

In order to monitor studies approved by the University Research Ethics Committee, we will ask you to provide a (very brief) report on the conduct and conclusions of the study in a year's time. If the study is completed in less than a year, could you please contact me and I will send you the appropriate guidelines for the report.

Yours sincerely

Hazel Abbott
Chair of the University Research Ethics Committee

cc RaminKeivani, Supervisory team
ZaharaddeenAlkaleelAhamad, Research Student
Pete Smith, Research Ethics Officer
Jill Organ, Graduate Office
Louise Wood, UREC Administrator

UNIVERSITY RESEARCH ETHICS COMMITTEE, FACULTY OF HEALTH AND LIFE SCIENCES

Headington Campus Gipsy Lane
Oxford OX3 0BP UK

Tel: 01865 482639
heabbott@brookes.ac.uk

Appendix (B): Transfer Approval from MPhil to PhD

OXFORD BROOKES UNIVERSITY

Mr Z A Ahamad
30 Dawes Street
Gillingham
Kent
ME7 5UQ

26 June 2012

Dear Mr Ahamad

Transfer of registration from MPhil to PhD

I am pleased to inform you that, following consideration of your application for transfer of registration at its meeting on Friday 15 June 2012, the Research Degrees Sub-Committee has approved the transfer of your registration from Master of Philosophy to Doctor of Philosophy.

Yours sincerely

Professor G Butina Watson

cc: Professor J Tah, TDE
Dr R Keivani, TDE, Postgraduate Research Tutor

Humanities, Environment & Social Sciences Sub-Committee
Chair: Professor G Butina Watson, BA MA PhD
Jill Organ (Secretary)

Buckley Building Gipsy Lane Oxford OX30BP UK
t. +44 (0) 1865 484244 f. +44 (0) 1865 484238
jorgan@brookes.ac.uk
www.brookes.ac.uk

Appendix (C): Participant Information Sheet

OXFORD BROOKES UNIVERSITY

Participant Information Sheet

Research Title: The Utilization of Local Building Materials to Provide Offsite Prefabricated Components for Low Cost House building in Urban Nigeria".

Invitation Paragraph

You are being invited to take part in a research study. Before you decide to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and ask if anything is unclear or if you need further information.

What is the purpose of the study?

This research project aims to develop a framework for understanding the use of local building materials in the production of offsite prefabricated components for low-cost house building in Nigeria through the formal building sector. The focus is hereby to understand why local building materials are used or not used for prefabricated low cost house building and explore the potential for the utilization and diffusion of prefabrication construction techniques in Nigeria.

Why have I been invited to participate?

Because of your company's expertise in the utilization of offsite construction techniques, you are being chosen among other companies to take part in this research. All questions will be based on your knowledge and expectation of prefabricated construction techniques in Nigeria.

Do I have to take part?

Your cooperation and involvement in this study is completely voluntary and you are free to participate or withdraw at any time without giving a reason, even if you have decided to take part initially there will be no consequences on your behalf. It is up to you to decide whether or not to take part.

What will happen to me if i take part?

If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. You will also be required to fill up an interviewer-administered questionnaire and would ask to volunteer further for an in-depth interview at a later date. But it's all voluntary as mentioned above.

The questionnaire and the interviewer questions are based on your experience and expectation of using local building materials for prefabricated construction techniques in Nigeria. The time required for the completion of the questionnaires will be at least 25-30mins. You will be further invited to take part in an in-depth tape-recorded interview if you wish to volunteer further to discuss the issues that could not be probed using questionnaire. The tape-recorded interview could take at least 45-60 minutes. There is a section at the last page of the questionnaire where you can leave your contact details should in case you wish to volunteer for the in-depth interview.

What are the possible benefits of taking part?
The information you provided will contribute to the useful input on Research and Development (R and D) regarding the utilization of local building materials for prefabricated low cost housing throughout the country.

Beside your time, no risk or cost is involved in the process. You will also further our understanding of the subject area. You can also have a copy of the result on demand.

Will what I say in this study be kept confidential?
Collected data will remain entirely confidential and anonymous, and will be used for academic purposes only. The data generated in the course of the research will be retained in accordance with the University's policy of Academic Integrity and will be kept securely in paper and electronic form for a period of ten years after the completion of the research project. All electronic data collected from you will be stored on a security –code encrypted computer and memory stick to comply with the Data Protection Act.

What should I do if I want to take part
It would be much appreciated if you could give an early notice if you decide either to opt-in or to opt-out from this research to the principal investigator via email: **10018242@brookes.ac.uk or via mobile on +2348032889922**

What will happen to the results of the research study?
The results of this research will appear mainly in the thesis submitted for the degree of Doctor of Philosophy in Real Estate and Construction Oxford Brookes University. Part of the research will also be published in journals and conference papers. A copy of the result will be distributed to all participants upon approval from the university on request. If you would like to receive a summary report of the results of this research project please let the researcher know.

Who is organising and funding the research?

The researcher is conducting this research as a PhD study at Oxford Brookes University, Department of Real Estate and Construction, Oxford, United Kingdom. The researcher is supervised by Prof Joseph Tah and Dr Ramin Keivani at Oxford Brookes University. This research study is self-funded by the Principal Investigator.

Who has reviewed the study?
The research has been approved by the University Research Ethics Committee, Oxford Brookes University.

Contact for Further Information

Please do contact me by either calling me on: (Nigeria) or (UK) or emailing me at 10018242@brookes.ac.uk if you have any queries regarding the study. You can also contact my Director of Studies Professor Joseph Tah on +44 (0) 01865483409 or email him at jtah@brookes.ac.uk.

If you have any concerns about the way in which the study has been conducted, you should contact the Chair of the University Research Ethics Committee on ethics@brookes.ac.uk .

Thank you very much for taking time to read this information sheet!

Name of Principal Investigator - **Zaharaddeen Alkaleel Ahamad**

Date – 21st January 2013

Signature - **Zaharaddeen Alkaleel Ahamad**

Appendix (D): Consent Form

OXFORD BROOKES UNIVERSITY

CONSENT FORM

Full title of Project: The Utilization of Local Building Materials to Provide Offsite Prefabricated Components for Low Cost House building in Urban Nigeria

Name, position and contact address of Researcher:
Zaharaddeen Alkaleel Ahamad
PhD Research Student
Department of Real Estate and Construction
Gypsy lane, Headington Campus
Oxford Brookes University
Mobile:
E-mail- 10018242@brookes.ac.uk

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. ☐
3. I agree to take part in the above study. ☐

Please tick box

		Yes	No
4.	I agree to the interview being audio recorded.	☐	☐
5.	I agree to the use of anonymised quotes in publications.	☐	☐

________________ __________ ______________
Name of Participant   Date   Signature

Zaharaddeen Alkaleel Ahamad
Name of Researcher   Date   Signature

Appendix (E): Questionnaire

QUESTIONNAIRE TO COMPANIES, HOUSING INSTITUTES, ORGANIZATIONS & GOVERNMENT

The Utilization of Local Building Materials to Provide Offsite Prefabricated Components for Low Cost House building Provision in Urban Nigeria

Appendix A: Interviewer Administered Questionnaire

SECTION 1: About your Organization

a. Name of Company/Institution……………………………………………………..

b. What is the approximate number workforce? …………………………………..

c. Job Title………………………………………………………………………..

d. Majority of your company's/institutional work is carried out on…….base.

1. Nation ☐
2. Regional ☐
3. State ☐
4. Local ☐

e. How would you describe your organization? Please tick all that apply.

1. Construction or building company ☐
2. Prefabrication/Offsite manufacturing company ☐
3. Local building materials Suppliers ☐
4. Housing or building authority ☐
5. A private sector housing institute firm or agency ☐
6. A public sector housing institute, firm or agency ☐
7. A charity housing organization ☐

SECTION 2: **(Knowledge and Awareness) the extent to which prefabricated local building materials is utilized towards housing provision in Nigeria**

1. Please state which local building materials are generally used for house building in Nigeria.

2. Which of the following local building materials do you mostly utilize for prefabricated low cost house building? Please **rank** (from **1-5, low to high**) the following based on your usage? If you never used local building materials for prefabricated low cost house building please go to Question 3.

Timber	
Clay	
Bamboo	
Stones (moulded stones)	
Sand (Sandcrete elements)	
Earthen Elements (eg., Adobe)	
Other: please specify	

3. To what extent does your organization utilize local building materials for house building in Nigeria? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always)

1	2	3	4	5
Never	Rarely	Sometimes	Mostly	Always

4. To what extent does your organization utilize local building materials for prefabricated **low cost** house building in Nigeria? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always) If you never used local building materials for prefabricated low cost house building please go to Question 5.

1	2	3	4	5
Never	Rarely	Sometimes	Mostly	Always

5. To what extent does your organization utilize local building materials in prefabricated components for **general** house building in Nigeria? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always). If you never used

prefabricated local building materials for general house building please go to Question 6.

1	2	3	4	5
Never	Rarely	Sometimes	Mostly	Always

6. How often does your organization utilize the following local building material components towards **low cost** house building in Nigeria? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always) If you never used local building materials components for low cost house building please go to Question 7.

