THE UNIVERSITY OF SALFORD

Development of a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials in Nigeria

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ACKNOLEDGEMENTS

DECLARATION

I declare that the work presented in this thesis entitled Development of Collaborative Innovation Management Framework to assist in the Utilisation of Agricultural Wates as Building Construction Material in Nigeria. To the best of my knowledge and belief, no material in this thesis has been previously published or written by another, person, except where due reference is made.

I certified that this thesis, which I now submitted for examination for the award of Doctor of Philosophy, is entirely my own and has not been taken from the work of other save and to extent that such work has been cited and acknowledged within the text of my work. This thesis was prepared according to the regulations for postgraduate study by research of the University of Salford and has not been submitted in whole or in part for an award in any other Institute or University.

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DEDICATION

This dissertation is dedicated to Almighty God and utmost affection to:

my beloved wife Janet Olasunkanmi and my children namely Tioluwani, Fiyinfoluwa, and Inioluwa

My parents Rev. Clement Abimboye Odewole and Rev. (Mrs) Cecilia Olalonpe Odewole who gave me the foundation to thirst for excellence in education.

Also, to my Uncle, Pa Elutade and his entire family (Daddy Bauchi) for the support and care in all ways.

ABBREVIATIONS

The meaning of the abbreviations used in this research is listed in alphabetical order below.

AC   Activated Carbon

AIS   Agricultural Innovation System

AKIS   Agricultural Knowledge Innovation System

CIA   Central Intelligent Agency

CoPS   Complex Product and System

CSF   Critical Success Factor

ESSM   Evolve Speed Sparrow Missile

FAO   Food and Agricultural Organisation

FCT   Federal Capital Territory

FMST   Federal Ministry of Science and Technology

IDRC   International Development Research centre

IMF   International Monetary Fund

ISNAR   International Services for National Agricultural research

KBV   Knowledge Based View

NARS   National Agricultural Research Institute

NEEDS   National Economic Empowerment and Development Strategy

NIE   New Institution Economics

NPK   Nitrogen Phosphorous and Potassium

NSI   National System for Innovation

OECD	Organisation for Economic Co-operation and Developments
OPC	Ordinary Portland cement
PKS	Palm Kernel Shell
PKSA	Palm Kernel Shell Ash
R&D	Research and Development
RBV	Research Based View
RII	Relevant Importance Index
RSI	Regional System for Innovation
S&T	Science and Technology
SIC	Standard Industrial Classification
SSI	Sectorial System for Innovation
STI	Science and Technology Innovation
UNEPA	United Nation Environmental Protection Agency
UNESCO	United Nation Educational, Science and Cultural Organisation
USDS	United State Department of State

Abstract

The high cost of building materials in Nigeria is creating a shortfall of conventional building materials, which is also exacerbating the housing crisis in Nigerian urban areas. In view of the above, there is an urgent need to produce low cost, sustainable building materials that are affordable to the construction industry in Nigeria to reduce construction cost associated with the shortage of housing in Nigeria. Although there is a recent interest in the transformation of waste materials into raw materials required for producing building materials, however the focus in this regard has been on general household waste materials with little or no attention paid to agricultural waste materials. Indeed, agricultural waste materials have been neglected and no effort made towards harnessing the substantial opportunities that abound in the utilization of the increasingly large agricultural waste materials generated. Therefore, this research integrates and analyses the organisational structure of construction, manufacturing, and agricultural sectors in order to develop a framework to assist in the better utilisation of agricultural waste materials as building material.

The research adopted a mixed methods approach using pragmatic philosophical stance as the main basis of the research. In terms of the strategy, it adopts a case study strategy that follows an abductive approach derived from both inductive and deductive approach. Data is obtained through synthesis of literature reviews, semi-structured interviews, and questionnaires from multiple cases from stakeholder's organisations in Nigeria. The research findings revealed that there is non-existence of institutional actor's that can assist in the utilisation of agricultural waste for building construction purposes. Hence the development of organisational innovation management framework that would better integrate the stakeholders that are involved in the implementation of management approach in converting agricultural waste to building materials. The developed framework shows an innovative organisational hierarchical process of how agricultural waste materials can be used or converted as building materials that involve the government as well as the other stakeholders. The framework was also validated using construction professional through a focus group setting to help determine if the framework will be viable in practice. To this end, this study reveals that there is an existing gap in the organizational structure required for the delivery of agricultural waste for building construction purposes. This research also has the potential to contribute to the policy debate on the issue of using agricultural waste materials as construction materials to help fill the shortfall of conventional building materials.

Keywords: Agricultural Waste Materials, Building Materials, Framework, Innovation, Nigerian Construction Industry.

1.0 Chapter One – INTRODUCTION

1.1 Introduction

This chapter begins with a description of the background of the research topic in Section 1.2. It then articulates the research problem statement that this research set out to explore in Section 1.3. The next is the question this research tends to answer in Section 1.4, followed by the research aim and objectives respectively in Section 1.5 and Section 1.6. The scope of the research is then presented in Section 1.7, followed by the Structure of the Data collection in form of a flow diagram in Section 1.8. the last in this chapter is summary and link to the next chapter.

1.2 Research Background

At over 177.2 million people, as of July 2014, Nigeria's population is estimated to be the seventh largest worldwide and the largest in the whole of Africa. Furthermore, it is projected to grow by 2.47% in 2014 and expected to add another 50 million by 2020 (World Bank, 2013). Moreover, the country is among the most linguistically diverse in the world, with over 512 different indigenous languages, although more than a third is only spoken by a limited number of the population. Hausa, Yoruba, and Igbo are the major languages spoken by the populace. English is the official language and Lingua Franca is widely used in business, education, and politics (World Bank, 2013). Furthermore, it has been reported that the current housing shortage of about 12 million units, especially in urban areas, affects over 140 million Nigerians (Yakub, Salawu, and Gimba, 2012). In addition, as the urban population comprises 60-70% of the total, the consequences of this shortage will be alarming; moreover, without affordable housing and provision of other amenities, the country is greatly at risk (Yakub et al. 2012). Even the former President-Obasanjo noted that disregarding other cities in Nigeria, in 2001 Lagos was an "urban jungle" unfit for human habitation. According to a survey carried out by the United Nations, Nigeria's housing deficit is currently put at approximately 17 million units. These are far below the figures that the former president, Yakubu Gowon, estimated in 2007 when he commented on housing shortfall in the country by saying "We over 177 million people in Nigeria today. If it is five persons per family, it shows that Nigeria will need conservatively 28 million housing units." (Ibem et al., 2011, p76).

This summarily means there is a substantial scarcity of existing housing stock in Nigeria, although the Federal Housing Authority estimates that new housing construction in Nigeria could number about 10,000 units a year, which is far below what the currently nation needs. Similarly, it was recently observed by The Deputy Governor of Nigeria's Central Bank, that about 63 million Nigerians are not living in proper housing due to under-development in the housing sector (Yakub et al., 2012). This apparent lack of adequate housing has often been attributed to the high cost of building materials in Nigeria, where the cost of building materials used in the construction industry worldwide comprises up to 40-50% of the total construction cost (Adenuga, 2013). Mogbo (2001) and Abiola & Oladele (2000), acknowledged building materials as one of the primary factors affecting the operation of the Nigerian construction industry. The building materials sector is thus a major contributor to the construction industry because materials constitute the single largest impact in construction in Nigeria often accounting for over fifty per cent (50%) of the total cost of construction (Okereke, 2003; Stanley, Ogbuagu et al., 2014). According to Adogbo and Kolo (2009), cited by Oladiran (2015), there is an ever-increasing demand for import-based innovative products in Nigeria, which has also led to a decline in the quality of its indigenous products; however, a substantial proportion of raw material used in manufacturing these products are sourced in Nigeria from abroad. Considering the crash in the exchange value of the Naira (Nigerian currency) and the high inflation rate in the country, the costs of building materials have dramatically increased.

Given the above, to reduce the construction costs associated with a shortage of housing, there is an urgent need to produce low cost, sustainable building materials that are affordable to both urban and rural dwellers (Taiwo and Adeboye, 2013). Nevertheless, recent significant interest has emerged in the transformation of waste into the raw materials required for producing building materials. These would represent an alternative to the high cost of conventional building materials (Oladipo and Oni, 2012). However, the focus has been on general household waste, with little or no attention paid to agricultural waste. Indeed, agricultural waste has been neglected and no effort has been made to harness the substantial opportunities that abound in the utilization of the increasingly large amounts of agricultural

waste that could be transformed into the raw material required for producing low-cost building materials (Oladipo & Oni, 2012).

1.3 Research Problem

Several types of research on building project cost have indicated that 50 to 60 per cent of a building project cost goes into the material procurement and this has affected housing development as a whole in developing countries. Adedeji (2010), explains that 60 per cent total housing spending goes to the procurement of building materials, but in Nigeria, more than 60 per cent is recorded as funds that go into building material procurement. The reason for the high cost of building material in Nigeria is due to the high exchange rate daily, due to the instability of Nigeria economy (Adedeji, 2002). He observed that one of the major barriers in getting the cost of building material to lower price is the government, policies, and politics. Adedeji argued that in the '50s, 60's and 70's, shelters in Nigeria was cheap as building materials were sourced from the immediate environment at a reasonable cost. This is due to advance in technology as occasioned by international influence has bought changes to tastes, house forms and importation of building materials (Arayela, 2005). These changes rendered the undeveloped local building materials inadequate while increasing demand for the foreign product where the raw materials sourced from developed countries (Arayela, 2005). Arayela further explains that housing development has greatly been hindered by excessive costs of building material but cannot easily be solved by resulting to use of locally made and sourced raw materials without a reasonable and considerable innovation initiative cum sustainability of the material developed. However, evidence abounds in the usage of agricultural waste material to develop sustainable building materials for construction purposes (Pappu et al. 2007). This agricultural waste has been generated in large quantity and causing a menace to the environment despite the enormous potentials it carries (Ogunwusi, 2014). However, to convert this agricultural waste into building materials, some factors are needed to be considered (Abeysundara et al. 2009). These factors are policies that encourage usage of agricultural waste as raw material to produce building material and government intervention and collaboration of stakeholders involve in the utilisation of the waste as a building material.

Ogunsemi (2013), observed that research is scarce about the collaboration of stakeholders as a single structure to address the issue of utilisation of agricultural waste as building material.

However, some problems in delivering building materials through the utilisation of agricultural waste are due to the lackadaisical attitude of the relevant stakeholders and players in seeing the potential that is enormous with agricultural waste for the construction industry in Nigeria and non-availability of innovation policies mix that can enhance this process through effective intra- and inter-industry collaborations amongst the stakeholders relevant to this innovation process. The essence of the research is how these stakeholders can collaborate to carry out the innovation of agricultural waste as building materials for construction (collaborative innovation) starting from the government that develop the policies to the construction industry that utilises the materials. This policies and regulations stand in the form of good practice transfer promulgated as a key means of achieving continuous improvement, especially within manufacturing industries. This is done by means of obtaining efficiency through performances comparison across organisations that are collaborating (Jha et al.1996). Hammer and Stanton (1999), also argued that organisations and firms adopting good practices enjoy considerable performance improvements in various aspects, including cost, quality, time, and services, transparently and predictably. In adopting good practice when adopting the framework, this helps in the process of material improvement and during implementation feedback.

In summary, there is an apparent lack of research on innovation management frameworks that can assist in the utilisation of agricultural waste as building materials in Nigeria. The dominant theory and framework largely focus on innovation systems in agriculture, without any emphasis placed on the factor behind non – utilisation of agricultural waste as building material. If the lack of a collaborative innovation management framework is not properly addressed, there is a risk that policymakers, industrialists, and stakeholders will produce the wrong solution to this problem. To avoid this, it is necessary to develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building material. This forms the central focus of the research, which then leads to the research question posed in the next subsection.

1.4 Research Question

The present study developed a research question to explore gaps that exist between intra- and inter-industry collaborations by developing a collaborative innovation framework that will assist in the utilisation of agricultural waste as raw materials required to produce building materials or the material itself and factors behind non- utilisation of agricultural waste. The research question developed is as follows:

What are the factors responsible for the non- utilization of agricultural waste as raw materials for construction purposes in Nigeria and how best this problem can be addressed?

1.5 Research Aim

The research aims to broaden and reinforce the theoretical support for wider intra- and inter-industry collaborations, and to determine the key prerequisites for successful innovation efforts by utilizing a case study of selected inter-industry actors in Nigeria to develop a collaborative innovation management framework that assists in the utilisation of agricultural waste as raw materials required for producing building materials or material itself.

1.6 Research Objectives

(i) To investigate the benefits associated with the utilization of agricultural waste as building materials.

(ii) To explore the factors responsible for the non-utilisation of agricultural waste as building materials.

(iii) To establish the critical success factors which enable the improved utilisation of agricultural waste as building materials.

(iv) To develop a collaborative innovation management framework that assists in the utilisation of agricultural waste as building materials.

(v) To validate the developed collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials.

1.7   Scope of the Research

The scope of this study is limited to agricultural waste in Nigeria and how these can be utilized as raw materials in the production of building materials or as the material itself. It focuses on how intra- and inter-industry actors can collaborate more effectively in enabling and driving the innovation process that culminates in the optimal utilization of agricultural waste as the raw material for producing building materials. As such, the present study mostly looks at innovation management through the lens of collaboration between the organisations responsible for the innovation rather than the competition amongst them.

1.8 Structure of the thesis

The research adopts a standard linear-analytic structure (Yin, 2017). Chapter one starts with the background, problem, aim, objectives, approach, research question, motivation and scope of the study that frames the research and ensures that this it is conducted in a manner to satisfy its primary aim and objectives. This is followed by a review, synthesis and summary of relevant literature presented in Chapter Two. Chapter Three discusses the steps of the research methodology developed for implementation throughout this study. This is followed by a presentation and discussion of the findings in Chapter Four. Chapter Five describes the proposed collaborative innovation management framework. The thesis concludes with Chapter Six; this presents the research conclusion and recommendations. However, to achieve this aim and objectives there is need to describe how the data collection and the analysis were undertaken throughout the study; this is illustrated in form of a flow diagram and depicted in Figure *1*.

Research methodology → Literature review

Data collection techniques → Published sources review

Analytical approach → Critical literature review

Objectives to achieved → Objective1,2 &3

Case studies

Data collection

Semi structured interview

Questionnaires

Qualitative data analysis technique

Quantitative data analysis technique

Mixed method

Objective1,2,3

Objective 4

Validation

Interview Observation, Focus group &feedback

Relative importance index (RII)

Objective 5

Figure 1 Structure of the Thesis.

1.9 Summary

This chapter laid out the foundation for this study. It described the background of this research and research problem. Then, discuss the research aim and objectives, including the scope of this research. The last section of this chapter illustrates the data collection structure in the form of a flow diagram. The next chapter contextualised this study by exploring and document relevant literature that can assist in the development of the collaborative innovation management framework to assist in the utilisation of agricultural waste as building material.

2.0 Chapter Two – LITERATURE REVIEW

2.1 Introduction

This chapter considered the review of literature under three broad themes, namely, innovations that have been one of the predominant topics in academic and economic circles in recent years. Every sector generally wants to innovate and still be relevant to the consumer market. However, to innovate in the private or public sector there is a need to understand the fundamentals of a planned innovation and the process to manage that innovation. Furthermore, this chapter reviews all available literature on innovation, construction and agricultural innovation that can assist in the development of a framework to assist in the innovation of agricultural waste. Also, a review of literature is conducted into the benefits associated with the utilisation of agricultural waste as a construction material in Nigeria and the factors responsible for non- utilisation of agricultural waste as a construction material in Nigeria are critically explored. The chapter further establishes the critical success factors that enable the improved utilisation of agricultural waste as construction materials in Nigeria and reviews literature on agricultural waste including how it can be transformed for construction. Finally, the chapter briefly discusses the conceptual framework developed for this research.

2.1.1 Innovation Definition

There is no doubt that comfort, convenience, and efficiency in everyday life is positively aided by innovation (Reddy and Reddy, 2014). The subject of innovation continues to be an important topic of study for several different disciplines, including pure science, engineering, and the social sciences. Banerjee (2011, p.11), highlights this point by noting that "due to its widespread effect, innovation is an important topic in the study of economics, business, entrepreneurship, design, technology, sociology, and engineering in everyday life". Since innovation has been studied in various disciplines and under different environmental influences, the term continues to confuse. It has sometimes been related to organisational change, design, invention, and creativity. Similarly, there is also a lack of agreement amongst research regarding the core meaning or definition of the term 'innovation'. Nevertheless, there are several convergences in most definitions of innovation as noted by successive researchers. These commonalities will be identified and further explored at the end of this section.

Dodgson and Bessant (1996, p31) define, "Innovation as the process through which organisation structure seeks to acquire and build upon their distinctive technological competence, understood as the set of resources an organisation possesses and how these are transformed by innovative capabilities and collaborations". Their definition does not indicate that innovation could also be 'destructive' in nature. There is also a hint that their definition is restricted to organisational processes, thus omitting other innovative areas, like new product development. A largely recent addition to the innovation sub-theme is the market exploitation of qualifications for innovation. Dodgson and Bessant's definition fails to consider this important prerequisite in their characterisation of the term. Firth and Mellor (1999), attempt to resolve some of the weaknesses observed in the definition of Dodgson and Bessant (1996). They contend that "Innovation means the application of new knowledge to industries, and includes new products, new processes, social and organisational change" (Firth & Mellor, 1999, p.199). Critically, Firth and Mellor's (1999) definition does not highlight the impact of innovation on the environment, as proposed by Atkin et al. (2009, p.196) who assert that "innovation achieved is when an invention or an idea begins to impact the environment". There is also an underlying requirement that, for the outcome of an innovation effort to achieve successful market exploitation, it must meet specific customer/market needs and requirements. Thus, Clark and Fujimoto (1991, p132) argue that innovation is "the development of new values through solutions that meet new requirements, inarticulate needs, or old customer and market needs in a value-adding new way". The basis of Clark's definition lies in the logic that it is only when the innovation adds value to the customer that the innovating organisation can retrieve the value by way of added revenue or profit.

Nevertheless, there is also the question as to the degree of newness required of a creative idea for it be to be considered 'innovative'. Egbu et al. (2001), attempt to resolve this question; they note that innovation is the successful exploitation of an idea where this idea is new to the unit of adoption. Emphasis has placed the phrase "new to the unit of adoption" or "where the idea is new to a particular context" (Egbu et al. 2001, p186). This indicates that, for a creative idea to be categorised as an "innovation", it must be "new to the unit of adoption". The unit of adoption could be a country, city, industry, organisation, or department of an organisation.

Whilst the above definitions are important, the present study adopts the definition offered by Dodgson & Bessant (1996, p127) who argue that innovation "is the process through which organisation structure seeks to acquire and build upon their distinctive technological competence, understood as the set of resources an organisation possesses and how these are transformed and managed by innovative capabilities and collaboration" (Dodgson and Bessant, 1996; Lawson and Samson, 2001). The framework for adoption is in line with the organisational innovation management structure framework that can assist in the utilisation of agricultural waste as a building material.

2.1.2 Innovation Definition: Summary

In reviewing the definitions of innovation discussed in the previous section, a few common sub-themes can be extracted. These commonalities include the newness of the conceived idea; the deliberate application of information by the organisation, how the innovative ideas have been managed by organisations; the collaboration of industries and stakeholders to create new ideas and products; the perceived value by the end-user, and the successful exploitation of the new idea. Where all these ideas generated are to be used to assist in the utilisation of agricultural waste as building construction material. Thus, having reviewed relevant literature about the definition of innovation, to understand the importance of this definition, it is important to understand the theories that guide innovation. The next section will discuss relevant literature about innovation theories.

2.2 Innovation Theories

2.2.1 Theory of Innovation

The reason why an organisation innovates is usually to increase its competitiveness, and the aim is to increase their market shares and thus profit, or simply to survive (Atkin et al.1999). Porter (1998) reiterates that industrial sectors should innovative, although when an industry fails to innovate there is a risk of lagging in terms of international reputation, or that the whole industry disappears. If the end-user needs something new, it is for those who have the capacity and capability to provide this to do so (Porter, 1998). To gain a competitive advantage the innovating company must ensure that the demands of the client are fulfilled at an affordable and acceptable cost. A study by Drucker (2002) affirms that, regardless of the reason for innovation, understanding the client's need is very important, especially when

existing or new technologies are combined in an innovation. Successful innovative works depend on the recognition of the need for innovation by the end-user (Drucker, 2002). The end-user may influence the success of an innovation undertaken by industry. Porter (1998) notes that many international industries have managed to become 'international players' due to the actions of their customers on the home market.

It is against this background that this research is based to develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials. To develop the collaborative innovation management framework to assist in the utilisation of agricultural waste as a building material, the next sub-sections explored the extent to which innovation theories inform the innovation subject.

2.2.2 Schumpeterian View of Innovation

Hanusch and Pyka (2007) stated that the concepts of innovation and entrepreneurship are probably Schumpeter's most distinctive contributions to economics. One of the most common themes in Schumpeter's writings was the role of innovation's "new combinations", otherwise known as collaboration and entrepreneurship in economic growth. Schumpeter highlighted the function of entrepreneurs who carry out new combinations. He viewed the occurrence of discontinuous and revolutionary change as the core of economic development; this breaks the economy out of its static mode ("circular flow") and sets it on a dynamic path of 'fits and starts'. Three decades later, in his publication "Capitalism, Socialism, and Democracy", Schumpeter took the view that dynamic capitalism was executed to fail because the very efficiency of capitalist enterprise would lead to monopolistic structures and the disappearance of the entrepreneur (Hanusch and Pyka, 2007). According to Schumpeter, consumer preferences are already given and do not change spontaneously. Moreover, consumers in the process of economic development play a passive role in the theory of economic development (Schumpeter, 1934). Schumpeter described the development as a historical process of structural change, substantially driven by innovation, which he divided into five types.

1. The launch of a new product or a new species of an already known product.
2. The application of new methods of production or sales of a product (not yet proven in the industry).

3. The opening of a new market (the market for a branch of the industry not yet represented).

4. The acquisition of new sources of the supply of raw materials or semi-finished goods.

5. A new industry structure, such as the creation or destruction of a monopoly position.

Schumpeter (1934), describes innovation in the form of industrial transformation, which incessantly revolutionizes the economic structure from within, destroying the old one, creating a new one. Schumpeter described innovation development as a historical process of structural change, substantially driven by innovation. Burton-Jones (2001) sees innovation as processes that are divided into four dimensions, namely: invention, innovation, diffusion and imitation, where the activity of entrepreneurs draw upon the discoveries of scientists and inventors to create completely new opportunities for investment, growth and employment (Burton-Jones, 2001). It is the Schumpeterian contention that innovations are essential to explain economic growth and that the "entrepreneur" is the central innovator. As Schumpeter described in his theory of economic development, the entrepreneur's main function is to allocate existing resources to "new uses and new combinations". However, as described by Schumpeter on approaches to innovation, there is a need to explore the two relevant approaches to innovation, which are addressed in the next subsection.

2.2.3 A Resource-Based Approach to Innovation

The resource-based view of innovation is expressly concerned with the combination of diverse products and their origins, functions, evolution, and sustainability (Mahoney and Pandian, 1997). Barney (2001) explained that the resource-based view (RBV) indicates that, firms with valuable, rare, and inimitable resources have the potential to gain a competitive advantage. Barney's explanation fails to note that RBV has a sustainable competitive advantage in terms of low costs/prices, better service, and faster delivery. Drew (2006) describes "innovativeness" in RBV as the development of a unique product-market combination, through the use of resources and taking specific strategic decisions concerning the business. Moreover, the description of Van der Heijden fails to describe how RVB can be categorised (Drew, 2006). Wiklund and Shepherd (2003) describe RBV as resources, distinctive capabilities or core competencies that be categorised as strong institutional

knowledge between a network of people; embedded processes with minimal costs and irreversible investments in standing; the use of legal protection in specialised assets which refer to tangible input resources. These are the ways in which firms combine and transform such resources into a product (Wiklund and Shepherd, 2003). Within the RBV, the knowledge gained increased attention as an important source of competitive advantage. Grant (1996) argues that the resource-based school of thought outlines some basic contributions; that innovation does not come simply from checking the external environment for market opportunities, but from looking inward and building on the resource endowment and core competencies of the organisation. Therefore, RBV is not only based on how to squeeze innovative output from organisations but also on how to provide the fuel for innovative activity to occur in the first place. RBV focuses on the opportunity to produce innovative output with increased future value (Grant, 1996). To make the RBV approach more effective there is also a need to consider the knowledge required on how to innovate. Therefore, the next section will consider the impact of the innovation school of thought on the knowledge-based approach.

2.2.4 A Knowledge-Based Approach (KBA) to Innovation

In the KBA, the primary goal of any organisation is the application of existing knowledge to the production of goods and services (Grant, 1996). Nonaka and Takeuchi (1996) explain that knowledge and skills give any organisation a competitive advantage because it is through this set of knowledge and skills that the organisation can innovate new products and processes, or improve existing ones more efficiently. Farr and West (1990) describe KBV as the intentional introduction and application within a role, group or organisation of ideas, processes, products or procedures, new to the relevant unit of adoption, and designed to significantly benefit the individual, the group, organisation or wider society. However, West and Farr fail to consider the strategy that supports the creation of new knowledge. Wathne et al. (1996) describe this as collaborative strategies that present the means of creating new knowledge or gaining access to knowledge and skills outside the boundaries of society or organisations. However, many questions remain unanswered in terms of KBA. There is little research undertaken from a knowledge-based view on innovation in project-based organisations and the impact of changing the group of collaborating partners in this

development of products and processes (Gann and Salter, 2000). Moreover, for a researcher to be able to achieve the aims and objectives of a research project there is need for existing knowledge on what they are researching, to draw from the literature the details they require to analyse data and thus help to achieve the research aims and objectives. Therefore, this research adopts a knowledge-based approach where the knowledge acquired from the literature on innovation systems, agricultural/ agricultural waste innovation and construction innovation helps to develop a collaborative innovative framework that will assist in the utilisation of agricultural waste as building materials.

2.2.5 Relationship Between Knowledge and Resource-Based Approach

As indicated, the KBV can be considered a subset of the RBV in the sense that knowledge begets resource, and resource begets innovation. Furthermore, when research is carried out, the researcher acquires knowledge about the area under study and uses the resources available to innovate. Also, the role of an organisation and its source of unique advantage, rest in its ability to integrate the knowledge of individuals and other collaborating sectors in the production process of goods and services (Grant, 1996). An important issue in KBV is the transfer of knowledge and the difficulty of transferring knowledge (Nonaka, 1994).

Another issue in the KBV findings is the different categories of knowledge (Grant, 1996; Nonaka, 1994). Kogut and Zander (1992) describe the categories as tacit knowledge (implicit know-how) and explicit knowledge (unambiguous knowledge). Some researchers suggest that explicit knowledge is easier to transfer since it can be codified, while tacit knowledge is more costly and uncertain since it cannot be codified (Kogut and Zander, 1992). However, the resource-based view argues that organisations have the potential to provide an enduring competitive advantage when they are unique and not readily substitutable (Peteraf, 1993). An important source of the creation of inimitable value-generating resources lies in an organisation network of relationships and collaborations (Gulati et al. 2000). Gnyawali and Madhavan (2001) distinguish four sets of arguments on why resources in external networks are important to firms or organisations who innovate:

- Relationships in a network are potential channels to internal resources held by connected actors.

- External economies (i.e. capabilities created within a network of competing and cooperating firms) often complement an organisation's internal resources.

- The rate of return on internal resources is determined by how well the organisational network is structured.

- The organisational position in a network contributes to its acquisition of new competitive capabilities (Gnyawali and Madhavan, 2001).

The argument, as advanced by the KBV, is anchored on the belief that knowledge transfers between internal and external resources in any organisation improve the level of product output acceptability in consumer markets. Besides, the integration of the sets of arguments and information available to collaborating organisations, as facilitated by the internal and external network of these organisations, is a key success factor in the achievement of an organisation's aims and objectives. Therefore, knowledge about the utilisation of agricultural waste, culture and traditions and other predominant factors play a vital role in the development of the collaborative innovation management framework and its implementation. Also, there are relationships between the potential channels to the internal resources connected by the actor's help. Moreover, collaborating organisations must view innovation as one of the resources they need to draw upon to conduct business.

2.2.6   Innovation Theories: Summaries

This sub-section explored the divergent theories within the ambits of innovation. This section reviewed Schumpeterian economic models that encourage greater entrepreneurship than innovation. However, new entrepreneurship has shifted from old entrepreneurship where investors have started investing in innovative businesses; therefore, for any entrepreneur to be successful in the consumer market they need to innovate.   However, a high rate of complication in modern economies necessitates a higher rate of the economic interface. Nevertheless, in today's economies dynamic technological progress is relied upon to solve economic challenges. The creation of innovation no longer depends on individuals but involves the cooperation of many different actors that requires cognitive capabilities to increase the flow. However, based on this view and the research aim, Schumpeter's innovation and new entrepreneur concept encourage collaboration between internal and external organisation actors, i.e. collaboration amongst farmers, construction/industrial

sectors, institutions, government and other relevant actors to collaborate and develop a workable innovation management framework that can assist in the management of agricultural waste and its transformation into building material. Furthermore, RBV is known to be a branch of KBV, where an organisation and its source of unique advantage, utilise the knowledge of individuals in the production process of any goods and services output. However, explicit knowledge is easier to transfer into codes and to analyse in data format; in comparison, tacit knowledge cannot be coded, is inherent and thus more complex to analyse. Therefore, explicit knowledge is of advantage in achieving the development of the framework. In summary, to innovate/manage agricultural waste as building materials, different sectors involved in the process need to collaborate, share or transfer management knowledge and ideas. Figure 2 shows the graphical summaries of innovation theories that are relevant in the development of an innovation management framework to assist in the utilisation of agricultural waste as construction material.
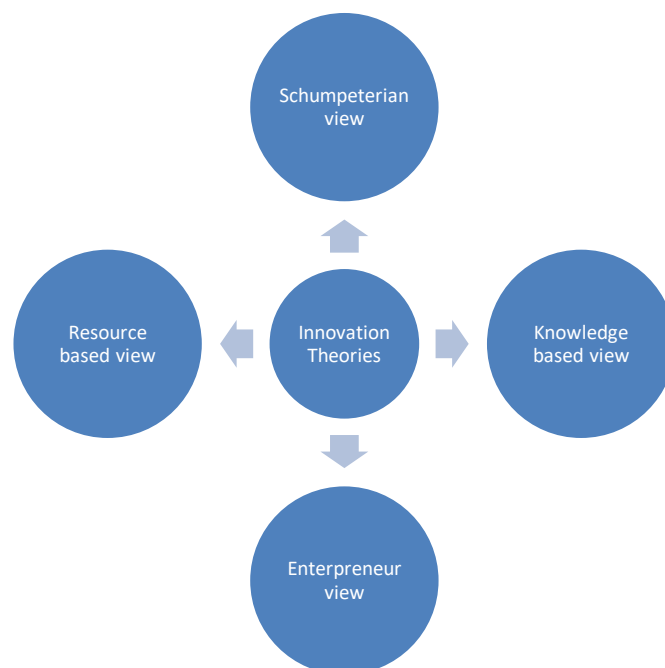
Figure 2: Innovation theory summaries

Having reviewed relevant literature about innovation theories in section 2.2, it is important to review relevant forms of innovation that are likely to influence the development of the innovation management framework proposed in this research. Thus, the next section will discuss relevant literature on forms of innovation.

2.3   Forms of Innovation

Innovation can be evident in diverse forms and represent the highly competitive capability of most firms and organisations. However, different evidence presented alongside practical implementation stages enables business leaders' understanding of how the different forms of innovation help to build an innovation philosophy (Henderson and Clark, 1990). The nature of innovation and the rate of technological transformation are significant and differ from sector to sector and across countries and periods (Henderson and Clark, 1990). Forms of innovation adopted by any firm or organisation differ and are always in line with end users' wants and demands. Although there are varying submissions regarding the form of innovation (Henderson and Clark, 1990), most studies indicate that innovations either take an incremental or radical form and, in line with this research aim, incremental and radical innovation will be discussed and reviewed in the next section.

2.3.1   Incremental Innovation

Incremental innovation refines and improves an existing design, through improvements in the components. However, it is important to stress these are improvements, not changes; the components are not radically altered. (Henderson and Clark, 1990) describe incremental innovation as a change that builds on a firm's expertise in component technology within an established organisation. This is a type of innovation that adds value to existing products for many reasons i.e. for production cost reduction to increase profit, at client requests, due to pushes in market value and increased efficiency in production (Henderson and Clark, 1990). However, these enhancements normally take the form of refinements in components rather than changes in the system. Therefore, a new model of an existing and established product is likely to leave the style of the system unchanged and instead offer refinements to its components.

Importantly, incremental innovation is an essential part of innovation in the modern age. The majority of products now add value to existing products to reduce the cost of production, increase profits and efficiency increase production (Henderson and Clark, 1990). Therefore, the adoption of an incremental innovation approach in the development of a collaborative framework to assist in the utilisation of agricultural waste as building material is vital in adding value to an existing product.

2.3.2 Radical Innovation

Radical innovation is about much more than improvements to existing designs. A radical innovation calls for a whole new design, ideally using a new configuration of components (i.e. integrated into the design). In (Henderson and Clark, 1990) terms, "Radical innovation establishes a new dominant design, and hence a new set of core design concepts embodied in components that are linked together in a new architecture.". Henderson and Clark fail to estimate the percentage at which radical innovation compares to incremental innovation. Gleave (1992) estimated that, at most, about 10 per cent of innovations are radical, which are often associated with the introduction of new technology. In some cases, this will be a transforming technology, perhaps even associated with the transforming effect of a long wave. Radical innovation combines the novelty of technological breakthroughs, and dramatic improvements to customer and user benefit evident in the market breakthroughs. However, they can have a powerful effect on the fates of individual firms and entire industries (Chandy and Tellis, 2000)).

In summary, incremental innovation involves only minor changes to technology or minor improvements in benefits, whereas, radical innovation deals with new product development and does not place importance on how a new product is developed.

2.4 Types of Innovations

The study of innovation is undeniably one of the most popular areas in social science in recent years. The literature on innovation indicates that it cannot be confined to any discipline. The concept cuts across various fields ranging from economics to anthropology, business to philosophy, science to engineering, and so on (Hoang, 2011). There are numerous views and academic models in different fields, which have attempted to deconstruct and re-construct the concept.

However, there are various innovation typologies developed by scholars and business gurus that suit the actual type of innovation model or framework for the research of work (Hoang, 2011). Nevertheless, in the context of this research four types of innovation typology will be reviewed to help in the development of the innovation management framework that can assist in the utilisation of agricultural waste as construction material. This is because; innovation management studies often focus on the typologies of innovation, where typologies have been advanced in the body literature. The present study focuses on the

generally accepted typologies, namely, product innovation, service innovation, process innovation and market innovation.

2.4.1 Product Innovation

Hoang (2011), explain that product innovation is the development of new products, changes in the design of established products, or the use of new materials or components in the manufacture of established products. Hoang's description deals extensively with the question, what is product innovation. However, he fails to mention why the innovation process of a product is embarked upon and to explain their classifications. In his definition of product innovation (Kam-Sing Wong, 2014) classifies product innovation into two categories; radical innovation which aims at developing a new product, and incremental innovation which aims at improving existing products. Furthermore, there are numerous characteristics of product innovation, which include the introduction of new products, enhanced quality and improvements to the overall performance of a product. Therefore, in the world of development, product innovation takes a principal role in the innovation of new products/goods in the market. Moreover, for any innovation management framework that allows a production company or organisation to work effectively, the product in which the management framework is developed needs to be thoroughly studied, and in doing this, product innovation techniques need to be considered. Therefore, product innovation techniques and procedures have an important role in the development of a collaborative framework to assist in the utilisation of agricultural waste into building material.

2.4.2 Service Innovation

Service innovation, as the name implies, concerns the rendering of services; however, no generally accepted definition is yet available. Although different authors note loosely coupled service elements, they hardly provide a clear definition of service innovation. Nevertheless, there are some attempts to define service innovation, which are presented below.

Sundbo and Gallouj (2000. p.16) define service innovation as, "a mix of reproduced although incremental innovations and 'small' non-reproduced changes to solve single customers' problems." However, Sundbo and Gallouj fail to deal with the cultural interaction process. On service innovation. Flikkema (2008) further explains that service innovation is a multidisciplinary process of designing, realising and marketing combinations of existing

and/or new services and products with the final attempt to create valuable customer experiences. Furthermore, service innovation is believed to be a new service or a renewal of an existing service that is put into practice to provide benefit to its developing organisation. The benefit usually derives from the added value that the renewal provides to the customers. However, for a service to be innovative, the renewal must be new not only to its developer but in a broader context and must involve some element that can be repeated in new situations. Preissl (2000) further describes that the actual outcome of service innovation might be a combination of various existing elements or new offers. The final goal is to fulfil customer needs in a valuable, high-quality way.

Analytically, service innovation brings a new service or added advantages to an existing service for an organisation to make a profit and in turn meet the new need of the customer. Research needs service innovation to encourage great change within a system or commodity market to satisfy customer needs and increase company income. Therefore, a service innovation approach will be incorporated into the collaborative framework to assist in the innovation of agricultural waste into building material.