Timber Roof components	1	2	3	4	5
Timber frames	1	2	3	4	5
Timber panels	1	2	3	4	5
Timber floor elements	1	2	3	4	5
Clay Bricks	1	2	3	4	5
Adobe Wall	1	2	3	4	5
Bamboo roofing	1	2	3	4	5
Bamboo truss	1	2	3	4	5
Bamboo Beam/Column	1	2	3	4	5
Bamboo panels	1	2	3	4	5
Bamboo floors	1	2	3	4	5
Stone plate roof	1	2	3	4	5
Stones for wall	1	2	3	4	5
Stone for wall finishes	1	2	3	4	5
Stones for flooring	1	2	3	4	5
Sandcrete Blocks	1	2	3	4	5
Rammed earth wall	1	2	3	4	5
Others: Please specify	1	2	3	4	5
	1	2	3	4	5

7. How often does your organization utilize the following local building material components towards **general** house building in Nigeria? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always)

Timber Roof components	1	2	3	4	5

Timber frames	1	2	3	4	5
Timber panels	1	2	3	4	5
Timber floor elements	1	2	3	4	5
Clay Bricks	1	2	3	4	5
Adobe Wall	1	2	3	4	5
Bamboo roofing	1	2	3	4	5
Bamboo truss	1	2	3	4	5
Bamboo Beam/Column	1	2	3	4	5
Bamboo panels	1	2	3	4	5
Bamboo floors	1	2	3	4	5
Stone plate roof	1	2	3	4	5
Stones for wall	1	2	3	4	5
Stone for wall finishes	1	2	3	4	5
Stones for flooring	1	2	3	4	5
Sandcrete Blocks	1	2	3	4	5
Rammed earth wall	1	2	3	4	5
Others: Please specify	1	2	3	4	5
	1	2	3	4	5

8. How often does your organization use offsite-prefabricated techniques for house building in Nigeria? Please circle where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always). If you have never used prefabricated construction techniques for house building please go to **Question 9.**

1	2	3	4	5
Never	Rarely	Sometimes	Mostly	Always

9. Nigerian building industry uses more traditional methods of construction for low cost house building over offsite prefabrication techniques? Please **indicate** your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

10. Where prefabrication is utilized, local building materials are not utilized? Please **indicate** your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

11. In order to reduce the housing shortage in Nigeria, the building industry must increase the diffusion and utilization of the techniques of prefabricated local building materials for low cost house building provision? Please **indicate** your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

12. Please indicate your level of prefabricated construction techniques application in the following building industry sectors. Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always). If you have never used prefabricated construction techniques please go to Section 3.

Residential	1	2	3	4	5
Industrial	1	2	3	4	5
Commercial	1	2	3	4	5
Others please specify	1	2	3	4	5
	1	2	3	4	5

13. **General House Building**: How often does your company apply the following prefabricated components towards <u>house building</u> within the Nigerian building industry? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always)

Volumetric/Modular	1	2	3	4	5
Kitchen pods	1	2	3	4	5

Bathroom/Toilet pods	1	2	3	4	5
Pre-assembled roof	1	2	3	4	5
Interlocking Blocks	1	2	3	4	5
Interlocking Bricks	1	2	3	4	5
Internal Wall Panels	1	2	3	4	5
External Wall panels	1	2	3	4	5
Pre-assembled doors/windows	1	2	3	4	5
Timber cassette	1	2	3	4	5
Timber frame	1	2	3	4	5
Precast concrete frame	1	2	3	4	5
Traditional Structural steel frame	1	2	3	4	5
Light Steel frame	1	2	3	4	5
Pre-assembled drainage	1	2	3	4	5
Pre-assembly formwork	1	2	3	4	5
Offsite prefabricated foundation	1	2	3	4	5
Precast piles	1	2	3	4	5
Interlocking floors	1	2	3	4	5
Pre-assembly drainage and underground services	1	2	3	4	5
Prefabricated Stairs	1	2	3	4	5
Others (please specify)	1	2	3	4	5
	1	2	3	4	5

14. **Low cost House Building**: To what extent do you or your company often apply the following prefabricated components towards low cost house building? Please **circle** where appropriate (1=Never 2=Rarely 3=Some times 4=Mostly 5=Always) If you never used prefabricated building techniques for low cost building please go to **Question 15**

Volumetric/Modular	1	2	3	4	5
Kitchen pods	1	2	3	4	5
Bathroom/Toilet pods	1	2	3	4	5
Pre-assembled roof	1	2	3	4	5
Interlocking Blocks	1	2	3	4	5
Interlocking Bricks	1	2	3	4	5

Internal Wall Panels	1	2	3	4	5
External Wall panels	1	2	3	4	5
Pre-assembled doors/windows	1	2	3	4	5
Timber cassette	1	2	3	4	5
Timber frame	1	2	3	4	5
Precast concrete frame	1	2	3	4	5
Traditional Structural steel frame	1	2	3	4	5
Light Steel frame	1	2	3	4	5
Pre-assembled drainage	1	2	3	4	5
Pre-assembly formwork	1	2	3	4	5
Offsite prefabricated foundation	1	2	3	4	5
Precast piles	1	2	3	4	5
Interlocking floors	1	2	3	4	5
Pre-assembly drainage and underground services	1	2	3	4	5
Prefabricated Stairs	1	2	3	4	5
Others (please specify)	1	2	3	4	5
	1	2	3	4	5

15. To what extent are you satisfied with the use of prefabrication techniques for house building in Nigeria? Please **circle** the number that best represent your level of satisfaction? (1=Highly Unsatisfied 2=Unsatisfied 3=Neither Unsatisfied nor Satisfied 4=Satisfied 5=Highly satisfied) If you never used prefabricated building techniques for house building please go to Section 3.

Volumetric/Modular	1	2	3	4	5
Kitchen pods	1	2	3	4	5
Bathroom/Toilet pods	1	2	3	4	5
Pre-assembled roof	1	2	3	4	5
Interlocking Blocks	1	2	3	4	5
Interlocking Bricks	1	2	3	4	5
Internal Wall Panels	1	2	3	4	5
External Wall panels	1	2	3	4	5
Pre-assembled doors/windows	1	2	3	4	5
Timber cassette	1	2	3	4	5

Timber frame	1	2	3	4	5
Precast concrete frame	1	2	3	4	5
Traditional Structural steel frame	1	2	3	4	5
Light Steel frame	1	2	3	4	5
Pre-assembled drainage	1	2	3	4	5
Pre-assembly formwork	1	2	3	4	5
Offsite prefabricated foundation	1	2	3	4	5
Precast piles	1	2	3	4	5
Interlocking floors	1	2	3	4	5
Pre-assembly drainage and underground services	1	2	3	4	5
Prefabricated Stairs	1	2	3	4	5
Others (please specify)	1	2	3	4	5
	1	2	3	4	5

SECTION 3: (Persuasion) Factors that Influence the diffusion and utilization of prefabricated local building materials towards low cost house building

16. To what extent do you agree or disagree with the following statement? Please **circle** each statement based on your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

Prefabricated construction techniques are not consistent with the existing values of potential adopters in Nigeria	1	2	3	4	5
Prefabricated construction techniques are difficult to apply towards low cost house buildings compared to tradition methods	1	2	3	4	5
Prefabricated construction techniques are not consistent with the existing needs of potential adopters in Nigeria	1	2	3	4	5
Prefabricated construction techniques are not economically viable or achievable when utilized towards low cost house buildings	1	2	3	4	5
Prefabricated construction techniques are not as visible to the Nigerian populace as traditional methods	1	2	3	4	5
Traditional construction methods have more advantages economically and socially compared to prefabricated techniques	1	2	3	4	5
Others: Please specify	1	2	3	4	5

	1	2	3	4	5

17. **Enablers**: What are the factors that could drive you or your organization to utilize offsite prefabricated local building materials in low cost house building in Nigeria? Please **circle** each statement based on your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

Reduction of construction duration	1	2	3	4	5
Achieving high building quality	1	2	3	4	5
To reduce Environmental impact during construction	1	2	3	4	5
Compensation for the shortage of skilled workers	1	2	3	4	5
Minimizing health and safety risk	1	2	3	4	5
Adequate Government policies	1	2	3	4	5
Limited company policies	1	2	3	4	5
Reduction of construction cost	1	2	3	4	5
Time certainty	1	2	3	4	5
Revision to the building regulation	1	2	3	4	5
Energy saving	1	2	3	4	5
Improvement of your organization's standard and reputation	1	2	3	4	5
Promoting the diffusion of offsite prefabrication	1	2	3	4	5
Reduction of construction waste during construction	1	2	3	4	5
Control of working condition and reduce local impacts	1	2	3	4	5
Other reasons: please specify	1	2	3	4	5
	1	2	3	4	5

18. **Barriers**: What are the factors that restrain you or your organization from utilizing offsite prefabricated local building materials towards low cost house building in Nigeria? Please **circle** each statement base on your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

Site specifics and transport restraint	1	2	3	4	5

Increase in construction cost	1	2	3	4	5
Adequate Government policies	1	2	3	4	5
Limited company policies	1	2	3	4	5
Increase in design cost	1	2	3	4	5
Lack of motivation from actors within the Nigerian building industry	1	2	3	4	5
Lack of adequate knowledge and awareness of the construction techniques	1	2	3	4	5
Dishonesty (Corruption) within the Nigerian Building industry	1	2	3	4	5
Lack of enough factories that produces components	1	2	3	4	5
Attitude of public and house builders towards offsite prefabrication	1	2	3	4	5
Limited design option	1	2	3	4	5
Inability to make changes	1	2	3	4	5
Previous negative perception of historical context from other industries	1	2	3	4	5
Lack of building policy that supports the use of prefabrication techniques	1	2	3	4	5
Other reasons: please specify	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

SECTION 4: (Decision) The potential for the utilization and diffusion of local building materials for prefabricated low cost house building in Nigeria

19. Low cost house building using prefabricated local materials has the potential to become a dominant method of building in Nigeria? Please **indicate** your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

20. What do you think might influence people to adopt and utilize prefabricated local building materials towards low cost house building? Please **indicate** your level of

agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

Prefabricated local building materials components are cheaper compared to Imported prefabricated building materials components	1	2	3	4	5
Prefabricated local building materials are more environmentally friendly compared to Prefabricated imported building materials	1	2	3	4	5
High availability of local building materials in comparison to imported materials	1	2	3	4	5
Availability of the prefabrication companies depends solely on local available raw materials	1	2	3	4	5
Successful examples of applications in the Nigerian building industries	1	2	3	4	5
Others: please specify	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

21. What do you think are the reasons why people do not adopt or utilize prefabricated local building materials towards low cost housing provision? Please **indicate** your level of agreement or disagreement? (1=Strongly Disagree 2=Disagree 3=Neither Disagree nor Agree 4=Agree 5=Strongly Agree)

Lack of codes of practice and Proper building standards for prefabricated local building materials	1	2	3	4	5
Lack of proper knowledge of prefabricated local building materials within the building industry of Nigeria	1	2	3	4	5
Construction industry inability to encourage the diffusion and utilization of local building materials for offsite prefabricated techniques	1	2	3	4	5
Dishonesty (Corruption) within the Building industry has prevented the diffusion of prefabricated local building materials for low cost house building	1	2	3	4	5

Incompatibility of prefabricated local building materials to the existing values of potentials adopters	1	2	3	4	5
Incompatibility of prefabricated local building materials to the existing needs of potentials adopters	1	2	3	4	5
Others: please specify	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

22. Which of the following local building materials components offers the greatest potential towards the application of offsite prefabricated low cost house building in Nigeria? Please **circle** (from **1-5, low to high**) in the grid below.

Timber Roof components	1	2	3	4	5
Timber frames	1	2	3	4	5
Timber panels	1	2	3	4	5
Timber floor elements	1	2	3	4	5
Clay Bricks	1	2	3	4	5
Adobe Wall	1	2	3	4	5
Bamboo roofing	1	2	3	4	5
Bamboo truss	1	2	3	4	5
Bamboo Beam/Column	1	2	3	4	5
Bamboo panels	1	2	3	4	5
Bamboo floors	1	2	3	4	5
Stone plate roof	1	2	3	4	5
Stones for wall	1	2	3	4	5
Stone for wall finishes	1	2	3	4	5
Stones for flooring	1	2	3	4	5
Sandcrete Blocks	1	2	3	4	5
Rammed earth wall	1	2	3	4	5
Others: Please specify	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

23. Which of the following prefabricated components offers the greatest potential towards the provision of low cost house building in Nigeria? Please **circle** (from **1-5, low to high**) in the grid below.

Volumetric/Modular	1	2	3	4	5
Kitchen pods	1	2	3	4	5
Bathroom/Toilet pods	1	2	3	4	5
Pre-assembled roof	1	2	3	4	5
Interlocking Blocks	1	2	3	4	5
Interlocking Bricks	1	2	3	4	5
Internal Wall Panels	1	2	3	4	5
External Wall panels	1	2	3	4	5
Pre-assembled doors/windows	1	2	3	4	5
Timber cassette	1	2	3	4	5
Timber frame	1	2	3	4	5
Precast concrete frame	1	2	3	4	5
Traditional Structural steel frame	1	2	3	4	5
Light Steel frame	1	2	3	4	5
Pre-assembled drainage	1	2	3	4	5
Pre-assembly formwork	1	2	3	4	5
Offsite prefabricated foundation	1	2	3	4	5
Precast piles	1	2	3	4	5
Interlocking floors	1	2	3	4	5
Pre-assembly drainage and underground services	1	2	3	4	5
Prefabricated Stairs	1	2	3	4	5
Others (please specify)	1	2	3	4	5
	1	2	3	4	5

24. To what extent do the following factors influence your decision to utilize the following local building materials for prefabricated house building in Nigeria? Please **circle** the level of influence (1-5) in the grid below?

Timber	Very low	Low	Medium	High	Very High
Cost Saving	1	2	3	4	5
Quality	1	2	3	4	5

Timesaving	1	2	3	4	5
Availability	1	2	3	4	5
Ease of use	1	2	3	4	5
Social Acceptability	1	2	3	4	5
Others: please specify					
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
Clay					
Cost Saving	1	2	3	4	5
Quality	1	2	3	4	5
Timesaving	1	2	3	4	5
Availability	1	2	3	4	5
Ease of use	1	2	3	4	5
Social Acceptability	1	2	3	4	5
Others: please specify					
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
Bamboo					
Cost Saving	1	2	3	4	5
Quality	1	2	3	4	5
TimeSaving	1	2	3	4	5
Availability	1	2	3	4	5
Ease of use	1	2	3	4	5
Social Acceptability	1	2	3	4	5
Others: please specify					
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
Stones (molded stones)					
Cost Saving	1	2	3	4	5
Quality	1	2	3	4	5
Timesaving	1	2	3	4	5
Availability	1	2	3	4	5
Ease of use	1	2	3	4	5
Social Acceptability	1	2	3	4	5
Others: please specify					
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

Sand (Sandcrete elements)					
Cost Saving	1	2	3	4	5
Quality	1	2	3	4	5
Timesaving	1	2	3	4	5
Availability	1	2	3	4	5
Ease of use	1	2	3	4	5
Social Acceptability	1	2	3	4	5
Other: please specify					
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
Earthen Elements					
Cost Saving	1	2	3	4	5
Quality	1	2	3	4	5
Timesaving	1	2	3	4	5
Availability	1	2	3	4	5
Ease of use	1	2	3	4	5
Social Acceptability	1	2	3	4	5
Other: please specify	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

25. Please provide any information that you think might be relevant to this research?

…………………………………………………………………………………………

……………………………………………………………………………………..

…………………………………………………………………………………………

……………………………………………………………………………………..

26. Please fill in the details below if you are happy to participate in an in-depth interview? (The interview will be audio recorded)

Please provide your contact number here…………………………… so I can call and arrange for interview.

THANK YOU FOR YOUR CO-OPERATION

Appendix (F): Research Interview Questions

Knowledge

1. Are you aware of offsite prefabrication methods construction?

2. Do you or your organization use offsite prefabrication methods of construction towards low cost housing delivery? Any reason why?

3. How often are local building materials used for prefabricated components towards house building provision in Nigeria? Why?

4. Are prefabricated local building materials used towards low cost house building in Nigeria? Any reasons why?

5. Which among the prefabricated building materials (prefabrication using local building materials or prefabrication using imported building materials) are mostly utilized towards housing delivery in Nigeria? Any reasons why?

6. Which type of offsite-prefabricated construction techniques do you mostly use within the Nigeria building industry? High technology (such as Volumetric and Pods); medium technology (such as panels, frames, precast elements); low technology (such as pre-assembled doors, windows, pre-assembled drainage element and pre-assembled roof components)? Why?

Drivers and Barriers

7. What are the major factors that would influence your decision to utilize prefabricated local building materials towards low cost house buildings provision in Nigeria?

8. What are the major reasons that would restrain your decision to utilize prefabricated local building materials towards low cost house buildings provision in Nigeria?

9. Are prefabricated methods of construction using local building materials consistent with the existing values and needs of the Nigerian citizens? Any reasons why?

10. Would factors such as visibility and viability affect your decision to use prefabricated local building materials for low cost house building provision in Nigeria? how?

11. Does corruption affect the utilization of local building materials for prefabricated components for low cost house building delivery within the building sector? If Yes, how and why? If No, Any reasons why you think it doesn't?

Promotion

12. Have you or your organization promoted the use of prefabricated local building materials towards low cost house buildings provision before? Are there any reasons why?

13. Do you think there will be a cost savings when prefabricated local building materials are utilized for house building over the conventional prefabricated imported materials? how?

14. Which among the local building materials utilize within building industry of Nigeria do you think could offer a greater potential towards offsite prefabricated low cost house buildings provision? Why?

15. Are there any strong policies set out by the government to encourage the higher utilization of local building materials for offsite prefabricated low cost house buildings in Nigeria? If yes what are the objectives behind the policies. If No, is there any reasons why there are no policies to support these techniques of construction?

16. What do you forecast to be the future of prefabrication construction techniques using local building materials in Nigeria? do you think it will increase or diminish? Any reasons why?

17. How could the adoption and utilization of prefabricated techniques of construction using local building materials be improved especially towards the provision of house buildings for all?

Appendix (G): Summary of Responses of the Qualitative Interview

Interview Questions and Answers with the Sixteen Respondents

Table 1: *Interview Question 1. Are you aware of offsite prefabrication methods of construction?*

All of the respondents interviewed (100%) are aware of prefabricated methods of construction.