2.4.4 Process Innovations

An effective innovation process starts with a deep understanding of the task the customer or end-user is trying to achieve and the desired outcome expected by the customer. Furthermore, by knowing how customers measure value, companies, organisations or sectors can align the actions of marketing, development, and R&D with the desired outcome and can systematically create customer value. Therefore, to better understand process innovation, the need to define process innovation cannot be over-emphasised. Davenport (1993) defines process innovation as "the implementation of a new or significantly improved production or delivery method". Nonetheless, the definition fails to address the issue that involves the development of a new way to produce a product using a newly developed machine, or a new method. Instead, it addresses the issue of delivery methods that are associated with the physical movement of the product from the factory floor to the end-user, i.e. the logistics of the company. This includes any system that is implemented in improving the delivery of the product to the customer, such as computer systems, tracking systems and any associated equipment. Chapman (2002) discusses early Nineteenth Century Luddite movement in and

around Nottingham, where stocking knitters who worked on machines in the home, took to rioting and breaking the new more efficient machines located in factories because they feared that the new machines would destroy their livelihoods. This example is a testimony to the power of process innovations. Although generally less well known than product innovations, there are examples of process innovations, including a process that had a dramatic impact on society (Chapman, 2002).

Based on the available literature, service innovations have the second most significant impact on society behind product innovation. Nevertheless, process innovations often have an even bigger impact on society than either product or service innovations. For any product or system/service to thrive in the economy, a ground-breaking approach taken by the innovator determines the longevity of a product in the market. The approach entails the combination of a detailed process, whilst with the adoption and application of a process determines the acceptance of the product by end-users. Process innovation has the potential to help an organisation achieve major reductions in process cost or time or major improvements in quality, flexibility, service level or other business objectives. If a process innovation has all these attributes it is an important step or approach that need to be incorporated into a framework; in this study, this would be to assist in the innovation of agricultural waste to building material for sustainability. The innovation management framework to be developed is a form of process innovation that would be adopted to assist in the utilisation of agricultural waste as construction material.

2.4.5 Market Innovation

Mortensen and Bloch (2005) define market innovation as, "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing" p38. Marketing innovations aim at better addressing customer needs, introducing new markets, or a recent positioning of a firm's product on the market, to increase a firm's sales (Mortensen and Bloch, 2005). It must be part of a new marketing concept or strategy that represents a significant departure from the firm's existing marketing methods. The new marketing method can either be developed by the innovating firm or adopted from other firms or organisations through collaboration. Nevertheless, new marketing methods can be implemented for both new and existing

products and play a key role in achieving acceptance of a product, service or process, market capitalisation and profit marginalisation. Therefore, marketing innovation has an important role to play in the marketing of construction material produced from agricultural waste. However, knowing the relevant types of innovation to assist in the utilisation of agricultural waste as a construction material is not enough. There is also a need to understand the actions of the innovators to implement the types of innovation. Therefore, the next subsection will review a relevant innovation process that can assist in the utilisation of agricultural waste as construction material.

2.5 Innovation Process

Drucker (2002) explains that the motivation of innovators depends on the actions of clients and is largely set by the client, either as a demand or as a new product or service to fill a lack that the client knew existed. The latter means that a company may identify a requirement in the market or the lack of a product or a service that the market itself is unaware of. No company can or want to engage in innovative activities if there is no time or return for it. Although, time and money are motivators for innovation, regardless of the amount of money and time available, if either the demand or the lack does not exist there will be no innovation (Drucker, 2002). Motivation, time and money influence the willingness to make an innovation; also, time and money are moderately straightforward in that they either exist or do no. In comparison, motivation is more complex. Tidd (2001) further explains that, if innovation is designed to meet a lack the client does not know about, it is purely up to the innovator to gather the knowledge needed to create the innovation and to introduce it to the market. If it is something the client demands, the innovator must acquire the necessary understanding of the client requirements. However, with the demand from the client, Tidd did not address the motivation to innovate. Tidd et al. 2005) explain that the general aspects of the innovation process, will also affect the motivation to innovate, but they may, if not working properly, reduce the motivation. Creating a new idea is an invention but improving and finding new ways and applications for existing ideas involve innovations to gain market capitalisation. This research aims at innovation that exists in construction industries and at key players who need to carry out the management of the process in utilising agricultural waste, but who are not aware of it. The researcher is gathering the required knowledge and processes needed to develop a collaborative innovation management framework that will assist in the process of

utilisation of agricultural waste as building material. However, innovation cuts across all fields of endeavour, even construction industries. Thus, as the context of this research is based on construction industries and organisations it is important to review relevant literature that discusses innovation in the construction industry. The next subsection reviews relevant literature about innovation in the construction industry.

2.6   Innovation in Construction

Innovation is long recognised as an essential element in promoting domestic economic growth; it is important in competition, significantly improves the quality of life, and is regarded as the core of a knowledge-based economy. Sexton and Barrett (2003) describe successful innovation as satisfying the needs of society and clients, and to enhance competitiveness, has increasingly become a challenge in the construction industry. Rutten et al. (2009) affirm that the government is now recognising the importance of innovation by developing different programs to encourage construction innovation. This section explores all the relevant and available works of literature about Innovation in the construction industry to determine the areas where innovation is lacking in the building industry globally and how relevant literature explored in the area of innovation in construction can help in the development of an innovation management framework to assist in the utilisation of agricultural waste as building materials.

2.6.1General Overview of Innovation in Construction

It has been argued that there is a lack of coherent flow for innovation within the construction industry. (Nam and Tatum, 1997) attribute this, not to the lack of capability, but to the absence of harmonised effort to connect market needs and inventive capacity despite adequate demand-pull. Furthermore, the supply of promising technologies, such as computers, robotics and advanced materials, is ready to be utilised through such a coordinated system. Veshosky (1998) attributes this lack of coherence inflow to ineffective documentation and the lack of communication regarding the innovations developed to solve problems at project levels for the future reference and rare commercialisation of a project by developers, engineers and other stakeholders in the construction industry. An empirical study conducted by Reichstein et al. (2005) using the data from a United Kingdom innovation survey, discovered that the number of firms engaged in product and/or process innovation in

the construction sector is lower than all other sectors. Moreover, construction firms are less open to the external environment and tend to have poorly developed research and development (R&D), with a low capacity to absorb ideas from external bodies. However, some researchers are unconvinced about the so-called conclusive evidence of the poor performance of the construction industry compared with other industrial sectors. (Winch, 2003) attributed this observation to the deficiency of the Standard Industrial Classification (SIC) on which most research category statistics are based within the construction and other sectors.

The construction sector in SIC excludes architectural and engineering consultancy firms where a large amount of innovative designs is carried out. Nevertheless, this is not the case in most of the other industries; thus, it can be argued that the construction sector under SIC is not comparable with other industries. Nevertheless, (Winch, 2003) admits that there is insufficient evidence to state that the construction industry is any worse or better compared than other industries. Seaden and Manseau (2001), argue that official statistics are limited in measuring innovation and existing measures about R&D statistics. R&D expenditure, the number of R&D personnel, the number of patents, the number of publications and their citations, etc. are considered indicators that measures R&D performance, and thus innovation.

Nevertheless, the OECD (1996, 1997) stated that innovation can emerge from various sources of activity, not only R&D, even though it constitutes an important part of innovation activities. The study by Slaughter (2000) also attests to this statement where the majority of innovation originated at sites by builders in transferring the innovative ideas of the architect to a real product. Based on experience, most of the innovation in a construction site is undertaken by the foremen especially in Nigeria. This has created a real issue as no knowledge is transferred from one artisan to the other. Kline (1985) explains that research is not the direct source of innovation and much innovation proceed with little or no input from current research. However, the level of R&D activity has been positively correlated with the relative innovativeness of various industrial sectors, particularly high tech manufacturing sectors, and is therefore considered a valid indicator of innovation (Seaden and Manseau, 2001). In their study, Nam and Tatum (1997) discovered that construction companies are keen on innovation due to the increasing labour charges on each construction phase. Moreover, construction

companies have now identified innovation as a means of being competitive in the international markets. This fact is reflected in the use of innovation and innovative words in the company brochures, marketing documents and other marketing strategies (Nam and Tatum, 1997). Nevertheless, the study fails to discuss the level of collaboration amongst construction industry actors, which was addressed by Barrett et al. (2007). They argued that construction is a project-based, service-enhanced industry innovation that involves multiple participants collaborating at a project level; thus, innovation in construction cannot easily be established. Not only is construction innovation different from traditional innovation (such as in the manufacturing sector), but it also has unique features when compared to general innovation based on the client design brief to achieve the organisation aims and objectives. Blayse and Manley (2004) noted that many researchers have observed, investigated, and made comments on the inherently conservative nature of innovation in construction and the negative attitude towards innovation in the construction industry. However, construction innovation is still at its developing stage and, as such, many of the research theories and practices are based on the body of knowledge from other industries (Sexton and Barrett, 2003).

Given the above literature, the construction industry time after time scores badly against the standard agency of innovation. This is one of the reasons why it is perceived that there is little or no innovation in construction. Objectively, there is demanded to look at innovation approaches in the construction industry and to proffer better solutions for innovation in construction, using appropriate measures that reflect the reality of innovation in construction practices. However, due to the difficulties inherent in the construction innovation process, measuring innovation in the construction industry is not an easy task. To properly measure innovation, all the key players in the industry need to actively collaborate and data sharing. An economy's rate of innovation depends on a range of activities and the links between them. Therefore, innovation needs to be consistent in the construction industry, if all construction sectors are to be assessed including architecture and engineering. Any design made by an architect is an innovation; it is a new idea generated due to demand from a client and the demand is processed and translated into a design based on the purpose of the building design. However, all architectural design and details are unique, and there are no buildings the same throughout the world; even prototype buildings differ in one way or another, whether

through the material or artisan variations. Furthermore, there is a clear need for greater innovative input into the construction industry by breaking the barriers of a conventional construction model (radical approach) to enhance productivity. Breaking barriers and bridging the gap that exists between innovation in construction and agriculture is one of the reasons for this research; therefore, it is intended that a collaborative innovation management framework will be developed to assist in the utilisation of agricultural waste as construction material. This aims to highlight and close the gap that exists between the construction industry, innovation systems and the agricultural sector.

Nevertheless, to encourage effective innovation and develop an innovation management framework in the construction industry, there is a need to identify factors affecting innovation in the construction industry. Therefore, in the next subsection, the researcher reviews all relevant literature on the factors affecting innovation in construction.

2.6.2 Factors Affecting Innovation in Construction

According to Egan (2002), existing literature tends to agree that productivity, value for money, and overall client satisfaction in the construction industry are fairly low compared with other industrial sectors and that the reasons for low client satisfaction are due to several factors. These factors are mutually dependent, as they support each other (Cox and Townsend, 1998); (Hardie and Newell, 2011). Many kinds of literature by various authors within the construction industry and beyond agree that a change is necessary, and this must affect by a collective effort on the part of industry stakeholders to satisfy new demands. However, to achieve the desired demand for innovation, the characteristics of a successful innovation process must be achieved, and this is essential in a construction process that is already noted as sub-standard (Cox and Townsend, 1998). Some general factors, which contribute to the problems of the construction industry, can be found in a range of literature (Cox and Townsend, 1998); (Hardie and Newell, 2011); these factors are summarised as:

- An adversarial culture,
- Changes in specifications,
- Cyclic demands,
- Fragmented industrial structure,
- Inappropriate procurement forms,

- Inappropriate allocation of risk,

- Inefficient methods of construction,

- Management problems,

- Poor quality.

Also, Manley (2008) argued further that, through competence and knowledge, communication, learning, relationships and co-operation with other parties (professionals), an organisation designs details to the simplest level to enable easy interpretation and this forms part of the factors that affect construction innovation. Manley's argument fails to address what influences these factors. Nevertheless, the work of Gordon (1994) addresses this influence as a form of partnership used in the construction process. He stated that many different procurement and contract forms, and forms of partnership used in the construction process influence the innovation process.

In summary, most of the above factors alongside partnership has a great effect on the innovation process in the construction industry. This is due to closeness to the concept of complex products and systems (CoPS) that militate against the construction innovation process. Therefore, there is a need to address the hindering factors affecting the construction innovation process by adopting a set of outlines and structures that are appropriate in developing an effective construction innovation system.

2.6.3 Construction Innovation Summary

The following summarises the key findings regarding construction and innovation.

- Construction is a project-based industry connecting multiple parties. Each of the parties is an independent organisational entity that pursues its interests and, in turn, expects to make a profit at the end of each project.

- Research about construction innovation demonstrates that collaboration is a significant factor for construction innovation.

- In construction innovation, inter-organisational cooperation, particularly those that engage in multiple projects, play a vital role in the construction industry.

- There is a major problem with the coordination and integration among the various organisations; the most significant features of the construction industry are the supply chain, which is more disjointed than in any other industry.

- The multiplicity of knowledge, materials, technologies, and skills applied in the construction industry makes it hard to achieve efficient internal cooperation. Furthermore, the same problem regarding supply chains, together with poor inter-organisational cooperation, hinders construction innovation.

- Innovation in construction should adopt collaborative projects that involve multiple partners with a broad knowledge base, who can eventually benefit from successful innovation. Also, the multiple partners in the construction industry should be permitted to provide input to the decision-making process.

- Innovation in construction needs to adopt robust supply chain management as an accessible way to enhance inter-firm coordination in construction. Moreover, there is a need for new procurement methods to adopt with new organisational structures and both should integrate for effective construction innovation process implementation.

- There is a need for the policy regulator to adopt relationship-based management strategies and demonstrate the benefit of managing inter-organisational innovation. Furthermore, the creation of a pleasant business environment is useful to improve the level of integration.

Having reviewed construction innovation and the factors affecting this in general, there is a need to review construction innovation in Nigeria to ascertain the level of innovation within the country. Thus, the next section reviews relevant literature on innovation in construction that can influence the development of an innovation management framework to assist in the utilisation of agricultural waste as building materials.

2.7 Construction Innovation in Nigeria

Construction innovation in Nigeria can be said to follow innovation diffusion theory, which explains the levels of adoption in the process, and product/technological and business system innovations within the Nigerian construction industry. In Nigeria, consultants are generally referred to knowledge-based professionals who are employed to provide expert analysis and advice that will enhance decision-making, provide specialised and one-off services and, perform tasks that are not ordinarily available within the departments or agencies of the clients (Ijigah et al., 2012). A study by Ibironke (2004) on innovation in the Nigerian construction industry suggests that consultants are usually approached and commissioned by

clients to provide services relating to the conceptualisation, planning and execution of construction projects. These key consultants are the architects, the quantity surveyors, professional builders and the engineers (civil/structural, electrical, mechanical, etc.). They usually follow the client's briefs and use their technical skills and professional decisions to realise the client's aims and objectives. However, the consultants, in general, have been found wanting by many clients in the discharge of their services. Cox and Thompson (1997) explain that construction consultants have been noted as inefficient in some construction project delivery services and have unsuccessfully met their client's requirements. As a result, numerous construction projects suffer problems in terms of cost overruns, time overruns, abandonment and (sometimes) structural failure leading to building collapses and associated colossal losses. There are considerable pressures from client's organisations and other stakeholders for a change in current thinking, including the culture and practices of the construction industry, in order to bring improvements in its project delivery and to satisfy its clients. Also, in Nigeria, construction innovation is experiencing a similar situation, and perhaps even more so than that in developed countries.

Yusof et al. (2010) emphasise the need for innovation amongst construction organisations to confront continuously increasing technological capabilities, changing client requirements, conducting tighter controls over the environmental regulations and quality standards, rising construction costs, increased competition and other challenges that are associated with the process. However, studies have shown that the key players of the construction industry in Nigeria are slow to adopt new innovative techniques and changes (Ijigah et al., 2012). Furthermore, actors within Nigerian construction industries were also rated as having a low disposition towards the adoption of innovative techniques and ideas about changes (Usman et al. 2012). Toole (2010) reaffirms that innovation in the construction industry produces architectural and engineering designs, buildings, industrial and infrastructure developments, procurement and services; moreover, innovation is well embraced by large engineering-procurement-construction. Furthermore, researchers have also indicated that construction industry innovation studies in Nigeria has been scarce and mainly focused on the contracting organisations with very few paying attention to the consultancy sector (Yusof et al., 2010).

Moreover, Arvanitis (2008) in his study on innovation activity in the service industry, concluded that innovation activity within the service sector remains an underexplored area

of research, due to a lack of appropriate data at the level of firms. This situation is also applicable to the Nigerian construction industry, despite the pivotal roles played by industry consultants in the conceptualisation, planning, execution and control of construction projects from inception to completion and who are therefore supposed to be the key-triggers for innovation in the built environment. Ozorhon et al. (2010) suggested that there should be a shift in research focus within construction innovation to move from the industrial/organisational levels within the industry where innovation initiatives and programmes can be more easily established and therefore monitored for their logical and successful accomplishment.

2.7.1 Construction in Nigeria

Worldwide, the Construction sector is known to be one of the nation's private, public and economic development and also a major contributor to the nation's economic development. One of the contributions that this industry does is in the area of employment generation and also promote valuable sectoral collaboration which enhances sustainable economic development in any nation, Nigeria inclusive. To be able to achieve and obtain a sustainable national and economic development the relevance of industrial development good infrastructural development (all means of transportation), residential accommodation, industrial development in form of collaboration is inevitable. Therefore, the relevancy of the construction sectors is indispensable. The Building and Construction sector has been significant in the advancement of the Nigerian economy. However, housing is a key component of the building and construction sector in any nation (Kissick et al., 2006). According to Kissick et al. (2006) housing can be described as an important contributor in economic, social, and civic growth; the contribution of all activities carried out in construction industry has a direct contribution to the socio-economic and political growth of any country; housing drives the economy of any country for sustainable growth and has been the sustained most of the developing countries in the area of job creation.

According to Glossop (2008), a housing development in a small or large scale has contributed immensely to economic growth to boost the economic performance of a country. In a similar note, in Nigeria Construction industry has contributed to the employment rate in major cities where construction activities have been immense and contributed GDP of 671110.60 NGN

Million in the fourth quarter of 2019 which is an increase to 557147.53 NGN Million in the third quarter of 2019. These cities include the Federal Capital Territory (FCT), Abuja, the various State capital cities like Lagos, Port-Harcourt, Ibadan, Kaduna, Kano, among other cities. Also, in the area of inter-organisational collaboration, the construction sector has links in the growth of other sectors, especially the building materials industry, real estate transactions, among others. More significantly, the drive in the direction of realizing the goal and objectives of the Nigerian Vision:2020 that is tagged to the building and construction sector (Nigeria, 2009).

From the technical report for vision 2020, housing development under the infrastructural growth is documented as crucial to the vision of achieving the economic transformation agenda of Nigeria Government (Nwachukwu and Emoh, 2010). However, for building construction to thrive in the Construction sector and effort to do this need collaboration of other sectors to achieve this transformational goal. An effort has to be made in transforming other sectors to a level to assist the construction sector to achieve the desired goal. The power, transport, housing and industrial sectors need to be transformed to support Construction section. But, building industry is not likely to bear the desired fruits without the active participation of the actors in other sectors as well as the effective and efficient performance of the sector. There are challenges linked with the functionality of the building and construction sector. These always harm the ability of the sector' to contribute immensely to the economic development of Nigeria (Mukhtar, 2016). Given the importance of the sector and the role it is expected to play towards achieving the country's vision, there is need to address those challenges/factors affecting the sector and put the sector in good stead for effective and efficient performance in the years ahead. The next subsection addressed the factors affecting the construction sector in Nigeria.

2.7.2 Factors Affecting Construction in Nigeria

Needless to say, that the construction sector in Nigeria is still not at par with the developed country, even not at par with some developing countries either. This been at par is associated with a lot of factors that have been discussed, research and written about by so many scholars and researchers. Also, these factors have to dig deep into the sector that a new approach needed to solve all these challenges that have banned the sector from growth in Nigeria.

However, to be able to tackle these factors there is a need to discuss a few of the predominant factors and these are discussed below.

2.7.2.1 Project Scope Creep

According to project scope creeping is when extra features or function is added to project requirement and not authorised by the appropriate body (Inder and Rivera, 2007). This simply means an act of distorting the original approved plan of the project that without considering time, costs and resources or without client approval, which invariably affect the completion of the project, at times the project gets abandoned (Shane et al., 2009). According to Shane et al. (2009), some other causes of project scope creep. The paucity of transparency, precision and intensity to the original design document; Granting unwarranted familiarity between client and team participants; Cheap bargain by artisans; Commencing design and development of a project before standard requirements analysis and cost-benefit analysis has been done.

2.7.2.1 Poor Project Planning

Poor planning in the construction industry has resulted in a string of challenges and setback in the past and are still causing more problem in the recent dispensation (Subbiah, 2012). Further, one of the main scenarios is the contractor of subcontractor trying to distort the approved design due to so many factors to the extent that it destroys the functionality of the said project. One of the baffling issues is that most of the construction project in Nigeria is sponsored fully or partially by the Government, with few banking sector involvements. It is expected that the project should be able to follow the required mapped out plan, but the reverse is the case as this government officers are the one that is even responsible for all this failure in project planning due to greed and self-aggravation (Subbiah, 2012).

2.7.2.3 Capital Intensive and Funding

One of the major factors affecting the effective growth of construction sector in Nigeria is that most of the proposed project is capital intensive and there is no available finance that can be used by developers to carry out this project (Tunji-Olayeni, 2008). However, most of the seen project is done mainly by politician or those who are close to the people in power or Government and has no direct effect on economic development as most of the building will

be too expensive for average citizens to acquire (Tunji-Olayeni et al., 2012). Also, the cost of equipment to execute this project cost millions of Naira, only those individuals that have the money go with the project, which at a time also become abandoned due to many factors. Coupled with these, majority of clients also do not mobilize budding contractors for fear of losing their money or becoming victims of abandoned projects. This creates a lot of pressure for contractors to source for funds to execute projects. Nigerian banks are not helpful in the area of financing construction projects especially if the contractor is not yet a big player in the industry.

2.7.2.4 High cost of building material.

This is one of the factors that are limiting the growth of the building industry in Nigeria as most of the material used for construction purposes are imported and expensive. Furthermore, Scarce production of raw materials by the country despite the abundance of raw material for this purpose has posed a major threat to sustainable development in the construction sector in Nigeria (Ogunlana et al., 1996). However, Tunji-Olayeni et al. (2012), observed that the major reason for this high-cost materials is lack of the Government and other players in the industry to harness the enormous potentials that are available in the area of raw materials delivery to produce building material at low cost by eliminating foreign exchange problem. Up until recent time Nigeria still export building material even though the material to produce this product can easily be sourced from an agricultural waste product. In another development, Ganiron Jr et al., (2017) observed that substantial percentage of the aggregate components for production and delivery of some of this material could be found within the waste system in Nigeria. Also, Mogbo (2001) and Abiola and Oladele, (2000) admitted that building is the primary factors affecting the operation of the Nigerian construction industry. The building materials sector is thus a major contributor to the construction industry because materials constitute the single largest impact in construction in Nigeria often accounting for over fifty per cent (50%) of the total cost of construction (Okereke, (2003); Stanley et al. 2014).

In line with the findings that the high cost of building material is one of the major setbacks in housing delivery in Nigeria. It is imperative to discuss and explore in the house way of developing this building material to the safe overall cost of the building project. In addition to

the high cost of building material, finances and capital shortages also play an important role that leads to a shortage of housing delivery in Nigeria. From the findings, there is a need for the Government and other stakeholders to look for alternative means of developing these materials within Nigeria to reduce the cost of foreign exchange spent on getting these materials. If these are done more housing development would be an easy task for developers and other stakeholders in the industry to deliver. One of the alternative means of reducing this cost of building material is developed a way of converting or innovating agricultural waste into building material, as few literature has proved these waste materials as a source of material that can be used in Nigeria to manufacture building materials. Given this, the next subsection will discuss what agricultural waste is all about and how it can be harness into the building industry for sustainable development and economic growth in Nigeria.

2.7.2 Construction Innovation in Nigeria -Summary

For a construction innovation system to be successful in Nigeria, there is a need for all actors in construction innovation to work within the existing construction innovation system; not in a destructive manner but instead like–for–like. However, given the lapse in existing innovation capacities and capabilities in Nigeria, the researcher introduces the process in the form of a framework that is easy to adopt. This can be described as a modular innovation that is more flexible and not agile for the easy evolution of an innovation management approach that links actors from various sectors of an innovation system to assist in the utilisation of agricultural waste as building materials (Tunji-Olayeni et al., 2012).

However, to give a clear view on the research aim and objectives, there is a need to review the literature on agricultural waste and its utilisation as building materials in the construction industry so far, and to further review the literature on the utilisation of agricultural waste so far in the Nigerian construction industry. The next section explains agricultural waste.

2.8 Agricultural Waste

2.8.1 Agricultural waste

Generally, agricultural waste is referred to as the by-products of agricultural activities, as they are not the main products. These wastes mainly take the form of crop residues, i.e. residual stalks, straw, leaves, roots, husks, shells and animal waste. Sabiiti et al. (2004) explained that agricultural waste is widely available, renewable, and virtually free, hence they can be an

important resource. They can be converted into heat, steam, charcoal, methanol, ethanol, biodiesel and provide raw materials for industries i.e. animal feed, composting, energy and biogas construction and building materials. Nevertheless, significant amounts of such waste are still largely under-utilised and left to perish in a dump, or burnt openly thus causing an environmental and health hazard in developing countries, including Nigeria. According to the report on Environment Statistics commissioned by the United Nations (1997, cited in Field, Kuczera, and Pont, (2007), agricultural waste is produced as a result of various agricultural operations. This includes manure and other waste from farms, poultry houses and slaughterhouses; harvest waste; fertilizer runoff from fields; pesticides that enter the water, air or soils; and salt and silt drained from fields. The ESSM fails to explain the resultant practices that evolve in generating agricultural waste. However, Obi, et al (2016b) defines this as the "residues from the growing and processing of raw agricultural products such as fruits, vegetables, meat, poultry, dairy products, and crops. They are the non-product outputs of production and processing of agricultural products that may contain material that can benefit man but whose economic values are less than the cost of collection, transportation, and processing for beneficial use". They further explain that this waste composition depends on the classification and the nature of agricultural. Agricultural waste is called agro-waste and comprises animal waste (manure, animal carcasses); food-processing waste (only 20% of maize is canned and 80% is waste); crop waste (corn stalks, sugarcane bagasse, drops and culls from fruits and vegetables, pruning), and finally, the hazardous and toxic agricultural waste (Obi et al., 2016b).

However, it is difficult to estimate the amount of agricultural waste; nevertheless, it is largely believed that agricultural waste contributes a significant proportion of the total waste matter in the developed world (Agamuthu, 2009). Globally, 140 billion metric tons of agricultural waste is generated every year from agriculture. Besides, there are increasing volumes and types of agricultural waste, due to intensive agriculture in the wake of population growth and improved living standards. Therefore, waste is becoming a burgeoning problem as rotten agricultural waste emits methane and leach, whilst open burning by farmers to clear their lands generate CO2 and other local pollutants (Agamuthu, 2009). In their report, (E. Sabiiti et al., 2004) explain that the impact of agricultural waste on the environment depends not only on the amounts generated but also on the disposal methods used and some of the disposal

practices that pollute the environment. For example, agricultural waste burning is a common practice in developing countries, but it is a source of atmospheric pollution. According to Tumuhairwe et al. (2009), agricultural waste burning releases pollutants, such as carbon monoxide, nitrous oxide, nitrogen dioxide and particles (smoke carbon). These pollutants are accompanied by the formation of ozone and nitric acid; hence, they contribute to acid deposition and pose a risk to human and ecological health.

In summary, the goal of any country's should be to consider the use of agricultural waste as a resource for utilization and not just discarding. Moreover, it is also important to set up private and public institutions that can collaborate and harness the significant potential of agricultural waste as raw materials or materials for building work that uses the appropriate conversion technologies and management methods. Nevertheless, there is a need to study the utilisation of agricultural waste globally.

2.8.2 Agricultural Waste Utilisation

According to, agricultural waste generation may, therefore, be obtained from the sector such as from horticultural fruit growing, seed growing, dairy farming and livestock breeding/keeping, the use of land for grazing, meadowland, market gardens and nursery grounds, and the use of land for woodlands where its use is ancillary to the farming of the land for other agricultural purposes. Furthermore, agricultural waste covers all that can occur on a farm or croft and includes activities such as slurry spreading, chemical and waste storage, silage making and waste pesticide disposal (Obi et al. 2016c).

Many countries in the world are adopting various legislation to classify waste from farms into different categories to help in the easy identification of waste products. Also, some of this waste generated in farms can be converted into various commodities or products that can be used on the farm or in other forms, as discussed in section 3.9.3 and section 3.94. Moreover, these agricultural waste materials can be converted to different products ranging from solid, liquid and gaseous items which can be beneficial to end-users and generate more income to the innovator (Obi et al., 2016c). Therefore, the products produced by this waste are generally non-expensive compare to those currently in existence; this is due to the cheap cost of production. As a result of recent interest in agricultural waste innovation, many products have been innovated from agricultural waste materials and the most common product that is

gaining global recognition is the Biomass that generate biological gas called Biogas. This can be used both as a household gas and as a commercial power generating gas. Lots of agricultural waste materials have been used to generate biogas, ranging from animal waste materials to plant waste materials.

Turning agricultural wastes, i.e. crop residues and animal manures, into organic fertilizers (through composting) is one of the waste treatment technologies that make it possible to use organic waste as a fertilizer, even in populated areas. Amodu et al. (2007) confirm that technology plays a key role in the improvement of soil fertility, and hence crop productivity, where the organic manure generated is used. Brouwer et al. 1998) in their study explain that the use of organic fertilizers is particularly important in most parts of Africa, i.e. Nigeria, where the low availability of nutrients is a serious constraint for food production, and finance to buy inorganic fertilizer is a serious issue due to the economic situation of the farmers. Also, composting reduces the volume of the waste, hence solving serious environmental problems concerning the disposal of large quantities of waste. It kills pathogens that may be present, decreases the germination of weeds in agricultural fields, and reduces odour. The compost can be sold for additional revenue or used on the same farm. Besides, the production of composts for agricultural use is gaining in popularity as a result of the rising interest in organic products, such as goat meats and maize. However, in Nigeria agricultural waste management and innovation for construction purpose have not gained any meaningful recognition despite the enormous potential that lies within the waste. Furthermore, the agricultural sector has suffered neglect in recent years due to the exploration for crude oil; this has meant that turning waste management into building materials for sustainability has been impossible.

2.8.2.1 Agricultural Waste Usages

Waste from agricultural production comprises 30–60 per cent of the product that is used for human consumption and animal feed. An additional 30 per cent is made up of wastes from humans and animals. However, traditional methods of using crop residue and cattle dung are of low efficiency and deprive agricultural lands of the organic matter needed and the plant nutrients. Also, such methods are a constant hazard to human and animal health and represent a major source of environmental pollution.

There are other ways to use agricultural waste, including (Obi et al. 2016a):

- Composting

- Animal feed production

- Mushroom culture.

- Biogas production.

- Building construction work

Furthermore, in Nigeria different kind of waste has become a threat to the environment, ranging from household waste to agricultural waste. However, in the context of this research, many researchers have worked on various areas to convert or innovate agricultural waste into meaningful products. Nonetheless, researchers have not considered the innovative approach system that will assist in managing the potential that lies within agricultural waste for construction and other purposes. The discussion in the following section provides a clearer view of the potentials that lie in agricultural waste.

2.8.2.2 Composting

Compost is a mixture of crop residues and animal manure fermented together for a period under aerobic conditions. Compost is used for plant nutrition in organic agriculture and is the cornerstone of the nutrient resources to conserve soil fertility. Compost plays a variety of roles in soil fertility and productivity, including:

- Providing soils with the required humus to improve the soil's physical properties

- Decreasing the water volume needed for irrigation by increasing the soil's capacity to hold water

- Building soil structure

- Increasing the capacity of the soil's molecules to exchange cations

- Adding elements required by plants to the soil

- Increasing soil aeration

- Generating more income for farmers

- With the increasing availability of nutrients and improvements in the chemical and physical structure of the soil, crop production also increases (Obi et al., 2016a).

The use of organic compost reduces pollution, and consequently health problems with pathogens available in raw animal wastes. In the composting process, heat reaches 70°Centigrade (C) for several days, which kills bacteria, protozoa, and weed seeds.

2.8.2.3 Animal Feed Production

Animal feeds are generated directly from agricultural waste or as a component of such feeds. This is one of their oldest and most widespread methods of disposing of these wastes. In rural African countries and Asia, cellulose residual plant waste plays an important part in animal production. Agricultural waste used as feeds is lower in value than those specifically processed for animal production. The residual agricultural wastes are high in fibre, low in protein, minerals, and vitamins (USEPA, 2012).

Several methods for increasing the feed intake and efficiency have been developed through the physical, chemical and microbial treatments of the raw materials. Processes for increasing the digestibility of agriculture residues and the availability of nutrition to the animal include (Obi et al., 2016a):

- Physical treatment:

    Shredding dried crop residues and mixing them with green wastes or clover

    Producing green fodder without soil.

- Biological treatment:

    Producing silage from fresh agriculture residues and/or such residues mixed with green wastes

    Improving dried crop residues through the use of white-rot fungi to increase the nutritional value

- Chemical treatment:

    Spraying or mixing agricultural residues with a urea solution

    Injecting agricultural residues with anhydrous ammonia

    Mixing agricultural residues with sugarcane molasses

2.8.2.4 Biomass/Biogas

Biomass is a group of organic materials currently made from plants and animals. It the fourth largest source of energy in the world and provides about 14% of primary energy. Developing countries derives 35% of their energy from biomass and for many, it offers over 90% of the total energy used in the form of traditional fuels, e.g. fuelwood and dung. Since 90% of the world's population may reside in developing countries by 2050, biomass energy is likely to remain a substantial energy feedstock (Küçük and Demirbaş, 1997). Biogas has rising demand

and promising potential in production in the country. Thus, this paper had reviewed and surveyed the status and potential of biogas production from biomass and agricultural waste, the existing biogas technology and biogas utilisation, its driving forces, and future aspects.

Historically, the reason behind developing biogas technology was the search for an alternative energy source; however, other environmental aspects and organic manure production have gained additional, often major, importance. The biogas plant is designed to process animal manures and organic waste to produce biogas and sludge and to control environmental pollution. The plant consists of two main parts: a digester (or a set of them) where the organic materials are organically processed; and the gasholder (or a set of them) where the biogas is collected and stored pending use.

Biomass energy has traditionally been used for cooking and baking, which was done in low-efficiency stoves or on open fires. Also, the removal of these nutrient-rich resources from the fields deprived the soil of much-needed fertilizers and their replacement often means the use of chemicals (Kücük and Demirbas, 1997). Nevertheless, biogas technology has the potential to improve the energy release from agricultural residues, save plant nutrients, and improve health conditions and quality of life in rural communities. Biogas technology provides (Kücük and Demirbas, 1997):

> • Clean and convenient fuel for cooking, lighting, and heating
>
> • Electricity for irrigation pumps and other internal combustion engines
>
> • Manure that is richer in nitrogen, phosphorus, and potassium (NPK); contains suitable amounts of micro-nutrients; acts as a growth regulator; and is freer of pathogens and parasites than traditional farmyard manures

Chaiprasert (2011) explains that the demand for energy has been increased over the years as the sequence by increasing the world population and expansion of global industries, especially for food and feed. Most of the energy consumption is from power generation, transportation, industry, and community sectors. Moreover, the most utility energy, are taken from fossil oil, gas and coal. Many developing countries have their policy to find alternative energy, such as biomass, biogas, solar energy, geothermal, hydropower, wind energy and ocean energy. The concept of the alternative energy aims to replace or substitute the need for petroleum by other resources to and to reduce the main issues associated with global warming. Since most countries in the world heavily depend on imported energy oil to

fulfil their energy requirements, to secure a country's energy security and its sustainable development as well as to minimise any environmental impacts, there is a need to promote and support the utilisation of alternative energy and improve energy efficiency.

2.8.2.5 Activation Carbon

Activated Carbon (AC) is produced from palm kernel shells (PKS) by an acid activation method that occurs at temperatures of 600°C. Ho and Ofomaja (2005) studied the effects of the carbonization and acid impregnation times on the absorption potential of AC and its purification of contaminated rain and flowing river water bodies. The AC produced from the palm kernel shell after two days of acid impregnation was followed by three hours of carbonization; this process purified both water bodies better than others on the reduction of microbial and micro impurities of water bodies. The production of AC from PKS is a valuable addition to oil palm processing; it boosts the national economy and has a positive environmental impact on the people who produce and use PKS. Hence, multiple-product derivations, such as bioenergy and biochar production for absorption purposes from palm kernel shells, are encouraged in process industries, as opposed to the sole traditional combustion for heat production (Ho & Ofomaja, 2005).

2.8.2.6 A Lightweight Aggregate for Concrete

These concrete mixes of widely opposing water/cement ratios were made using palm kernel shell as coarse aggregate. The physical properties of the shells and the compressive, flexural and tensile splitting strengths of the concrete were tested; these properties were compared with those of similar concrete specimens made with crushed granite as coarse aggregate. Results of the tests suggest that a palm kernel shell cannot produce concrete with a compressive strength above 30 MPa. However, for concrete grade 25 and below, the material was found to compare favourably with another conventional aggregate, such as crushed granite (Okafor, 1988; Olanipekun et al. 2006). Furthermore, these aggregates have been used in many advanced and developed countries to reduce the amount of aggregate used.

2.8.2.7 Asbestos-Free Friction Lining Material

Friction materials are applicable for braking and transmission in various machines and equipment. Their composition keeps changing to keep pace with technological development

and environmental/legal requirements. For more than 80 years, asbestos has been used as a friction material because of its useful physical and chemical properties (Ibhadode and Dagwa 2008). However, due to the health hazards associated with its handling, it has recently lost favour and several alternative materials are being increasingly used (Ibhadode et al., 2008). Recently, an asbestos friction material was developed using palm kernel shell (PKS), coconut shell and other agricultural waste shells - along with other constituents. For this, the Taguchi optimization technique was used to achieve optimal friction material formulation and manufacturing parameters (Aigbodion et al., 2010). The derived friction material was used to produce automobile disk brake pads, and they were tested for wear and effectiveness on a car (Aigbodion et al., 2010). He concludes that the brake produced performed satisfactorily when compared with a premium asbestos-based commercial brake pad. However, more pad wear was observed on the shell's pad at high vehicular speeds beyond 80km/hour.

2.8.2.8 Bio Briquette

Briquetting is a process of binding together pulverized carbonaceous matter, often with the aid of a binder (Oladeji, 2012). Somsuk et al. 2008) the most common forms of briquette are coal and the biomass. Biomass briquettes mostly originate from agricultural residue; this includes the charcoal briquettes that are generated from palm kernel shells through the conversion system. The advantages derived include:

1. An easier way of getting an energy supply for domestic needs, such as cooking and the ironing of clothes. This is because the briquettes can be transported easier than the agricultural residue (Ugwu et al. (2013).

2. Cleaner emissions than wood and other dried plants usually used for rural energy supplies (Ugwu et al., 2013).

3. It converts waste to energy as the raw material for making briquettes are sourced from materials that would have been chunked.

4. They can be used in stoves and boilers (Martin et al., 2008)

5. They increase the strength, density, and heat emitted per volume of the biomass (Martin et al., 2008).

2.8.2.9 Energy Source

The palm oil effluent initially used to be dumped in the open thereby negatively impacting the environment without any economic benefit. However, over time, the benefit of its properties as fuel was realised, and that they could easily replace coal as industrial fuel for generating heat and steam; this has subsequently made it an essential commodity (Sumath et al. 2008).

Nowadays, the primary use of agricultural waste, such as affluent, coconut shell, sugarcane shaft, is as boiler fuels supplementing the fibre and this used as the primary fuel. In recent years, kernel shells are extensively sold as alternative fuel around the world (Sumathi et al., 2008). Besides selling shells in bulk, some companies produce fuel briquettes from shells, which may include the partial carbonisation of the material to improve the combustion characteristics. Palm kernel shells have a high dry matter content (>80% dry matter); therefore, the shells are generally considered a good fuel for boilers as it generates low ash amounts, and the low K and Cl content will lead to less ash agglomeration. These properties are also ideal for the production of biomass for export (Sumathi et al., 2008).

6. As a raw material for fuel briquettes, palm shells are reported to have the same calorific characteristics as coconut shells. The relatively small size makes it easier to carbonise for mass production, and its resulting palm shell charcoal can be pressed into a heat efficient biomass briquette (Sumathi et al., 2008).

2.8.3 The Utilisation of Agricultural Waste as Building Material

Many factors have contributed to the recent surge in the utilisation of agricultural waste as building construction materials. Furthermore, many kinds of literature had explored the different types of building materials produced locally. It has now become important to utilise agricultural waste as building materials. Pappu et al. (2007) explain that this demand was caused by population growth and improved standards of living. Furthermore, technological innovations have contributed to the increasing quantity of a variety of waste generated by industrial, mining, domestic and agricultural activities. However, the disposal of these wastes has become a major environmental problem and thus the possibility of recycling solid waste for use in construction materials is becoming increasingly important. Many countries in the

world are now embracing the use of agricultural waste from developed to developing countries. The next subsections outline the agricultural wastes presently utilised as construction materials and their products.

2.8.4 Agricultural Waste and Utilisation in Nigeria

According to Sridach (2010), there is increasing global interest in the agricultural residue. The need to promote the use of agricultural waste is influenced by the increase in the production rate of agricultural items, as man seeks to improve his quality of life by transforming nature to provide more food, better conditions and longer life (Hall et 2009). Agricultural mechanisation and technology have helped to accomplish this change; however, this change has left a progressive environmental problem. The problems associated with agricultural waste and its management are numerous and could escalate into a disaster, resulting from improper management. Furthermore, a lack of adequate information on the quality of waste generated, its handling, treatment and disposal have been a constraint to the industrial utilisation of agricultural waste in Nigeria where farmers in most parts of the country have concentrated on the rigorous production of field crops which has led to the generation of large quantities of agricultural waste (Ogunwusi, 2014). Nevertheless, the quality, quantity and properties of this waste have not been researched in detail in Nigeria. Moreover, the geographical distribution of the country into zones through climatic locations, coupled with the distinctive characteristic of the zones, impacts the major types of agricultural waste generated that can be used in the construction industry and other industries. These are presented in Table1. In most cases, this agricultural waste provides cheaper raw material than any raw material exported for construction purposes and helps in the greenhouse generation and sustainable development programmes in construction industries in Nigeria.

S/N	Ecological Zone	States Involved	Agricultural waste
1	South West	Oyo, Ogun, Ondo, Osun, Ekiti, Lagos	Maize (cub, shaft, brow) rice brow, palm kernel shell and shaft, bagasse, coconuts shell

2	South-South	Edo, Delta, Bayelsa, Rivers, Cross River, Akwa Ibom	Maize straw, palm kernel and coconut shell
3	South East	Anambra, Enugu, Imo, Ebonyi, Abia	Maize straw, palm and coconut shell
4	North Central	Plateau, Benue, Niger, Kogi, Jigawa, Zamfara	Sorghum straw, rice straw, benissed straw, bagasse
5	North West	Kaduna, Kano, Sokoto, Kebbi, Jigawa, Zamfara	Sorghum straw, Millet straw, Beniseed, Bagasse
6	North East	Bauchi, Gombe, Taraba, Yola, Adamawa, Yobe	Bagasse, sorghum straw, millet straw

Table 1: Agricultural Waste Generated in Different Ecological Zones in Nigeria. (source adapted from Ogunwusi, 2014)

Furthermore, to understand this agricultural waste, Figure 3, Figure 4, Figure 5, Figure 6shows the various types of agricultural waste that have the potential for utilisation for building construction purposes.

Figure 3: Palm kernel shell left unprocessed to waste in Ijagbo. (source: Tomiwa, 2010)

Figure 4: Maize cub litter on an agricultural farm in Modakeke, Osun State, Nigeria (source: Tomiwa, 2017)

Figure 5: Hips of rice brow after milling in Yelwa Rice Mill, Bauchi, Nigeria (source: Tomiwa, 2016)

Figure 6: Palm fund and effluent waste pilings (source: Tomiwa, 2016)

2.8.4.1 Palm Kernel Shell as Lightweight Aggregate for Concrete and Ceramics

One of the predominant agricultural waste in Nigeria is palm kernel shell (PKS). Palm Kernel Shell (PKS) is an economically and ecologically sustainable raw material for renewable energy industry (Okoroigwe and Saffron, 2012). Historically, oil Palm origin had been linked with the tropical rainforest of West Africa but in recent years has spread to most of the equatorial tropics of South-East Asia and America (Sheil et al., 2009). With this spread, the by-product from these palm oil has formed part of foreign income earner for most of the Asian countries such as Malaysia, Indonesia and Thailand and after production of palm oil and the kernel oil production, palm oil effluent, kernel shell and empty fruit bunch are regarded as wastes (Abdullah and Sulaiman, 2013). According to Abdullah and Sulaiman, (2013), about 0.07 tons of palm shell, 0.103 tons of palm fibre and 0.012 tons of kernels are produced as the solid wastes for every ton of oil-palm fruit bunch being fed into the palm-oil processing plant. The amount of each component waste generated from palm oil (PO) and Palm Kernel Oil (PKO) processing may be attributed to the type of oil palm species dominant in the quantity being processed.

However, in modern construction, lightweight ceramics and aggregate material are in vogue. These types of ceramics are made in the form of clay bricks and block are generally adopted and used in modern-day construction. However, to manufacture these lightweight ceramic

materials, agricultural waste is used as the forming agent- this agricultural waste includes rice husk, straw of rye and barley, palm kernel shell and husk, etc (Bogdanov et al. 2012). Furthermore, the usage of these burnable materials as absorbent forming agents for the production of lightweight insulating bricks has two main advantages - the necessity for less energy due to the large amount of energy that is released during combustion by-products and reduces the cost of material that would have been incurred using other combustible materials (Al-Marahleh, 2005). Consequently, this is an unconventional method for the efficient utilization of large amounts of agricultural waste materials. Using agricultural waste like PKS, rice husk manufacturing. Investigations showed that interest in rice husk is increasing worldwide. It is connected with the leading role of these waste products cannot be used as food, fertilizer or fuel. In this aspect, utilization of the large amounts of this material elimination certain ecological threat that has been in using chemically produced material and promote sustainable development. Furthermore, this PKS has been the study and used in the production of lightweight cement/ sand aggregate and the shell used has physical properties of the shell, the compressive, flexural and tensile splitting strengths of the concrete were tested and these properties were compared with those of similar concrete specimens made with crushed granite as coarse aggregate. Results of the tests suggest that palm kernel shell cannot produce concrete with compressive strength above 35 MPa. However, for concrete grade 35 and below, the material was found to compare favourably with another conventional aggregate such as crushed granite (Eziefula, 2018).

2.8.4.2 Fly Ash, Rice Husk Ash and Coconut Husk Ash as an Additive for Concrete Work

Fly ash is a by-product from burning crushed coal in electric power generating plants. During combustion, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters (Prodan, et al. 2017). Prodan et al., 2017) explain that the fine powder resembles Portland cement with slight differences in composition. However, cementitious properties are exhibited to varying degrees depending on the chemical and physical properties of both the fly ash and cement. In comparison to cement, Aprianti et al (2015), argue that supplementary cementing

materials are widely used as pozzolanic materials (creating extra strength by a pozzolanic reaction) in high-strength concrete, to reduce the permeability and improve the durability of the concrete. Many types of pozzolans are used globally and are commonly used as an addition or replacement for Portland cement in concrete. It is well known that pozzolanic concrete contributes to the compressive strength in two ways: first, as the filler effect and second as the pozzolanic reaction. Thus, the pozzolanic material could reduce the demand or usage of cement.

2.8.4.3 Expanded Cork

Cork is a natural agricultural waste material obtained from the cork oak. Corkboards are products obtained through the natural agglomeration of granules in their resin and can be used in any environment and climate conditions (Aciu and Cobîrzan, 2013). Furthermore, the lengthened cork board is a material generated from agricultural waste with very good thermal insulating and acoustic properties (Figure 7). It is stable during extending and compression (elastic), has an antibacterial wall, is antiallergenic, fire-resistant, durable and it does not absorb water through capillarity. This material is readily available to use in the construction industry. Figure 7 below shows the finished product from cork waste.

Figure 7: Corkboard made from cork waste (Source:(Aciu and Cobîrzan, 2013)

2.8.4.4 Hemp

Hemp is one of the oldest cultivated plants; it has an important contribution to the supply of mankind's need through clothes, paper, oil, fuel, and food. Hemp can reach four meters in height in 100-120 days (Aciu and Cobîrzan, 2013). Nevertheless, in construction, hemp is used as insulating pads of various sizes that are easy to handle and install (Figure 8). Furthermore, in the construction industry, products made from the flux are recommended for the insulation of roofs, walls and floors, with their thermal conductivity coefficient $\lambda \approx 0.040$ W/m K [10] (Aciu and Cobîrzan, 2013). One of the advantages of hemp beds is the good diffusion capacity of the product that ensures the automatic regulation of humidity and allows for healthy indoor climatic conditions and reduces the carbon emission due to the natural nature of the raw material used. Meanwhile, hemp fibres do not contain albumin, therefore no treatment against moths and beetles is necessary (Aciu and Cobîrzan, 2013). Whether insulation is intended for new or old buildings, the installation of the insulation poses no problems for users. Clean, almost dust-free processing, good skin tolerance without the presence of irritations, as well as good insulation values, make this product a good building material (Aciu and Cobîrzan, 2013). Protection against freezing during winter and adequate protection against high temperatures during the summer months is guaranteed. Research has shown that there is the potential for the utilisation of agricultural waste as building materials and the need to develop how the waste material is managed by all key players in form of an organisational level with linkages and collaborations.

Figure 8 below shows a typical hemp bed made from hemp flux an agricultural waste

Figure 8: Hemp bed for thermal insulation (source; (Aciu and Cobîrzan, 2013)

Thus, countless agricultural waste products can be used as raw materials for the production of building materials.

2.8.5 Manufacturing building material using agricultural waste in Nigeria.

Either a developed or developing country, manufacturing has always taken a leading role to ensure economic development (Karjust et al. (2019). Furthermore, any country that does not take manufacturing that does not have a strong policy or legislation about manufacture and production is driving towards economic doom. There is no way a country can be progressive without having studied what and what needed to be manufactured within or outside based on the availability of the raw material for the production of that said material or product (Rautetal. 2011). However, in the construction industry, materials quality and supply is one of the aspects that is well-considered and deliberated upon before the commencement of any building project. Also, the quality of the material and cost is considered (Costopoulos and Newhouse, 1987). However, in most project material cost has been the bane of building project delivery where price fluctuation due to the unstable foreign exchange rate (Makinde, 2014). These challenges happened as most of the material used for construction are imported, especially in Nigeria (Ezeigwe, 2015). Starting from raw materials and building products delivery for small- or large-scale structures, whether new or redevelopment projects, the business of manufacturing and delivering building materials and products can be intricate and challenging. Faraway from being a single activity, the delivery of building and

construction materials can be an exploit of multi-tasking between designers, project managers, architects, and all other stakeholders that are involved.

However, with the current global economic meltdown, importation of building material has become too expensive and has caused a shortage in the delivery of housing unit for the Nigerian populace be it private or public developers (Ezeigwe, 2015). Recently, research has shown that some even not most of these materials can be manufacture and be produced in large scale if the usage of waste generated from agriculture can be used to produce some of the building materials as discussed in subsection 2.8 and subsection 2.9. But, one of the problems is the acceptance from local and indigenous manufacturers to accept this new approach. The main reason is that most of these companies are owned by a politician that are using this company to carry out money laundering activities. Until the strong policy is been enact in Nigeria about using agricultural waste the shortage of housing delivery will still be in existence in years to come. Another, the challenge is that will the indigenous manufacturer and suppliers of building products maintain a strong reputation for reliability, quality assurance and that reputation of getting your customers what they need when they need it. To do this promptly and profitably demands visibility across your entire supply chain combined with the flexibility to act quickly.

2.9 Agricultural Innovation System

2.9.1 Agricultural Innovation

Technological change has been a major factor in shaping agriculture in the last 100 years (Sunding and Zilberman, 2001). A comparison of agricultural production patterns in various countries around the world in this technological age shows that the share of the agricultural labour force has decreased substantially (from 26 to 2.6 per cent), and the number of people now employed in agriculture has declined (from 9.5 million in 1920 to 3.3 million in 1995). Nevertheless, agricultural production in 1995 was 3.3 times greater than in 1920 (Alston et al. 2010). Substantial international changes in production patterns have occurred, although the world population has more than doubled between 1998 and 2014 (Alston et al., 2010).

Furthermore, innovation within agricultural research and technological change is fast becoming a popular area to study to understand how society generates, disseminates, and

utilises knowledge, and how such systems can be strengthened for better social advantage. In recent years, the literature on theoretical innovation systems has helped to transform research from the conventional, linear perspective on agricultural research and development (R&D) to the provision of a framework for the analysis of complex relationships and innovative processes that occur among multiple agents, social and economic institutions, and endogenously determined technological and institutional opportunities (Bientema and Stads, 2005). Thus, an innovation systems framework in agriculture demonstrates the importance of studying innovation as a process in which knowledge is accumulated and applied by various agents through complex interactions that are conditioned by social and economic institutions (Bientema and Stads, 2005).

According to Agricultural Knowledge and Innovation Systems (AKIS), which propose and develop practical ideas to support innovation, knowledge transfer and information exchange, AKIS development develop innovation policies that need to reflect the way innovation occurs today. This often occurs through a diffuse network of actors who are not necessarily focused on the traditional research and development shown in *Figure 9*.

Source: (Birner & Spielman, 2007)
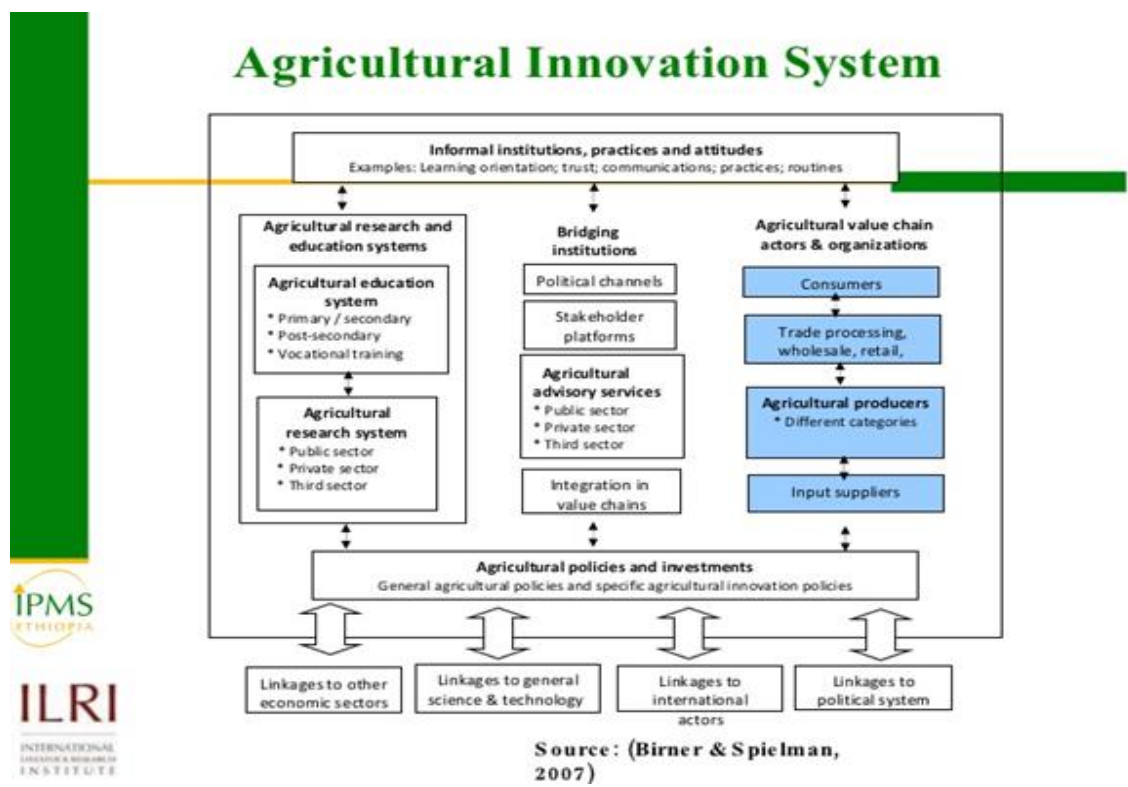
Figure 9: Possible actors in the agricultural innovation system. (source: adapted from Birner and Spielman, 2007)

2.9.2 Agricultural innovation Summary

In line with the literature reviewed, the agricultural sector is developing within a period of rapid markets, and technological, social, and environmental developments that are occurring unpredictably. This is an era when collaborative aptitude will be used and where the ability to use knowledge effectively in response to changing circumstances will characterise a country's resilience to universal agricultural problems, as shown in Figure 6. Managing and thriving in this new era will require scientists, policymakers, the public and private sectors, consumers, and entrepreneurs to collaborate to mobilise knowledge and continuously innovate in the face of change. In summary, the literature identified some key issues concerning agricultural innovation. An agricultural innovation system comprises the organisations and individuals that demand and supply knowledge and technologies, and the policies, rules and mechanisms that affect the way different agents interact to share, access, exchange, and use knowledge.

- Agricultural innovation is rarely triggered by agricultural research and, instead, is most often a response of entrepreneurs to new and changing market opportunities.

- Agricultural sectors begin to fail because, with ever-changing market demands, patterns of interaction between entrepreneurs, farmers and other sources of technology and information are insufficient to support a knowledge-intensive process of innovation continuously.

- A lack of interaction weakens the innovation capacity and reflects deep-rooted habits and practices in both public and private sector organisations. Moreover, mechanisms at the sector level that are critical for coordinating the interaction needed for innovation are either overlooked or missing.

- The market alone is not enough to promote interaction and collaboration; the public and private sector have a central role in developing and adopting habits and practices that foster the capacity to innovate, which integrates pro-poor and pro-market agendas.

- Social and environmental sustainability are integral to economic success and need to be reflected in patterns of participation and collaboration that are considered when strengthening innovation capacity.

2.10 Opportunities and Benefit of Utilising Agricultural Waste as Building Materials in Nigeria

Studies have shown that agricultural waste could be processed into liquid fuels or combusted/gasified to produce electricity and heat (Enweremadu and Ojediran, 2004). Moreover, agricultural waste in recent times has been innovated to produce various commodities and products. Ibhadode and Dagwa (2008) discovered that palm kernel shell (PKS) can be used to develop an automobile brake pad as a substitute for asbestos. The mechanical and physical properties compare well with the commercial asbestos-based friction lining material. Its performance under static and dynamic conditions compares well with the asbestos-based lining material. They recommend that the further refinement of the PKS lining formulation is recommended to ensure comparable wear rate at higher vehicular speeds. A comparative study carried out by Evbuomwan et al. (2013) determined the Physio-chemical properties of the absorption of PKS as activated carbon for water purification. The result discovered that the activated carbon prepared from palm kernel shells have better Physio-chemical properties for absorption than that prepared from oil palm fibre. Furthermore, PKS and OPF are suitable for the removal of toxic metals, such as Cadmium, Lead and Chromium, since these toxic metals are not detected; therefore, PKS is good for water purification. In construction, agricultural waste possesses significant potential as a raw material to produce building materials. A study by (Olutoge et al. 2012) found that ashes contain all the main chemical constituents of cement in varying quantities in comparison to OPC; therefore, shell ashes are an appropriate replacement if the right aggregate is added. Furthermore, the use of PKSA as a partial replacement for cement shows a lower water absorption rate and slower setting time for concrete. Moreover, concrete strengths increase with curing age and decrease with an increased percentage of the PKSA replacement in concrete. The advantage of using PKSA as a replacement for OPC includes the reduction in the volume of cement used in concrete, which also reduces the cost of concrete production,

minimises the environmental hazards caused by agricultural waste and improves waste management practices.

According to Enweremadu et al. (2004), the main benefits of the use of agricultural waste as Biomass to generate energy are; rural economic development, an increase in farm income, market diversification, reduction of agricultural commodity surpluses and derived support payments (risk-averse), the enhancement of international competitiveness, the revitalization of underdeveloped rural economies, and the reduction of negative environmental impacts. The new incomes for farmers and the rural populace could improve the material welfare of rural communities and therefore, result in the further activation of the local economy. Jekayinfa and Omisakin (2005) explain that the innovation of agricultural waste will eventually help to reduce the emigration to urban environments. There is also the added advantage of the creation of several jobs in the area of production, harvesting and use. The use of agricultural wastes as energy also has many unique merits that provide environmental benefits. It helps to mitigate climate change and reduce acid rain, soil erosion, water pollution and the pressure on landfills. It also provides wildlife habitat and helps to maintain forest health through better management. Thus, the main benefit and opportunities important in the utilisation of agricultural waste in Nigeria are:

- Cost-effectiveness,
- Improved accessibility,
- Generation of employment,
- Creation of economic activities,
- Improved waste management practices,
- Improved environmental sustainability and forest health.

2.11 Potential Factors Responsible for Non-Utilisation of Agricultural Waste as Building Materials in Nigeria

The rapid increase in the world's population together with urban movement has increased food demand worldwide. However, the increase in the world's population has led to an increase in the amounts of agricultural waste generated both at the farmer, municipal and city levels. The bulk of the agricultural food in developing countries is transported to cities in its raw forms, thus compounding the net effect on large deposits of waste in urban markets,

around homes and in slums as well as in various dumping grounds (Sabiiti, 2011). In Nigeria, the rural area and sub-urban area have suffered great environmental degradation due to the high volume of agricultural waste. However, the urban areas and the megacity are also experiencing a substantial amount of agricultural waste due to food transportation from rural areas to urban settlements. However, to reduce the level of impact caused by this waste in Nigeria, it can be managed as a useful range of commodities if it is addressed. Most of this agricultural waste has been established and identified as a potential raw material for utilisation as a building material. However, some factors are responsible for the non–utilisation of these potential raw materials in producing sustainable building material in Nigeria.

Studies have been carried out by various researchers on the agricultural sectors concerning the factors responsible for agricultural waste management and there is need to extend the research to further areas that explore the direct benefit of the use of agricultural waste as building materials. Nevertheless, when utilising agricultural waste as building construction material, it is envisaged that challenges will abound and therefore there is a need to examine these presumed or existing challenges. Although it is recognised that the accumulation of waste has considerable ill effects on humans and the environment, such waste, if properly managed, could be considered an important bio-resource to enhance food security in the smallholder farming communities that cannot afford inorganic fertilizers. These organic wastes contain high levels of Nitrogen, Phosphorus, Potassium and the organic matter that is important in improving the nutrient status of soils in urban agriculture. Madurwar et al. 2014) identify various factors that intensify the problem of agricultural waste, especially in developing countries where there are limited waste recycling facilities. Most of the nutrients are leached from the damp fills and end up polluting water bodies; however, this has been associated with the invasion of water weeds. Most importantly, there is a lack of planning, poor public awareness, poor government policy and laws, and a lack of (or the insufficient) utilisation of resources. In Nigeria, agricultural waste is referring to as A-class solid waste and can be found in every area of the country, i.e. from megacities to rural areas. The deposit of this waste has caused enormous damage to Nigeria's ecological system, water bodies and the health of its populace (Kalu et al. 2009). Furthermore, in a report submitted by Water Aids in

October 2011 on challenges of solid waste in Nigeria, the following challenges were listed as mitigating against solid waste innovation in Nigeria:

- Institutional challenges: a lack of mutual information sharing between private and public sector partnerships, R&D, inadequate industrial partnership, a lack of relevant knowledge and technical know-how and a lack of incentives from the private and public sector.

- Infrastructural challenges: Basic amenities, a lack of adequate research centres, etc.

- Socio-economic challenges: political instability, the ethnic bias in policymaking, corruption. The marginalisation of the agricultural sector in favour of the oil sector, a lack of finance due to oil sector biases, the culture that places value on imported items.

- Legal challenges: a lack of laws that safeguard waste management and agricultural waste innovation and management, a lack of implementation of the available policies on innovation, the unavailability of appropriate local content laws, and impediments by local regulatory bodies

There is insufficient literature or research to adequately address the factors responsible for the non-utilisation of agricultural waste as building materials. However, most literature tends toward the innovation of agricultural waste and falls within the same factors, which are mainly:

- A lack of mutual information-sharing between private and public sector partnerships,

- A lack of research and development within the collaborating organisations and research centres

- A lack of relevant knowledge and technical know-how

- A lack of incentives from the private and public sector.

- Political instability and ethnic bias in policymaking.

- The corruption and marginalisation of the agricultural sector in favour of the oil sector.

- A lack of finance and funds

- Placing more value on imported building materials.

- A lack of laws that safeguard waste management and agricultural waste innovation and management

- A lack of implementation of the available policies on innovation, the unavailability of appropriate local content laws, and impediments by local regulatory bodies.

However, the researcher will focus on these areas in this study to validate these factors and properly address the factors responsible for the non–utilisation of agricultural waste as a building material from data collection. Furthermore, to effectively develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building construction material, there is a need to adopt critical success factors (CSF) that help to improve innovation and the utilisation of agricultural waste as raw materials in building projects. The next section will discuss with the CSF for enabling an effective innovation system.

2.12 The Critical Success Factors that Enable the Improved Utilisation of Agricultural Waste as Building Materials

This section examines the critical success factors that influence successful innovation, construction innovation and agricultural innovation. The section is divided into three categories; the CSF that affects innovation and process, the CSF that affects construction innovation, and the CSF for an agricultural innovation system. The findings from the three categories are compared and analysed to identify the likely CSF to affect innovation management and assist in the utilisation of agricultural waste as building materials.

The literature review generally comes from leading international journals in the field of construction, agriculture, management, and engineering. Moreover, some relevant books and Internet materials, such as Managing Innovation in Construction, Innovation Ecosystem and Agricultural Innovation for Developing Countries, were also fully studied to gain a broad understanding of the CSFs for construction innovation, innovation systems (ecosystems) and agricultural innovation. After collating and analysing the existing literature, a summary of relevant literature that explored the CSF of innovation systems (ecosystems), construction innovation and agricultural innovation are shown in Tables 6, 7 and 8 respectively.

According to (Govindarajan and Trimble, 2012), innovation becomes successful when factors that determine the level of innovation progress are in place. Furthermore, they later mentioned that much research over the years has discovered the factors that separate successful innovation from less successful; however, they fail to mention these factors. (R. G. J. M. Cooper, 1999) explains that most modern industries understand the importance of

continuous improvement in the value they offer and in how they offer it as a factor, which can affect innovation success. However, a number of these companies do not understand that breeding and nurturing innovation requires an appropriate environment, as explained by (Maxamadumarovich et al. 2012). They also submit that the innovation ecosystem entails a complex range of economic, legal and societal inputs that allows innovation to flourish. Also, Jackson et al. 2011) argues that an innovation ecosystem framed the economic dynamics of the complex collaboration that are formed between the actors that enable development and innovation. She added that the actors in this collaboration include the material resources (funds, facilities, equipment, etc.) and human actors (students, researchers, industry, staff and industry representatives, etc.) that comprise the institutional entities participating in the system. She further explains that the fundamental expectation behind ecosystems thinking is to expand the capabilities of one actor beyond its own boundaries and to transfer knowledge into innovation in collaboration with others. Based on the aim of this research, there is a need for a suitable innovation ecosystem that meets different conditions. Furthermore, these conditions must address natural, structural, organisational and cultural factors.

One question is important: How can the existing innovation policy approaches of developed countries be adapted to work in developing countries? Aubert, 2004) states that the first step is to look at the innovation policy mix (ecosystem) where developed economies have a notable preference and adopted over the last decades, and to draw up the factors that enhance the successful implementation of the policy mix. Nevertheless, Aubert fails to discuss collaboration and interaction between the innovation actors. However, Padilla-Pérez and Gaudin, 2014) explain that the policymakers in developed countries follow an innovation system approach as a result of the complex interaction among all innovation actors, policies, and institutions. The reverse is the case when discussing the innovation system approach as individual governments and policymakers of the day make policies that are suitable to the desire and aspiration of their party. Furthermore, the dedicated innovation policies of nations should target both innovation actors and linkages among them. These include collaborative research projects, private-public partnerships, and clusters (OECD, 2010). OECD (2014) observes that developed countries follow a set of dedicated supply-and demand-side innovation policies.

However, in the course of this study, the researcher reviewed more literature about the factors that are documented as important to improve innovation. These factors are shown in Table 2 below with their corresponding references.

Table 2: The critical factors necessary for establishing an innovation system (ecosystem) based on examined literature

References	Success factors for an innovation system (ecosystem)
Watanabe and Fukuda, (2006)	Resource management, allocation, and availability
Samila and Sorenson, (2010)	Availability of different funding possibilities (private and public)
Adner, (2006)	Timing referring to all partners involved, strategy and leadership
Tassey, 2010; Iyer and Davenport (2008)	Good governance by continuous investments in infrastructure, clear role assignment, open to failure and chaos, pluralism of a diversity of agents, actors and organisations
Rohrbeck et al. (2009)	Own organisational structure, a flexible system that allows integration and expansion,
D'Allura, Galvagno, and Mocciaro Li Destri (2012)	Focus on the relationship between technology, innovation and industrial location, organisational culture and structure and sector
Fromhold-Eisebith, (2007	Clarity of purpose and attention to detail for innovation objective
Mezzourh and Nakara, 2012)	Distanced view on innovation and innovation culture
Iyer and Davenport, 2008)	Human resources management, top management support, innovation as an integral part of job descriptions
Carayannis and Campbell, 2009); (Rohrbeck et al., 2009	Involving researchers to get access to worldwide R&D community, university and industry collaboration, clustering and fostering interactions
Carayannis and Campbell, 2009; Freeman, 1995.	Use of a variety of partners, diffusion of new technology and institutional network

Pavitt, ((1984)	Technology source, innovation users' requirements and appropriability regime
Korres, (2013)	The organisational relationship, policy and politics, institutional setup.
Agarwal et al. (2009); Tan, (2014)	Organisational regional location, population, capacity and capability
Adeoti, (2005)	Resource mobilisation, Funding and grants the effective link between demand and supply in innovation
Rubens et al, (2011)	Encourages the idea of local clustering to encompass global, networked economies and various interdependent actors
Chesbrough, (2003)	Expanding the scope of potential participants of the innovation process from internal actors of the R&D function to the numerous possible co-creators and co-innovators outside an organisation
Adner and Kapoor, (2010)	Extends the cooperation and collaboration beyond the personal value capture of each actor and includes consideration of the challenges that different actors need to overcome to make sure that the value is created during the innovation

Having studied and reviewed the relevant literature on innovation from various writers and researchers, the researcher identifies the critical factors that can improve innovation systems (ecosystems). To streamline the factors further, the researcher identified the influential factors that address the current research objective and, in this area, seems to be primarily driven by the researchers´ scope of interest, as shown in Table 2. Therefore, it can thus be concluded that the existing literature only provides rather fragmented insights into innovation systems (ecosystems) and their implementation. Given the assumed importance of the CSF of innovation systems (ecosystems), there is a need for more intense research activities. This would simultaneously help to underpin the legitimacy of CSF innovation as a research field. The review of the papers suggests that factors for the successful implementation of innovation systems (ecosystems) can be identified in the areas of resources, governance, strategy and leadership, organisational culture, human resource management, people, partners, technology and clustering. Nevertheless, to identify the

critical success factor that enables the improved utilisation of agricultural waste as building materials, there is a need to further study the factors that drive construction innovation. This is discussed in the next subsection.

2.13 Critical Success Factors for Driving Construction Innovation

The construction industry is one of the most dynamic industries that drive any country's economic development and, with the recent interest in innovation across all sectors, there is a need to also consider this for construction. However, for innovation to succeed in this sector, some factors would drive innovation adoption. Therefore, this section considers the success factors that drive innovation in the construction industry.

Zwikael, (2009) argues that, due to the nature of the construction industry, every project is unique, which requires the use of required project management tools and techniques, as opposed to conventional standardised management techniques. Furthermore, he mentions that, if a project is completed on time, within the agreed budget and quality, then the project is deemed successful. However, evidence suggests that this is far from the truth. Hence, the construction industry needs to pay particular attention to its critical success factors if it is to survive the challenges posed globally, including the assumption that construction industry does not innovate (Toor and Ogunlana, 2005). Moreover, Yang et al. (2009) explain that the unique nature of each completed projects does not allow the critical success factors identified in one project/industry to directly transfer to another project/industry; rather, the unique nature can be referred to as innovation. However, the successful implementation of innovation requires major contextual changes, i.e. culture, business strategies, capacity and capability from the participants involved, which tends to be complicated. On the other hand, for innovation - whether technical or non-technical, linear or non-linear, dynamic or rigid - critical management skills are prerequisite to effectively manage the collaborative working relationship (Cheng et al. (2000). However, to ensure successful construction innovation, long-term stable collaborative interactions with proper partners should be implemented by developing a productive context and by using appropriate management skills (Cheng et al., 2000). Although Cheng et al. fail to proffer further solutions to the complex nature of the construction industry, Blayse and Manley, (2004) suggest that organisations must rely on the capabilities of other organisations to create innovations. He also explains that the selection of actors and their relationships with other actors must be considered as important for

initiating innovation in construction. However, the focus on the context of the findings is the channel towards success in improving construction innovation, and a movement to the development of a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials. Therefore, a range of literature was assessed and relevant success factors, in line with the area of interest for this study, were documented, as shown in Table 3.