Table 2: Interview Question 2. Do you or your organization use offsite prefabrication methods of construction towards low cost housing delivery?

1. *"When you are talking of offsite prefabrication methods of construction we have the low technology, medium technology and the high technology. Well to the extent of the low technology, we do use, because we are a small growing firm and we do use the low-tech prefabrication methods of construction in providing low cost housing delivery. The major ones we use are imported. They are prefabricated materials but imported and that makes it expensive*"

2. "*Yes. We use prefabrication construction techniques, mostly expanded polystyrene components. We use them in general house building not just low cost".* Any reason why*? "To deliver affordable low cost house buildings in Nigeria*".

3. *"No, we do not use prefabrication construction techniques".* Any reason why? *"Because, we are small scale company".*

4. *"Yes. We use prefabrication construction techniques".* Any reason why? *"It is efficient, saves construction time and less use of human resource".*

5. "*Yes. We use prefabrication construction techniques".* Any reason why? *"It is cost effective, it saves time and It is idle for mass housing".*

6. *"Yes. We use prefabrication construction techniques".* Any reason why? *"To speed up construction, to reduce cost, to produce component under controlled and better condition".*

7. *"Yes. We use prefabrication construction techniques".* Any reason why? *"Time saving, degree of accuracy and usually client specification".*

8. "*Only few elements are used recently; Because of reasons such as high cost,*

lack of prefabricators, finance and the availability of technology".

9. *"No, we don't use prefabricated components, but we will go into it in the future".* Any reason why? *"Few numbers of prefabricated factories in the country, small amount of housing contracts are usually awarded in the country, high initial capital cost is required to go into prefabrication and use of heavy machineries".*

10. *"Yes. We use prefabrication construction techniques".* Any reason why? *"We use prefabrication when there is no enough space on site, because of the quality of factory made product, to maintain uniformity where mass house buildings are needed, to avoid nuisance to site neighbours, to speed up construction, to reduce cost and to save time".*

11. *"No, we don't use prefabrication for low cost house building delivery".* Any reason why? *"They are not cost effective for low cost house building project. Where we used prefabricated components, they are an imported prefabricated building material which is expensive".*

12. *"Yes. We use prefabrication construction techniques, but not in a very large scale because it is not generally accepted in Nigeria. We use prefabricated materials to bring down cost".*

13. *"We only use prefabrication materials if it is a design and build project. Otherwise we only act as consultants".*

14. *"Yes. We use prefabrication construction techniques, but not much".* Any reason why? *"We only use it when clients specified it".*

15. *"We don't use prefabricated components".* Any reason why? *"Lack of qualified personnel to work with the components and because it is expensive".*

16. *"Yes. We use prefabrication construction techniques".* Any reason why? *"Because it is cost effective and it speed up construction".*

Table 3: Interview Question 3. How often are local building materials used for prefabricated components towards house building provision in Nigeria?

1. "*Not very often".* Any Reason Why? *"Prefabricated local building materials are not readily available. The only ones you find are low technology such as blocks and roofing sheets. Most of the ones use in the country is imported prefabricated building materials".*

2. "*Prefabricated local building materials are used in Nigeria especially the expanded polystyrene components".* Any Reason Why? *"Prefabricated local building materials are cost effective, easy to handle and offers good finishes".*

3. "*The low technology is fairly used. But prefabrication as a building process, as a system, as a building system honestly, yes it is been appreciated but its level of usage is frankly low, may be less than 25%".* Any Reason Why? *"People perception cannot be changed overnight. it is not easy to abandon the traditional methods of construction. The level of the technology is not advanced and the infrastructural development is not there. Regular power and water supply must be in place in order to go into prefabrication".*

4. "*They are quite fairly used, especially the low technology such as roof components and blocks. Because they are made locally by the local artisans and it save time".*

5. "*Prefabricated local building materials are not used very often. The technology is not at an advanced stage*".

6. "*Prefabricated local building materials are highly used in Nigeria. In fact there is no house that will be built without at least 50% of local building materials content. Therefore it is highly used because most of the building materials are readily available*".

7. "*It is used very often".* Any Reason Why? *"Prefabricated components offer accurate result in terms of measurement and strength because of its quality and it saves construction time*".

8. "*Prefabricated local building materials are not used very often, especially the low technology".* Any Reason Why? *"It is cost effective and readily available".*

9. "*Prefabricated local building materials are not used too often in Nigeria".* Any Reason Why? *"High importation of prefabricated building materials affects the realization of locally produced prefabricated materials. Prefabricated construction techniques require heavy plants and equipment's".*

10. "*It is used quite often, depending on the kind of building project we do".* Any Reason Why? *"Prefabricated local building materials are used quite often to be able to achieve profit without compromising quality and to save construction time".*

11. "*The use of prefabricated local building materials in Nigeria is very minimal".* Any Reason Why? *"People are used to prefabricated imported building materials and they are not aware of the locally produced ones*".

12. *"Prefabricated techniques of construction are not generally accepted in Nigeria. People are used to the traditional methods of construction and no one cares to research on how local building materials can be used to produce prefabricated components".*

13. "*We hardly use prefabricated construction techniques because we are small scale company*".

14. *"It is highly used in Nigeria"*. Any Reason Why? *"The prefabricated local building materials are locally sourced"*.

15. "*There is an insignificant use of prefabricated local building materials in Nigeria. The components are mostly imported and the components that are produced locally are very expensive*".

16. "*Prefabricated local building material is quite fairly used in Nigeria, especially the expanded polystyrene. We use them for most of our buildings because they are versatile*".

Table 4: Interview Question 4. Are prefabricated local building materials used towards low cost house building in Nigeria?

1. "*Prefabricated local building materials are used for low cost house buildings but to a very little". Any Reason Why? "It is readily available and it is cost effective compared to prefabricated imported materials".*

2. *"Prefabricated local building materials are used for low cost house buildings in Nigeria". Any Reason Why? "It is low cost and saves construction time".*

3. "*Prefabricated local building materials are used for low cost house buildings in Nigeria". Any Reason Why? "NNPC estates in Kaduna, Worri, and Port Harcourt they did a lot of prefabricated structures. Even in the early 1970's a lot of university units were prefabricated, in Kaduna ABU teaching hospital, professorial quarters in ABU Zaria were all prefabricated. Then we had prefabricated structures in (UPE) Universal Primary Education Scheme 1976 during Obasanjo's tenure, they had a lot of prefabricated classrooms all over the country. But I don't know why these days the traditional methods are preferred. Crème Etalo in Minna the first set of houses that were built immediately after the creation of Niger state, Crema etalo was all prefabricated units fully*".

4. "*Prefabricated local building materials are used for low cost house buildings in Nigeria, but mostly just the low technology*".

5. "*Prefabricated local building materials are used for low cost house buildings in Nigeria, but the level of awareness is still low". Any Reason Why? "Lack of awareness and corruption might be there as well".*

6. "*We are talking about affordability of housing, been able to bring down the cost of housing. Now a typical house in Nigeria, say 60% of the cost comes from building materials and 40% comes from labour, when you use prefabricated local building materials because of the technology that is involve you speed up the process. What 10 men will do, with the aid of machinery one man would do, so when you prefabricate, you are able to bring down the labour content, or if you look at that 40% content for instance, with*

prefabrication you can bring it down to 20%. And when you look at the speed of construction with the aid of machinery you can produce blocks much faster".

7. "*Prefabricated local building materials are used for low cost house buildings in Nigeria*".
8. "*Prefabricated local building materials are used for low cost house buildings in Nigeria*". *Any Reason Why?* "*It is readily available and it is cheaper*".
9. "*Prefabricated local building materials are used for low cost house buildings in Nigeria, because it offers high quality buildings and speed up construction*".
10. "*Prefabricated local building materials are used for low cost house buildings in Nigeria*". *Any Reason Why?* "*Because you can have nominal items adopted. Standard is monitored when prefabricated local materials are used. Construction time is reduced. It maximizes profit and still retains quality*".
11. "*Prefabricated local building materials are used for low cost house buildings in Nigeria. It is used to serve the purpose where awareness is high*".
12. "*Prefabricated local building materials are used for low cost house buildings in Nigeria, because they can be used to achieve low cost house buildings. They are easy to work with and they are usually materials you can pick up and use*".
13. "*Prefabricated local building materials are used for low cost house buildings in Nigeria*". *Any Reason Why?* "*It is cost effective and speed up construction process*".
14. "*Prefabricated local building materials are used for low cost house buildings in Nigeria*". *Any Reason Why?* "*Prefabricated local building materials speed up construction and saves time*".
15. "*For low cost house buildings prefabrication construction techniques are not even an option. Prefabricated components are expensive*".
16. "*Prefabricated local building materials are used for low cost house buildings in Nigeria*".

Table 5: Interview Question 5. Which among the prefabrication building materials are mostly utilize towards house building delivery in Nigeria; is it prefabrication using local building materials? or prefabrication using imported building material?

1. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials*". Any Reason Why? "*Most of the Nigerian populace are considered low income earners, so they go for the locally produced components because it is cheaper and*

available".

2. "*Both prefabricated local and imported building materials are used within the building industry of Nigeria*".