Table 3: Factors that affect innovation in construction based on examined literature

References	Success Factors
Pinto and Covin, (1989)	Top management support in project schedule/plans; communication; troubleshooting; characteristics of the project team leader; power and politics; environmental effects;
Nam and Tatum, (1997)	Owner's leadership; the long-term relationship; employing collaboration of champions; the professionalism of project participants
Freeman and Soete, (1997)	Strong in-house professional R&D as well as the conduct of basic research; readiness to take risks; identification of a clear need and market research; effective internal and external communication
Cheng et al., (2000)	Adequate resources; funding; management support; mutual trust; long-term commitment; coordination; creativity; effective communication; perceived satisfaction of partners' expectation; compatible goals; proper innovation system
Kamara et al, (2002)	Organisational culture for knowledge sharing and learning
Rahman et al. (2014)	Close relationships between partners
Jones and Saad, (2003)	Linkage within and between organisations leading to collaborative relationships; developing and sustaining a supportive organisational culture for innovation; monitoring and sustaining innovation;

Van der Panne et al., (2003)	The strength of competition; R&D intensity with multidisciplinarity; organisational culture and structure; blended experience with innovation.
Bossink, (2004)	Environmental pressure; technological capability; knowledge exchange.
Chan et al., (2004)	Commitment to win-win attitude; regular monitoring of the partering process; a clear definition of responsibilities; ability to generate innovative ideas between partners.
Ozorhon et al., (2013)	Resource ties; actor bonds; activity links, team spirit. inter-organisational relationships.
Wan et al., (2005)	Decentralised structure: the belief that innovation is important; willingness to take risks; willingness to exchange ideas
Liu et al., (2014)	Planning and effective execution; product champion; external communication; customer involvement; market research and testing; launch
Bosch-Sijtsema et al., (2009)	Cooperation and innovation; collaborative attitude between partner firms; strategic importance of innovation project; new knowledge of the innovation project to business project; promoting knowledge sharing over project boundaries by boundary spanners
Kim et al., (2009)	Systematic methodologies to carefully and accurately monitor research innovation performance; strict incentive system
Forcada et al. (2013)	Organisational culture for knowledge sharing and learning
(Ozorhon et al., (2014)	Owner's leadership; integration and collaboration.

| Skibniewski et al., (2013) | Mutual trust; culture change for effective and on-going learning and innovation as the cooperation intention of partners. |

This review shows that construction innovation is mostly considered within a broad 'product system' perspective. Furthermore, this perspective incorporates the clients, contractors and consultants, together with a range of other players who are important to construction innovation. These other players include manufacturers, regulators, and technical support providers and professionals in various fields who are associated with the project (innovation). Thus, several key success factors are responsible for a successful innovation process in the construction industry and these factors improve construction innovation. The reviewed literature identifies the innovation success factors that are widely acknowledged as important to innovation outcomes in the construction industry. These include the identification of a clear need for change; the achievement of good linkage within and between organisations leading to more collaborative relationships; treating innovation as a corporate-wide task; adopting a strategic approach in the management of innovation; and enhancing client leadership, through high levels of technical competence, advanced demand patterns, and prudent risk-taking. Most importantly, an integrated approach to construction projects discourages the fragmented approaches with improvements in knowledge flows, by developing more intensive industry relationships. All this improves the construction innovation of an organisation. However, to successfully adopt CSFs that improve the usage of agriculture as building materials, the CSFs that affect agricultural innovation need to be reviewed.

2.14 Critical Success Factors that Affects Agricultural Innovations

To successfully innovate in the agricultural sector, there are success factors needed to be considered. Therefore, this section reviews relevant literature to determine the success factors that affect agricultural innovation. Many researchers believe that valuable innovations will sell themselves, that the obvious benefits of a new idea will be widely realised by potential adopters, and that the innovation will, therefore, diffuse rapidly. Nonetheless, this is seldom the case. Most innovations diffuse at a disappointingly slow rate (Rogers, 1995). (Spielman, 2005) describes innovation in agriculture as an idea, practice, or object that is perceived as

new by an individual or another unit of adoption. However, in industrial and agricultural innovation literature, a division is made between products, processes, and social/organisational innovations, where, agricultural innovations, as conventionally premeditated, are mainly categorised as products, but with elements of processes; moreover, technology is also used synonymously with innovation (Spielman, 2005). In his description, Spielman fails to discuss the classification of agricultural innovation; however, Sonnino et al. (2009) further define agricultural innovation according to several parameters. These parameters include genetic, mechanic and chemical innovations (private goods) and agronomic, managerial and animal husbandry innovations (public goods). Moreover, individual innovations (individual adopter) and collective and collaborative innovations (the group of persons and organisations are also outlined (Sonnino et al., 2009). Nevertheless, for an innovation to be effective and improved, many success factors must be considered in line with the innovation objectives. This researcher reviewed, examined and documented relevant literature in line with the research objective to determine suitable factors that can influence and improve innovations concerning the effective use of agricultural waste material.

Table 4 outlines the identified CSFs from the theoretical literature reviewed regarding improvements to agricultural innovation.

Table 4: Factors that affect agricultural innovations as examined in the literature

References	Success Factors
(Sabiiti, (2011)	Leadership and policies making
Madurwar et al., (2013)	Planning, public awareness, government policy and laws, and enough utilisation of resources.
Klerkx et al., (2009)	Mutual information sharing between private and public sector partnerships, R&D, industrial partnership
Jekayinfa and Omisakin, (2005)	Political instability, the ethnic bias in policies making, corruption, marginalisation
Ogunwusi, (2013)	Rural economic development, increase in farm income and availability of grants, market diversification,

	reduction derived support payments (risk-averse), competitiveness, leadership and policy
Hall, (2006)	Organising forums and supporting the establishment of producer agricultural innovation systems, partnering with other actors, orientation.
Rajalahti et al., (2008)	Promoting information flows and experimentation with new approaches to facilitate access to knowledge, skills, and services from a wide range of organizations.
Yanqi and Hongling, (2010)	Mutual information sharing between private and public sector partnerships, R&D, adequate industrial partnerships, etc.
Feder et al., (1985)	Basic amenities, an adequate research centre
Report, (2008)	Political, ethnicity in policymaking, corruption, the promotion of the agricultural sector in favour of the oil sector
Andersson et al., (2016)	Enactment laws that safeguard waste management and agricultural waste innovations, implementation of available policies on innovation.
Andersson et al., (2016)	Technology change, actors and linkages for research purposes.
World Bank, (2006)	Creating a market-driven product
World Bank (2012)	Demand responsiveness, the better connectivity and interaction of agricultural research with actors beyond farmers.
Ekboir et al.,2009)	Create a dependence on the individual capacity and collective capabilities possessed by the actors on culture.
Klerkx et al., (2012)	Actors to interact and collectively address issues including the improved identification of opportunities

	for and challenges with innovation and information sharing.
Ekboir, (2012)	Different technological regimes, a lack of collaboration cultures, inappropriate incentives, weak channels of communication, and insufficient innovation capabilities.
Rivera-Huerta et al., (2011)	Interacting with other actors - farmers, firms, farmer organisations, researchers, financial institutions, and public organisations.
(Davis, 2008)	Stronger interaction and coordination, public research and extension organisations.

2.15 Adopted Critical Success Factors that Enable the Improved Utilisation of Agricultural Waste as Building Materials in Nigeria

To illustrate the CSFs that could enable the improved utilisation of agricultural waste as building materials from the reviewed literature, the 59 references generated from the literature reviewed were outlined in Table 2,3 and 4 concerning innovation, construction and agricultural innovation (respectively). The selected references and key factors suitable for the purpose of this study are documented in the relevant table.

The abstracts of the selected documents were analysed to understand their suitability and usefulness to the purpose of this study. The researcher identifies a set of characteristics that a paper should present to maximise the quality of the methodical review. These inclusion criteria are industries and sectors that are involved in the utilisation of agricultural waste as building materials; this aims to gain a wide picture of the factors that affect the utilisation of agricultural waste that are not limited to innovation alone. This inclusion was extended to the area of agricultural and construction innovation and the area of innovation management. However, to gain broader knowledge about the topic, all countries involved help to ensure a cross-cultural view about innovation and innovation management in the agricultural manufacturing industry and construction sectors, including the public sector. As a result of this stage, more than 108 factors with documented references, and 14 common and relevant success factors were adopted as critical success factors; these were referenced as enabling the improved utilisation of agricultural waste as building materials.

Given the above factors documented and explored by the researcher (in sections 3.12, 3.13 and 3.14), the following factors were adopted as the critical success factors that enable the improved utilisation of agricultural waste as building materials in Nigeria. The critical factors adopted areas shown in Table *5*.

Table 5 Adopted CSFs that Enable the Improved Utilisation of Agricultural Waste as Building Materials in Nigeria.

References	Adopted CSFs
Tassey, 2010); Iyer and Davenport (2008); Pinto and Covin, (1989); Sabiiti (2011)	Good Governance
Adner (2006); Kim et al., (2009); Report, (2008)	Effective Strategy
Iyer and Davenport (2008); Carayannis and Campbell, (2009); Freeman, (1995); Nam et al., (1997); Adner and Kapoor, (2010); Ekboir et al, (2009); Klerkx et al, (2012)	People/ Actors/ Stakeholders
Adner & Kapoor (2010); Chesbrough (2003); Ozorhon et al., (2013); Bosch-Sijtsema and Postma (2009); Davis (2008)	Coordination and cooperation
Carayannis and Campbell, (2009); Rohrbeck et al., (2009); Chesbrough (2003); Freeman and Soete (1997); (Van der Panne et al., (2003); Klerkx et al., (2009)	Research and Development
Mezzourh and Nakara (2012); Jones and Saad (2003); Kim et al., (2009); Chesbrough, (2003); Andy, (2006)	Innovation Monitoring and Culture
Pavitt, (1984); Chesbrough (2003); (Liu et al., (2014); Andy, (2006).	Orientation
Carayannis and Campbell, (2009); (Kamara et al., (2002); Yanqi (2010)	Knowledge Transfer

Carayannis & Campbell, (2009); Rohrbeck et al., (2009); Kamara et al., (2002); Davis, (2008)	External Support
Adeoti (2005); Samila, (2010); Cheng et al., (2000); Ogunwusi (2013); Rivera-Huerta et al., (2011)	Easy access to Funding and Grants
Madurwar et al., (2013); Van der Panne (2003); D'Allura., (2012)	Organisational structure
Hall, (2006); Cheng et al. (2000);	Innovation System

2.15.3 Top Management Commitment

The role of top managers in any organisation is enormous and cannot be overemphasised. Javed(2015) explains that every manager is responsible for quality (especially senior management and the CEO); however, only the CEO of an organisation provides the leadership system to achieve results. He further explains that senior management has numerous responsibilities to carry out in an organisation or project. Furthermore, (Litie et al., (2008) describe top management commitment as an approach that brings about quality awareness in all organisational processes and is committed to the process of empowering employees by delegating sufficient authority for them to make both individual and collective decisions. However, some criticisms arise concerning the empowerment of employees, due to the lack of confidence amongst top management in delegating tasks; they feel that most employees lack the managerial ability and appropriate skills and suggest that management should draw up programmes for employees to be trained to develop the appropriate skills and knowledge. As a result, employees will be motivated which would then lead to better job satisfaction. Furthermore, top management should be committed to the empowerment of the employees who can resolve customers' complaints quickly and effectively after receiving proper training on teamwork and problem-solving techniques. However, communication is key in the successful management of an organisation or process, and every leader should devise a proper means of communication within his organisation.

However, for top management to succeed they need to be committed to all other players in the effective implementation of organisational goals by decentralised decisions, and to deal with all deficiencies in training and the application of acquired information. Furthermore, top management needs to deal with the inequality between employees and a lack of trust between employees and their managers. These issues could be managed and resolved through middle management and their commitment.

2.15.1 Good Governance

According to (Bevir, 2012), governance means all processes of governing, whether undertaken by a government, market, or network, formal or informal organisation, or territory, and whether through laws, norms, power or language. Governance differs from the government in that it focuses less on the state and its institutions and more on social practices and activities. Bevir further explains that good governance is the process of decision-making and the process by which decisions are implemented. However, governance can be used in numerous perspectives, such as corporate governance, international governance, national governance, even in the private and public sector. However, Bevir fails to discuss the attribute of good governance, although ESCAP (2006) explains that there is a handful of attributes that are associated with good governance. These attributes are in the remainder of the section.

Participation by all actors in governance is one of the key attributes, either directly or through a structured institution, or indirectly by the collaboration of institutions or organisations. However, for effective participation, actors need to be knowledgeable and prepared to associate and communicate freely within the structure and guidelines of the information given. The second attribute is the rule of law, where good governance entails open-minded permissible frameworks that are prescribed objectively (ESCAP, 2006). However, in the context of this research, the rule of law means were the actors involved in the implementation of the developed framework to assist in the utilisation of agricultural waste as building construction materials, and follows the procedures, policies and guidelines that govern the implementation of the framework with impartiality (ESCAP, 2006). Furthermore, the third attribute in good governance is transparency, which means that decisions are taken in the developed framework and the other guidance that follows, whilst their implementations are carried out by participating actors in a way that accord with procedures and principles that

guide the framework. Also, the information should be freely and directly available to those who will be affected by such decisions and their implementation, where enough information is provided in easily understandable methods and media. The fourth attribute is responsiveness, where all participating institutions that are involved in good governance try to serve information to all actors and key players quickly or within a reasonable time. The fifth attribute of good governance is harmony-oriented, which means that all the actors who participate in the utilisation of agricultural waste as building construction materials need to always reach a far-reaching consensus in the best interest of the end-user. Furthermore, the sixth, seventh and eight attributes are equity and inclusiveness, effectiveness and efficiency and accountability, respectively (ESCAP, 2006).

2.15.2 Effective Strategy

Von Scheel explains that strategy is an activity to deliver a unique mix of value - choosing to perform activities differently or to perform different activities than rivals. Similarly, McKeown (2011) argues that strategy is all about shaping the future of an organisation and is the human attempt to get to desirable ends with available means. In comparison, Rumelt, (2011) describes strategy as a type of problem-solving in and that good strategy has a fundamental structure called 'shell'. He explains further that the shell has three parts where the third part is a diagnosis that defines or explains the nature of the objectives with a guiding policy for dealing with the challenge; moreover, intelligible actions are designed to carry out the guiding policy. Therefore, to utilise an effective framework, all actors involved needs to draft a strategy that is suitable for the implementation of the developed framework.

2.15.4 People/Actors

Many researchers and authors have written about innovation and the success factors that drive innovation. However, when innovating, we often overlook the most important success factor that guarantees successful innovation in all aspects of life. This success factor is the actors or people with whom innovations are developed. Without human capacity and capability that require the right skills and attitudes, it is impossible to innovate successfully. Furthermore, these actors are all personnel involved in the process that culminates in the utilisation of agricultural waste as building construction materials, from farmers, engineers, manufacturers, professionals and private and public officers in all institutions and

organisations and involved at all stages of the process and implementation of the collaborative innovation management framework.

2.15.5 Cooperation and Coordination

Ahuja, (2000), describes organisational cooperation as the joint pursuit of agreed-on goals in a manner equivalent to a shared understanding about contributions and remunerations. Cooperation, in the context of this research, is the interactive outcomes of inter-organisational relations to foster an innovative process to achieve the organisation's desired goals and aspirations. However, to effectively achieve cooperative successes, all actors that are involved rely solely on partners' agreements on the provision and appropriation of resources for the collaborative effort (Okhuysen and Bechky, 2009). Therefore, organisations negotiate what they are willing to contribute in terms of time, resources, market access, and so on, to get what they want, such as new IP, greater efficiency, enhanced legitimacy, and so on, from the alliance (Oliver, 1990). This agreement, forged on these inputs and outputs, describes the extent of cooperation or the intended scope of the relationship. However, organisations typically engage in cooperation to share investment risk or to pursue a variety of operational, commercial, technological, or reputational benefits that may be difficult or impossible to attain via transactional relationships (Oliver, 1990).

Also, coordination in the social sciences is largely understood as the linking, engaging, synchronization, or alignment of actions by actors or leaders of any organisation. In an inter-organisational context, Oliver (1990) described coordination as thoughtful and systematic arrangement or alteration of partners' actions to achieve mutually determined goals. Furthermore, Oliver describes coordination as an outcome that can be characterised by efficiency, the relative cost of designing and operating coordination mechanisms, and by effectiveness, namely the degree to which coordination efforts produce the desired alignment or adjustment of action. However, Oliver fails to describe how coordination should be achieved. In comparison, Okhuysen and Bechky (2009) briefly explain how coordination can be achieved; this typically involves the specification and operation of information-sharing, decision-making, and feedback mechanisms in the relationship to unify and bring order to partners' efforts and to combine partners' resources in productive ways. This information

helps all actors involved in the coordination to develop a clearer idea about the innovation objective.

2.15.6 Research and Development

Research and development are described as organised action linking both basic and applied research and aimed at discovering solutions to problems or creating new goods and knowledge (OECD, 2002). However, R&D may result in the rights of intellectual property, such as patents and copyright laws. Also, research is normally described as the initiator of new knowledge, including the one piloted at universities; this is fundamental for sustainable development (OECD, 2002). Nevertheless, the "Declaration on Science and the Use of Scientific Knowledge", adopted at the World Conference on Science, held in Budapest in 1999 and co-organised by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council for Science (ICSU), firmly stated that, "the sciences should be at the service of humankind as a whole, and should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life and a sustainable and healthy environment for present and future generations." Becker and Dietz, (2004) explain that the important role of R&D cooperation in the development of new products cannot be overstressed, where the increased dynamic of technical progress, the growing complication of technology and the expanding stress of competition and costs underline the necessity to collaborate in R&D effectively. However, the continuous expansion and improvement in in-house R&D and outside collaboration shows positive output effects when properly managed and can encourage an increase in new product development. In addition, collaboration with a multiplicity of partners along the value chain makes it possible to realise cumulative learning effects with positive impacts on the efficiency of a firms' R&D and the greater probability of success in the development of new products (Becker & Dietz, 2004). Therefore, for the effective implementation of agricultural waste utilisation for building construction purposes, R&D is one of the major critical success factors that can affect the actualisation of the new product from agricultural waste.

2.15.7 Innovation Monitoring and Culture

Monitoring is a primary part of policymaking and is usually perceived as equivalent to evaluation. However, as a stand-alone exercise, it has received less attention towards the end

of the different policy stages. However, Lundy et al., (2013) describe innovation monitoring as a collection of methods and tools to track and measure innovation activities, including processes among partners, and the results of these processes. It involves clarifying the hoped-for changes, identifying what to track over time, identifying who designs, participates and decides what to do about emerging results, and coherently connecting all this. In addition, policy-makers focus on convictions or legal requirements and thus place prominence on evaluating what has been done to learn for the future. Nevertheless, the logical first step in achieving a greater organisational objective is to monitor what is being done to progressively generate the information needed for evaluation. In the context of European Regional Development Policies, the European Court of Auditors (2007, p.7) states that "poor monitoring systems had hampered many evaluations" in the past by not providing relevant information. Therefore, for the smooth and effective development of a collaborative innovation management framework that assists in the utilisation of agricultural waste as building construction materials, all stages involved in achieving the objective must be thoroughly monitored to generate adequate information to evaluate the progress achieved during the implementation and adoption. Innovation culture is described by (Dobni, 2008) as the work environment that leaders cultivate to nurture unorthodox thinking and its application. He further describes innovation culture as workplaces that foster a culture of innovation, which generally subscribes to the belief that innovation is not the jurisdiction of top leadership but can come from anyone in the organisation. Given Dobni submissions, an innovation culture concerns the nature of an organisation that competes in markets, and the status quo that the organisation embraces to compete effectively in an economic system, thus making an innovation culture essential for success. Dobni (2008, p.539) further explains that innovation culture is a multi-dimensional context that comprises four dimensions: "the intention to be innovative, the infrastructure to support innovation, operational level behaviours necessary to influence a market and value orientation, and the environment to implement innovation".

2.15.8 Orientation

Orientation is described as basic information or training that is given to people starting a new job, school, new process, new product development or course. Furthermore, orientation

is a form of knowledge transfer process and procedure in which a person or organisation/institution transfers their intention or purpose, steps, and direction of an activity to a new client or organisation. In the context of this research, orientation means how information about the potential of agricultural waste utilisation for building construction purposes has been disseminated to all actors involved in the innovation management process.

2.15.9 Knowledge Transfer

Based on Argote et al. (2000), knowledge transfer is becoming increasingly important in organisations and society. Furthermore, they maintain that organisations that can transfer knowledge effectively from one unit to another are more productive and more likely to survive an economic crisis than those that are less skilful at knowledge transfer. This submission is explained further by (Cummings and Teng, (2003) whereby even though organisations can realise remarkable increases in performance through knowledge transfer, successful knowledge transfer in any form needs to follow unit by unit information dissemination. However, it is difficult to achieve, and managed knowledge transfer is now based on a wider range of information that is informed by internet pages and can bring confusion. In the world, today, knowledge transfer is becoming more important in successfully driving home the aims and objective of an organisation. Moreover, today's firms are more frequently organised on a global basis to take advantage of differences in expertise that are readily available, including labour costs, and access to global markets (Messick & Mackie, 1989). In the context of this study, effective knowledge transfer from the agricultural sector to research institute, and from research institute to manufacturers is an important success factor that can enhance the innovation management of agricultural waste for building construction purposes.

2.15.10 External Support

Support can be received from the organisation, individual, or cooperate and private sectors in the form of funds, grants to fund research and development, vital information about a process, and so on. Woodman et al. (1993) explain that information exchanges within an organisation and the outside environment is an important variable affecting organisational innovation. Moreover, Demeanour (1991), in his review of organisational innovation studies, reported a positive association between external communication and innovation where

external knowledge complements and leverages a firm's knowledge output and, as such, can be a critical source of organisational innovation. Thus, firms can build a wide range of relationships with different parties, and, strategic alliances with other companies to share expertise, funding, or outputs. Also, they can cooperate with research institutes and universities for technical assistance and consulting; furthermore, they can receive financial and technical help from public or private support organisations for innovative projects. Therefore, external support moderates the relationship between transformational leadership and organisational innovation, such that the effect of transformational leadership on organisational innovation will be stronger when the degree of external support is higher (Woodman et al., 1993).

To effectively utilise the critical success factors detailed, most organisations need easy access to credits and grants. They also need to implement a structure and innovation system that will effectively assist in the utilisation of agricultural waste as building construction material. The next sub-section considers access to credit and grants, and later discusses organisational structures and innovation systems.

2.15.11 Easy access to Credits and Grants

One of the success factors that improved innovation management is access to funds. In most developed and developing countries, the governments have made the most of the funding available to research organisations and universities. Furthermore, based on the researchers' personal experience, most developing countries do not share the privileges received in developed countries due to the politics, policy and corruption that have prevailed. Banks are even scared to give loan and credit due to corruption and the potential inability of an organisation to break even to service the loan. However, Samila and Sorenson (2010) suggest what is called a venture capital system that helps: to develop the pool of entrepreneurial talent in an area, to develop ideas, and to train and encourage a community of entrepreneurs capable of bringing ideas to market Furthermore, since high technology businesses often require both inventors and entrepreneurs, venture capital allows regions to exploit a larger share of the ideas that emerge from the region and consequently to grow more rapidly. Nevertheless, some agencies may sponsor technologies that better fit with established firms than with start-ups.

2.15.12 Innovation System

According to Lundvall, (2010), the concept of an innovation system explains that the flow of technology and information among people, enterprises and institutions is significant during the innovative process. Furthermore, this contains the interaction between various sectors, whereby actors turn an idea into a process, product or service to gain market capitalisation. In line with innovation in the agricultural sector, Hall et al. (2003) explain that conventional approaches to agricultural development or any other development regarding innovation as the product of research, views dissemination as a linear process at large. More recent approaches to improve the impact of research and development place notable emphases on the rapidly changing socio-economic, political and environmental issues. New products and processes are brought into economic and social use through the activities of this network of organisations, as mediated by various institutions and policies, which together are referred to as innovation. To be able to achieve an effective innovation there is a need for a country or region to have good support in the form of a national, region or local innovation system.

Moreover, the National System of Innovation originated when Freeman and Lundvall worked together in the late 1980s, which was described by Lundvall when writing about product innovation Lundvall, (1985). However, Freeman drew deeply on the political economy of Friedrich List and gave a historical account of the rise of Japan as an economic superpower. Furthermore, Lundvall's work explored the important social interactions between suppliers and customers and their role in encouraging innovation in Denmark.

However, there is no definitive characterisation of national innovation systems, although a few of the definitions are dominant in the literature. For instance, (C. Freeman, 1995) argues that NIS is, "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". Freedman's definition fails to address the issue of relationships that connect production and knowledge that bonds the innovation sector. However, Lundvall (1992) considered the drawbacks of Freedman definition and defines NIS as, "the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and are either located within or rooted inside the borders of a nation-state". Furthermore, Nelson (2013) defines NIS in his book as a "set of institutions whose interactions determine the innovative

performance of national firms". His definition does not address the structures in which the innovation system operates and the direction that the learning often takes. Moreover, Patel and Pavitt, (1994) study clarify national innovation as national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning or the amount and control of change generating activities in a country. Nevertheless, Patel and Pavitt, (1994) describe NIS as a set of discrete institutions united to contribute to the development and diffusion of new technologies that provide the framework around which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts that define new technologies. In view of this, NIS is an essential tool for the economic development of a nation that helps in the implementation process of an innovation project; the process is conceived in line with this research aim and objectives. Therefore, an effective national innovation system in terms of the organisational innovation system is important in supporting the utilisation of agricultural waste as building materials in Nigeria.

2.15.13 Organisational Structure

Mintzberg (1989), describes the organisational structure as to how an organisation divides its labour into distinct tasks and coordinates them. Mintzberg further describes the organisational structure as the formal system of task and management reporting of relationships that coordinates and motivates organisational members so that they work together to achieve organisational design goals. Barnard (1938. p4) cited in

Tolbert and Hiatt, (2009, p162) defined organisational structure as, "all complex organisations are built up from units of the organisation consist of many units of working or basic organisations, overlaid with units of executive organisations ..." Traditionally, as stated by Taylor-Biancoand and Schermerhorn Jr, (2006), the organisational structure was bureaucratic in nature, pyramidal, and condensed, with several management levels, distinct chains of command, a rigid line of authority, and a narrow span of control. However, Tailor fails to address the organisational structure of today; instead, he referred to old, traditional structures. To understand modern-day organisational structures, Senior (1997, cited in Anumba et al., 2002) offers an insight into a modern organisational structure where contingency theory was developed as part of emerging management theories. This theory

emphasises that there is no single way to organise; that most work depends on the type of work carried out by the organisation and the environment's demands and conditions. Nevertheless, there are some characteristics or variables that define an organisational structure. Thus, Egbu et all2000) describes these variables as centralisation, complexity, formalisation and stratification.

Therefore, to achieve a successful innovation, and to implement an innovation system, the organisational structure takes the centre stage of any process. In summary, for the effective utilisation of agricultural waste as building materials, there must be a structure in place in form of an innovation management system (framework) to help all actors involved to communicate, coordinate, transfer knowledge, share ideas, and so on within themselves to achieve the innovation goals. As such, an organisational structure approach is believed to determine how a collaborative innovation management structure will be developed so that each organisation involved will understand the level of their involvement and the actions needed to achieve their objective in the innovation process. Meanwhile, to achieve this organisational structure, there is a need to understand what type of activities that are going on in building materials manufacturing industries, and why most of them are not into the utilisation of agricultural waste as building materials.

2.16 Conceptual Framework

The use of the term conceptual framework crosses both large and small scale theories (Ravitch and Riggan, 2016). However, the conceptual framework is an analytical tool with several variations and contexts. It is used to make conceptual distinctions and to organise ideas. In Nigeria, the shortage of housing unit is the major problem and this housing is a main factor of the building and construction sector. However, from the reviewed literature, one of the major factors that hinder housing delivery is the high cost of building material. To resolve this challenge high cost of building material poses on housing delivery strong suggestion was made in the area of using agricultural waste as a source of raw material or material for the building project. Further, the literature reveals that for the building sector to benefit from utilisation of agricultural waste s building materials actors and stakeholders from various

organisation need to come together to develop process, policies, R&D and so on to be able to achieve this new goal.

In this regard, the connection between the actors and stakeholders in construction, manufacturing, farming, public and private organisations will help in the development of this noble product to ease the problem of housing deficit in Nigeria. There are several conceptualisations about the relationship between the construction, manufacturing sector, the Government, and public organisations. Willey et al. (2008) present a framework as indicated in figure 10, below that shows how construction and other sectors links together for economic growth. However, to go in line with the concept of utilisation of agricultural waste as a building material, the framework is adapted to solve the present research problem. The linkage is highlighted, as shown in the figure under the following headings:

- Construction and manufacturing sector collaboration
- Construction and agricultural sectors
- Public and private sectors collaborations
- R&D via educational and other sectors
- Government and manufacturing collaboration sector
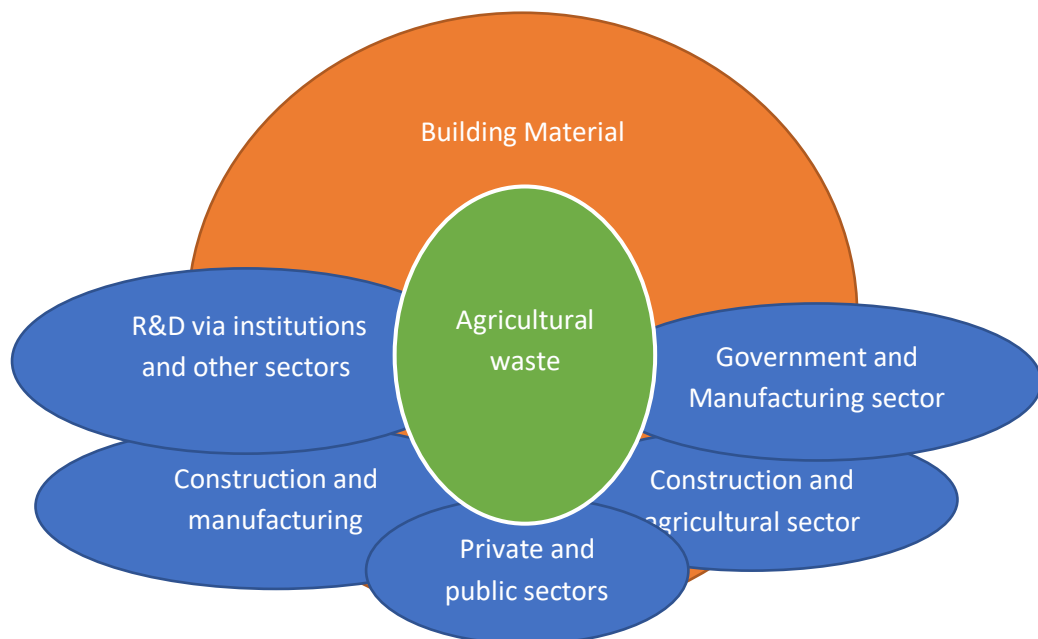
Figure 10: Conceptual innovation management framework to assist in the utilisation of agricultural waste as building materials (Adapted from Martin Willey et al., (2008)

Figure 10 reflects the conceptual collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials. However, to arrive at this conceptual framework, the literature on construction in Nigeria, innovation, construction innovation and agricultural innovation, agricultural waste, agricultural waste usage in Nigeria and agricultural waste conversion to building material was reviewed and shown that to effectively develop a framework that assists in the utilisation of agricultural waste as a building material, there is need for a network of various organisations and sectors

- Government and manufacturing sector

There are several ways and form of collaboration between the government and the manufacturing industry. One of the areas is the government developing an industrial strategy to see the government working in corporation with industries that are dealing with manufacturing of construction. in addition to this partnership is another way for job creation, long time economic growth and sustainable development in Agro-construction material manufacturing industries.

- Research and development via institutions and the sectors

R&D is one of the important areas when discussing innovation and it is often the first stage in the process of development. This area encourages organisation, industries and other private organisation when adequately funded to go into findings on how a new product that area cost-effective is introduced to the economy i.e. new building material development using agricultural waste. This aspect linked both the private and public organisation together to forge ahead in contribution to national economic development. In summary, R&D helps in the area of the collaboration of institutions and other sectors to form an alliance in the area of information and data sharing that can help in the process of utilisation of agricultural waste as build

- Construction and manufacturing sector

The construction industry is one of the industries that have experienced ups and downs in the 21st century due to economic crunch. However, with the recent resurgent in the global economy and universal clamour for sustainable development and research has identified the high cost of building material as one of the factors that have hindered

housing deliver the developing world. To address this factor, effort need to be made to collaborate with the manufacturing industry to develop building material product that can be used as a replacement of the expensive material due to foreign exchange and importation. This collaboration helps bring stakeholders in both sectors together to develop a way forward for sustainable development programmes.

- Construction and agricultural sector

With the recent high cost of construction material and resent clamour for in house development of agricultural waste for building construction purposes. There is need for the construction industry to collaborate with the agricultural sector for the supply of some of the agricultural waste that can be used directly for construction purposes and any other information that can be shared to enhance the usage of agricultural waste as a building material.

- Public and private sector partnership.

This involves the collaboration of government agencies and private sector stakeholder that are involved in the process of utilisation of agricultural waste in the area of policies making, finance and so on.

In summary, this framework is developed to show the levels of collaborating within the stakeholder in those organisations and sectors that are involved in the process of utilisation of agricultural waste as a building material.

3.0 Chapter Three - RESEARCH METHODOLOGY

3.1 Introduction

This section presents the research philosophy, methodology, data collection and analysis techniques adopted for this research. Having considered the literature, which addresses the research objectives, this chapter discusses the research methodology considering the traditional approaches of quantitative, qualitative, and mixed methods, to choose the method that is appropriate for this research. The mixed-method was selected as the best method to address the objectives and answer the research question. A questionnaire survey was conducted among collaborating organisations involved in the process of producing innovative transformations of agricultural waste into building materials, as well as semi-structured interview to probe further the assertions of the respondents. Data were collected through questionnaires and semi-structured interview, then the data were analysed to gather more in-depth information on how a collaborative innovation management framework can be achieved to assist in the utilisation of agricultural waste as raw materials or material for construction purposes in Nigeria. The framework developed were validated using the questionnaire approach and was further validated through focus group interview. However, to develop this framework, different types of research methodology have to be considered and selected to obtain and analyse the data collected to meet the research objectives. This methodology was discussed in the next subsection.

3.2 Research Methodology

A research methodology can be defined as, "giving a clear-cut idea on what methods or process the researcher is going to carry out in his or her research to achieve research objectives" (Collins et al., 2004. pp.16). The strategy, plan of action, process lying behind the choice of methods and linking the choice and use of the method to an outcome (Collins, Joseph, & Bielaczyc, 2004). Furthermore, Easterby-Smith et al. (2008) explain that in choosing a research methodology the researcher should be familiar with the philosophical background and can discuss and defend this position with confidence and clarity. Also, a research methodology maps out the whole study and gives credibility to the effort of the researcher.

The entire research plan is based on the concept of the right methodology; thus, this research adopts the "research onion" process Saunders (2009) as the preferred model for designing a methodology. This process helps to anchor the research in data generating techniques that are compatible with the appropriate approach to address the research questions. Moreover, it establishes a framework that defines the research philosophy, giving clarity and purpose to the approach and techniques of the research process. Figure 11 illustrates the nested elements of the research onion.
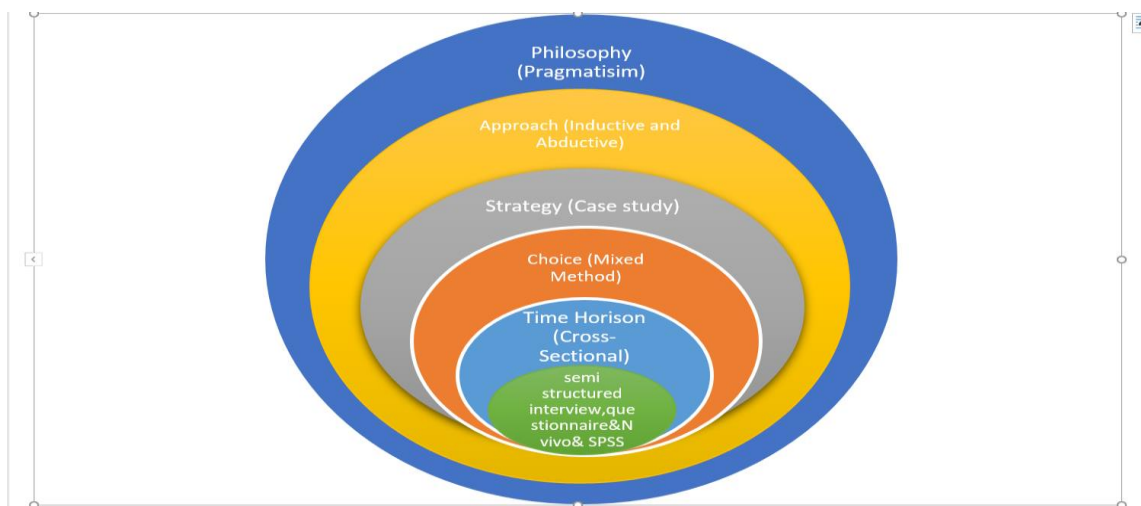
Figure 11: The Research Onion Process (adapted from (Saunders et al., 2009))

3.3 Research Philosophy

The research philosophy is a set of beliefs that relate to the development of knowledge and the nature of knowledge (Saunders, 2012). According to Creswell, (2009), a research philosophy is identified under different terms, such as research paradigms, epistemologies and ontologies, and philosophical worldviews, by different authors. However, Creswell fails to address the beliefs about the way data are gathered, analysed, and used to address the issues of belief. Saunders and Lewis (2012) explain that research philosophy is a belief about how data about a phenomenon should be gathered, analysed, and used, although they failed to mention the two most prevalent branches of research philosophy. However, Johnson et al., (2007) explain that it is important to study and reflect on different research paradigms and matters of ontology and epistemology. However, Sarantakos, (2012) added a third dimension and states that the core components of research philosophy include axiology since this describes perceptions, beliefs, assumptions and the nature of reality and truth

(knowledge of that reality); this can influence how the research is undertaken, from design through to conclusion. However, it is important to understand and discuss these phases in approaches are harmonious to the nature and aims of the inquiry adopted, and to ensure any researcher biases are understood, exposed, and minimised.

3.3.1 Ontology

Ontology is attributed to the science or study of being and focuses on social sciences that make claims about what exists, what it looks like, what units make it up and how these units interact with each other. According to Duan et al., (2011), ontology is a way of answering the question about 'what is the nature of social reality?', and the assumptions that concern what exists, what it is like, and how these units interact with each other. However, Hatch and Cunliffe (2006) use everyday examples, and a social science example to illustrate the point by considering phenomena such as culture, power or control, and whether they really exist or are simply an illusion. They further extend the discussion as to how individuals (and groups) determine these realities in terms of whether reality only exists through the experience of it (subjectivism), or it exists independently of those who live it (objectivism).

1. Objectivism (Realism)

Easterby-Smith et al., (2008) and Saunders and Lewis, (2012) describe objectivism as a portrayal of the position that social entities exist external to social actors. An example of this may be management itself; thus, Cheney et al., (2010) explain that management is an objective entity and decided to adopt that particular stance based on the study of an aspect of management in a specific organisation. Accordingly, to substantiate this view, the managers in an organisation need to know the job descriptions which prescribe their duties, the operating procedures to which to adhere, the part of a formal structure that locates hierarchies in which their subordinates report to them, and in turn, to report to more senior managers (Saunders and Lewis, 2012). The objective approach to management in an organisation has a reality that is separate from the managers that inhabit that truth about the organisation.

2. Subjectivism (Idealism)

In contrast, the subjectivist view considers that a social phenomenon is created from the perceptions and consequent actions of social actors. Moreover, this is a continual process

through which social interaction is in a constant state of revision. Remenyi et al., (1998) stress the need to study the details of the situation to understand the reality or perhaps a reality working behind them.

On these bases, both objectivism and subjectivism are the most appropriate ontology approaches for this research based on the research objectives. The study will evaluate all relevant literature in the general areas of innovation, agricultural and construction innovation and examine the challenges and opportunities associated with the introduction, implementation, and maximisation of the benefits of innovation by transforming agricultural waste into building materials, where the role and impact of end-users on the introduction of innovative building materials into the construction market will be considered. The research will develop a collaborative framework to assist in the innovation from agricultural waste to building materials. Therefore, the study considers its diverse ontological assumptions in answering the research questions, and the outcome of the research is achievable through both subjectivism and objectivism where views of collaborating organisations, scientific facts and figures, and the data analysis of those individuals involved in agriculture, science and the construction environment are consulted.

3.3.2 Epistemology

Epistemology is closely coupled with ontology and its consideration of what constitutes reality, epistemology considers views about the most appropriate ways of enquiring into the nature of the world, what is knowledge, what are the sources and limits of knowledge (Easterby-Smith et al., 2008). Eriksson and Kovalainen, (2008) explain that an epistemology defines how knowledge can be produced and argued for; thus, it considers the research method adopted to produce the data. Blaikie (2007, p144) further describes epistemology as "the theory or science of the method or grounds of knowledge" expanding this into a set of claims or assumptions about how it is possible to gain knowledge of reality, how what exists may be known, what can be known, and what criteria must be satisfied to be described as knowledge. Chia, (2002) describes epistemology as 'how and what it is possible to know' and the need to reflect on methods and standards through which reliable and verifiable knowledge is produced. Furthermore, Hatch and Cunliffe, 2006) summarise epistemology as 'knowing how you can know' and expand this by asking how is knowledge generated, what

criteria discriminate good knowledge from bad knowledge, and how should reality be represented or described. The researcher is adopting a positivist position to the development of knowledge about agricultural waste innovation and the innovation system, whereas to consider 'feelings' the researcher adopts an interpretivist perspective.

3.3.3 Axiology

Axiology is a branch of philosophy that studies judgments about value, although this may include values in the fields of visuals and ethics. Saunders and Lewis, 2012) describe axiology as a process of social enquiry about a situation to know the social value of the situation. However, the role that a researcher plays at all stages of the research process is of great importance if they wish the research results to be credible. Furthermore, Sexton (2003) explains that our values are the guiding reason for all human action. He further argues that researchers demonstrate axiological skill by being able to articulate their values as a basis for making judgements about what research they are conducting and how they undertake it.

This researcher will consider axiology in the study of all moral philosophy that involves systematising, defending, and recommending concepts of right and wrong conduct, religious beliefs, cultural values, and the standards of behaviour that society accepts in the utilisation of agricultural waste as building materials. The researcher needs to evaluate all views, opinions, data and experiences shared by respondents from questionnaires and semi-structured interviews, as well as appreciate their meanings to arrive at a conclusion that is considered to represent the ideas of all respondents.

In the study, objective points of view will be mixed with the subjective views of the respondent to gather an overall finding that is accepted globally. Furthermore, in summary, this research adopts a research philosophy where ontology, epistemology and axiology are combined to underpin and achieve the aim and objectives of the study.

3.4 Research Approach

The possible research logic that can be applied is also considered in the development of this study; such logic may be deductive, inductive, or abductive. According to Teddlie and Tashakkori (2009), deductive reasoning infers instances from a general law while inductive reasoning involves infers a general law from an instance. Abduction is general a concern with

the practical need to act, which motivates players to provisionally accept the hypothesis upon which they base their next steps. However, in abductive approach, the procedure is dedicated to the description of 'imperfect comments', 'astounding data's or 'conundrums' indicated at the introductory level and during data collection stages of the study. Referring to the research topic of the development of collaborative innovation management framework to assist in the utilisation of agricultural waste as building material. The research adopted the inductive and abductive research approach so that the study can be devoted to the explanation of this phenomenon by using qualitative and/or quantitative methods of data collection and data analysis in an integrated manner and also, in inductive inference, known premises are used to generate untested conclusions. Further, in abductive also, inference known premises are used to generate testable conclusions. With this in mind, the findings from the data collected are used to develop the framework which is testable to develop the final framework in this research.

3.5 Research Method

To properly conclude a research study, the researcher needs to adopt a research approach to address the research aims and objectives. Although there are various research approaches to consider, two basic approaches are possible, which are qualitative or quantitative research. Macdonald and Headlam (2008) explain that all research undertakings are either required to count things and/or to talk to people; research methods can be broadly classified using this distinction. Quantitative is concerned with trying to quantify things; it asks questions such as 'how long', 'how many' or 'the degree to which'. Quantitative methods look to count data and generalise results from a sample of the population of interest (Saunders and Lewis, 2012). Qualitative is concerned with the quality of the information, and the attempts to gain an understanding of the underlying reasons and motivations for actions to establish how people interpret their experiences and the world around them (Saunders and Lewis, (2012).

The present study adopts a mixed method approach, utilising quantitative as well as quantitative data, which are retrieved simultaneously to explore the research question posed to validate and address the findings from the research objectives. Although the two approaches are perceived as opposing ends of a continuum, they are frequently used in combination in an approach called a mixed method (Creswell and Zhang, 2009; Saunders,

2012). This approach is consistent with a pragmatism view (Creswell, 2009). Table 6 provides a breakdown of the key features of each of the research approaches adopted for the present study.

Table 6: A comparison between quantitative and qualitative approaches (adapted from MacDonald and Headlam, 2009)

	Quantitative	Qualitative
Aim	The aim is to count things in an attempt to explain what is observed.	The aim is a complete, detailed description of what is observed.
Purpose	Generalizability, prediction, causal explanations	Contextualisation, interpretation, understanding perspectives
Tools	The researcher uses tools, such as surveys, to collect numerical data.	The researcher is the data gathering instrument.
Data collection	Structured	Unstructured
Output	Data is usually in the form of numbers and statistics.	Data is usually in the form of words, pictures or objects.
Sample	Usually, many cases represent the population of interest. Randomly selected respondents	Usually a small number of non-representative cases. Respondents selected on their experience.
Objective/ Subjective	Objective – seeks precise measurement & analysis	Subjective: individuals' interpretation of events is important
Researcher Role	The researcher tends to remain objectively separated from the subject matter.	The researcher tends to become subjectively immersed in the subject matter.
Analysis	Statistical	Interpretive
Measurement	High level of measurement	Low level of measurement

3.6 Research Strategy

There are research strategy and sources that can be used by researchers, ranging from search engines, Government documents, surveys, forms, laws, policies, services and information by non-profit organisations and by for-profit businesses, or discussion groups, resources at local (public) libraries, Newspapers, journals, magazine databases, questionnaires, and interviews. Nevertheless, the selection of any of these listed strategies aligns with the research philosophy of the research objectives and question.

In this study, the possible strategies based on this research choice are surveys, focus group, direct observations and case studies. However, no research method is inherently superior or inferior to any other (Saunders and Lewis, 2012). The choice of this strategy is guided by the research objectives and question, in consideration of the extent of the knowledge required, the time and other resources available, and the philosophical stance. The innovation management framework development is purely behavioural and involves all collaborating organisations. Diaz and Hansz (2007) confirm that there is a growing recognition of the contribution to be made by understanding the behaviour of key players rather than theories. Therefore, since this research question aims to understand the key factors responsible for the non-utilization of agricultural waste as building materials in Nigeria, it is a unique study that prioritises a development framework as a phenomenon. As such a study, the case study methodology will be adopted since the study is explorative and explanatory. Table 11 describes the relevant situation for different research strategies, as suggested by Yin (2009).

Table 7: Relevant situations for different research strategies (Yin, 2009)

Research strategy	Research questions	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	⟵————— How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes

Archival Analysis	Who, what, where, how many, how much?	No	No/Yes
History	How, why?	No	No
Case study	How, why?	No	Yes

3.7 Case Study Method

A case study research method has been widely used in quantitative research approaches to examine contemporary real-life situations and provide the basis for the application of ideas and an extension of other methods. Yin, (2009, p3) defines the case study research approach "as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clear; and in which multiple sources of evidence are used". By triangulating multiple sources of evidence to carry out a detailed investigation and enable a holistic study, the researcher recognises the complexity of social truths. Furthermore, Yin, (1994) categorises the case study into three broad types, namely: Exploratory, descriptive and explanatory.

- Exploratory case studies explore any phenomenon that serves as a point of interest to the researcher.

- Descriptive case studies describe the natural phenomena which occur and the real-life context in which they arise; for instance, the different strategies used by a reader and how the reader uses them. The goal set by the researcher is to describe the data as they occur (McDonough and McDonough, 2014).

- Explanatory case studies examine the data closely, both at a surface and deep level, to explain the phenomena. For instance, a researcher may ask the reason as to why a student uses an inferencing strategy in reading (Zainal, 2007).

Considering the aim of this study and the research question raised, the researcher adopts an explorative and explanatory case study strategy. The scarcity of literature about innovation management that helps an understanding of the utilisation of agricultural waste as building materials requires the adoption of an explanatory and exploratory case study strategy. This helped the researcher to adequately explore the research problem in a real-life

context. Furthermore, the need to explain the developed framework in the context of agricultural waste innovation required the researcher to adopt an explanatory case study. With the selection of an explanatory and exploratory case study, a multiple case study approach is adopted to understand the views of the proposed collaborating organisations involved in the process of utilising agricultural waste as building materials by using the literal replication. This means that the cases selected are similar and the predicted results also are similar.

3.7.1 Case Study Design

Yin (2003) explains that a case study design should be considered when the study focus is on 'how' and 'why' questions; this is because it is not possible to manipulate the behaviour of participants involved in the study and the researcher wanted to address the contextual conditions. Furthermore, Yin (2014) indicated five components of a case study design method that need to be considered, namely; the research questions, the research propositions (if any), the unit of analysis, the logic linking the data to the proposition, and the criteria for interpreting the findings.

A case study might be a single case or a multiple-case design. A single-case research design is most often used in the applied fields of psychology, education, and human behaviour where the subject serves as the researchers' control, rather than using another group. Researchers use single-subject design because these designs are sensitive to an individual organisation, which are sensitive to group averages. In comparison, a multiple case study design approach involves the in-depth exploration of a specific bounded system, utilizing multiple forms of data collection to systemically gather information on how the system operates or functions.

3.7.2 Case Study Data Collection

Yin (2009) explains that irrespective the sources of evidence used in research, there are three key principles of data collection, which need to be observed:

1. Use Multiple Sources of Evidence - Triangulation: using multiple sources of evidence. The approach to individual sources of evidence limits the strength of the study; thus, is not recommended in the conduct of case studies. In comparison, a major strength of case study data collection is the opportunity to use many different sources to collect the data to validate the same findings.

2. Create a Case Study Database: This principle involves how the data collected for the case study is organised and documented. However, documentation commonly consists of two separate collections: the data or evidentiary base and the researcher's report. Furthermore, most case study reports do not present adequate data without a case study database. Therefore, every case study project should strive to develop a formal, presentable database, so that, in principle, other researchers can review the evidence directly and not be limited to written case study reports.

3. Maintain a Chain of Evidence: For the reliability of the information in a case study, the researcher needs to maintain a chain of evidence. This permits external observers and the reader of the case study to follow the derivation of any evidence from the initial research questions to the ultimate case study conclusions. Also, other researchers should be able to trace the steps from inferences back to initial research questions or questions to inference.

In this research, a multiple case study method is adopted. Nigerians are suffering from the challenges caused by agricultural waste because every state in Nigeria is an agrarian state. Therefore, Nigeria constitutes the case study and the collaborating organisations involved (public and private organisations, and farmers) constitute the cases.

3.7.3 Justification for a Multiple Case Study

Yin (2003) defends the use of findings from a case study as a basis for generalisation. It is reasonable to ask how results from a case study can be generalised, and the role of the researcher is to provide the reader with the information needed to judge the validity of the generalisability of the research finding from a case study (Yin, 2003). Yin, (2003) explains the difference between statistical and analytical generalisations, where the statistical treats the research subject as representative of a population. It extends the knowledge of the universe and analyses this by using the results generated by the case study to expand and generalise from the purpose that supports the research questions. The research design for a case study follows Yin's blueprint for a multiple case study, which is generated from this preliminary research purpose. The research adopted a multiple-case study design to investigate the phenomenon. A multiple-case design allows for numerous sources of evidence through replication rather than sampling logic. Yin, (2009) observes that a multiple case study design

accommodates more than one case within the same study. For instance, a study to develop a collaborative innovation management framework that assists in the utilisation of agricultural waste as raw materials for building materials involves multiple inter-industry actors. The rationale for selecting a multiple-case study strategy centres upon the need to obtain the views of the multiple inter-industry actors required in developing a collaborative innovation management framework that assists in the utilisation of agricultural waste as raw materials for building materials. It also provides a better base population for a purposive sample selection.

Generally, to justify the use of multiple case study, Flyvbjerg (2006) introduces five reasons:

1. Case studies are necessary, as predictive and universal theories cannot be found in the study of human affairs, such as understanding the organisation that this research is concerned with. Furthermore, he argued that context-dependent knowledge is better than the search for predictive theories.

2. A case study may be central to scientific development as an alternative to other methods.

3. Both the generation and testing of the hypothesis are important when using a case study but are not limited to research activities alone.

4. The case study contains no greater favouritism towards the verification of the researcher's preconceived notions than other methods of enquiry.

5. It is often difficult to summarise case studies; therefore, it is not desirable to summarise and generalise case studies, as good studies can be read as a narrative in own right.

3.8 Unit of Analysis

This component relates to the fundamental problem of the significance of the research problems that need to be solved. Yin, (2012) makes it clear that the unit of analysis (which is the same as the definition of a "case" is related to the way a researcher has defined their initial research question. However, there is a need to study the research question to help identify the relevant information for collection in a study. Without such a question, the researcher might be tempted to cover "everything" about the unit of analysis, which is impossible to do. The research question frames this research as a contextual study, where a

single unit of analysis is adopted, and a multiple case study approach is projected. The unit of analysis is agricultural waste.

In section1.1 of this thesis, Taiwo and Adeoye revealed that there is an urgent need to produce low cost, sustainable building materials that are affordable to both urban and rural dwellers to reduce the construction costs associated with the shortage of housing in Nigeria. The present-day materials are produced abroad, and Taiwo and Adeboye, (2013), Oladipo and Oni, (2012) clarified that the interest in the transformation of waste into raw materials required for producing building materials offer an alternative to the more costly conventional building materials. Nevertheless, in the past, this focus has been on general household wastes, with little or no attention paid to agricultural waste. With the present-day economic situation and high level of the housing shortage, there is need to know what can be done to utilise the substantial opportunities that abound in the increasingly large amounts of agricultural waste (unit) that can be used as raw materials to produce low-cost building materials. This would help to address these shortages including who is responsible for the process of managing agricultural waste for construction purposes.

3.9 The Logic Linking the Data to the Proposition

The fourth component foreshadows the data analysis steps in this case study research. Thus, the analytic techniques and choices of data must link with the design propositions. There are various ways to link the data to the propositions, which are: pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis. The actual analyses require a combination or calculation of the case study data as a direct reflection of the initial study propositions.

3.10 The Criteria for Interpreting the Findings

The criteria partly relate to the way that the experiments have been set up, which are experiments with defined objectives, the interpretation of which would initially be based on that background information. The results are analysed by plotting them in various ways, carrying out the statistical analysis and comparing them with the expected views from the experiment. Five evaluation criteria form the basis for organising and analysing the data, and these are relevance, effectiveness, efficiency, results/impact, and sustainability. This study

explores all the management criteria in the development of a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials.

3.11 Time Horizon

According to Saunders et al. (2012), time horizons are needed for the research design and the self-governance of the research methodology applied. However, there are two types of time horizon, namely longitudinal and cross-sectional. In longitudinal studies, the research is repeated over an extended period, whilst cross-sectional studies are limited to a specific timeframe. Given this research, the study is also limited to a specific time frame and hence the cross-sectional time horizon is used.

3.12 Methods and Techniques of Data Collection

A summary of the data collection methods and techniques utilised in the present study is presented in Table 8.

Table 8: Illustrative summary of the methods and techniques of the data collection

Serial number	Research Objectives	Data collection method
1	To investigate the benefit associated with the utilisation of agricultural waste as building material in Nigeria.	• Literature review– • Semi-structured interview • Questionnaires
2	To explore the factors responsible for the non-utilisation of agricultural waste as building materials in Nigeria.	• Literature review • Semi-structured interview • Questionnaires
3	To establish the critical success factors which enable the improved utilisation of agricultural waste as building materials in Nigeria.	• Questionnaires • Semi-structured interview
4	To develop a collaborative innovation management framework that assists in the	• Research data Outcome

	utilisation of agricultural waste as building materials.	
5	To validate the developed collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials.	• Questionnaire • Focus group

3.12.1 Data Sampling

Sampling is understood to be a precise principle used in selecting population members to be included in the research study. This is due to the large population and is difficult to deal with when conducting a research survey. However, because of this larger nature of the population, statistical sampling technique was developed to obtain the sample size needed to represent the large population during the research (Proctor, 2003). Nevertheless, due to the large size of the target population, researchers have no choice but to study many cases of elements within the population to represent the population and to reach conclusions about the population. There are positives to using sampling in data collection as sampling makes research manageable and cost-effective. Further, using sampling the result is more precise and provide the chance to process the information in a more economical manner (Brown, 2006). Sampling is divided into two main types which are probability and non- probability, however, one of the non- probabilities are snowballing, which is adopted for this research work.

3.12.2 Snowballing sampling

Snowball sampling features are infrequent and hard to find. This sampling method contains primary data source recommending another potential primary data source to be used in the research. Furthermore, the snowball sampling method is based on recommendations from the initial subject to generate additional subjects. Therefore, when applying this sampling method member of the sample group are engaged via network referral. Also, snowball

sampling is the most popular in studies focusing on specific organisation or organisations that involve primary data collection from employees of that organisation. Once you have contact details of one employee, then the contact can help to recruit other employees to the study by providing contact details (Saunders et al., (2012).

Snowballing sampling is categories into three designs, which are: Linear snowball sampling, Exponential non-discriminative snowball sampling, Exponential discriminative snowball sampling.

Linear snowball is develop using only one subject and the subject provides only one referral. The referral is recruited into the sample group and that referral also provides only one new referral. This pattern is continued until the sample group is fully formed. While exponential non- discriminative snowballing starts with a subject recruited to the sample group provides multiple referrals. Each new referral is explored until primary data from the sufficient number of samples are collected and exponential discriminative snowballing is subjects give multiple referrals, however, only one new subject is recruited among them. While the choice of a new subject is guided by the aim and objectives of the study.

In line with the objectives of this research and question pose, Exponential non-discriminative snowball sample adopted. This is done by recruiting a contact or referral in the proposed organisation (sample frame) and the contact further identify multiple referrals until primary data from the sufficient number of samples are collected in the organisation (Saunders et al., 2012).

3.13 Data Analysis

The data collected informs the approach employed in its analysis; however, in this research mixed methods are adopted. In some research statistical procedures, descriptive and inferential statistics are employed to conclude a complete population from quantitative data (Collis and Hussey, 2013). Whilst descriptive analysis focuses on the measurement of central tendency, and the spread of data-standard deviation, inferential analysis/group comparison concerns the patterns and relationships in quantitative data. However, Saunders (2012) stated that the qualitative method of data analysis is subdivided into; thematic, content,

comparative, grounded and discourse. In respect to this research, the quantitative data collected from the questionnaires will be analysed using NVivo computer software; those from semi-structured interviews use thematic analysis and the use of the Statistical Package for the Social Science (SPSS) software package will aid the quantitative data analysis from the questionnaires. At a later stage when validating questionnaire method used and further with a focus group interview.

3.14 Background of the Case Study Context

3.14.1 Demographic Description of Nigeria

Nigeria is the most populous country in Africa, with over 170 million inhabitants, a land surface area of almost a thousand km^2 and a national growth rate of 3.2% per annum (Akinyemi and Isiugo-Abanihe, 2014). The amalgamation of the Northern and Southern Protectorates in 1914 by Sir Lord Laggard marked the birth of Nigeria as a British colony. Nigeria became an independent nation in 1960 and a sovereign republic in 1963 (Akinyemi & Isiugo-Abanihe, 2014). Currently, the population of Nigeria is 196,418,525, as of Wednesday, August 15, 2017, based on the latest United Nations estimates; this is equivalent to 2.57% of the total world population. Furthermore, Nigeria ranks number 7 in the list of countries and dependencies by population(Worldometers, 2017). Also, the population density in Nigeria is 215 per Km^2 (557 people per mi^2) and the total land area is 910,770 Km2 (351,650 sq. miles), where 51.0% of the population is based in urban areas (99,967,871 people in 2018) and the median age in Nigeria is 17.9 years (Worldometers, 2017).

Nigeria is a country located in West Africa along the Atlantic Ocean's Gulf of Guinea. Its land borders are with Benin to the west, Cameroon and Chad to the east and Niger to the north (Nations, 2013). Nigeria is a multi-ethnic and culturally diverse society. Its main ethnic groups are Hausa, Igbo and Yoruba. It is the most populous country in Africa and its economy is considered one of the fastest-growing in the world (Nations, 2013). However, about 50% of Nigerians are urban residents, with the rate of urbanisation estimated at 4.3% (Factbook, 2017). Furthermore, Nigeria has over 250 ethnic groups, whose people speak over 502 languages, and the variety of customs and traditions among them give the country great cultural diversity (Factbook, 2017). Nevertheless, the three largest ethnic groups are the Hausa/Fulani, which constitutes 29% of the population, the Yoruba at 21% and Igbo at 19.7%

(Factbook, 2017). The Efik, Ibibio, Annang, and Ijaw constitute other South-Eastern populations. The Urhobo-Isoko, Edo and Itsekiri constitute Nigerian's Midwest with the Urhobo notable as the majority (Factbook, 2017).

Most of the population is young, with 42.54% between the ages of 0-14; there is also a high dependency ratio at 88.2 dependents per non-dependents (Akinyemi & Isiugo-Abanihe, 2014). Also, three of the main religious groups are Muslim at 50%, Christian at 40% and other indigenous beliefs at 10 % (Factbook, 2017).

Nigeria is known for being the regional centre of West Africa. With approximately 180 million inhabitants (Nations, 2013), Nigeria accounts for 47% of West Africa's population and has one of the largest populations of youth in the world.

Table 9: shows the historical populations of Nigeria (by year). (Source: Worldometers, 2017)

Nigeria Population by Year (Historical)

Year ▾	Population	% Male	% Female	Density (km²)	Population Rank	Growth Rate
2018	195,875,237	50.68%	49.32%	212.04	7	2.61%
2017	190,886,311	50.67%	49.33%	206.64	7	2.63%
2016	185,989,640	50.66%	49.34%	201.34	7	2.65%
2015	181,181,744	50.65%	49.35%	196.13	7	2.70%
2010	158,578,261	50.58%	49.42%	171.66	7	2.68%
2005	138,939,478	50.50%	49.50%	150.41	9	2.58%
2000	122,352,009	50.42%	49.58%	132.45	10	2.52%
1995	108,011,465	50.35%	49.65%	116.92	10	2.54%
1990	95,269,988	50.31%	49.69%	103.13	10	2.64%
1985	83,613,300	50.26%	49.74%	90.51	10	2.62%
1980	73,460,724	50.27%	49.73%	79.52	11	3.00%
1975	63,373,572	50.07%	49.93%	68.60	11	2.51%
1970	55,981,400	50.01%	49.99%	60.60	11	2.23%
1965	50,127,214	49.96%	50.04%	54.26	13	2.12%
1960	45,137,812	49.91%	50.09%	48.86	13	1.90%
1955	41,085,563	49.89%	50.11%	44.48	13	1.65%
1950	37,859,744	49.89%	50.11%	40.98	13	0.00%

However, the recent population projection review for Nigeria, estimates that, by 2025, the Nigerian population will reach in the region of 223 million people (Worldometers, 2017). This projection will make Nigeria number 5 in world population ranking, as shown in Table 10.

Table 10: Nigeria population projections by year (source: Worldometers, 2017).

Nigeria Population by Year (Projections) ⓘ

Year ▲	Population	% Male	% Female	Density (km²)	Population Rank	Growth Rate
2020	206,152,701	50.70%	49.30%	223.17	7	0.00%
2025	233,691,888	50.73%	49.27%	252.98	5	2.54%
2030	264,067,527	50.75%	49.25%	285.86	5	2.47%
2035	297,323,173	50.76%	49.24%	321.86	5	2.40%
2040	333,172,092	50.75%	49.25%	360.67	4	2.30%
2045	371,119,359	50.74%	49.26%	401.75	4	2.18%
2050	410,637,868	50.72%	49.28%	444.52	3	2.04%
2055	451,310,617	50.69%	49.31%	488.55	3	1.91%
2060	492,643,358	50.65%	49.35%	533.30	3	1.77%
2065	534,359,116	50.60%	49.40%	578.46	3	1.64%
2070	576,062,295	50.54%	49.46%	623.60	3	1.51%
2075	617,054,577	50.47%	49.53%	667.98	3	1.38%
2080	656,683,661	50.40%	49.60%	710.88	3	1.25%
2085	694,557,237	50.32%	49.68%	751.87	3	1.13%
2090	730,325,352	50.24%	49.76%	790.59	3	1.01%
2095	763,551,079	50.17%	49.83%	826.56	3	0.89%

Also, Table 11 describes the age and sex population distribution in Nigeria as of 2016.

Table 11: Age/sex population distribution in Nigeria. (source: Factbook, 2017)

The World Factbook

AFRICA :: NIGERIA

Nigeria - 2016

Male | Female

Age groups shown: 100+, 95-99, 90-94, 85-89, 80-84, 75-79, 70-74, 65-69, 60-64, 55-59, 50-54, 45-49, 40-44, 35-39, 30-34, 25-29, 20-24, 15-19, 10-14, 5-9, 0-4

Population (in millions) — Age Group — Population (in millions)
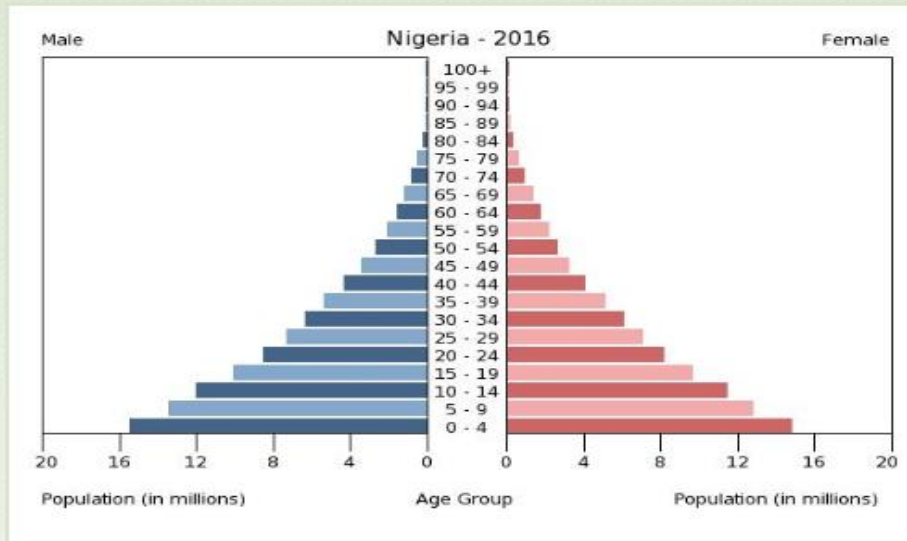
3.14.2 Administrative Structure of Nigeria

Nigeria is a political federation consisting of 36 autonomous states and the Federal Capital Territory, Abuja. Nigeria is further sub-divided into 774 Local Government Areas (LGAs). Furthermore, the states are grouped into six geopolitical zones, namely the: North West, North East, North Central, South East, South-South, and South West (Suberu, 1991). According to the General Census 2006, Nigeria has eight cities with populations of over 1 million people (from the largest to smallest, these are: Lagos, Kano, Kaduna, Ibadan, Benin, Port Harcourt). Lagos is the largest city in Africa, with a population of over 12 million in its urban area (Onuah, 2007).

Figure 12:shows the administrative map of Nigeria with the 36 states and Federal Capital Territory. (source: (Suberu, 1991)

A clickable map of Nigeria exhibiting its 36 states and the federal capital territory.
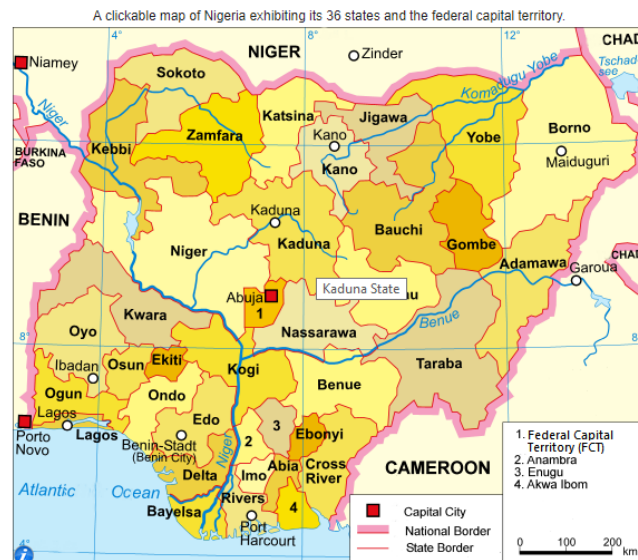
States

1. Abia	13. Edo	25. Nasarawa
2. Adamawa	14. Ekiti	26. Niger
3. Akwa Ibom	15. Gombe	27. Ogun
4. Anambra	16. Imo	28. Ondo
5. Bauchi	17. Jigawa	29. Osun
6. Bayelsa	18. Kaduna	30. Oyo
7. Benue	19. Kano	31. Plateau
8. Borno	20. Katsina	32. Rivers
9. Cross River	21. Kebbi	33. Sokoto
10. Delta	22. Kogi	34. Taraba
11. Ebonyi	23. Kwara	35. Yobe
12. Enugu	24. Lagos	36. Zamfara

3.14.3 Economy of Nigeria

Nigeria is a lower-middle-income, mixed economy and emerging market, with expanding manufacturing, financial, service, communications, technology and entertainment sectors. It is ranked as the 30th-largest economy in the world in terms of nominal GDP, and the 23rd-largest in terms of purchasing power parity (Fund, 2017). It is the largest economy in Africa; its re-emergent manufacturing sector became the largest on the continent in 2013, and it produces a large proportion of goods and services for the West African subcontinent. (Ohuocha, 2014). Also, the debt-to-GDP ratio is 11%, which is 8% & below the 2012 ratio (Ohuocha, 2014).

Nigeria is Sub Saharan Africa's largest economy and depends on oil as its main source of foreign exchange earnings and government revenue. After the 2008-09 global financial crashes, Nigeria recapitalized and regulated its banking sector which in turn enhanced Nigeria's economic growth through agriculture, telecommunications, and services. However,

this economic diversification and strong growth have not transformed into a significant decline in poverty levels (Factbook, 2017). According to Factbook (2017), over 62% of Nigeria's people still live in extreme poverty.

Notwithstanding, the oil-rich Nigeria has been affected by a scarce power supply, a lack of infrastructure, interruptions in the passage of legislative restructurings, an inefficient property registration system, restraining trade policies, an unpredictable regulatory environment, a slow and ineffective judicial system, defective dispute resolution mechanisms, insecurity, and prevalent corruption. Regulatory constraints and security risks mean limited new investment in oil and natural gas, and Nigeria's oil production has been contracting every year since 2012 until a slight rebound in 2017 (Factbook, 2017).

While crude oil exports provide 95% of its foreign exchange earnings, Nigeria's has other potentially vibrant industries and these include: mining (including coal, iron ore, limestone, tin etc.); agriculture (hides and skins, textiles, cocoa, peanuts, cotton, palm oil, corn, rice, sorghum, millet, cassava, yams, rubber, cattle, sheep, goats, pigs, timber and fish) (Iyoha and Oriakhi, 2002); and manufacturing (including cement and other construction material, food products, footwear, chemicals, fertilizer, printing, ceramics, steel). Figure 13 shows the sectoral composition of Nigeria's GDP.

Figure 13: GDP Composition by Sectors in Nigeria (source: Economic watch, 2010)

Nigeria : GDP Composition by Sectors
© EconomyWatch.com

	Agriculture	Industry	Service
GDP Composition	33.4	34.1	32.5
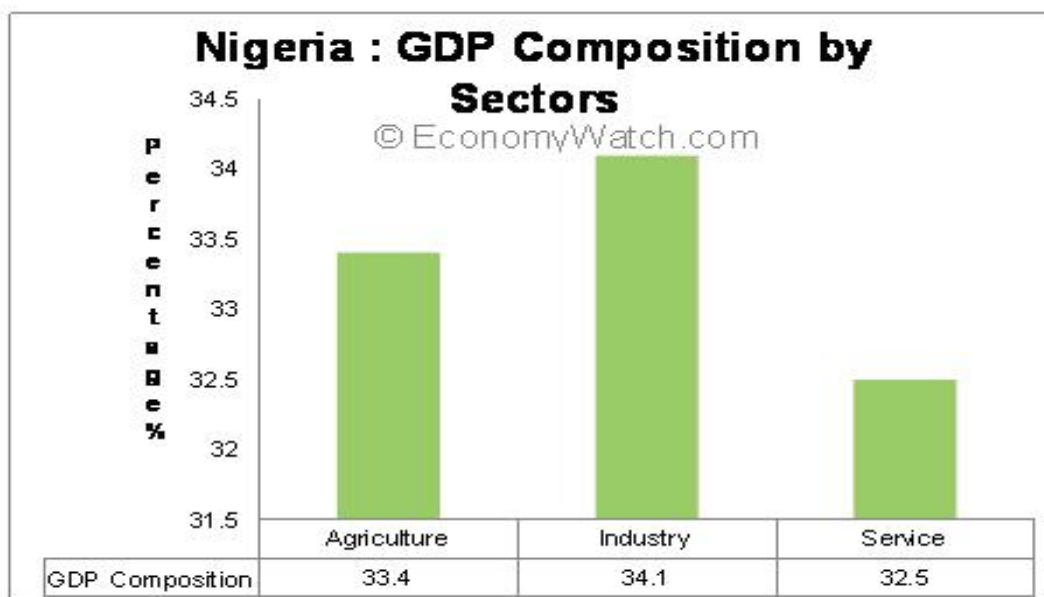
The extractive sector in the Nigerian economy is large and extensive, with oil playing a dominant role. With nearly 37.2 billion barrels in reserves and 2.13% of global production, Nigeria has the world's tenth-largest proven reserves (3.1% of global reserves) and is among the top 10 oil producers. Since the discovery and production of oil in Nigeria in 1958, the subsector has continued to play a major and dominant role in the Nigerian economy. In terms of output production and product contribution, oil has witnessed steady progress throughout the period under consideration. Crude oil production increased from 1.9 million barrels in 1958 to 152.4 barrels in 1966 (Akinlo, 2012). In 1967 and 1968 crude oil production declined suddenly as a result of the Nigeria civil war. However, in 1970 production increased from 395.7 million barrels to 660.1 and 845.5 million barrels in 1975 and 1979 respectively (Akinlo, 2012). Furthermore, the increase in production witnessed during this period was triggered by the Middle East crisis and the 1973/74 oil embargo which caused a sharp reduction in the world oil supply (Akinlo, 2012). Consequently, the crisis and embargo helped to boost local oil production in Nigeria. However, this was short-lived in the early 1980s due to over-supply, which resulted in a sharp drop in prices and an eventual reduction in the production quotas by the OPEC member countries (Akinlo, 2012).

Consequently, oil production in Nigeria dropped from 760.1 million barrels in 1980 to 535.9 and 383.3 million barrels in 1986 and 1987 respectively. The situation improved in the 1990s as crude oil output rose from 383.3 million barrels in 1987 to 711.3, 742.3 and 772.9 million barrels in 1992, 1996 and 1998, respectively. The trend continued between 2000 and 2009 when the cumulative crude oil production for the country increased from 20,575,881 million barrels (2000) to 27,052,0677 million barrels (2009). In general, Nigeria's crude oil production witnessed an appreciable increase over years until 2009 when the oil market started dwindling (Akinlo, 2012).

The contribution of a product or sector to the national economy can be measured by its size in the GDP. The contribution of oil to the GDP in Nigeria has increased steadily over the years. Oil accounted for just 3.43 per cent of the GDP in 1965. The share of oil in the GDP increased from 9.27 per cent in 1970 to 19.37 per cent in 1975, whilst the figure increased to 38.87 per cent in 2005. The share of oil in the GDP decreased marginally to 37.44 per cent in 2009. Two main reasons can be offered for the increasing share of oil in GDP. The first is the discovery

of oil in large quantities since the early 1970s, which led to massive oil production and export (Akinlo, 2012). The huge revenues from oil led to massive rural-urban migration and the neglect of agriculture. The second reason is the natural tendency for a share of the agricultural sector to fall while the non-agricultural sector increases as the economy develops (Akinlo, 2012).