3. "*Basic prefabricated building materials are produced locally, but the sophisticated components are mostly imported. It is expensive to import the basic materials, so the only materials that are imported are mostly the fittings and finishes*".

4. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials".* Any Reason Why? *"Prefabricated locally produced components are readily available and most of the technology that is involved is low technology*".

5. "*Prefabricated imported materials are more dominant in the market".* Any Reason Why? *"The Nigerian government does not encourage the use of local building materials for prefabricated components. The foreign companies that set up the prefabricated factories in Nigeria do not aim at producing the components towards low cost*".

6. "*Most of the prefabricated materials used today in Nigeria are produced locally, because many people are now setting up their own local prefabricated factories*".

7. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials".* Any Reasons Why? *"It is accessible, it is cheap and it is easier to specify what you want*".

8. "*Prefabricated imported building materials are mostly utilized within the building industry of Nigeria. The locally made ones are not up to standard, the components are not readily available and the quality is poor*".

9. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials. The local prefabricated components are readily available*".

10. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials. Imported prefabricated components are only used when they are needed*".

11. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials. We use them mostly for low cost house building*".

12. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials. Local prefabricated components are mostly used because local building materials are readily available*".

13. "*Prefabricated local building materials are more utilized within the Nigerian building industry than the prefabricated imported materials".* Any Reason Why? *"Standard can be monitored because the materials are produced in local factories*".

14. "*Prefabricated local building materials are more used within the Nigerian building industry than the prefabricated imported materials".* Any Reason Why? *"Prefabricated local building materials are more utilize within the building industry of Nigeria because they are readily available*".

15. "*Prefabricated imported building materials are more used within the Nigerian building industry than the prefabricated local materials. The technology is still not highly acknowledged within the building industry of Nigeria. Therefore, imported materials are mostly used for house building delivery*".

16. "*Prefabricated local building materials are more used within the Nigerian building industry than the prefabricated imported materials".* Any Reason Why? "*The reasons are embedded in the question, cost, before you import something from UK, US, India, China or wherever, it will include the purchase, the freights, and the clearance and then moving to site compared to something that is produced at the nearest town. The cost of freights from that place to your site will be far cheaper. So in terms of cost, in terms of delivery when you put a cargo on the water it will take one or two months, but if you go to the nearest town you can easily get the materials you want to use in your site and get it to site faster*".

Table 6: Interview Question 6. Which type of offsite prefabricated construction techniques do you mostly use within the Nigerian building industry? High technology (such as volumetric and pods), medium technology (such as panels, frames, pre cast elements), low technology (such as pre-assembled doors, windows, drainage, roof components)?

1. "*The low technology prefabricated techniques of construction is mostly used within the building sector of Nigeria".* Why? *"It does not require large amount of fund to go into and the components are readily available*".

2. "*The low and medium technology prefabricated techniques of construction is mostly used within the building sector of Nigeria. The components are easy to work with. High technology requires heavy lifting's which is expensive*".

3. "*It depends on the region. The low technology is mostly utilized, but at the urban areas the medium and low technology competes with the low technology*".

4. "*The low technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*The low technology is idle with low cost house buildings. The labour force mostly consists of the local labourers and you don't need any special skill*".

5. "*The low and medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*There is more demand in the market for medium and low technology*".

6. "*The low technology prefabricated techniques of construction is mostly used within the building sector of Nigeria. Medium and high technology requires the use of many types of machinery. People prefer to use the low technology because it is not complex compared to others*".

7. "*The medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*Because it is easily adoptable and does not require technical expertise. It is more common than the high technology and it is accessible*".

8. "*The low technology prefabrication technique of construction is mostly used within the building sector of Nigeria". Why? "The resources to go for medium and high technology are not there*".

9. "*The low and medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*The level of prefabricated technology is still low in Nigeria. The low and medium technology does not require heavy lifting. Since it is produced locally it creates jobs for the local artisans and it is more popular compared to the high technology*".

10. "*The medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*When you take an average of the entire prefabricated techniques of construction used in Nigeria, you will find out that it is the medium technology that is mostly use within the building industry. It does not require heavy transportation compared to the high technology*".

11. "*The low and medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria". Why? "The low and medium technology is more used because people are more aware and understand the low and medium technology compared to high technology*".

12. "*The medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*The high technology requires heavy lifting and it is expensive. The medium and smaller companies are the majority and can only afford the medium and low technology*".

13. "*The medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*The medium and low scale companies do not have the facilities and manpower to use the high technology*".

14. "*The low and medium technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*The high*

technology requires special skills and in terms of providing the low cost housing we want to minimize the importation of skills and use the local labour. And when we talk of high technology we have to think about precision as well. But for the medium and low technology the precision is been taken care of. You just put up your block or bricks and use mortar to bind them together or just lock the interlocking materials together without thinking about so much precision like the high technology".

15. "*The low technology prefabrication technique of construction is mostly used within the building sector of Nigeria*". Why? "*The medium and high technology requires heavy lifting and machineries. The high technology is mostly attributed to high cost*".

16. "*In terms of volumetric and pods we don't use it more often, because of the technical knowhow, the cost of equipment, the complexity of the structure, the cost of the technology itself and accessibility and low demand for the component. In terms of medium technology, that one is widely used and is under which this company falls, the use of panels, frames etc. our walls are made of Expanded Polystyrene (EPS), and so it falls within the medium. We also produce doors and windows here, which is the low technology and we have many other companies that do the same, so in Nigeria, I can say that the medium and low technology prefabrication is more used in the level we are now*".

Table 7: Interview Question 7. What are the major reasons that would influence your decision to utilise prefabricated local building materials towards low cost house building provision in Nigeria?

1. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria are mostly client specification, low cost and it must be acceptable by the client*".

2. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria include; improvement of local technological capabilities within the building sector and other sectors*".

3. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria include; Good contract agreement, good infrastructure and large number of units to be delivered*".

4. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Availability of skilled personnel to do the job, availability of locally sourced materials, simplicity of project and quality*".

5. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Affordability, time savings and speed of construction*".

6. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria include; Time savings, speed of construction, distance from factory to site, low cost and quantity of houses to be build*".

7. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Availability of technology and low cost*".

8. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Availability of high quality materials at an affordable cost, ease of access and low cost*".

9. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Quality, efficiency and ability to mass produce*".

10. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria include; Accessibility, availability of technology, eases of use and cost effectiveness*".

11. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria include; it is cheaper, it saves time and ease of use*".

12. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; low cost, time saving, technical requirement and personnel*".

13. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Time saving, cost saving and personnel to execute the project*".

14. "*Factors that influence my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Quantity of units to be delivered, closeness of factory to site and infrastructure*".

15. "*Prefabricated local building materials are not mostly used in Nigeria. We mostly used the prefabricated imported materials. The prefabricated local building materials we used are mostly the Hydro foam which is produced using clay. We use hydro foam because it is cheaper*".

16. "*You want to talk of speed when you are talking about the provision of low cost housing for populace, people want to seen in time what you deliver for*

them. So speed of construction is what will make me use these methods and that's what we are into, it also gives us the opportunity to use less labour for more work. A house that we are going to use 20people to lay blocks over a month, we can use 4people to complete within two weeks using prefabrication, so when you compare the two you will see that it's of advantage in terms of speed and reduction of construction cost".

Table 8: Interview Question 8. What are the major reasons that would restrain your decision to utilise prefabricated local building materials towards low cost house building provision in Nigeria?

1. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; If it is not functional compared to alternatives, high cost and if it is not durable quality wise".*

2. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; if the building materials are not available and lack of good government policies on prefabricated local building materials".*

3. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Lack infrastructural facilities such as electricity and water supply".*

4. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Inability to interpret the technology locally, if i am to hire professional to do the job then i will reject it, if the manpower is not there".*

5. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria is high cost".*

6. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; when less number of houses are to be build and when the prefabrication factory is not close to the site".*

7. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery is when the project involves larger components that requires machineries to lift".*

8. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; high cost, if it is not easily accessible and complexity of technology".*

9. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria is, it is not flexible in terms of expansion".*

10. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria is Quality".*

11. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria are if the technological requirement is not there and if it is not giving the required result".*

12. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; High cost and if the project cannot be covered on time".*

13. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria include; High cost and lack qualified of technician to do the job".*

14. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria includes; Low quantity of units to be delivered and if it is not profitable".*

15. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria are precision. Prefabricated techniques require a high degree of precision".*

16. *"Factors that would restrain my decision to use prefabricated local building materials towards low cost house buildings delivery in Nigeria is, where i can build less number of houses i will not go for prefabricated techniques because of cost".*

Table 9: Interview Question 9. Are prefabricated methods of construction using local building materials consistent with the existing values and needs of the Nigerian citizens?