Although the share of oil in the total GDP has increased over the years, the sector has had an unreasonably low contribution to the GDP and the overall economic transformation of the country. However, Nigeria's substantial dependency on the oil sector combined with the insecurity in the international oil market has brought mixed economic performances and macroeconomic discrepancies, which in turn affected international oil prices; this was followed by revenue shortfall that culminated in a relatively low real GDP growth in 2002. This led to decline in the financial account and pressure on external payments amounted to a debt crisis; however, the upturn in the oil market in 2000 brought about the anticipated increase in real GDP growth, which rose to 5 % (Ekperiware and Olomu, 2012). Nevertheless, in 2005 there was a drop-in oil GDP from 47.72% to 38.87%, as shown in Table 12

Table 12: Oil output, export and revenue in Nigeria, 1969-2009 (Data Source: CBN Nigeria,2010)

Oil output, exports and revenue in Nigeria, 1960-2009

Year	Production (bm)	Oil Revenue	Oil/Total Revenue (%)	Oil/GDP (%)	Oil Export (₦m)	Oil Export/ Total Export (%)
1961	16.80	nil	Nil	0.9	23.1	6.65
1965	150.3	nil	Nil	3.43	136.2	25.37
1970	395.7	166.4	26.3	9.27	509.6	57.54
1975	660.1	4271.5	77.5	19.37	4563.1	92.64
1980	760.1	12353.2	81.1	28.48	13632.1	96.09
1985	507.5	10923.7	72.6	16.75	11223.7	95.76
1990	660.6	71887.1	73.3	37.46	106623.5	97.03
1995	712.3	324547.6	70.6	39.65	927565.3	97.57
2000	797.9	1591675.8	83.5	47.72	1920900.4	98.72
2005	919.3	4762400	85.8	38.87	7140578.9	98.53
2009	759.2	3191938	78.7	37.44	8543261.2	96.73

Source: (a) Central Bank of Nigeria, Statistical bulletin, various years

3.14.3 Agricultural Development in Nigeria

Nigeria is predominantly an agrarian country endowed with numerous agricultural resources. Also, in 1990 Nigeria had an expanse of land estimated to be around 91 million hectares, of which 81 million hectares were arable. The majority of the landmass of the country is rich in

soil nutrient, with a well-distributed rainfall Metz (2009), whilst 18 million hectares of land was classified as permanent pasture, for livestock production (Metz, 2009). Agriculture serves as the major source of livelihood for over 75% of the population. Nigeria's Bureau of Statistics (2010) report that the agriculture sector employs about 30% of the population.

In the past, Nigeria was a prominent exporter of groundnut and palm kernel oil. Nigeria was noted to be self-sufficient in the sense that it produced most of what its population consumed (Olawumi and Oyewole, 2018). However, over the years the rate of production within the agricultural sector has reduced, and the key reason for this is easy to determine. As Nigeria's crude oil production and export increased, its priorities shifted from agriculture to crude oil production. It is noted that this shift in attention created substantial setbacks for agricultural development and, until now, Nigeria has not been able to harness the enormous potential of its agriculture sector. Nevertheless, the previous government of Dr Jonathan Goodluck commenced a massive drive to restore the agriculture sector to the forefront of Nigeria's economy. Incentives were provided to farmers, infrastructures are continuing to be restored, and up-to-date knowledge has continued to be developed and diffused within the agriculture sector. Consequently, Nigeria is beginning to produce significantly more agricultural commodities and have recently recommenced the export of agricultural produce. Figure 14 shows the locations of production and processing of the main agricultural commodities in Nigeria.

The increased productivity in the agriculture sector bears significant implications for the quantity of agricultural waste generated in Nigeria. This work argues that the quantity of agricultural waste generated will naturally increase as the quantity of agricultural commodities increase. Therefore, there is a need to study and document how this can be utilised as a building material in the context of this research study.

Figure 14: Production and processing locations for main agricultural commodities in Nigeria (source: IITA, 2010)

Location of production and processing of main agricultural commodities
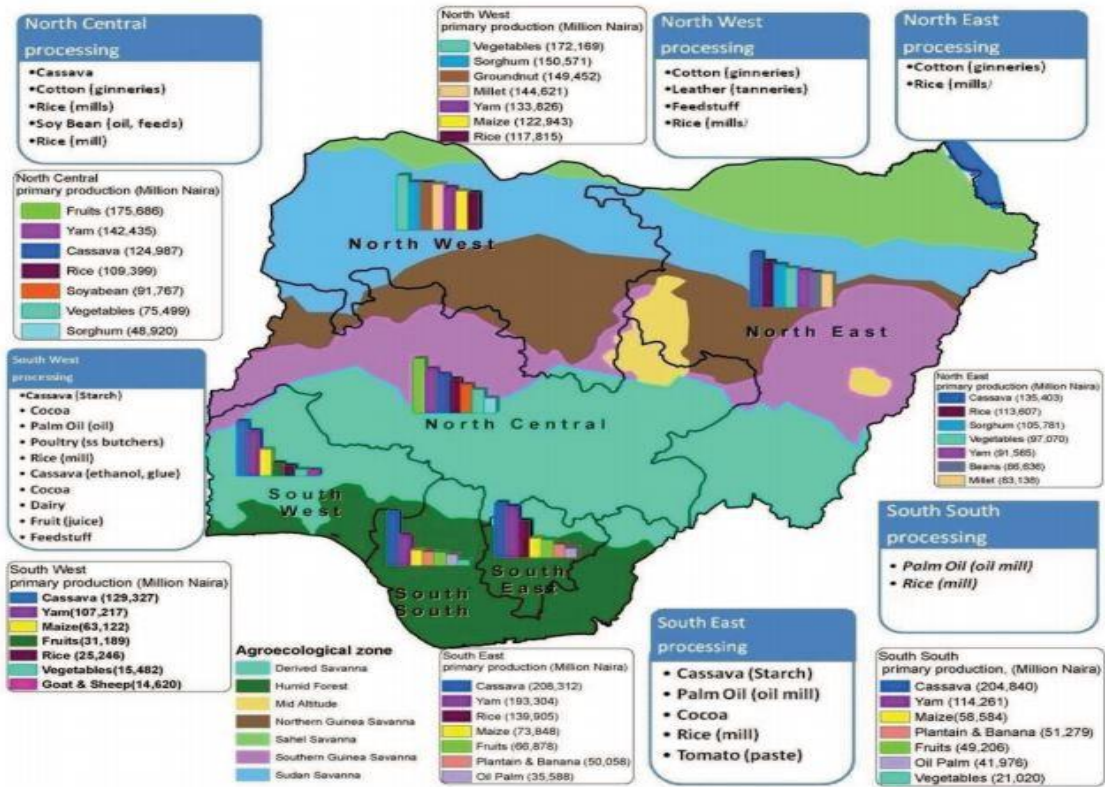
Source: Prepared by IITA Geospatial lab, Nigeria

3.15 Description of the organisations that provided bounded systems within which the case was studied

3.15.1 Organisation One (O$_1$)

Organisation One is a construction company based in Abuja which was founded in 1976. The company is among the top-rated construction companies in Nigeria, with a staff population of around 3,000 employees including over 80 expatriates. The company has a solid background in the construction industry with its fleet of over 1000 mobile vehicles, trucks and construction equipment plus its aggregate crushing and asphalt mixing plant to ensure self-sufficiency and enable a guarantee on the performance and quick delivery of the project to their clients. Majority of raw material used is imported from other countries in African and Europe. Over the years, the company have constructed several hundred kilometres of highways and township roads, dozens of bridges and flyovers, several housing estate infrastructures and three airport runways; moreover, the organisation has recently ventured

into the industrial plant construction sector. However, the company has been known in the market as a reliable partner for the Government as well as private investors and developers. The justification for choosing this organisation is based on the fact that most of the material used by the company are imported and there is need to understand the reason why available raw material via agricultural waste is not adopted for usage in the construction project.

3.15.2 Organisation Two (O₂)

The second organisation used for this research case study is a farm in Nigeria with the headquarters located at Idiroko Road, Ota, Ado Odo/Ota, Ogun State Nigeria. The farm has been in existence since 1979 and has pioneered integrated mechanised farming in Nigeria as a means of sustaining its fast-growing population. Furthermore, the farms have locations in various areas of the country and are managed by highly experienced and skilled agricultural experts as well as professionals in other fields related to the production system of the background integration exercise. Furthermore, with over 30,000 hectares of land, over 5,500 employees who form its workforce manage the farm.

Also, from the information gathered, the organisation sees farming as an economic, practicable, lucrative, and all-around beneficial business requiring technology and building entrepreneurship to enhance the lives of all concerned in an atmosphere of peace, unity, security, and profitability. In doing so they aim to meet the needs of the present and the forthcoming generations.

This farm specialises in the production of agriculturally based products and agricultural allied groups, which includes:

- Chickens (broilers, growers, layers, day-old chicks,)
- A cocoa plantation
- A palm plantation
- A cashew plantation
- A coconut plantation
- A piggery
- A commercial and parent stock poultry farm and so on.

This organisation is used in this project to have an in-depth view of the farmer and agricultural sector about the usage of agricultural waste as building materials and what is needed to be done to achieve the utilisation of agricultural waste as building materials in Nigeria.

3.15.3 Organisation Three (O₃)

The third organisation used for the case study is a manufacturing company based in Abaji, close to the federal capital territory, Abuja Nigeria. It has employed 12 workers of whom 5 are professionals in the field of manufacturing. The company manufactures ceramics tiles. Since 1987, the company has been a leading distributor of tiles and the largest supplier of mosaics throughout Nigeria. The organisation has a vast product range to meet the daily requirements in the Nigerian market, producing tiles for domestic and contract use. However, most of the raw material used is imported which increases the cost price of their product and means it is expensive.

The justification of using this organisation is to understand the view of an indigenous manufacturing company on the potentials in the utilisation of agricultural waste as building material and the best way to adopt these materials for construction purposes.

3.15.4 Organisation Four (O₄)

The fourth organisation is a cement production company that was incorporated by the Kogi State Government in 1992. However, it was acquired by a private investor in 2002 and commenced the construction of the first cement production plant in 2004. The plant became a green-field cement plant in 2003 and was commissioned in 2007 with an annual capacity of 5 million tonnes. The company's assets comprise a cement plant, limestone quarry, 135 MW captive power plant, 90 km natural gas pipeline, a 351-unit housing complex for staff, an earth dam, water reservoir and 500 trucks for cement transportation. The company uses limestone to produce cement products, although this is problematic as limestone exploration has the potential to cause a major environmental hazard in future.

The reason for choosing this organisation is based on the literature review findings that some of this agricultural waste has proved to be in the same chemical composition as ordinary Portland cement used. In line with these findings, the researcher wants to know the view of cement manufacturer on the potentiality of agricultural waste for cement production in Nigeria.

3.15.5 Organisation Five (O₅)

This organisation comprises ministries of the Nigerian government that regulate agricultural research, agriculture and natural resources, housing and housing development throughout Nigeria . These ministries are responsible for various parastatals. They supervise and provides funding for research institutes and colleges of agriculture and forestry and other colleges that deals with the built environment i.e. Ministry of Agriculture and natural resources, Ministry of Works, and Housing.

To achieve this new innovative product, and reduce housing deficit, there should be government and public sectors involved in every stage of the innovation processes in the area of policymaking, finance, regulation and so on. Therefore, it is of importance to bring on board the view of the stakeholders in public organisations into the study to know how best these key players can collaborate in the process of utilisation of agricultural waste as building materials.

3.15.6 Selection of Case Study Participants

The case study participants were involved in the construction industry, agricultural sector and governmental bodies (within the case study organisations outlined in section 4.13). The participants were key decision-makers for their respective organisations, contributing their unique capacities to the progress of the organisation and any subsequent decision-making. However, the selection of several knowledgeable interviewees generated a range of different perspectives on the research case studies (Eisenhardt and Graebner, 2007) and enabled data analysis across the construction, agricultural and public/private sectors. Furthermore, the Director-General in the Federal Housing Authority in Abuja and his counterpart in the Ministry of Agricultural development for the public sector (in line with Organisation Five), were the researcher's initial contacts from whom the names and contact e-mail addresses of the members of staff at other public organisations were collected (architect, engineer, local authority, farmers' extension workers, housing teams and regional homes and communities agency). The researcher sent introductory e-mails to all individuals who agreed to take part in the case study, by committing to complete the questionnaire and/or to participate in a semi-structured interview. On the other hand, another participant was selected for the other

four organisations (in section 4.13) by the heads of each department in the organisation, and the researcher also sent an introductory e-mail to the individuals concerned.

3.16 Data Collection

The data collection took place over a critical four-month period for the research, in which the development of the collaborative innovation management framework took place. This framework aimed to assist in the utilisation of agricultural waste as building materials and was created through consultation with the individuals involved in innovation, agriculture, construction innovation, and particularly about the unique demands of a housing deficiency due to high cost of building materials. The data collection instruments took the form of questionnaires and semi-structured interviews. These were fresh and immediate and collected in a 'real-time' context from individuals who were currently engaged in the current situation rather reflecting on past actions.

3.16.1 Semi-structured interviews

The personal contact and the continually new insights into the subject's world make interviewing an exciting and enriching experience (Van-Teijlingen, 2014) and this is emphasised in the collection of data from the semi-structured interviews within the case study design. Interviews are the primary source of data for a case study technique, and these take a structured, semi-structured and unstructured format (Yin, 2003). The styles describe the degree of constraint placed on both the researcher and the participants by the form of the questions. Based on the context of this research where real live issue needed to be addressed, the study adopts a semi-structured interview format where the focus of the questions, or a guided conversation follows a series of open questions that are designed to meet the purposes of the research (Yin, 2003). The semi-structured questions (summarised in Appendix E) were distributed to the participants by e-mail in advance of the interview, whilst some were handed out on the day of the interview. The interview was designed to be open-ended and neutral, focusing on the process and 'story' of the case study to facilitate an exploration of participants' perceptions and beliefs regarding the context of innovation, and the usage of agricultural waste for building projects. The format enabled participants to offer additional information, comments and views and provided opportunities for the researcher

to invite and probe for clarification and further knowledge. *Table 13*, summarises the interviewees, their details, and the roles, which are used to identify each interviewee and linking them to the relevant organisation in section 4.13.

Note that the participating organisations are codes as O1, O2, O3, O4, O5 as specified in section 3.15, section 3.16.1, Table 13.

Case study organisation and their assigned ID are shown in *Table 13*.

Table 13: Case study organisation and their assigned identity for the semi-structured interviews (Source: Field Data, 2016)

Role	Assigned ID	Organisation	Job functions	Time
CS1	AJBMI	Construction material manufacturing company (O3)	Projects officers	1h 21m
CS2	STNL	Construction firm (O1)	Housing officer	1h 12m
CS3	AFOOS	Agricultural farm (O2)	Field officer	1h 42m
CS4	AFSAOS	Agricultural farm (O2)	Field officer	1h 8m
CS5	OSPKI	Cement Industry (O4)	Local farmer	59m
CS6	FOMAONR	Ministry of Agriculture (O5)	Director	1h 6m
CS7	PMTSCL	Construction firm (O1)	Project manager	1h 11m
CS8	FMLFNL	Construction Products Manufacturing Company (O3)	Operation manager	1h 18m
CS9	LCAPCB	Cement Industry (O4)	Product manager	58m
CS10	FMANR	Ministry of Housing (O5)	Director (Housing)	1h 17m

3.16.1.1 Roles of the key players interviewed

- Project Officer

The Project Officer provides vital support to a project, working with the Project Manager and other team members to achieve project success. In the context of this research, the Project

Officers worked in the agricultural field to communicate, educate and sell new ideas to farmers when a new development is being undertaken in the Ministry of Agriculture and Natural Resources.

- Housing Officer

Housing officers manage a certain number of properties within a geographical area that belongs to the Ministry of Land and Housing. Also, the Housing Officer undertakes several administrative duties, such as writing reports and keeping records, dealing with neighbourhood disturbances, ensuring rent is paid by tenants, managing residents expectations and enquires, organising property repairs, interviewing house applicants and ensuring that the property is following the specifications.

- Field officer

The Field Officer plans to manage and monitors programmes in the Ministry of Agriculture and Natural Resources, to help ensure resources are targeted to the best effect. Also, the Field Officer takes an active part in the area by checking activities to verify both recorded and identify potential errors, e.g. dubious returns and unregistered plantings. The officer visits each farm/agribusiness in the allocated area at least once per year or season, where issues cannot be resolved by other means. The officer also mediates where required, and, where appropriate, makes recommendations, with a timescale, for improvements to accommodation and facilities. Another aspect of the role is to regulate how current Health and Safety regulations affect workers and the advice to employers on these matters, when necessary, including any relevant action plans.

- Project manager

The Project Manager, in this context, is the construction manager of the construction firm case study. This role oversees planning, coordination, budgets, and the supervision of construction projects from the preliminary to the finishing the stages. The Project Manager also prepares and negotiates cost estimates and work timetables. Furthermore, the manager selects appropriate construction methods and strategies, and interprets and explains contracts and technical information to workers and other professionals. The role reports on work progress and collaborates with architects, engineers, and other construction and building specialists. They also instruct and supervise construction personnel and activities onsite and respond to work delays and other problems and emergencies. Also, they

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work closely with other building specialists, such as architects, engineers, and a variety of trade workers, such as stonemasons, electricians, and carpenters.

- Operation Manager

In the context of this study, the Operations Manager is the employee who oversees the production of goods and the provision of services for the construction product manufacturing industry. The Operations Manager also manages both raw materials and personnel and oversees the inventory purchased and supplies. Also, the role carries out human resource responsibilities, which include determining needs, hiring employees, overseeing the assignment of employees and planning staff development.

- Product Manager

The Product Manager is in charge of the daily management of farm produces and identifies the potential that lies within a farm product. The role also conducts market research and how the farm produce can best bring economic income to the organisation.

- Directors (Ministry of Agriculture and Housing)

The role of the Director in the Ministry in Nigeria is to execute the policies and regulations given to the sector for which they are responsible. Furthermore, the Director makes the strategic and operational decisions of the Ministry and is responsible for ensuring that the Ministry meets its statutory obligations. They participate in board meetings to enable the board to reach these decisions and ensure that the policies' objectives and obligations are fulfilled. They are the agent of the government and appointed by the shareholders and politicians to manage its day-to-day affairs.

3.16.2 Questionnaires

A questionnaire is simply a 'tool' for collecting and recording information about an issue of interest. Usually associated with quantitative research, questionnaires are mainly comprised of a list of questions but should also include clear instructions and space for answers or administrative details. Questionnaires always have a definite purpose that relates to the objectives of the research, and it needs to be clear from the outset how the findings will be used. The participants are made aware of the purpose of the research and questionnaire copies were distributed to individuals involved in the selected organisation again, is this section correct? (Amaratunga et al., 2002). The questionnaire for the study was divided into

three parts; firstly, the general background information about innovation; secondly, construction innovation and agricultural innovation in relation to innovation management to assist in the utilisation of agricultural wastes as building material for the construction industry (Appendix D shows the questionnaire format and the nature and type of questions asked). The questionnaire survey was administered by post, together with a covering letter explaining the objectives of the research to the selected respondents. The covering letter specifically provided background information about the researcher; it outlined the main objectives of the study, gave reasons why the respondents' assistance was being sought, and finally provided assurance on issues relating to the confidentiality of respondents' information and responses (Sarantakos, 2013) (a copy of the covering letters are provided in Appendix C). In all, a total of 155 questionnaires were sent out in the first week of January 2016 to the selected respondents who were identified for their involvement in the delivery of an innovative management framework to assist in the utilisation of agricultural waste as a building material in Nigeria. Furthermore, to reach the appropriate respondents, the selected organisations were contacted through the heads of each organisation. Pre-survey contact was also made by telephone call via the heads and emails were also sent to the selected respondents before the final questionnaire survey was issued. Follow-up telephone calls were also made weeks later to thank the respondents who had completed the questionnaire and to remind those who were yet to respond. This was done to further emphasise the importance of completing the questionnaire on time and to increase the response rate (Saunders, 2009). Altogether, within eight weeks, a total of 102 responses were received. Also, another batch of 155 questionnaires was sent out in the third week of May 2018 making a total of 310 questionnaires using the same method of distribution like the first set and within 9 weeks a total of 109 responses were received, representing an overall response rate of 68.06% out of the total selected sample of 310. However, Table 14shows the breakdown of the questionnaire distribution, completion rate, and the response rate, respectively.

Table 14: Questionnaire survey distribution, completion and response rate (source: Field Data, 2016)

Organisation Category	Questionnaire Distributed 1st and 2nd	Completed Questionnaire Received	Questionnaire Not Completed	Response Rate
O1, O2, O3, O4, O5.	155 +155	102 +109	53 +46	68.06%
Total number	310	211	99	68.06%

As shown, the response rate of the questionnaire survey was 68.06%, where 211 questionnaires received in total and 99 were not completed. Nevertheless, in dealing with the non-response preconception, the enquiries of the questionnaire survey were made mandatory. To ascertain if any significant issues of non-response bias arose amongst the data collected a comparison was conducted between the non-response results for respondents with the response results. The analysis indicated insignificant differences between the non-responding and responding participants; this suggested that the data was representative of the survey population, and further indicated the absence of any likely bias in the data obtained for the study. Rogelberg and Stanton (2007) argued that, although some observed differences might exist, it is important to understand that these differences between respondents and non-respondents (or the population in general) do not necessarily indicate response bias. Furthermore, this method has also been used to check for the non-response bias of their data by comparing responding and non-responding participant characteristics. Also, another way non-response can be considered is by using triangulation or through the application of a different set of data (interviews and questionnaire survey) (Rogelberg and Stanton, 2007). Using the data obtained under varying conditions has enabled the mitigation of the effect of a non-response bias for this present study.

The questionnaire survey for the study was directed at the key players in the organisations involved in the delivery of an innovative management framework. The results and statistical breakdown of the key players who responded to the questionnaire survey are also shown in Table 15.

Table 15: Results and statistical breakdown of respondents of the questionnaire survey

(source: Field Data, 2016)

Job title	Frequency	Per cent	Valid Percent	Cumulative Percent
Perm. Sec. ministry of works and housing	2	1.0	1.0	1.0
Perm sec min works	2	1.0	1.0	2.0
Local farmers	34	16.8	16.8	18.8
Structural Engineers	19	8.9	8.9	27.7
Farm managers	21	9.9	9.9	37.6
Surveyors	7	3.1	3.1	40.7
Architects	12	5.1	5.1	45.8
Project Engineers	19	8.9	8.9	54.7
Project Managers	6	3.0	3.0	57.7
Agric. Engineers	7	3.1	3.1	60.8
Production Managers	7	3.1	3.1	63.9
Dir. Ministry of Agric.	7	3.1	3.1	67.0
Dir. Ministry of works	8	4.2	4.2	71.2
Procurement Officers	18	7.9	7.9	79.1
Exp. Mason	10	5.7	5.7	84.3
Heads of Farm Workers	11	5.2	5.2	90.0
Quantity Surveyors	5	2.5	2.5	92.5
Site Managers	7	3.6	3.6	96.1
Quality assurance Mgt.	4	1.9	1.9	98.0
Construction Workers	5	2.0	2.0	100
TOTAL	211	100	100	

Also, the outcomes from the questionnaire survey indicated the frequency (the number of years spent in delivering in their field of practice) of the key players who responded to the questionnaire survey, as shown in Table *16*.

Table 16: Number of years the respondents have spent in their field of practice (source: Field Data, 2016)

Years	Frequency	Per cent	Valid Percent	Cumulative Percent
1-5	19	8.7	8.7	8.7
6-10	69	32.2	32.2	40.9
11-20	68	33.3	33.3	74.2
16-20	38	17.4	17.4	91.6
21-25	11	5.7	5.7	97.3
26-30	6	2.7	2.7	100
TOTAL	211	100	100	

Also, the results obtained from the questionnaire indicated the highest level of educational background and experiences achieved by key players in various organisations who responded to the questionnaire, as shown in Table 17.

Table 17: Frequency of the maximum education level achieved by respondents in their field of practice. (source: Field Data, 2016)

	Frequency	Per cent	Valid Percent	Cumulative Percent
Primary School Leaver	16	7.1	7.1	7.1
Secondary school	18	8.9	8.9	16.0
OND	22	10.5	10.5	26.5
NCE	16	7.1	7.1	33.6
HND	31	14.6	14.6	48.2
B.Sc.	48	21.2	21.2	69.4
PGD	22	10.5	10.5	79.9
Masters	29	11.2	11.2	91.1
PhD	19	8.9	8.9	100
TOTAL	211	100	100	

Furthermore, to analyse the collected data logically and systematically, Sarantakos (2013) outlined six steps to be followed when undertaking a computer-aided analysis for quantitative research. These are:

- Preparing the collected data by cleaning and checking for possible errors and omissions.
- Entering the prepared data into SPSS and NVivo for analysis, as required.
- Presenting the findings from the analysis in graphical and table forms.
- Conducting inferential statistical analysis of the data.
- Presenting the data with tables and figures, and explaining the findings, and
- Concluding the analysis of the findings.

Giving proper attention to the above steps helps to reduce errors, misinterpretation and the drawing of wrong conclusions from the research findings (Saunders, 2009). Consequently, for this study, the preparation of the data was the first step taken in the data analysis process, as it allowed the researcher to check and edit the raw data for any possible errors or omissions and inconsistencies within the data set. According to Sarantakos (2013), using computer software for the analysis is the best way to ensure the validity and reliability of the research findings; this is why SPSS was adopted for the data processing and analysis. Once the data is fed into the computer software, the researcher can explore and analyse them far more quickly and thoroughly than any other form of analysis (Saunders, 2009).

For quantitatively oriented studies, two tests are normally conducted, namely parametric and non-parametric. Their use depends on the type and nature of the data collected. Non-parametric tests make fewer assumptions about data and are used under conditions where the data collected is considered as not normally distributed. Also, non-parametric tests are most appropriate with a reasonably small amount of data which can be measured on nominal and ordinal scales and are more flexible to apply (Pallant, 2010). Nevertheless, parametric tests, on the other hand, are based on a hypothesis about the population from which the data is taken. However, none of these tests may be needed for this research.

3.17 Descriptive analysis method

Once the basis of the research is established from the literature, the study needs more information in the form of data from the field of research. Therefore, the next step in

analysing the data is through descriptive research analysis. According to Naoum (2012), descriptive analysis is an attempt to explore and explain quantitative data in a manner that gives a general overview of the findings while providing additional information about the research study. Furthermore, the descriptive analysis describes what is happening in more detail, filling in the missing parts and expanding our understanding. Thus, as much information as possible is collected to construct a framework based on data, rather than on guesses or elaborate models to predict the future. This involves the 'what' and 'how,' rather than the 'why'. Usually, descriptive analysis is carried out to provide statistical information such as the mean and median, percentage of frequencies and the cumulative frequency of any data collected (Pallant, 2010). Also, the descriptive analysis enabled the researcher to describe and compare the results both graphically and numerically for the easy interpretation of the results and findings. This analytical approach has been adopted by several recent construction management research studies; for example, Akotia (2014) and Ihuah (2015) employed this approach when analysing their quantitative data.

3.18 Summary of the Research Methodology

In summary, the research philosophy depends on how a researcher views or develops knowledge, which is the first layer in the research onion adopted for this study. Furthermore, the researcher considers the combination of three influences onto research philosophy, which are epistemology, ontology and axiology. Epistemology establishes knowledge in the field of study, ontology is concerned with the nature of reality, whereas axiology studies the researcher's value at all stage of the research process.

The philosophical stand in this project will take a pragmatic approach to address a practical problem; it will neither be based on a strong pre-determined theory nor built on the personal aims to invest meaning (Easterby-Smith et al., 2012). Hence, the study considers the ontological assumption that is not pre-determined, but is socially constructed; moreover, it is based on the epistemological assumption that knowledge is acquired by examining the views of the people, with the consideration of objective facts; finally, the valued-balanced axiology both objective and subjective approaches. With the adoption of an interpretive approach to the research, the study incorporates an inductive and abductive logic where a collaborative framework will be developed on abductive logic; this is due to the scarcity of relevant

literature on the development of an innovation management framework to assist in the utilisation of agricultural waste as building materials.

Saunders and Lewis (2012) state that the choice of philosophy depends on the research question posed and whether the researcher feels that the approach must be dynamic by combining the three philosophical approaches. Moreover, Saunders and Lewis (2012) argue that research and research philosophy vary according to the research question. This research focuses on how a collaborative innovation management framework can be developed to assist in the use of agricultural waste as building materials by trying to explore the collaborating organisations' (public and private sectors) responses to semi-structured interviews and questionnaires that addressed the research question. Furthermore, Saunders and Lewis (2012) state that all research work involves theories and suggests the clarity of the researcher's theory at the beginning of the research helps in the process of adopting research approaches. Nevertheless, the researcher adopts an inductive and abductive approach over a deductive approach, where the researcher collects data and develops a theory or framework with the results of data analysis. According to Saunders and Lewis (2012), the following are the features of an inductive approach.

- Gaining an understanding of the meaning's humans attach to events
- A close understanding of the research context
- A collection of qualitative data
- A more flexible structure to permit changes of research emphasis as research progresses
- A realisation that the researcher is part of the research process
- Less concern with the need to generalise

In comparison, abduction permits researchers to move forward in the absence of complete evidence or proof. Dew (2007) verifies this by defining abduction as the process of making deductions about the best way to explain a collection of surprising or abnormal facts from the research findings. Furthermore, Taylor et al. (2002) confirm this by explaining abductive reasoning as a process where advance in science is often achieved through intuitive leaps that emerge, while logical processes are ignored. Furthermore, Saunders (2012) explains that seven different strategies can be used for research, which is: experiment, survey, case study, action research, grounded theory, ethnography, archival research. However, in choosing the research strategy and considering any of the stated strategies, the research questions and

objectives, and other resources available are the major determinants (Saunders (2012). The most practical solution for this research is the case study method, where the researcher's choice is associated with the inductive and abductive approach. It allows the collection of a large amount of data from the sizeable population in a highly economical way. By utilising the questionnaire, data can be made uniform allowing for easy compilation and comparison. Nevertheless, it is also a cheaper option for the researcher and allows for quantitative data collection. Furthermore, Saunders (2012) mentions that there are two main methods of data collection; quantitative and qualitative, whilst the use of both is known as a mixed method. A mixed method helps to address the weakness of both quantitative and qualitative methods. In the context of this research, the researcher used a combination of both quantitative and qualitative data techniques to collect the data; quantitative data were obtained through questionnaires and qualitative through semi-structured interviews. The response of key players from collaborating organisations can be studied using the questionnaire surveys (for quantitative data) and the report of the interview (for qualitative data). Therefore, the researcher uses a mixed method of data analysis to generalise the findings.

Also, Saunders (2007) explains that time horizons are needed for the design of the research methodology. However, there are two types of time horizon, namely longitudinal and cross-sectional. Longitudinal studies are repeated over an extended period, whilst cross-sectional studies are limited to a specific time frame based on the data collection method. As this research is limited to a specific time frame, the cross-sectional time horizon is used. Also, there are two types of data involved in this research; the first is primary data and the second is secondary data. The secondary data contains the literature review, which considers the views of various researchers and authors about the research topic. Most often, secondary data does not answer most of the research objectives and questions. This gives room to collect primary data to fill the gap unfilled by the secondary data; the primary data is gathered in the form of questionnaires and semi-structured interviews in the case of this research. In other words, the secondary data is collected to find out about the research objectives while the primary data is collected specifically to answer the research questions.

One important thing to be noted is the language used in the questionnaire; simple language is usually preferred than using technical jargon. (Bruce et al. (2004) mention that "double-

barrelled questions and jargon must be avoided to reduce confusion among both parties".

Furthermore, Table *18*below shows the philosophical stance of this study.

Table 18: The philosophical stance of the study

Ontology	Realism	Relativism/Idealism
Epistemology	Strong Positivism ⟷	Constructionism /Interpretivism
Axiology	Value-neutral	Value-Balance

Chapter Four – FINDINGS AND DISCUSSION

4.1 Introduction

This chapter discusses the outcome of the data analysis and proposes answers to the research question. The research question is: What are the key factors responsible for the non-utilisation of agricultural waste as building materials in Nigeria? However, to address the research question effectively the question is divided into three parts that also help to address the research objectives. Part one dealt with the key benefits of the utilisation of agricultural waste as a building material. Furthermore, part two dealt with the key factors responsible for the non-utilisation of agricultural waste as building materials. The final part considers the best approach to enable and improve the utilisation of agricultural waste as a building material in Nigeria. This chapter will explain the pilot study, present the findings, and discussing their implications.

4.2 Pilot Study

Before conducting the case studies (CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9 and CS10), preliminary pilot interviews were tested with four specialists, one each from the Ministry of Agriculture and Natural Resources, one from the Ministry of Work and Housing, a farmer and a building materials manufacturer. These experts were carefully selected to respond to a similar level of questions as the real case studies used for this research. The preliminary study helps to test the reliability, effectiveness and comprehensibility of the main interview questions that relate to the overall research questions. Building on the preliminary study, the researcher developed the main interview questions (Appendix D) within the 10 case studies. The main themes developed in the qualitative data analysis responses to the research question are highlighted in Table 19. This use NVivo software as a qualitative data analysis tool.

4.3 Research Question

What are the key benefits of the utilisation of agricultural waste as a building material in Nigeria? This section dealt with research objective two, namely, to critically investigate the benefit associated with the utilisation of agricultural waste as building materials in Nigeria. Having critically investigated the literature on the benefits associated with the utilisation of agricultural waste (as shown in section 3.9.4, section 3.9.5 and section 3.10), understandings were sought from those interviewed to examine part one of the research question and address objective two of this study. This section discusses data obtained from the field using a semi-structured interview and questionnaire survey. Responses were sought from ten participants for the qualitative phase: two civil servants from government ministries, four farm employees, two employees of construction-based firms and two from the manufacturing industry. Furthermore, responses to the questionnaire surveys comprised the quantitative stage to adequately answer the research questions raised (the interviews and questionnaires were conducted in parallel). The cases are coded as CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9 and CS10 with an assigned ID, as shown in Table 13 in section 3.16.1. The data collected are analysed and discussed under the research question and objective they seek to address.

To address part one of the research question, it is subdivided into three categories, which helps to effectively structure the questionnaire and interview. These sub-structure questions are.

(i)   What is the current benefit of agricultural waste in Nigeria?

(ii)   Has agricultural waste been effectively utilised and benefitted from in Nigeria?

(iii)   What is the suitability of the benefit associated with the use of agricultural waste as building materials in Nigeria?

4.3.1   The Current Benefit of Agricultural Waste in Nigeria

According to Kaur and Singh, (2015), agricultural waste is any agricultural or horticultural material, which the holder discards, intends to discard or is required to discard. It is waste specifically generated by agricultural activities. However, this waste must be identified and managed properly to protect individuals, the community, and the environment. Furthermore,

agricultural waste has been utilised in many developed and developing countries for domestic, engineering (brake pad), and building construction purposes, but in other countries, agricultural residue, as it is often called, is the surplus of production that has not been utilised to its fullest extent. In Nigeria, agricultural waste has been used, as shown in section 3.9.5.1 of this study. To further validate this current benefit, a total of ten semi-structured interviews were conducted during the qualitative phase of the study, while 211 individuals were surveyed during the quantitative stage to address this theme of the study.

About the semi-structured interview, all ten interviewees were asked questions about their views on the current benefit of agricultural waste in Nigeria. As revealed in Table 19, eight of the ten (80%) participants who were interviewed were aware that agricultural waste has been used for various foundry work and mentioned 'blacksmith and goldsmith smelting work to generate income to the family'. Furthermore, 8 out of 10 (80%) participants indicated that agricultural waste has been utilised for domestic purposes and mentioned 'cooking in place of charcoal and as fuel for local wood-burning' which has helped in the reduction of money spent to buy gas. This also improved sustainability development and helps in sustaining the ecological system by preventing ozone layer depletion.

Also, seven (70%) of the participants mentioned agricultural waste as one of the raw materials used in the production of domestic animal feeds. Most importantly, six out of ten (60%) noted in their responses that agricultural waste is sparsely used as an additive for concrete work and other construction purposes and the need to ascertain the potential that lies in the use of agricultural waste for building purposes. This confirms the literature (section 3.9.4.1) that agricultural waste is used as fly ash and an additive to concrete. Furthermore, three out of ten (30%) participants mentioned that agricultural waste is used to generate biogas for domestic usage, which shows the potential for the energy retention capacity in agricultural waste materials, as confirmed in section 3.9.5.1. Also, one out of ten (10%) of participants reported that 'agricultural waste is used for beddings of local and hybrid birds in poultry farms.' Similarly, one (10%) participant noted the use of agricultural waste for 'land reclamations. Thus, this suggests that there is limited awareness of agricultural waste for building purposes in Nigeria despite its potential for utilisation in both the developed and some other developing countries in the world.

Furthermore, in the case study analysis one participant (AFOOS), states that the current benefit of agricultural wastes is as, "*Local charcoal for cooking purposes*". Likewise, AFSAOS and AJBMI remarked that "*Agricultural wastes are used as fuel for domestic purposes".* OSPKI, FMANR, LCAPCB and the rest of the respondents referred to agricultural waste as the raw materials to generate energy for domestic cooking and domestic foundry works. Given the current usage of agricultural waste, it can be understood that agricultural waste has been beneficial and is used in local energy production but has not been properly used in the construction industry (as revealed in the literature).

Table 19: Traditional/Present uses of agricultural waste, as identified by the participants in the semi-structured interview (source: Field Data, 2016)

Usages	Respondents (%)
For local foundry work	80
Domestic Uses	80
It is sparsely used as an additive for concrete work and construction purposes	60
A key source of nutrition for domestic animals in Nigeria.	70
Used as manure for crop production	40
Beddings for local and hybrid birds in poultry farms	10
Used to generate biogas for local usage	30,
Land reclamation:	10

To further clarify the results that emerged from the semi-structured interviews, questionnaire survey data was also collected from 211 participants. Table 20 presents the results that emerged from the analysis of the questionnaire survey. Based on the questionnaire survey results in Table 20, 90.2% of the respondents either strongly disagreed or disagreed that 'agricultural waste is effectively utilised and benefits the region'. This suggests that agricultural waste has not yielded to its full potential. Also, 10.8% of the respondents indicated that they either strongly agreed, agreed or neither agreed nor disagreed (neutral) that 'agricultural waste is effectively utilised and benefitted their region'. This indicates that

the level of utilisation of agricultural waste in most regions in Nigeria is insignificant compared to the potential that it poses. To gain greater clarity in the current benefits of agricultural waste in Nigeria, there is a need to analyse the findings concerning the effectiveness of utilising, and the current benefits of, agricultural waste in Nigeria. This will be discussed in the next subsection.

4.3.2 The Effective Utilisation and Benefits of Agricultural Waste in Nigeria

To further clarify the results that emerged from the semi-structured interviews, the respondent was asked about their views concerning the utilisation and benefit of agricultural waste in Nigeria as a whole. Over 88.9% of respondents either strongly disagreed or disagreed that 'agricultural waste has been effectively utilised and benefitted Nigeria as a whole' compared to 11.1% who either strongly agreed, agreed or neither agreed nor disagreed (neutral). This suggests that the agricultural waste generated in Nigeria and the potentials that it carries has not been given proper attention by the government. Therefore, non-utilisation is an indicator that there is a need for the government and other stakeholders in the country to develop an innovation management framework to influence the utilisation of agricultural waste for building purposes, either in form of building material (as indicated in section 3.9.4) or concerning the benefits (in section 3.10.3). However, the non-utilisation of agricultural waste for building construction purposes in Nigeria could be the result of many factors and reasons. Therefore, there is a need to develop an innovation management framework that will assist in the utilisation of agricultural waste for construction purposes in Nigeria. The majority of these management approaches must come from the government and other stakeholders in the process to enable innovation enhancement policies.

Table 20: Questionnaire survey results showing the utilisation and current benefits of agricultural waste.

Agricultural waste usage and current benefit	Mean Scores	Rank	Strongly Disagree %	Disagree %	Neutral %	Agreed %	Strongly Agree %
Effectively utilised and beneficial in my region	1.98	1	23.5%	66.7%	4.8%	3.0%	2.0%

Effectively utilised and beneficial in Nigeria	**1.88**	**2**	**31.9%**	**57.0%**	**10.1%**	**0%**	**1.0%**

In the current context of accelerated development in the construction industry across all continents, the use of agricultural products and waste in the building materials industry offers promising perspectives in the field of ecological construction and sustainable development (Hansen and Zöld, 2001). However, in some developing countries, the use of agricultural waste materials for construction purposes has not yet gained any tangible recognition in the past years. To further clarify the effectiveness and utilisation of agricultural waste over the past few years, respondents were asked, based on their experience, whether 'agricultural waste has been fully been utilised and beneficial for building construction purposes in the past 10 years in Nigeria'. All respondents were explicit in uttering their disappointment concerning the wastage of agricultural waste in Nigeria, and most bore the opinion that agricultural waste has never been effectively used for construction purposes in Nigeria compared to other countries.

For instance, AFOOS responded that agricultural waste:

> "*Has not been fully utilised; rather been abandoned to create an environmental hazard in the past 10 years, even more than that*"

Also, AFSAOS responded that:

> "*Most of the agricultural waste in Nigeria goes to open field or dumpsites which now become a menace to the environment.*' He added that '*what caused this is, a lack of standard innovation management framework and developmental policies has affected the utilisation of agricultural waste despite the enormous potential that lies within for construction industry*"

Furthermore, AJBMI's response also clarifies the non-utilisation of agricultural waste in Nigeria:

"As far as I am concerned agricultural waste has not been fully utilised despite the potential that lies in the use of agricultural waste, and this is a great concern for me. This can easily to help solve Nigeria's housing deficiencies in many ways."

In a similar response to AFSAOS and AJBMI, FOMAONR stated that:

"In Nigeria, as far as I know, agricultural waste has not been utilised at all. These wastes are all over the streets, villages and causing menace in the environment while few are used sparsely. Agricultural waste has not been regarded as anything useful as far as I know"

However, OSPKFI made a statement of fact about agricultural waste when responding to the question:

"Despite the potentials that agricultural waste possesses for building construction purposes, the usage has been limited to non-significant level".

In support of the respondent's responses, the researcher has observed the menace that agricultural waste is causing to the environment and similarly wondered why these readily available raw materials for the construction industry have not been utilised, despite the economic crises and housing shortages in Nigeria. To support OSPKF's statement, the researcher observed that some of these wastes are sparsely used in rural areas as additives for construction purposes. However, the bulk of the waste is littered around in rural, urban and big cities. The responses of the other respondents on the effective utilisation and potential benefits of agricultural waste in Nigeria over the past 10 years (as collated by research data from the interviews) are highlighted in Table 21

When FMLFNL was asked about the benefit of agricultural waste in Nigeria, the response was similar to the other interviewees:

'*Based on my experience and knowledge, agricultural waste has not been fully utilised and does no tangible benefit in the past and even at present in Nigeria'*.

This shows that, despite the benefit of agricultural waste, it has not gained full acceptance and recognition in Nigeria. LCAPCB clarified that:

'As far as I am concerned, agricultural waste as ever been underutilised in Nigeria in the past 10 years and beyond'.

Also, LCAPCB's response is echoed by that of PMTSCL who stated that:

'Based on the global innovation approach where the majority of waste or agricultural waste is being recycled to produce the new product. In my country, agricultural waste potentials have not been fully utilised.'

LCAPCB is one of the interviewees who gave an insight into the importance of waste management for new product production. The response clarified the need to utilise waste or agricultural waste to produce new material and to help reduce the cost of raw materials. Nevertheless, most respondents failed to deal with the issue of manufacturing and research to ascertain the level of use of agricultural waste. However, one interviewee (STNL) offered some insight into this:

'With my experience in the manufacturing and construction industry, agricultural waste has not been fully utilised in the past years in my region and country. Furthermore, little or no research has been carried out on how to unlock the potential of agricultural waste in Nigeria as a whole'.

This also indicates that, despite the potential that lies within the agricultural waste, there is a need for adequate research and development, as identified in the literature, as a factor to enhance the usability of agricultural waste in Nigeria.

Table 21: The responses and comment on utilisation and benefit of agricultural waste in Nigeria for the past years

Interviewees	Responses	Comments
FMLFNL	No	Based on my experience and knowledge, agricultural waste has not been fully utilised and has no tangible benefit in the past and even at present in Nigeria
FOMANR	No	In Nigeria, as far as I know, agricultural waste has not been utilised at all. These wastes are all over the streets, villages and causing menace in the environment. While a few ones

		are sparsely used. Agricultural waste has not been regarded as anything useful as far as I know.
LCAPCB	No	As far as I am concerned, agricultural waste has been underutilised in Nigeria in the past 10 years and beyond.
PMTSCL	No	Based on the global innovation approach where the majority of waste or agricultural waste is being recycled for the production of a new product, in my region, agricultural waste potential has not been fully utilised.
PSMANR	No	Although the question focuses on the past ten years, I will say that agricultural waste has never been adequately utilised in Nigeria. They have always been regarded as waste. Although, they have been utilised in some ways, then, that is a very insignificant portion of what is generated in Nigeria. The uses of agricultural waste have remained the same over my lifetime.
STNL	No	With my experience in the manufacturing and construction industry. Agricultural water has not been fully utilised in the past 10 years in my region, Furthermore, little or no research has been carried out on how to unlock the potential of agricultural waste in Nigeria as a whole.

Having explored the current benefit of agricultural waste and the level of utilisation of agricultural waste with its benefit so far from the findings, it is of utmost importance to understand the views of respondents about the suitability of agricultural waste as raw materials or materials for building purposes in their region and Nigeria as a whole. Therefore, the next subsection deals with the suitability of agricultural waste for building purposes in Nigeria.

4.3.3 The Suitability of the Benefits Associated with the use of Agricultural Waste as Building Materials in Nigeria

Rapid development is creating a shortage of building construction materials due to the inadequate availability of natural resources. Conversely, the energy consumed to produce building materials pollutes the air, water and land. To meet the increasing demand in sustainable building materials, the adoption of cost-effective, naturally appropriate

technologies and advanced traditional techniques with available local materials is essential; this was explained by the researcher in the literature in section 3.9.4. The application of agro-waste for sustainable building materials provides a solution, which offers a reduction in the use of the natural resource as well as energy. A large demand has been placed by the building material industries, especially in the last decade, owing to the increasing population, which is causing a chronic shortage of building materials. However, to meet the increasing housing demand, there is an exponential need for the production of building materials, like bricks, cement, aggregates, wood, cladding and partitioning materials from agricultural waste material. Therefore, this confirmation prompted the consultation of opinion about the suitability and utilisation of agricultural waste as a raw material for building purposes. Nevertheless, the need to know about the suitability of agricultural waste for building purposes in Nigeria is of equal importance to this research. Thus, this study explores the suitability of agricultural waste for building purposes in Nigeria via the semi-structured interview responses and questionnaire survey returns.

When asked to comment, based on their experience of the suitability of agricultural waste for building purposes, all respondents were explicit in uttering a positive response to its usefulness, particularly in the current global recession. For instance, AFOOS stated that.

> "With *the global campaign on the usage of waste material for production, which is called recycling in some developed countries, I think the usage of agricultural waste for building purposes will be suitable if properly managed by the government and other players concerned*".

In another word, the respondent believed that agricultural waste is suitable for construction purposes when Nigerian policymakers (Government and politicians and so on) implement a proper management framework to aid the use of agricultural waste. Similarly, AFSAOS response clearly stated one of the areas where agricultural waste can fit as a building material.

> "*Honestly, in my own opinion, the cost of concrete production is increasing daily and steadily. Thus, the call for the usage of agricultural waste as additive or admixture inside concrete is also increasing gradually. Research studies have shown that agricultural waste, such as palm kernel shell, corn cobs, rice husks and coconut shells,*

have the potential to replace concrete. Furthermore, agricultural waste is gradually being utilised in cement, concrete and other construction materials and provides numerous indirect benefits, such as reductions in landfill costs, energy savings and protecting the environment from possible pollution. Therefore, agricultural waste will be suitable for construction purposes"

This shows that there is awareness about the benefit of using agricultural waste as a viable raw material for the development of building material for construction purposes. Therefore, it is important to note that agricultural waste will serve as a veritable tool for sustainable development in the construction industry and reduce the risk to the ozone layer due to its natural properties. Furthermore, FMLFNL mentioned the exchange rate as one of the areas that the adoption of agricultural waste will address:

'With the recent economic situation in Nigeria cum high exchange rate, the suitability of agricultural waste as an alternative means of manufacturing building material needs to be considered. Also, different studies have shown that some of these wastes have similar properties to those raw material used in the production of imported building materials.'

However, some of the respondents only share their opinion about the suitability of agricultural waste as raw materials or building materials; FOMAONR stated that:

'… agricultural waste will serve as a good replacement raw material for building industry in Nigeria. Furthermore, before crude oil was discovered, agriculture was predominantly a source of revenue generation in Nigeria and since most of the agricultural waste is in a natural form invariably the product will assist in building a sustainable building to reduce carbon emission'.

Also, LCAPCB clear stated that there is a need for research and that it needs to be properly funded:

'with little research, I have made from the past years, it is possible for innovation, utilisation and development of agricultural waste into building materials to replace some imported building material in Nigeria. For example, palm kernel shell, can be

converted to roofing slate and serve as an additive to cement. The major problem is research on how these can be developed and how to finance the research. Furthermore, a lot of research reports have pointed towards the suitability of agricultural waste as building material'.

Moreover, OSPKFI considered the suitability of agricultural waste:

'*looking at the potential that has been discovered by researchers all over the world and potential waste to the material campaign going on globally, I think some of the agricultural waste is suitable for construction purposes and assists in achieving sustainable development goals.*

The response from STNL is a little different from other respondents. After declaring the suitability of agricultural waste as a building material, STNL talked about the importance of the government and other stakeholders to orientate people towards the suitability of agricultural waste as a building material:

'*there is a need for proper orientation and introduction about the importance and the potentials of agricultural waste to the general public, to enhance their awareness. Furthermore, the government should encourage the use of locally made building materials and product, as we have them in abundance.*'

The interviewee responses on the suitability of agricultural waste as raw materials for building purposes in Nigeria are highlighted in Table *22*.

Table 22**:** Responses on the suitability of agricultural waste as raw material for building purposes

Interviewees	Responses
FMLFNL	With the recent economic situation in Nigeria cum high exchange rate, the suitability of agricultural waste as an alternative means of manufacturing building material needs to be considered. Also, different studies have shown that some of these wastes have similar properties to the raw material used in the production of imported materials.
FOMAONR	Based on my opinion, agricultural wastes will serve as a good replacement for raw material for the building industry in Nigeria.

	Furthermore, before crude oil was discovered agriculture was predominantly a source of revenue generation in Nigeria.
	Since most agricultural waste is in a natural form, invariably the product will assist in building a sustainable building to reduce carbon emission.
LCAPCD	Based on my opinion and little research I have made over the past years; it is possible for the innovation and development of agricultural waste into building material to replace some imported building material in Nigeria. For example, palm kernel shell, can be converted to roofing slate and serve as an additive to cement. The major problem is research on how these can be developed and how to finance the research. Furthermore, a lot of research reports have pointed towards the suitability of agricultural waste as a building material.
OSPKFI	Looking at the potential that has been discovered by researchers all over the world and the potential waste to the material campaign going on globally, I think some agricultural waste is suitable for construction purposes and assists in achieving sustainable development goals.
PMTSCL	My candid opinion is that agricultural waste in Nigeria is suitable for building purposes. Going back to 50 years ago, most rural buildings were the product of one agricultural waste, like palm fronds for roofing, bamboo for beams and columns etc. Considering the innovative development in Asia and some part of East Africa, we could see that agricultural waste is used in the production of building materials.
PSMANR	I think there is a lot of potential for the use of agricultural waste as raw materials for building purposes in Nigeria. Firstly, being a predominantly agriculture-based economy, agricultural wastes are commonly available in Nigeria. Secondly, there is a huge need for an alternative to the mostly imported raw building raw materials in Nigeria, especially, during this period of naira crash and the subsequent hike in the prices of imported items.
STNL	My opinion on the suitability of agricultural waste for building purpose is that there is a need for the proper orientation and introduction about the importance and potentials of agricultural waste to the general public, to enhance their awareness. Furthermore, the government should encourage the use of locally made building materials and product, as we have them in abundance.

Moreover, to consider further the benefit of using agricultural waste as building materials, questionnaire survey data was collected from 211 stakeholders to inform the development of an innovation management framework to assist in the utilisation of agricultural waste as building materials. Findings to the question about the 'potential for using agricultural waste for building materials in Nigeria' (shown in Table 23) indicate that 100% of the respondents either strongly agreed or agreed that agricultural waste has great potential when used as building materials. It was recognised that this is one of the key areas to reduce construction cost and enhance sustainable housing developments. Furthermore, when asked about the 'suitability of building materials derived from agricultural waste for construction purposes in Nigeria', 95.1% of the respondents either strongly agreed or agreed that agricultural waste is suitable as building materials. When probed further, why the respondent think it is the way forward in reducing construction cost, most of them responded explained pointed at how the UK and other developed countries have been able to harness the potentials with the waste management system and why not Nigeria where waste is generated from the agricultural sector daily. This is an indicator that agricultural waste has the potentials for use in construction purposes. Only 4.9% of the respondents stayed neutral that agricultural waste is suitable for construction purposes.

Furthermore, the respondents were asked 'whether material developed or manufactured from agricultural waste is suitable for local residential building construction'. The findings show that 97.0% of respondents either strongly agreed or agreed, compared to 3% who either strongly disagreed, disagreed that the materials from agricultural waste are suitable for local residential building. Moreover, over 98% of respondents either strongly agreed or agreed that the 'material developed or manufactured from agricultural waste is suitable for modern residential building construction', which is an indicator that agricultural waste is suitable for use as building materials. However, 2.0% of respondents either strongly disagreed, disagreed that building materials generated from agricultural waste are suitable for construction purposes.

Also, the questionnaire survey results in Table 23 show that 95.1% of respondents either strongly agreed or agreed that a 'material developed or manufactured from agricultural waste is suitable for commercial building construction'. Therefore, agricultural waste has the

potential to dominate the building construction industry as one of the major sources of affordable building material for the construction industry. Moreover, 4.9% of the respondents either strongly disagreed, disagreed that the material produced from agricultural waste is suitable for commercial building construction. In all aspects, the statistical evidence has indicated that the sample populations feel that agricultural waste is suitable for building construction purposes as raw material or the building material itself.

Table 23: Questionnaire survey results of the suitability of agricultural waste as raw material for building construction purposes in Nigeria?

Suitability of agricultural waste	Mean Scores	Rank	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
There is the potential to use agricultural waste for building construction material in Nigeria	4.54	1	0%	0%	0%	49.0%	51.0%
Materials developed or manufactured from agricultural waste are suitable for local residential building construction	4.52	2	1%	1%	1%	41.2%	55.8%
Materials developed or manufactured from agricultural waste are suitable for modern residential building construction	4.51	3	0%	0%	1.9%	49.0%	4.1%
Building materials derived from agric. waste are suitable for construction purposes in Nigeria	4.47	4	0%	0%	4.9%	45.1%	50.0%
Materials developed or manufactured from agricultural waste are	4.45	5	0%	2.9%	2%	4.3%	52.9%

suitable for commercial
building construction.

In summary, agricultural waste has shown the potential to develop energy-efficient and cost-effective sustainable construction materials along with improved thermo-mechanical behaviour. Various literature and data collected for this research have shown that construction products from agricultural waste materials are relatively cheaper, have lower thermal conductivity and are durable, lightweight and more environmentally friendly than the orthodox materials; moreover, they are sustainable. The utilisation of agricultural waste and its by-product as a raw material has real significance for developing material components as substitutes for established construction materials and are environmentally sustainable. Furthermore, the finding shows that to be able to utilise agricultural waste effectively in Nigeria, a proper innovation management framework must be developed to show how all key players collaborate in the form of organisational knowledge.   This entails sharing linkages from the government as policies maker through to the end-users of the building materials. To effectively utilise agricultural waste, there is a need to develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building material.

To establish a better insight into how to develop a good collaborative innovation management framework, the respondents were asked about factors responsible for the non-utilisation of agricultural waste as building materials in Nigeria. This section addressed the research objective, to validate and answer some questions that the literature cannot address. Having critically investigated the literature on the factors that are responsible for the non-utilisation of agricultural waste (section 2.11), the researcher validated the factors to discover if other factors are not mentioned in the literature. This aimed to establish a holistic view of the best factor affecting the non-utilisation of agricultural waste as building materials in Nigeria.

To adequately address part two of the research question, the present study dealt with research objective 3, namely.

- What are the factors affecting the non-usage of agricultural waste as raw materials for construction purpose?

4.3.4 Factors Affecting the Use of Agricultural Waste as Raw Materials for Construction in the Local Regions

It has been noted that growing population levels, a thriving economy, the rapid development and rise in living standards have greatly enhanced the generation of agricultural waste in developing countries (Minghua *et al.*, 2009). Cities are usually responsible for waste management for effective and efficient safety to inhabitants. However, they often face difficulties beyond the ability of the municipal authority to resolve (Sujauddin, Huda, & Hoque, 2008). This is mainly due to lack of organisation, financial resources, complexity and system multidimensionality (Burnley, 2007). In the last few years, many research studies have been undertaken to determine the influential factors affecting agricultural waste management systems in the cities of developing countries. However, this section of the research aims to determine the key factors responsible for the non- utilisation of agricultural waste for building construction purposes and the factors that influence the performance of the system in Nigeria. Furthermore, to determine the factors that are responsible for non-utilisation of agricultural waste, a number of factors were discovered and documented in the explored literature (as shown in section 4.3.4 and section 4.4). However, to validate and discover further factors, ten respondents in various organisations that are presumed to handle the management of agricultural waste as raw materials for construction purposes were interviewed using semi-structured interviews during the qualitative phase of the study. Meanwhile, 211 individuals were surveyed during the quantitative stage to address this theme of the present study.

When asked to comment about the factors affecting the non-usage of agricultural waste as raw material for the construction of his region, AFOOS identified several factors responsible for lack of utilisation of agricultural waste:

> "*Successive governments have paid lip service to technological developments in general. The Transformation Agenda of the previous government is a classic example*

of this. In a nutshell, I will say that the Nigerian government has continued to lack the will needed to advance innovations in that area".

AFOOS also noted that:

"Agricultural wastes are often viewed as 'waste' by an overwhelming majority of Nigerians, and this stems not only from cultural beliefs but also from the religious beliefs of most Nigerians".

Given AFOOS comment, the utilisation of agricultural waste in Nigeria has been relegated as a concern, which contrasts with other developing and developed countries that have thrived in the area of agricultural waste regeneration programmes. AFOOS further noted that not only cultural and religious beliefs caused this effect; however, economic factors also affect the non-utilisation of agricultural waste for construction purposes:

"It is very hard to invest in innovative processes that enhance the usage of agricultural waste for construction due to the economic situation in Nigeria".

AFOOS referred to the economic crises that have recently impacted Nigeria, due to the fall in foreign exchange earnings:

"Foreign exchange factor is also a major factor affecting the non-usage and innovation of agricultural waste into building material, where importation of building material is used as means of foreign exchange fraud by businessmen and politicians".

Similarly, FOMANR affirms the statement made by AFOOs that the Government pays lip service to innovation advancement and innovation management structures that can help in the utilisation of agricultural waste as building materials:

"Because of the political conditions in Nigeria coupled with the failure of the government in power supporting waste to wealth program and develop a tangible innovation management framework in form of an organisational framework, most agricultural wastes are laying waste as that result".

This suggests that successive governments in Nigeria have not paid adequate attention to the broad issue of agricultural waste management and the utilisation of agricultural waste as raw

material for building construction purposes by not developing an appropriate innovation management framework to enhance the use of agricultural waste as building materials.

Thus, similarly, LCAPCB states that:

> "*Politicians are not ready to fund any research and development program due to greed and self-centeredness and lack of vision for the country*".

Furthermore, STNL mentioned factors that need to be addressed to be able to utilise agricultural waste as a building material:

> "*Inadequate knowledge sharing between private and public sectors that are needed to come together to develop a model that can be used for utilisation of agricultural waste as a building material, lack of incentives for those involve in the use of agricultural waste as building materials and inadequate funding for research and development*"

Also, FOMANR describes the cultural factor in the context of agricultural waste in his statement as:

> "*As a local product for local people. Therefore, private and public organisation find it hard to invest in the research and innovation drives that can help in transforming agricultural waste for building purposes as seen in some developed and developing countries. People will opt for modern imported products that are still products from recycling process*"

In summary, some of the factors revealed by the literature were validated during data collection. However, some factors are new and of importance to the objective of this study. These factors include a lack of research and development, political instability and corruption with the inability of the government to develop a standard innovation management framework (in form of an organisational framework) that can assist in the utilisation of agricultural waste as a building material. However, the need to develop this framework can never be overemphasised. For clarity's sake, the key factors affecting the use of agricultural waste as raw materials for construction in Nigeria, as collated by research data collected from semi-structured interviews, are highlighted in Table *24*.

Table 24**:** The key factors affecting the use of agricultural waste as raw materials for construction.

Factors	Respondents %	Number of responses
Lack of innovation system, collaboration, research and policies by government and private organisations	100	10
Lack of innovation management framework and structure	100	10
Economic	90	9
political instability (corruption inclusive)	80	8
Socio-cultural (beliefs and traditions inclusive)	70	7
No mutual information sharing system and information implementation problem	80	8
Ignorance, awareness and lack of technical know-how	50	5
Climate	10	1

To further explore the factors that are responsible for the non-utilisation of agricultural waste in Nigeria, the questionnaire survey data collated the views from 211 participants who responded to factors affecting the non-use of agricultural waste as raw materials for construction purposes. The responses of those who participated in the study are shown in

Error! Reference source not found..: Questionnaire survey results of the factors affecting the non- usage of agricultural waste as raw materials for construction purposes in Nigeria

Factors affecting the use of agricultural waste as raw materials for construction	Mean Scores	Rank	Strongly Disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
The govt. provides support for innovative approaches to the use of agric. waste as building materials	4.55	1	56.8%	41.2.8%	0.0%	2.0%	0.0%
Private investors provide strong support for	4.52	2	47.0%	50.3%	2.7%	0%	0%

innovative approaches to the use of agric. waste as building materials							
Lack of government support system is a key reason for neglecting the potentials of agric. waste as raw materials for building	4.51	3	1%	2%	1%	45.0%	51.0%
Complacency from Government due to crude oil earning is a key reason for neglecting the potentials of agric. waste as raw materials for building	4.46	4	0%	2%	4.1%	41.2%	52.7%
Lack of research and knowledge transfer is a key reason for neglecting the potentials of Agri. Waste as raw materials for building	4.45	5	0%	2.6%	4.2%	40.9%	52.3%
Traditional believe and culture is a key reason for neglecting the potentials of agric. waste as raw materials for building	4.40	6	0%	4.0%	6.9%	39.0%	50.1%
Lack of appropriate policies is a key reason for neglecting the potentials of agric. waste as raw materials for building.	4.38	7	0%	0.2%	2.9	46.1	41.8%

One of the major setbacks for the utilisation of agricultural waste as building material is the inability of the Nigerian government to provides support for innovative approaches for the use of agricultural waste as building materials. This is one of the factors that the respondent from the questionnaires emphasized. When asked that the government provide adequate

support for the innovative approach, 98% of the respondents either strongly or disagreed that the government are providing support for innovative approaches. If the government is not providing support, it will be a difficult task to achieve the objective of the utilisation of agricultural waste as building materials in Nigeria. Furthermore, when asked about the 'private investors provide strong support for innovative approaches to the use of agricultural waste as building materials in Nigeria', 97.3% of the respondents (from Table 26) either strongly disagreed or disagreed that private investors provide strong support for an innovative approach in Nigeria, due to economic instability and uncertainty about the political situation in Nigeria. Another factor pointed out by the respondent is the complacency from Government due to crude oil earning against the potentials of agricultural waste as raw materials for building materials in Nigeria. From the data collected, 93.9% 0f the respondents either strongly agreed or agreed that complacency of from the Government towards crude oil earning has hindered the process of utilisation of agricultural waste as building materials in Nigeria. The product from agricultural waste could also be one of the major sources of foreign exchange earnings if properly managed by the Government. Furthermore, another factor pointed out by the respondents is lack of research & development and knowledge transfer, where 93.2% of the respondent strongly agreed or agreed that lack of research & development in the area of waste management and waste to wealth hinder the use of agricultural waste as building materials in Nigeria compare to 6.8% of the respondent that either strongly disagreed or disagreed that lack of research & development with knowledge transfer hinders the use of agricultural waste as building material in Nigeria. One of the surprise factors is traditions and cultural beliefs that waste is waste as the name implies. From the data in Table 26, 89.1% of the respondent strongly agreed or agreed that traditions and cultural believes amongst Nigerian has made the utilisation of agricultural waste possible as people believe that 'waste is waste' as the name implies. This one of the major factors that needed to be addressed through an awareness program and proper orientation about the benefit of using agricultural waste as building material or as raw material to produce building material in Nigeria.

To further investigate, the respondents were asked about the best approach to enable and improve the utilisation of agricultural waste as building materials in Nigeria. The presentation is shown in the next subsection.

4.3.5 What is the best Approach that Enables and Improves the Utilisation of Agricultural Waste as Building Material in Nigeria

The innovation management approach describes the context in which innovation takes place and sets the guideline for its implementation. Nevertheless, the role of innovation management cannot be overemphasised as it helps an organisation to achieve its growth targets (Koetzier and Schorling, 2013). Although there are several theories about innovation management approaches many organisations until the present moment still fail to develop and execute an innovation management approach which leads to a failure to achieve the desired organisational growth (Koetzier and Schorling, 2013). However, it is widely known that an effective product innovation management approach is of great importance to the success of most organisations (March-Chorda et al., 2002). Therefore, if an innovation management approach is of great importance in an organisation's overall success, managers and decision-makers must ensure that the development of the innovation management framework is well managed and effective. Nevertheless, the innovation of a product and material is uncertain and expensive, which results in low success rates and of many plans being terminated midway in the development cycle (Cooper, 1999).

However, Koetzier and Schorling, (2013) highlight five characteristics of an effective innovation management approach. These are:

- It needs to be truly inspiring and should describe a desirable future state for the organisation.
- It needs to be ambitious by providing the basis to break away from the competition, beat the competition, and create new spaces.
- The process of developing the strategy needs to be open.
- It must also be specific to the time in which it is developed.
- It needs to be adaptive and to evolve.

Furthermore, after reviewing the relevant literature, the findings show that there is a need to know the best approach to enable the utilisation of agricultural waste as building materials. Therefore, the respondents were asked about the best approach to enable the utilisation of agricultural waste as building materials in Nigeria. The responses are shown in Table 25 confirm that 100% of the respondents were keen on research and development. AFSAOS suggested that the government should develop research centres that cluster agriculture, manufacturing and the construction industry for collaboration purposes. However, he suggested that the government should finance research programs that enhance agricultural waste management and its development into building materials. Similarly, AJBMI suggested that the government should adequately fund research centres, universities and polytechnics and provide them with adequate experience manpower to carry out the research project on agricultural waste. Furthermore, he suggested that there should be a support system for private investors of agricultural waste innovation and the encouragement for banks and other financial industries to partner with researchers exploring the potential that lies in the use of agricultural waste for the building industry.

Moreover, FMLFNL suggested that policymakers should find a way to create viable policies that support the innovative transformation of agricultural waste into building materials. FOMANR echoed the view of FMLFNL in remarking that the Government should develop a standard system to encourage the innovation of agricultural waste into building material, as experienced in other countries, for sustainable development and economic growth. LCAPCB remarked that a national innovation system should be developed that will serve as a standard for any developmental programmes and research in the country. Similarly, PMTSCL suggested that the government should develop a policy or innovation management framework that encourages collaboration amongst private and public organisations, where the framework of the innovation system focus on collaboration amongst the agricultural sector and other stakeholders in the construction industry. PSMANR reiterates that policymakers should find a way to incentivise banks and other financial institutions to provide liquidity for institutions and organizations that engage in worthwhile innovation endeavours. This is significant as innovations often require substantial investment, and this is often much more than a single company or organisation can sustain.

In a different suggestion about the best way to manage the development of a new construction product from agricultural waste STNL stated that:

> "[The] *Government should discourage the use of imported material and encourage in house development of building material development and production*."

STNL alluded to the policies and regulation that will encourage and discourage the importation of building product that can be easily manufactured for use as raw material for housing, like an agricultural waste. Similarly, AJBMI reaffirmed STNL's opinion by stating:

> "*[The] Government should discourage and ban the importation of products that our agricultural waste can produce in Nigeria. For example, plywood, particleboard, etc. The government should monitor the activities of the manufacturing industry and [the] raw material used.*"

Another approach suggested by AFOOS is the area of collaboration:

> "*[The] Government should provide an enabling environment for private and public sectors to collaborate in managing agricultural waste for construction purposes*".

Also, AFSAOS said that the Government should: promote the

> "*Development of research centres that cluster agricultural and construction industry to collaboration in developing an innovation management system that enhances productivity from agricultural waste material for construction purposes*"

The above findings confirm Martinez-Moyano, (2006) description of collaboration as the process of two or more people or organisations working together to realise and achieve something successfully. Moreover, collaboration represents affiliation between two or more organisations in which the contributing parties agree to invest resources, equally achieve objectives, share information, resources, rewards and responsibilities.

Association between the public and private sectors can be effective in tackling complex policy problems but maybe handled more effectively by committed boundary-spanning teams and networks than by formal organisational structures (Fischer, 2008). OSPKFI confirmed Fischer's submission by suggesting that:

"[The] Government should develop a system that brings groups, companies, institution and other notable enterprises that will help in managing the development of agricultural waste into building material".

However, to develop a better understanding of Table 25 (which presents the best approach for managing the innovation of agricultural waste as raw materials in Nigeria), all ten participants presented their views based on their experience in various fields. However, it occurred when analysing the interview data that there were multiple responses to what these approaches could be. The initial analysis results of the semi-structured interviews are shown in Table 26. It outlines that all ten (100%) participants who were interviewed mentioned the development of a framework of concepts that support the usage of agricultural waste for construction purposes (innovation system) in form of organisational framework.

Furthermore, nine (90%) participants indicated that 'Funding research and development' is one of the best approaches to enable the utilisation of agricultural waste for building construction purposes in Nigeria, though six (60%) participants suggested 'Agricultural waste innovator players should collaboration with other sectors'; 'creating awareness about potentials in agricultural waste' and 'enabling environment (provision of basic amenities)' as approaches that the government should take to enhance and support private investors and local farmers in the use of agricultural waste for building construction purposes. Also, five (50%) participants report that 'Improved policies and planning' is key to assisting the development of a collaborative framework for the utilisation of agricultural waste for building construction purposes in Nigeria. Meanwhile, four (40%) of the interview participants mention 'encouraging the use of local material for manufacturing (importation of available local raw material)' as one of the approaches to adopt when utilising agricultural waste for building construction purposes in Nigeria.

Table 25**:** Best approach for managing innovation of agricultural waste as raw material.

The best approach for managing the innovation development of agricultural waste as raw materials/materials for building construction purposes	No of Respondent (%) Rank

Develop a framework of concepts that support the usage of agricultural waste for construction purposes (innovation system)	10 (100)	1
Funding research and development	9(90)	2
Proper market orientation about viability and customer requirements	7(70)	3
Agricultural waste innovator players should collaborate with other sectors	6 (60)	4
Creating awareness about the potential for agricultural waste	6(60)	4
Enabling the environment (provision of basic amenities)	6(60)	4
Improved policies and planning	5(50)	5
Encourage the use of local material for manufacturing (discourage the importation of raw materials available locally)	4(40)	6

4.4 Discussion of Findings

This chapter presents the discussion of the main findings from the research. The discussion is as a result of the findings from both the qualitative and quantitative data analysis. However, the findings are analysed using a mixed method approach so that one can supplement another.

Nevertheless, this section will discuss the outcomes of the sub-questions generated to address the gap found in the literature review and to address the issues raised by the research objectives. This first section for discussion is section 4.4, namely the identification of the participants' views about the current benefits of agricultural wastes and the suitability of agricultural waste for construction in Nigeria. The responses were similar and included: the use of agricultural waste for local foundry work, domestic uses, an additive for concrete work and construction purposes, a key source of nutrition for domestic animals in Nigeria, manure for crop production, bedding for local and hybrid birds in poultry farms, to generate biogas

for local usage, and land reclamation. This feedback from respondents indicates current approaches to the utilisation of agricultural waste; thus, no clear effort is made to innovate this waste material for construction purposes. On the other hand, when respondents were asked about the suitability of and benefit from the usage of agricultural waste, the response was encouraging and noted out that agricultural waste is suitable to replace all existing high-cost building materials in the market with lower-cost materials. The usage will potentially reduce the impact of foreign exchange rates, create jobs, and improve environmental sustainability.

Furthermore, to address the factors that hinder the utilisation of agricultural waste as building materials or raw materials in the production building material, seven major factors were discovered from both the qualitative and quantitative data collected and analysed. The seven basic factors are detailed in the following sub-sections:

4.4.1 Lack of Government Support for Innovative Approaches

Having presented the findings in sections 4.3 and 4.4, one of the main factors that affect the utilisation of agricultural waste as building materials is the lack of government support for innovative approaches. Respondents from both the qualitative and quantitative data collection methods made it clear that the Nigerian Government does not support innovative approaches in the area of waste management, nor in the area of conversion and the utilisation of agricultural waste for construction purposes. Also, 86.3% of respondents either strongly disagreed or disagreed that 'the government provides support for innovative approaches to the use of agricultural waste as building materials', which is a key indication that the Nigerian government does not provide support for innovative approaches that can be used in the utilisation of agricultural waste as building construction materials. From the researcher's observations, it is deduced that due to political instability and corruption within the Government, major approaches to innovation management are foregone to focus on the personal interest of political parties or individual politicians. It is suggested that this has hindered the utilisation of agricultural waste as building materials in Nigeria despite its potential. Furthermore, the finding identified another factor that affected the utilisation of agricultural waste in Nigeria as building materials; this factor is addressed in the next subsection.