1. *"Majority of average Nigerians are classified as low income earners and prefabricated techniques of construction is expensive and far beyond an average citizen. Therefore, it is out of the average Nigerian needs. In terms of values, it is well within their values".*

2. *"Prefabricated local building materials are consistent with the values and needs of Nigerians. In terms of values and needs, the prefabricated techniques of construction have no limitation. You have a plan and your design, you design them base on your values and needs. Our system is like an abacus system A,B,C, if you employ it, you now have your shelter according to your values and needs".*

3. *"Prefabricated local building materials are consistent with the values and needs of Nigerians. Housing is a need and prefabrication is one way of delivering those houses".*

4. *"Prefabricated local building materials are consistent with the values and needs of Nigerians. An average Nigerian is not interested in substandard housing; if it is standard they will go for it. So I know one of the advantages of using prefabricated methods of construction is to be able to finish your house with high standard and specification. For you to be able to achieve better than what you usually achieve using traditional methods. Everybody will be interested in that especially when it is cheaper compared to traditional methods of construction, so the bottom line is quality and affordability; it is not in variance with the needs and values of Nigerians".*

5. *"Prefabricated local building materials are consistent with the values and needs of Nigerians. The low technology prefabricated local building materials has been in use for a very long time and it is used to deliver affordable houses. Therefore it is consistent with the Nigerian values and needs".*

6. *"Prefabricated local building materials are consistent with the values and needs of Nigerians.* Because, *when you look from the perspective of needs, there is need for housing. I have also mentioned a moment ago that the shortfall in housing delivery in Nigeria is about 16million, so to be able to meet these needs we must look at methods and ways to fast tract the process of meeting the needs".*

7. *"Prefabricated local building materials are not really consistent with the values and needs of Nigerians. Construction industry is the major employer of labour in Nigeria and prefabrication reduce the number of jobs within the construction industry. The fact that prefabrication takes off some number of artisans from the site, that I don't think it will be welcome in our local context here. If you are talking about the needs, yes. Because we are talking about houses that meet the minimum standard, yes that will help if we put it in that context but in the converse you will find out that it is actually a conflict".*

8. *"Prefabricated local building materials are consistent with the values and needs of Nigerians. All what Nigerians need is a house. Since it is available locally then it is consistent".*

9. *"No because it is going to take a way jobs".* And *"Yes, because Nigeria has a shortfall of about 16 million houses. There is the need to produce a lot of efficient house buildings within a short period of time. Therefore, prefabricated techniques of construction have the potential to house teeming population of the country".*

10. *"Prefabricated local building materials are consistent with the values and needs of Nigerians". Why? "Prefabricated local building materials are used in Nigeria to a certain degree. However, people believe in it more".*

11. *"Prefabricated local building materials are not consistent with the values and needs of Nigerians".* Why? *I can't think of any reason".*

12. *"Prefabricated local building materials are not consistent with the values and*

needs of Nigerians. Because not many Nigerians are aware of the technology and people prefer to stick to what they know best. Many Nigerians prefer imported prefabricated building materials than the locally produced ones".

13. *"Prefabricated local building materials are not consistent with the values and needs of Nigerians".* Why? *"The Nigerian culture doesn't like changes we are use to the traditional system of blocks and timber, Nigerians do not have the knowledge of this prefabricated methods, it is new to them and they don't like change".*

14. *"Prefabricated local building materials are consistent with the values and needs of Nigerian citizens. But mostly the low technology, because people are becoming more use to it".*

15. *"The proper prefabrication meets and exceeds whatever standard we have but they are not affordable"*

16. *"Prefabricated local building materials are consistent with the values and needs of Nigerians".* Why? *"It is something that is welcome by the community. The only hitch we are having is lack of awareness from the faraway local community, but it is a hurdle that will be overcome by time. At the rate at which the Nigerian population is growing, I think our best bet will be to use prefabricated local building materials such as EPS".*

Table 10: Interview Question 10. Would factors such as visibility and viability affect your decision to use prefabricated local building materials for low cost house building provision in Nigeria?

1. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. Successful application of these techniques of construction within the building industry will definitely influence it uptake. If they are cheap and within my client's budget, yes it will affect my decision definitely, positively*".

2. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. How? Visibility and viability are among factors that help you sustain a healthy business. Therefore it has to be visible and viable*".

3. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. But Nigerian problem is beyond mathematics because corruption influences a lot of things*".

4. "*Visibility and viability will not influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. Our company is interested in these techniques of construction. The only problem we faced is, for prefabrication to be cost effective it has to be applied in multiple units. If we don't have multiple units we will not employ it. So it is not*

the matter of visibility or viability for this form of construction".

5. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. If the techniques of construction won't stand the test of time, i will definitely reject it. It has to be low cost and beautiful visually, and people will appreciate it more*".

6. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria.* A*nybody who goes into the building practice is not for charity; you are into business to make profit or to make that business sustainable. If a particular project is not visible I will not venture it, if it not viable I will not venture it, if you have to use prefabrication construction on a project and your check reveals it is not viable it will be foolishness to go ahead with it*".

7. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria*". How? "*It has to be viable economically and the more these techniques of building are visible, it will not only increase the uptake but it will also improve our company's reputation*".

8. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. Off course an average Nigerian want something beautiful. From the contractor's point of view, little profit is all that we need. Therefore, it has to be viable profit wise and beautiful visually as well*".

9. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria*". How? "*It has to be viable in terms of all the benefits needed to provide a decent house. It has to look appealing visually as well*".

10. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. When you see it more you will like to use it more. It is what people see that entice them to use and to some extent it is viable too because ones you are sure that you have continues and repeated patronage as a businessperson, it makes your business viable*"

11. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. The more people use it and it serves the purpose, it will definitely influence me to use it more*".

12. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria*". How? "*Visibility and viability are among the key factors to be considered when starting up a business. So even in terms of adopting prefabrication it is going to be a major stand on our decision making*".

13. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria*". How? *"If i am certain about the quality and cost effectiveness of prefabricated local building materials, off course it will influence me to use it more*".

14. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. If government can encourage the use of prefabricated local building materials and use it on their projects it will definitely encourage me to use it more*".

15. "*Visibility and viability would definitely influence my decision to use prefabricated local building materials for low cost house building provision in Nigeria. It is been established that these techniques of construction is not affordable. The visual impact is undeniable and it is used by many companies, but it is not viable because of the cost*".

16. "*Yes. It is the best bet in areas where there is high awareness, but people often ask the question to whether the techniques of construction are viable or not*".

Table 11: Interview Question 11. Does corruption affect the utilisation of local building materials for prefabricated components towards low cost house building delivery within the Nigerian building sector? If yes, how and why? If no any reason why you think it doesn't?

1. "*Corruption definitely is a factor and a strong one in our society here. Because prefabrication involves some level of technology and the technology available to us here is the low tech, but the few big firms in Nigeria use the higher technology and it is with this big firms that our government officials can siphon funds. Because they are going to import basically everything from abroad where we can't confirm what price the materials or equipment was procured, and what duties were paid and all that. We can't really do a comprehensive check up on their prices as they are imported and for every contract giving to all these big firms, all this government officials have their percentages, they have their stakes in them. So it is only through these big companies that they can siphon fund, they can get paid for gratified so to speak. So they have not really encouraged us the smaller companies available, they have not encouraged the growth and the use of local prefabricated building materials*".

2. "*Corruption has a very big effect in the building industry. Corruption affect the use of prefabricated local building materials in Nigeria because of the bottlenecks involve in getting approval to set up your own company. You have to pay a lot of unnecessary dues for you to set up a company. The infrastructural facilities are not available. You need your own generator to run a business*".

3. "*Corruption affects every facade of the Nigerian economy not just the building industry. Even for you to get approval for basic infrastructural facilities, one needs to pay beyond the official fees*".

4. "*No, it does not. The choice to use any sort of construction techniques depends on the client needs and the designer's guidance. I would say yes, because corruption is a general phenomenon in Nigeria. For example if iron rods are been imported from abroad the prices can be change before arriving into the country. But these are situations outside ones problem, so it will be naïve to say that corruption does not affect the system indirectly*".

5. "*Corruption affects everything in Nigeria, including low cost housing delivery and prefabrication. Sometimes you have to pay few people to get a contract and at the end it affects the entire concept of prefabricated low cost house building. Corruption affects investors from coming into the country to start up prefabricated company*".

6. "*It does. Some people do temper with the quality of building materials. For example one bag of cement should produce at least 35 blocks, but due to the level of corruption people produce up to 70blocks*".

7. "*Yes it does. Corruption do happen onsite where materials leads to wastage or theft. Some developers don't like prefabrication techniques because everything is purchase according to exact specification*".

8. "*No it doesn't. The issue of corruption within the building industry is highly exaggerated. What affect projects are usually design and cost not corruption. Because when they were not able to implement the design by not understanding it properly or fund the project to completion there are usually delays*".

9. "*No it doesn't. Something at infancy level, something that is hardly even pronounce, so for you to judge if corruption is affecting it or not is premature, wait till when the industry pick up and is in big move then you could see whether there is corruption*".

10. "*Corruption does affect the use of local building materials for prefabricated low cost house building delivery in Nigeria. Because of the level of corruption, some retailers tempers with the standard of the building materials before selling it to the building companies. Let's take cement for instance; some people mix it up with other substance to reduce the quantity. By doing so, they end up reducing the quality of the cement as well*".

11. "*Corruption does affect the use of local building materials for prefabricated low cost house building delivery in Nigeria. The inflation of prices for local prefabricated materials is also an issue. Due to the level of corruption, the government does not monitor the high inflation of building materials which at end affects the entire concept of low cost house buildings in the country*".

12. "*Corruption does not affect the use of local building materials for*

prefabricated low cost house building delivery in Nigeria. Because the utilization of prefabricated local building materials is still at the cradle, so the issue of corruption in it cannot be created".

13. "*Corruption does affect the use of local building materials for prefabricated low cost house building delivery in Nigeria. It is very hard for individuals to even get the license to process or produce the components because of corruption*".

14. "*Corruption does affect the use of local building materials for prefabricated low cost house building delivery in Nigeria. People inflate the prices of materials and nobody cares*".

15. "*Corruption does not affect the use of local building materials for prefabricated low cost house building delivery in Nigeria. The prefabricated local building materials do not meet the standard and where they are produced to standard, it is very expensive. So the is about cost not corruption*".

16. *"Corruption has indeed affected a lot of things in Nigeria especially the provision of prefabricated low cost housing. The government isn't doing enough to encourage the use of indigenous building materials and the issues going on the country such as lack of electricity has affected the production of prefabricated local building materials in the country. A lot of times we use generators 24/7 for the electricity supply and when the generator is down it affects the production and delivery, so we have to have generators standby at all our factories around the country. If the nation would have been healthy and no one siphoned our resources I think the electricity problem would have been dealt with and this would have helped the delivery of prefabricated local building for low cost housing at a cheaper rate*".

Table 12: Interview Question 12. Have you or your organisation promoted the use of prefabricated local building materials towards low cost house building provision before? Any reason why?

1. "*We promoted the low technology types of prefabrication techniques, but not consciously. We use the low technology on our project because they are available. But we are willing to promote it because it is cheap, function and faster to construct*".

2. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision. We have showcased our components to government. Because with this method you can have excellent house building finishes*".

3. "*I have not promoted these techniques of construction before. Because our company is small scale and we build only few units at a time*".

4. "*We have promoted the use of prefabricated local building materials for low*

cost house buildings provision. We have promoted it through our design and build. We have promoted the techniques because it saves time and speed up construction process".

5. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision and we are still doing it. We promoted the techniques by using it and by advising our clients on the benefits of it. The reasons includes, bringing down cost and speeding up construction*".

6. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision. We use these techniques to bring down cost*".

7. "*We do not promote these techniques of construction. Because we have not secured a big house building contract that will make economic sense for us to adopt prefabrication techniques. Prefabrication is more advantageous when large number of units is to be delivered*".

8. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision. We use to have our research team exploiting on different components of prefabricated local building materials. But not anymore, because we are not involved with many house buildings contracts that involves a large number of units*".

9. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision. But like i mentioned earlier, these techniques of construction is still new in the country*".

10. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision and we are still doing it. Because the technique assures quality, saves time and it is available*".

11. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision. Because it is cost effective to use these techniques and it saves time to build using these techniques*".

12. "*We have not done it in such a way that we advertise it on air, we have not done any flyer about it but we have used them for people to see in half of our projects. A lot of people have seen us use them in one or two ways, so in some way we have promoted it, just that is not on a global scale, we have not advertised it on TV but by using it and people are already occupying those houses I think we have promoted it in some way*".

13. "*My organisations have no power to promote these techniques. We only make suggestion but government decide*".

14. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision. We used these components in our building projects and we will promote them again*".

15. "*We have promoted the use of prefabricated local building materials for low*

cost house buildings provision. We promote it to demystify the concept of low cost in Nigeria. Using some of these components is about the most effective solution for providing low cost house buildings in the country and producing it locally provide a lot of jobs for local artisans".

16. "*We have promoted the use of prefabricated local building materials for low cost house buildings provision and will continue promoting it. Because our aim in this company is to house Nigerians with the best technology and at an affordable prices as possible. That's why out company use Expanded polystyrene for low cost house buildings in Nigeria*".

Table 13: Interview Question 13. Do you think there will be cost savings when prefabricated local building materials are utilised for house building over the conventional prefabricated imported materials? how?

1. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. Locally produced materials are logically cheaper. The components are readily available and the technology is not complex".*

2. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. There is a huge energy savings when locally produced expanded polystyrene is use for house building over the imported components".*

3. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. The number of units you build the cheaper the techniques".*

4. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. It readily available and you don't have to pay for any duties or shipping cost".*

5. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. The materials are readily available that makes it cheaper than the imported materials. People import building components because the technology is till new and the local building materials are not appreciated".*

6. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. Locally sourced materials are cheaper. The only problem with locally produced components is standard. They are not up to standard. Components that are produced locally are cheaper in terms of maintenance compared to imported materials".*

7. *"Cost of labour is not expensive here; So will go for locally produced prefabricated components, because I have control over it, it is cheaper for me to use, it is faster and been faster is also cost savings as well. Importation will*

definitely be more expensive".

8. *"There will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. There will be cost savings when it involves large number of units".*

9. *"There will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. But for individual companies who recently adopted prefabrication techniques of construction and wants to deliver project quickly, imported materials is cheaper because of the initial starting cost. However, because of the low level of technology usage, the quality of locally produced components is not up to standard".*

10. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. The best way to save cost is by applying multiple units at the same time. When you reduce construction time, you can also reduce the overhead cost and assurance of quality. These building materials are readily available. Therefore, there is no way it can be more expensive than imported materials".*

11. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. The imported prefabricated materials are more expensive due to the duties and transportation cost. It takes time to ship in materials from abroad as well. The locally made ones are readily available and cheaper".*

12. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. It offers at least 22% cost savings. It is readily available compared to imported materials".*

13. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. Transportation cost is less compared to the imported building materials".*

14. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. It is better to buy the machineries and produce it locally".*

15. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. But the awareness and skills is still lacking".*

16. *"Definitely, there will be cost savings when prefabricated local building materials are used compared prefabricated imported building materials. Imported materials are more expensive because of the duties".*

Table 14: Interview Question 14. Which among the local building materials utilise in within building industry of Nigeria do you think could offer greater potential towards offsite prefabricated low cost house building provision?

1. *"The local building materials that offers greater potential for prefabricated low cost house building includes; sandcrete blocks and clay bricks".*

2. *"The local building materials that offers greater potential for prefabricated low cost house building includes; expanded polystyrene, timber, bamboo, sand and cement. They are readily available".*

3. *"The local building materials that offers greater potential for prefabricated low cost house building includes; cement, sand and stones".*

4. *"The local building materials that offer greater potential for prefabricated low cost house building includes; reinforce concrete and sandcrete".*

5. *"Local building materials that offer greater potential for prefabricated low cost house building are bamboo, clay and polystyrene".*

6. *"Most of the substructures are done conventionally and for some time to come it will be done conventionally. The roof components are mostly prefabricated".*

7. *"The local building materials that offers greater potential for prefabricated low cost house building includes; concrete, timber, steel and aluminium".*

8. *"The local building materials that offer greater potential for prefabricated low cost house building in Nigeria is cement and chippings".*

9. *"The local building materials that offer greater potential for prefabricated low cost house building includes; simple components such as columns, light weight panels and slabs".*

10. *"The local building materials that offer greater potential for prefabricated low cost house building in Nigeria is the granite stones".*

11. *"The local building materials that offer greater potential for prefabricated low cost house building are timber and granite stones".*

12. *"The local building materials that offer greater potential for prefabricated low cost house building are usually Timber and clay".*

13. *"The local building material that offers greater potential for prefabricated low cost house building includes Timber and clay bricks, because they are readily available".*

14. *"The local building materials that offers greater potential for prefabricated low cost house building includes; Cement, granite stones and clay, because they are readily available".*

15. *"The local building materials that offer greater potential for prefabricated low cost house building are timber and aluminium".*

16. *"Local building materials that offer greater potential for prefabricated low cost house building in Nigeria as at today are expanded polystyrene, because it is versatile and can be applied for all parts of the building".*

Table 15: Interview Question 15. Are there any policies set out by the government to encourage the higher utilisation of local building materials for offsite prefabricated low cost house buildings in Nigeria? If yes, what are the objectives behind the policies? If No, is there any reason why there are no policies to support these techniques of construction?

1. *"I am not aware of any policy that supports the higher use of prefabricated local building materials. This issue also goes back to corruption. I don't think there are any. Even if there is, I have never come across. Why they are not promoting this policy is because they encourage importation, because they are involve in all this importation and they have their stakes in the imported materials through all the big foreign firms that are available in the country. They are involved. So by the time they bring about the issue of using local building materials that means they are discouraging importation and that means it's bad business for them. But when they are no policies, the importation keeps on, that means it keeps them in business, so corruption also comes in here as an issue".*
2. *"When you import building materials you pay a lot of duties, so that policy should encourage people to use local prefabricated materials more. There are other policies that support prefabrication construction techniques, but they are inadequate".*
3. *"All the housing policies out there are just paper jargons. They are not at all effective in any way. Even the government bodies that are suppose promote these techniques are not making any impact. So i am not aware of any policy that encourages the use of prefabricated local materials in Nigeria".*
4. *"I am not aware of any policy. The reason is may be the market. It is basically an individual decision. The designers are the ones that will encourage their client to use it. The government cannot come and legislate where there is no need. If the industry is happy with the way they build then the government won't come and enforce any king of law. The only think government can do is provide some sort of incentive to anyone who uses prefabricated techniques of construction".*
5. *"There are policies. There are few government institutes that promote these techniques of construction using local building materials. The policies are there, but the implementation and government support is the problem. The enlightenment, let people know what you're doing, appreciate what you're doing, have some of those structures where people can see visibly appreciate it and then they start to ask about it, how can I get this structure, the enlightenment will just pass around before you know it everybody will know*

be aware i can get a house over my roof for just few amount of money instead of waiting until I get a lot of money for me to be able to put a roof over my head".

6. *"There are no policies that i am aware of. But there are a lot of work that is been done over the years. The awareness and development of building codes for these techniques of construction is still in progress. So hopefully when the building code is ready it could be a platform for more local technological awareness in Nigeria".*

7. *"No, there isn't. There isn't any policy that speaks, motivates or enforces you to use prefabrication because the national housing plan does not take into consideration modularization as well as mass production of building. A lot of policies are geared towards tradition processes and no thought was giving to cost savings as well as time saving. So is totally lack of focus from the government bodies. Because a country that lacks housing units like Nigeria oath to look at prefabrication as a viable means of bridging that gap".*

8. *"I will not be able to answer precisely this particular question because you are talking about government policy and my personal experience is not on that policy formulation as such, but I can only imagine that the same reason of availability of fund, the scale at which these things are required rather influence the policy of this construction".*

9. *"There are policies. These policies are been promoted through the building code and building institutes in the country. The technology is still new; it needs to reach a certain level before things pick up. The market has a way of driven things no matter how or what policy you introduce, until and unless a market exist, until and unless it became viable you can't force. The policies are working in a way. The only thing is the sector has to bring down it capital cost in such a way that it can benefit best from these policies. There are many things that need to be in place for these techniques of construction to pick up, not just policies. To me the prefabricated companies have to do some homework to bring down their competitiveness within the Nigerian economy, within the Nigerian building sector".*

10. *"There are policies but it isn't enough to encourage prefabricated local materials usage. We have institute that are aimed at exploiting local technology. But these institutes are not doing enough. The level of impact is minimal".*

11. *"I am not aware of any policy that supports these techniques of construction. It is simply due to selfish interest and lack of awareness".*

12. *"Even the ministry of land and housing the kind of development they are doing all over all the ministries of this country, none of them is considering the use of local building materials, as of today the government of this country have no policy that support or encourage the use of prefabricated local building materials for the sole aim of having a low cost housing".*

13. *"There are policies that support these techniques. We even have policies that banned the importation of building material. The policy is not making impact because of us the Nigerians. Some people are so ostentatious that they import even drinking water".*

14. *"There are no policies that i am aware of. May be because the technology is still new, the government is not bothered about providing policies that would support it".*

15. *"Nigeria is not a country that lacks policies. What is lacking is the moral and political way to implement them. We do have the local content policy, which discourages importation by raising higher duties of imported materials. But even with the high duties, it is cheaper to import that fabricate materials locally".*

16. *"No policies, because of the lack of enough support of local production of indigenous building materials from the government. There is also lack of awareness within the professional bodies".*

Table 16: Interview Question 16. What do you forecast to be the future of prefabrication construction techniques in Nigeria? Do you think it will increase or decrease? Any reason why?

1. *"The future of prefabricated local building materials will increase. The awareness is growing within the community and the building industry as well".*

2. *"It will increase, because the technology is easier to adopt and the buildings are good looking. The future of prefabrication is bright in Nigeria, but the government have to intervene by discouraging importation in other to pave way for the local prefabricated materials".*

3. *"There is a bright future for prefabrication techniques in Nigeria. It is just like any other technology. It picks up gradually. I won't be surprise if the technology takes off as a means of fashion or statues, but not for profit because the infrastructure is not available".*

4. *"I think the forecast is quite good. Nigeria is reported to have a housing deficit of about 15 to 17 million nationwide and prefabrication has proven to be the fastest method of construction and you can manufacture the whole component ahead of time, now you have a lot of private players in the real estate, a lot of private developers developing one estate or the other and off course the developers are in the business to make profit, ones everybody realizes prefabrication is the best way to achieve the targeted housing unit, the developers will start leaning toward prefabrication and before you know it will take off and more factories will be build".*

5. *"It will certainly increase. The reason is been that the population of people is increasing so as the housing demand in the country. Therefore, there is the*

need for low cost houses. Prefabricated local building materials bring down the cost".

6. *"It will certainly increase. The awareness is increasing so as the demand for prefabricated local building materials. There is currently about 16million housing deficit in Nigeria and housing prices is increasing. Therefore, we are looking for ways to bring down cost and meet the housing demand. So all of these will propel the need for prefabrication techniques".*

7. *"The future of prefabrication is bright, because Nigerians catch up quickly. If the bigger companies adopted and it is effective, it will just be the matter of time before we the smaller companies start to use it".*

8. *"It will definitely increase, because people are now having higher taste for standard. The enlightenment is growing as well".*

9. *"The future for prefabrication is very bright. The urbanization in Nigeria is increasing. Ones you are getting urbanized, you have to adopt the way the urban countries have done all over the world. So prefabrication usage will pick up soon because people are becoming more aware of it gradually".*

10. *"It will continue to increase because the constraint that makes you use it still persists. Prefabricated techniques of construction prove to be efficient. It will definitely increase".*

11. *"It will increase. Prefabricated local building materials are cheaper and the demand is increasing".*

12. *"I think it will take a little longer for prefabricated techniques to pick up, because the government does not support it. The level of poverty in the country is too high that an average person cannot afford to use even raw materials in their raw foam to build. When government becomes more active and keen to provide more houses in the country, then they will think about how to use locally available building materials for house buildings".*

13. *"I think it will increase. When people are more aware of the benefits such as cost saving and time, the techniques will be more appreciated".*

14. *"It will increase if the government encourage the technology by providing an enabling environment such as regular power supply".*

15. *"It will diminish. The infrastructural provision that is supposed to make it cheaper is not put in place. Therefore, the imported building materials will continue to be used".*

16. *"It will increase. Our organization is working hard to promote the technology at seminars so that that knowledge can be spread across the industry".*

Table 17: Interview Question 17. How could the adoption and utilisation of prefabricated techniques of construction using local building materials be improved especially towards the provision of house buildings for all?

1. *"The utilization of prefabricated local building materials in Nigeria can be improved if there is more awareness, if the cost is cheaper and if the components are more durable. The institutes and the professionals within the building industry need to create more awareness to promote these techniques".*

2. *"One of the best ways to improve prefabricated techniques of construction using local building materials is through research and development. We need to increase research and development within the building industry of Nigeria".*

3. *"To improve prefabrication, infrastructural facilities must be in place. There should be collaboration between the smaller companies to establish some sort of medium organizations so they can compete within the industry".*

4. *"It can be improved through the institutes. The institutes should encourage more seminars where these techniques of construction can be promoted. The awareness can be created through academic and professional institutions".*

5. *"This technique of construction can be improved by training. Involve the local artisans and train them how to produce the materials locally. The agencies that are supposed to promote local technology must be properly funded in order to promote the technique".*

6. *"It can be improved by creating more awareness within the building industry and among Nigerians. The government must put down a legislation to encourage and monitor the cost of prefabricated local building materials. The cost of prefabricated techniques must be affordable in order to increase it uptake".*

7. *"The government have to support these techniques policy wise. The policy must include high utilization of prefabricated components in Nigeria and creation of prefabrication centres such as technical colleges and skill development centres to train local artisans. It will then become like a movement that is geared towards low cost house building delivery".*

8. *"It can be improved by making the components readily available, and training local artisans. The quality, reliability, availability and affordability of any product is important when it comes to its marketing and promotion. It is paramount to improve all of the criteria in order to increase its diffusion".*

9. *"The medium technology should be more improved because of the level of prefabrication usage in Nigeria. High technology requires so much use of machineries. Therefore, the focus must be on the medium technology, so that the medium and low technologies companies will be more involve. We the professionals have to play our part in terms of creating awareness".*

10. *"It can be improved through researching on better productivity and better way to implement these techniques".*

11. *"It can be improved by creating more awareness and government should create policies to encourage the use of prefabricated local building materials. The professionals within the building industry must also push for a legislature that will support the use of local technology".*

12. *"The government must provide an enabling environment to promote prefabricated local building materials. If the government start to use it in their housing projects and people see the benefits, it will encourage them to use it as well. The government and we the professionals must support research and development by providing financial assistance".*

13. *"It can be improved by educating the professional and non-professionals within the building industry about the benefits of prefabrication techniques of construction. The education can be achieved through vocational centres or skill development centres".*

14. *"It can be improved by encouraging the production of the components locally. The production of the local components must be encouraged through government motivation and support. The design of prefabricated houses should be make more flexible instead of the usual rigid designs. Infrastructural facilities such as power supply must be in place in order to increase the utilization of prefabrication".*

15. *"If we have to take the determination and the refocusing of the professional bodies to move the necessary government agencies to partner with them in insuring that this goes accordingly. For us the players in the industry, this is our desire, but we have to find a way to convince the policy makers and the drivers within the industry to partner with us in bringing this to fruition. Ones we show people it is doable the rest will follow. We have to do it in a small scale and show cases it".*

16. *"We need government policies that will encourage mass production of prefabricated low cost housing. Individuals and corporate bodies should be actively involved with prefabrication techniques of construction and more prefabrication factories should be in place in order to increase the usage in Nigeria. More research institute must be involved and companies must promote these techniques in order to increase their usage".*