4.4.2 Lack of Private Investors' Interest in Innovative Approaches for Managing Agricultural Wastes

Both the qualitative and quantitative data collected and analysed pointed to the lack of private investors and the lack of interest in innovative approaches to the management of agricultural waste and its utilisation as building materials. These findings seem well-founded, as the Government appears to have no provision for the enabling environment for private investors. Also, corruption amongst some government officials has forced private investors to withdraw their interest in managing agricultural waste. To understand this better, over 84.3% of the respondents either strongly disagreed or disagreed that 'private investors provide strong support for innovative approaches to the use of agricultural waste as building materials. This indicates that there are organisational frameworks or guidance that can help and support private investors to access legislation and policies that can help to reduce the impact of corruption on support for the development of new materials from agricultural waste. To address the non-utilisation of agricultural waste as building materials in Nigeria, other factors were investigated and are discussed in the next subsection.

4.4.3 Government Support System

According to Dubai (2011), the government support system facilitates, enables, supports and develops programs focused on particular sectors: policy development and advocacy (remove barriers), training and capability development (sector productivity & competitiveness), incubation, access to finance and market access. When all areas mentioned by Dubai are missing, there is no enabling environment for development and no framework for development. Based on the data collected from the qualitative data, 100% of respondents either strongly agreed or agreed, that the lack of a government support system is the key reason for the neglect of the potential for agricultural waste as raw materials/materials for building. This means the government does not support any formal or informal network comprising institutions, services, personnel, and organisations that support the innovation management of agricultural waste and its utilisation for building construction purposes. It is suggested that the main reason why the Nigerian government does not support this is due to its earnings from crude oil. This factor will be discussed in the next subsection.

4.4.4 Complacency from the Government due to its Crude Oil Earnings

In Nigeria, the government meets its targets through the crude oil earnings and neglect every other sector that has the potential to increase the GDP of the country. Therefore, when there is a fall in the price of crude oil per barrel, economic problems emerge in all other sectors, including building sectors in Nigeria. Also, responses from the quantitative data shown that 98% of respondents either strongly agreed or agreed that complacency from the Government due to their crude oil earnings is a key reason for neglecting the potential of agricultural waste as raw materials/materials for building. However, due to the potential for a fall in crude oil prices and the subsequent economic impacts, the transformation of agricultural waste into building materials needs to be investigated by the government to enhance sustainable development in the construction industry specifically, and to support economic growth generally. Nevertheless, there is a belief system that affects the utilisation of agricultural waste as building materials. This is discussed in the next subsection.

4.4.5 Traditional Beliefs and Culture

There are a traditional belief system and culture concerning waste. Traditional beliefs form a system amongst rural and some urban dwellers and form part of a cultural ideology that been in existence concerning agricultural waste. These beliefs have, in part, prevented people from developing their knowledge on how agricultural waste can best be managed to produce building materials. Interestingly, some of the responses from the key stakeholders still demonstrate that belief system and cultural belief. Also, from the quantitative data collected, 93.1% of respondents either strongly agreed or agreed that 'traditional beliefs and culture are the key reason for the neglect of the potential of agricultural waste as raw materials for building' purposes. This suggests that cultural beliefs have a significant effect on the non-adoption of agricultural waste for building materials in Nigeria. Another factor that affects the utilisation of agricultural waste as building materials is research and knowledge transfer; this is discussed in the next subsection.

4.4.6 Lack of Effective Research and Knowledge Transfer Structures

Another major factor affecting the utilisation of agricultural waste is the lack of research and knowledge transfer. However, the term research and development are widely linked to innovation, both in the corporate and governmental world, or the private and public sectors.

In every sector, research and development allow organisations and sectors to maintain a top-level amongst market competition (Von Zedtwitz and Gassmann, 2002). Furthermore, in the absence of research and development (R&D) programs, an organisation may not survive on its own and may have to rely on other ways to innovate, including acquisitions or partnerships. In contrast, R&D partnering helps both organisations to design new and improve existing products.

R&D is different from most activities performed by a corporation in the process of operation. Research and/or development is typically not performed, unless with the expectation of immediate profit. Instead, it is focused on the long-term profitability of a company, which may lead to patents, copyrights, and trademarks. Based on this reason and results of the data analysed, 97% of the respondents either strongly agreed or agreed that an organisation improves greatly with the development of R&D programmes that enhance its productivity and support its position amongst the market competition. On the other hand, developing internal and external knowledge transfer capacities help in achieving organisational goals and enhances an organisation's profitability. Therefore, for the effective utilisation of agricultural waste as building materials, the government and individual organisations should engage in rigorous R&D programmes and policies, and link with international organisations and universities with track records for innovation management techniques and methods that share knowledge and information about how best agricultural waste can be utilised as building materials. To achieve the best R&D and the best knowledge transfer, the Nigerian government should develop holistic policies that support the innovation management of waste material (including agricultural waste). This is discussed in the next subsection.

4.4.7 Lack of Appropriate Policies

The lack of appropriate policies is considered one of the key reasons for neglecting the potential of agricultural waste as raw materials/materials for building construction. When asked about the policies that are in place to support the innovation management of agricultural waste, 97.1% of respondents either strongly agreed or agreed (compared to 2.9% who strongly disagreed or disagreed) that the country lacks a good policy that can help to assist in the utilisation of agricultural waste as building materials. Furthermore, literature in

Sections 2.11 and 4.4 identified the lack of effective innovation management systems, limited collaboration between key stakeholders, and no organisational innovation management framework. These represent major factors that affect the innovation and utilisation of agricultural waste as raw materials for the production of construction in Nigeria (these results are shown in Table 24)

Furthermore, findings from the qualitative survey gave a clearer view of the factors affecting the non-utilisation of agricultural waste (shown in table 25), where a higher percentage of respondents agreed that the lack of innovation systems, the collaboration between key parties, and no policies hindered the utilisation of agricultural waste for construction products. Moreover, 70% believed that socio-cultural beliefs and traditions are major factors, whilst 80% of respondents noted that political factors, such as corruption and other vices, have a great effect, where politicians do not believe in the development of internal capacity for the development of sustainable approaches. However, 90% believed that the economic situation was a major factor affecting the utilisation of agricultural waste as raw materials for construction purposes; this was due to the economic recession, the inability to acquire adequate machinery and funding for innovation purposes, and the challenges of accessing manufacturing equipment by private individuals. Furthermore, 50% of the respondents agreed that ignorance and a lack of awareness and technical know-how hinder the utilisation of agricultural waste as building materials. Moreover, 70% of the respondents agreed that political instability is also a major factor that affects the use of agricultural waste as building materials. Given these factors, there is a need to develop a collaborative innovation management framework (Innovation System) to assist in the utilisation of agricultural waste as building materials. This framework will provide a clearer view of the organisational hierarchy from the government through to the smallest key stakeholders.

4.5 The Best approach to Assist in the Innovation of Agricultural Waste

To develop a clearer view on the utilisation of agricultural waste as a potential raw material/material for the construction industry, the participants were asked about the best approach to assist in the innovation of agricultural waste for construction purposes. The responses were discussed in the next section.

4.5.1 Incentivising the use of Locally Manufactured Building Materials

Motivation is a way of bringing the best out of any employee. When an employee is well taken care of, the aim of an organisation can usually be met. In the same way, this can occur when a government encourages the use of locally made material using subsidy or by creating an enabling policy that encourages its usage, more sustainable changes occur. The research findings from questionnaire survey (shown in Table 25) highlight that 99% of the respondents either strongly agreed or agreed that incentivising the use of locally manufactured building materials is one approach to manage the innovation of agricultural waste as raw materials/building materials for construction purposes. In contrast, only 1% indicated that they were neutral about the statement, whilst none of the respondents strongly disagreed or disagreed. Therefore, encouraging the construction industry to use agricultural waste by providing incentives will help a management approach that can effectively utilise agricultural waste for building construction purposes.

According to Akosua (2014), the government should encourage builders to use locally manufactured building materials in real estate development because they are more sustainable. Akosua urged the government to promote the use of local materials by developing a policy target that 60% of local materials are in all public building projects by 2025. She noted that local materials, such as timber, compressed earth blocks, laterite, bamboo, coconut fibre, wooden shingles, and shells, among others, would reduce the number of cement bags that could be used in constructing an estate building and reduce emissions to the smallest percentage, which in turn encourages sustainable development. Hopkins (2010) encourages builders to use locally manufactured materials from waste; he explains that locally manufactured materials from locally sourced raw materials have a range of benefits that enables the use of a local workforce. Therefore, a greater proportion of economic value is netted in the local economy, whilst the manufacturing of materials could create jobs. It could also result in professional skills development and create a heightened sense of personal dignity and respect resulting from long-term professional employment. It could also enhance social well-being, improve social capital, help in developing healthier buildings and a more resilient building supply chain. Furthermore, it helps in reducing CO_2 emissions and increases the longevity of building stocks (Hopkins, 2010).

Akosua (2014) said that the Building Council should get involved and be more proactive in assessing and certifying buildings that use local materials because their inherent properties make them suitable for the construction of green buildings. Furthermore, Akosua explains that the government should also play a leading role in providing legislation, financial incentives, and creating the necessary public awareness for a change in the current building culture, which sees the use of local materials as a practice and tradition of unenlightened villagers and farmers. Therefore, Akosua (2014) confirms the views of FOMANR (from the qualitative analysis in section 4.3.5) about the approach to adopt when utilising agricultural waste as raw material for construction purposes:

> *"Government to discourage and ban the importation of products that our agricultural waste can produce in Nigeria. For example, plywood, particleboard etc. The government should monitor the activities of the manufacturing industry and raw material used".*

If the government can encourage the use of locally generated material from agricultural waste, there are a lot of benefits to derive as highlighted by (Hodges, Buzby, & Bennett, 2011). From direct observations, the government has not recently encouraged the use of locally sourced raw materials for construction purposes. However, due to the fall in the price of crude oil, the government has started exploring the area of sustainable development within the agricultural sector. This could be an avenue for the adoption of the research outcome by the government in Nigeria. However, one of the ways this can be achieved is by improving the quality of research and development as discussed in the next subsection.

4.5.2 Improving the Quality of Research and Development

From the questionnaire survey results in Table 25, it was observed that 99% of the respondents either strongly agreed or agreed that 'improving the quality of research and development' is an approach to managing the innovation of agricultural waste as raw material/materials for building construction purposes. This is compared to just 1% who indicates that they are neutral towards this view. To further demonstrate that research and development is one of the indicators for the improved usage of agricultural waste as building materials, none of the respondents disagreed that improved research and development helps

in the utilisation of agricultural waste as building materials in Nigeria. Therefore, an improvement in R&D has a greater impact on the innovation management approach adopted when developing an innovation management framework that assists in the utilisation of agricultural waste for construction purposes.

Craig (2001) describes R&D as the key to the future success of an organisation. He further explains that R&D is a critical component that all organisations rely on for growth via new product development to stimulate incremental improvement. However, some organisations conduct no R&D and view it as an unnecessary expense. Craig (2001) explains that the most important role of R&D is the development of important knowledge or enabling technology. Such knowledge and technologies could have a major impact on the competitive landscape, but their applicability or absolute value is still unknown. However, organisations are increasingly using collaborations between university and research organisations to augment their long-range research efforts to achieve the desired goal of their organisation. The second important function of R&D is to provide support to manufacturing, customers, and business management (Craig, 2001). Craig further explains that R&D organisations are often the source of technical know-how and calculate competitive technology threats and opportunities, which allows business managers to make decisions with greater confidence. Therefore, by pointing out the strengths and weaknesses of technology or forecasting technology trends, new business opportunities can be created. The work in this second role tends to be sporadic and is often done in conjunction with project work (Craig, 2001). Consequently, establishing a research and development centre will assist in the innovation management approach when developing the innovation management framework that will assist in the utilisation of agricultural waste as material for construction purposes, as cited by AFSAOS in section 4.3.5. He said that the government should focus on the:

> *"Development of research centres that cluster agricultural and construction industry to collaboration in developing an innovation management system that enhances productivity from agricultural waste material for construction purposes".*

Similar to AFSAOS, FOMANR also suggested that.

"[The] Government *should adequately fund research centres, universities and polytechnics and provide them with adequate experience manpower to carry out the research project on agricultural waste"*.

Similarly, this suggestion was affirmed by LCAPCB that.

"[The] *Government should fund research centres and build more research centres in each region of Nigeria, with adequate funding of our universities, polytechnics and college of education"*.

Over years of experience in the field of agriculture and construction in Nigeria, there has been inadequate funding of Nigeria's research centres and institutes. This lack of research and funding has meant that Nigeria has become the 'dumping station' for various foreign manufacturing industries to bring lower quality building materials that have caused the collapse of many building structures. Therefore, if the government can adequately fund research institutions, it will help to develop building material from agricultural waste for building construction purposes. To support research and development, the government needs to develop policies and set out plans for innovation management, as discussed in the next subsection.

4.5.3 Improved Policies and Planning

The policy is described as a course or principle of action, adopted or proposed by a government, party, business or individual. However, the term is used in many ways, varying from institution to institution, organisation to organisation and sometimes within institutions and organisations. It is difficult to define policy in the present-day economy, but there are some central features common to all policy development, which are: policy states as to matters of principle, policy focused on action, stating what is to be done and by whom, the policy as an authoritative statement, made by a person or body with the power to do so.

However, good policy is a tool which makes administration easier and allows people to get on with the organisation's core business more efficiently and effectively (Schlager, 2007). However, Paquette (2002 p.45) defines policy as, "*a definition of the organization's objectives*

and guidelines for how to achieve those objectives. Down into the tactical and operational parts of the organization, the policy will get into specific practices and guidelines that will help people and the systems that they use to stay within the framework expressed at higher levels".

In the same way, an organisation will have definitions of its objectives and guidelines at its highest levels. Following that comes various layers that deal with how particular business units, departments, and teams will operate (Kilpatrick, 2000). Kilpatrick explains further that in any society, governmental bodies enact laws, make policies, and allocate resources to achieve a desired goal and objectives. He then defines policy as "a *system of laws, regulatory measures, courses of action and funding priorities concerning a given topic promulgated by a governmental entity or its representatives*" (Kilpatrick, 2000 p. 22).

Nevertheless, individuals and groups often attempt to shape policy through education, advocacy, or the mobilisation of interest groups. The shaping of policy is different in Western-style democracies than in other forms of government, but it is reasonable to assume that the process always involves efforts by competing interest groups that influence policymakers in their favour (Kilpatrick, 2000). From the semi-structured interview, five (50%) participants report that 'improved policies and planning' is a key approach to assist in the development of a collaborative framework for the utilisation of agricultural waste for building construction purposes in Nigeria.

In his response when interviewed, PSMANR recommended that.

> "*Policymakers should develop a policy that finds a way to incentivise banks and other financial institutions to provide liquidity for institutions and organisations who engage in worthwhile innovation endeavours. We know that innovations often require substantial investments, and this is often much more than a single company or organisation can sustain*".

Governments can develop enabling frameworks, which can help the private investor to approach banks to finance research and development programmes that assist in the utilisation of agricultural waste as building construction material. In terms of the

questionnaire survey results (shown in **Error! Reference source not found.**) 99% of the r espondents either strongly agreed or agreed that the best approach to manage the innovative development of agricultural waste as raw material/material for building construction purpose is 'improved policies and planning'. However, 1.0 % responded as neutral, whilst none of the respondents strongly disagreed or disagreed that improved policies and planning help to manage the utilisation of agricultural waste as raw materials for building construction purposes. Therefore, improved policies and planning by the government and private organisations would support an innovation management approach and assist in the utilisation of agricultural waste for construction purposes. However, for effective policy and planning, there is a need to develop a significant innovation framework and this is discussed in the next subsection.

4.5.4 Significant Innovative Framework Development

The framework is illustrated as a logically structured representation of the concepts, variables and relationships involved to identify the action needed to be taken and what should be explored, examined, or measured in the process of solving a real-world problem (J. Creswell & Poth, 2017). The concepts that constitute a framework support one another, articulate their respective phenomena and establish a framework-specific philosophy. Frameworks possess ontological, epistemological, and methodological assumptions, and each concept within a framework plays an ontological or epistemological role. The ontological assumptions relate to the knowledge of the "way things are", "the nature of reality", "real" existence, and "real" action (Creswell and Poth, 2017).

However, to ascertain the literature about the development of innovative frameworks from the semi-structured interview analysis, all ten participants unanimously mentioned 'develop an organisational framework that supports the usage of agricultural waste for construction purposes in form of innovation system'. This sentiment is echoed by LCAPCB's response who mentioned that:

> "*A standard national innovation system framework should be developed that will serve as a standard for any developmental programmes and research in the country".*

This view was further confirmed by PSMANR who stated:

"[The] *Government should develop a framework of an innovation management system that brings together all major and minor contributors to the process of utilisation of agricultural waste for construction purposes*".

Similarly, AFOOS suggested that:

"[The] *Government should draw out, plan and a system like a framework of activities to be done for effective utilisation of agricultural waste in the building sector*".

Based on the questionnaire analysis in Table 25, all respondents strongly agreed or agreed that 'significant innovative framework development' is the best approach to help utilise agricultural waste for building construction purposes in Nigeria. Consequently, the development of a conceptual framework of activities and governmental levels will give all stakeholders insight into how an innovation management approach to the utilisation of agricultural waste as building construction materials will be carried out within collaborating organisations. According to Miles et al. (2014), the quality of a conceptual framework is not merely a collection of concepts but rather a construct in which each concept plays an integral role, lays out the key factors, constructs, or variables, and presumes relationships among them. To further understand the best approach to assist this innovation, the next subsection will discuss partnership and collaboration between key players.

4.5.5 Agricultural Waste Innovation Champions (Players) and Learning and Partnering with other Sectors (Collaboration)

Mattessich (2005) explains that collaboration is the mutual engagement of participants in a coordinated effort to solve a problem together. He further explains that collaborative interactions are characterised by shared goals, the symmetry of the structure, and a high degree of negotiation, interactivity, and interdependence. However, interactions produce elaborate explanations that are valuable for improving the set objective. Similarly, collaboration is a mutually beneficial and well-defined relationship entered into by two or more organisations to achieve common goals (Mattessich, 2005). Mattessich further explains that within the collaborative relationship includes a commitment to mutual relationships and goals, a jointly developed structure and shared responsibility, mutual authority and accountability for success, and the sharing of resources and rewards. Also, collaboration

brings a more durable and universal relationship. It brings previously separated organisations into a new structure with the full commitment to a common mission, where such relationships require comprehensive planning and well-defined communication channels that operate on many levels (Mattessich, 2005).

From the semi-structured interview analysis, six (60%) of the 10 interviewees mentioned that 'agricultural waste innovator players should collaborate with other sectors. His response from the semi-structured interview suggests that:

> "[*The*] *Government should encourage the collaboration of the organisation that will help in managing agricultural waste into building material".*

Similarly, OSPKI suggests that:

"[The] Government should encourage the collaboration of researchers and professionals in the various field of development that can help in the development of a system that will help in assisting in the utilisation of agricultural waste for construction purposes".

Furthermore, similarly, AFSAOS suggested that.

> "*There must be the development of research centres that cluster agricultural and construction industry for collaboration purposes".*

Based on the questionnaire analysis, 100% of the respondents strongly agreed or agreed to the statement that 'agricultural waste innovation champions (players) should learn and partner with other sectors'. They confirmed this is the best approach to help in the utilisation of agricultural waste for building construction purposes in Nigeria whilst 0% were either neutral, strongly disagreed or disagreed. Consequently, the collaboration between all players to assist in the utilisation of agricultural waste as building construction material needs to be carried out. Correspondingly, 100% of the respondents strongly agreed or agreed that 'learning from other sectors about management and development (collaboration)' is another approach for adaption to assist in the utilisation of agricultural waste for construction purposes, while 0% neutral, disagreed or strongly disagreed

In summary, collaboration is the act of working together to accomplish more than any one person or organisation could alone. Moreover, it is much more than just trying to find

common ground; it is about bringing out the best in the group, helping them to achieve greater accomplishments and increase the capability of the organisation. Furthermore, collaboration is the ability to multiply each other's strength to produce results that have not yet been carried out. However, collaboration happens when there is the freedom to achieve the goal, with very few restraints. This freedom could come in the form of a national innovation system, which is discussed in the next subsection.

4.5.6 Development of a National Innovation System

The study of national innovation systems focuses on the flows of knowledge. The analysis is increasingly directed to improving performances in "knowledge-based economies" – economies which are directly based on the production, distribution and use of knowledge and information (OECD, 1997b). Knowledge, as embodied in human beings and technology, has always been central to economic development. However, only over the last few years has the relative importance of a national innovation system been recognised; this has occurred just as that importance is growing (OECD, 1997). Also, economic activities are becoming increasingly knowledge-intensive, as seen in the growth of high-technology industries and the increasing demand for highly skilled people. Investments in knowledge, such as in research and development, education and training, and innovative work, are considered key to economic growth (OECD, 1997). Therefore, the national innovation systems approach reflects the increasing attention given to the economic role of knowledge. Here, the emphasis is on planning knowledge flows as a complement to measuring knowledge investments. These flows, particularly of knowledge, are "codified" in publications, patents and other sources, and are both increasing and becoming easier to detect due largely to information technology. The intent is to evaluate and compare the main channels for knowledge flows at the national level, to identify bottlenecks and to suggest policies and approaches to improve their fluidity. Therefore, this involves tracing the links and relationships among industry, government and academia in the development of science and technology (OECD, 1997). The national innovation systems approach also reflects the rise of systemic approaches to the study of technological development. However, ideas for innovation can come from many sources and at any stage of research, development, marketing and diffusion. Innovation is thus the result of a complex interaction between various actors and institutions. Technical change does not

occur in a perfectly linear sequence, but through feedback loops within this system (OECD, 1997).

Results that emerged from the analysis of data obtained from semi-structured interviews show that all ten interviewees indicated that the 'development of a national innovation system approach' will enhance the utilisation of agricultural waste for building construction purposes.

For example, FOMANR suggested that.

"[The] *Government should develop a standard system that will encourage innovation of agricultural waste into building material as experienced in other countries".*

Similarly, LCAPCB suggested that.

"*A standard national innovation system framework should be developed that will serve as a standard for any developmental programmes and research in the country".*

Also, PMTSCL suggested that.

"*[The] Government should develop a policy or innovation system that encourages private and public organisation collaboration; also, the nation should develop a framework of the innovation system that is focusing on the collaboration of agricultural sector and other players in construction industries".*

From the questionnaire analysis, 100% of the respondents either strongly agreed or agreed that the 'national innovation system development' is one of the best approaches to assist in the utilisation of agricultural waste for construction purpose. In comparison, 0% were either neutral, disagreed and strongly disagreed. However, from the literature review, the Nigerian government does not have any tangible innovation system in the adoption of an existing and reasonable national innovation system to assist in the development of the collaborative innovation management framework. Having discussed the uniqueness of the innovation system as an approach to enhance the utilisation of agricultural waste as a building material,

the developed system needs to be introduced, as an awareness of the system is important. In the next subsection, the raising of awareness will be discussed.

4.5.7 Raising Awareness

In the context of this research, awareness is simply letting the right people know about the information, services that exist, and the potential and advantages that are inherent with the agricultural sector via agricultural waste as an alternative source of raw materials or materials for building construction purpose. In comparison, creating awareness is the process and tactics used efficiently and intelligently to achieve awareness about the potential inherent in the utilisation of agricultural waste for building construction purposes. However, creating awareness about a product is similar in function to a promotional or advertising task. There are various ways in which the government or individual organisation can raise awareness, for example, through social media, conferences, seminars, and so on.

In addition to a more thorough understanding about the importance of creating awareness, 86 (60%) of the interviewees confirmed that 'creating awareness about the potential for agricultural waste' will encourage private and public investors to know the potential that is inherent in the utilisation of agricultural waste for building construction purposes.

FMLFNL responded that.

> *"Governments should provide awareness about the potential that locks in agricultural waste".*

In a similar response, AJBMI stated that.

> *"Create awareness about the viability of products production by using agricultural waste"*

Also, AFSAOS's response, when asked for suggestion to help develop a collaborative innovation management framework for the utilisation of agricultural waste as building construction material, was:

> *"[The] Government should create awareness about agricultural waste potential".*

From the questionnaire analysis, when asked whether the 'national government should create awareness about the potentials that are inherent in agricultural waste', 96.1% of participants either strongly agreed or agreed, while 3.9% were neutral and 0% either disagreed or strongly disagreed. Nevertheless, when the participants were asked whether, 'non-governmental organisations should create awareness about the potentials inherent in agricultural waste', 99% of respondents either strongly agreed or agreed, while 1% were neutral and 0% either disagreed or strongly disagreed. Moreover, when the participants were asked whether 'educational institutions or agricultural focused financial institution should create awareness about the potentials that are inherent in agricultural waste', 97.1% either strongly agreed or agreed, while 2.9% were neutral, and 0% either strongly disagreed or disagreed. Furthermore, when asked if 'manufacturing industries should create awareness about the potential inherent in agricultural waste', 69.8% either strongly agreed or agreed, 8.8% were neutral, nearly 27% strongly disagreed, and 4.9% disagreed. Concerning the analysis in this section, the creation of awareness is one of the best approaches to adopt when developing a framework that assists in the utilisation of agricultural waste for building construction purposes. However, when considering raising awareness there is a need to consider the market orientation and this is discussed in the next subsection.

4.5.7 Market Orientation

Marketing ideas, particularly the basis of modern marketing thought, specifies that to achieve and sustained success, firms should identify and satisfy customer needs more effectively than their competitors (Kotler, 2002). However, productive market orientation prose examines the extent to which firms behave, or are motivated to behave, following the marketing concept (Kiessling, et al., 2016). Also, market orientation has been conceptualized from both social and cultural viewpoints (Homburg and Pflesser, 2000). The social viewpoint concentrates on organisational activities related to the generation and dissemination of, and responsiveness to, market intelligence (Kiessling et al., (2016); Saunders, 2012). Meanwhile, the cultural perspective focuses on organisational norms and values that encourage behaviours that are consistent with market orientation (Deshpande et al., 1993; Jogaratnam, 2017).

To further explore the importance of market orientation, the researcher investigated numerous backgrounds and consequences to better understand its role in organisations and to thoroughly analyse the quantitative and qualitative data collected in the field of research.

To investigate the importance of market orientation, semi-structured interviews were conducted and analysed (as shown in Table *26*). Thus, 70% of the participants responded that 'there is a need for market orientation' to know the viability and the wants of end-users.

PSMANR advocated the.

> *"Proper market orientation about the viability and the reliably of the proposed material for agricultural waste"*

Also, OSPKFI suggested that.

> *"Proper market orientation is an essential tool for development; therefore, [the] government should carry out [a] proper market orientation to know what is obtainable in the construction market and also to know any obstacle that may follow when used agricultural waste for building construction purposes".*

From the questionnaire analysis, the responses from participants about the market orientation show that 98% of respondents either strongly agreed or agreed that market orientation is one of the best approaches to adopt when developing a collaborative framework that will assist in the utilization of agricultural waste for building construction purposes. However, 2% of the respondents were neutral and 0% either strongly disagreed or disagreed.

Table 26: Best approach for managing Innovation of agricultural waste for building construction purposes.

The best approach for managing the innovation development of agricultural waste as raw materials/materials for building construction purpose	Mean Scores	Rank	Strongly agree on %	Agree %	Neutral %	Disagree %	Strongly disagree %

Incentivising the use of locally manufactured building materials	4.56	1	56.8	42.2	1.0	0	0
Improving the quality of research and development	4.53	2	53.9	45.1	1.0	0	0
Improved policies and planning	4.59	3	58.8	41.2	1	0	0
The significant developmental conceptual framework	4.52	4	52.9	46.1	0	0	0
Agricultural waste innovation champions (players) should learn and partner with another sector	4.56	5	55.9	44.1	0	0	0
Development of a national innovation system in Nigeria	4.49	6	49.0	51.0	0	0	0
Creating awareness (National government)	4.45	7	49.0	47.1	3.9	0	0
Creating awareness (non-governmental organisation)	4.41	8	44.1	53.9	1.0	1.0	0
Creating awareness (manufacturing industries)	3.53	9	29.4	30.4	8.8	26.5	4.9
Creating awareness (educational institutions and others)	4.52	10	54.9	42.2	2.9	0	0
Creating awareness (agricultural focused financial institutions)	4.52	11	54.9	42.2	2.9	0	0
Leaning from other sectors about management and development (collaboration)	4.59	12	58.8	41.2	0	0	0
Market orientation	4.55	13	56.8	41.2	2.0	0	0

In conclusion, the collaboration of private and public sectors in the construction and agricultural sectors will play a vital role in managing the innovation management framework that will assist in the utilisation of agricultural waste as a building material

4.6 Discussion of Findings Summary

From the literature review, it was revealed that agricultural waste has been used for various purposes; also, from the semi-structured interviews, the participants indicated that agricultural waste has been used for various foundry work including 'blacksmith and goldsmith smelting works to generate income for the family'. In addition to foundry work, agricultural waste has been utilised for domestic purposes, including 'cooking in place of charcoal and as fuel for local wood-burning', which has helped in the reduction of money spent to buy kerosene for cooking stoves, and the raw material used in the production of domestic animal feeds. Most importantly, the sparse usage of agricultural waste as an additive for concrete work and other construction purposes, which ascertained the potential that lies in the use of agricultural waste for building construction purposes, either as raw materials or as a product itself. Furthermore, the analysis revealed that agricultural waste is used to generate biogas for domestic usage, which shows the potentiality for energy retention capacity in agricultural waste materials. This revelation is an attestation that agricultural waste, when rightly utilised, will help in the process of sustainable development in the construction industry by developing a product that has an energy retention capacity for greenhouse construction. Observed critically, this established that the interviewees' responses confirmed the potential that lies in agricultural waste in Nigeria, and that this has not been fully utilised.

Furthermore, to discover if the utilisation of agricultural waste for building construction purposes has fully gained its awareness in Nigeria, the researcher probed further using quantitative and qualitative data analysis. The findings showed very encouraging responses based both on a professional and personal perspective, including that agricultural waste, has not gained any tangible awareness in Nigeria. However, the respondent pointed out that based on limited experience and findings, agricultural waste is suitable for construction purposes**.** There is an indication that agricultural waste has not been fully utilised for building

construction purposes despite established proof that agricultural waste is suitable for building construction purposes, either as raw material for building materials or as the material itself. Therefore, it is of utmost importance to determine the factor responsible for the lack of innovation in the transformation and utilisation of agricultural waste for building construction purposes. The results from the data highlighted some key factors responsible for this, including; socio-cultural (believe and tradition inclusive), political (corruption inclusive), the lack of innovation system, collaboration and policies, economic, ignorance and awareness, climatic, government support, corruption, the lack of research and development and the lack of innovation management organisational framework.

Given the findings, to develop a collaborative innovation management framework that assists in the utilisation of agricultural waste for building construction purposes in Nigeria, there are particular approaches to take. The findings from the data identified approaches and thus provided suggestions that the Government should.

- Encourage the use of local materials for manufacturing (discourage the importation of raw materials available locally).
- Provide funding and improve the quality of research and development.
- Develop policies and planning that enhance sustainable development.
- Develop a framework of concepts that support the use of agricultural waste for construction purposes (innovation system).
- Allow all agricultural waste innovator players (Champions) to collaborate with other sectors.
- Create awareness about the potential for agricultural waste.
- Create an enabling environment (provision of basic amenities).
- Ensure proper market orientation about the viability and customer want.
- Develop a collaborative innovation management organisational framework to outline the hierarchy of responsibilities.

Having analysed the best approach suggested to develop the collaborative innovation management framework that assists in the utilisation of agricultural waste as building construction material, it is imperative to develop the framework that shows the

organisational hierarchies responsible for the innovation and utilisation of agricultural waste as building materials in Nigeria. Therefore, the next chapter will outline the development of the proposed collaborative innovation management framework that will assist in the utilisation of agricultural waste as building construction material.

Chapter 5 PROPOSED COLLABORATIVE INNOVATION MANAGEMENT FRAMEWORK TO ASSIST IN THE UTILISATION OF AGRICULTURAL WASTE AS BUILDING MATERIALS

5.1 Introduction

Having analysed all the relevant data available and document the findings after the analysis. One of the striking revelations is that the utilisation of agricultural waste as building material either in form of raw material for production or as a direct material cannot be possible until the government put up to develop policies that support the usage of locally made material from agricultural waste. Also, most of the stakeholders identified to enhance the innovation process are put under one framework or guideline for them to collaborate to achieve this goal. However, to do this there must be a well-structured organisational and sectoral linkage that will address how this stakeholder can work together in the form of information sharing, incubation, R&D and so on. Given the best way to achieve this is to develop a collaborative innovation management framework that will assist in the utilisation of agricultural waste as building material in Nigeria. This development and design of this framework will commence from this chapter. This proposed framework is segmented to core levels of organisation that are involved in the innovation process that enables the utilisation of agricultural waste as building material possible in Nigeria. The framework shows each level of various organisations and stakeholders that are involved in it and also shows how each core level linked with one another. Further in this chapter, the proposed developed framework each core levels were discussed to give an elaborate insight on the stakeholders/ organisation's involvement. The next subsection discussed the validation and enhancement of the proposed framework using focus group and professional feedback through questionnaire. The feedback from the focus group and professional feedback collated were used to develop the final collaborative innovation management framework that assist in the utilisation of agricultural waste as building material in section 5.3.6. The last sub-section of this chapter summarises the whole chapter.

5.1.1 The Proposed Framework

The proposed framework consists of five broad level systems that synchronise key organisational fields comprising construction, agriculture, and manufacturing; these include both private and public sectors and together to form a collaborative innovation management

framework in the form of an organisational chart to assist in the utilisation of agricultural waste as building construction materials in Nigeria. The proposed framework before validation is shown in Figure 15.

Figure 15: Proposed collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials

5.2 Description of the Proposed Framework

This objective of the proposed framework (Figure 15) is to provide a set of practical and structured organisational guidelines to all key stakeholders that would be involved in the process of assisting the utilisation of agricultural waste for construction purposes. This framework identifies and considers the involvement of the Government at the first stage of management; this is followed by the Government ministries at the second stage, funding institutions at the third stage, research institutes at the fourth stage, and industries at the final stage in developing the collaborative innovation management (as a descending ladder) framework to assist in the successful utilisation of agricultural waste as building materials. The proposed framework consists of stacked Venn core levels in the form of onion. The reason

why the researcher choose stacked Venn core levels is that Venn core levels shows the overlapping relationships (collaboration) within the framework and creates visible concepts that are easier for any researcher, reader, and audience to comprehend. Furthermore, the stacked Venn core helps to emphasise growth and progression. It also shows the interrelationship of concepts when communicated; although these details may seem complicated, a Venn diagram simplifies and clarifies to enable people to absorb the information easier and faster.

5.2.1 Core Level 1: Government and Politics (Policymakers)

There have been conflicting findings regarding the extent which the actions of policymakers impact innovations (Thum-Thysen *et al.*, 2017). However, there is the near-perfect agreement by researchers regarding the role that policymakers can play to stimulate innovation. A common strategy adopted by governments is to influence innovation through the tax system by offering a tax break for businesses spending on R&D (Thum-Thysen *et al.*, 2017). A classic example of this is the R&D tax credit introduced by the US government under Ronald Reagan in 1981. It was noted in the literature that there are robust arguments that firms are unlikely to significantly increase their R&D efforts in response to tax incentives, even though real-life successes abound. However, Thum-Thysen et al. (2017) argue that an evaluation of the UK system appears to reveal that, after a few teething problems, UK firms responded positively to these tax incentives introduced by the government. The point here is that firms in Nigeria often cite high operating costs as the reason why they lag in terms of innovation (Ayedun and Oluwatobi, 2011). Thus, tax relief and other forms of financial incentives that are tied with R&D investments should be applied to spur innovation.

The World Bank's business report for 2017 places Nigeria as 169th out of 190 countries. Similarly, the difficulties that characterise the conduct of business in Nigeria has often been noted as a key reason why investors are sceptical about investing in long term endeavours in Nigeria. In consideration of the fact that innovation efforts are often long-term endeavours, positive action by policymakers focus on the reduction of administrative bottlenecks, the reduction of difficulty in patent registrations, the enforcement of patent protections, and the provision of basic amenities such as road, electricity, water and security of life and properties. These will go a long way in encouraging investors' interest in long-term endeavours, such as

innovations, that will assist in the utilisation of agricultural waste as building material in Nigeria.

Given this research, the policymakers are the Nigerian government and those involved are the politicians. The reason for this is that the Nigerian system operates under the political setting and policies are based on the political ideologies within a political party. Furthermore, the literature reviewed and the findings from data collected reveal that the government of a country (Nigeria) needs to develop policies that enhance developmental programmes and innovation in every sector of the economy. Therefore, in considering the effective utilisation of agricultural waste as building materials in Nigeria's construction industry, the government should develop a policy that encourages sustainable development. This includes the innovation and management of agricultural waste for construction purposes and the development of a legal system that encourages the use of locally made building materials. Also, it is important to encourage SMEs by developing policies align with this aspiration. Moreover, the government should encourage local manufacturing industries by providing incentives that support the innovation activities of local manufacturing industries. This includes the promulgation of laws and acts that support the usage of agricultural wastes as one of the raw materials used in the manufacturing of building materials and the introduction of punitive methods for dealing with defaulters. Alongside a government that develops policies, laws and acts to support the utilisation of agricultural waste as building materials, there are organisations that the government must involve in the process of implementing such policy and laws. This is discussed in the next subsection as level 2 of the proposed framework.

5.2.2 Core Level 2: Organisational and Administrative System (Actors and Executors)

The administrative system is understood to be a set of rules and regulations to which individuals who run organisations or units must adhere. Furthermore, these rules and regulations are implemented to help create a greater level of efficiency and accountability within the organisation. The administrative actors are policy executors; these involve different ministries and government parastatals, such as the Ministry of Science, Technology, colleges of innovation and management, the Council of Innovation and Management, and national orientation agencies, and so on. In the context of the proposed framework,

organisational administrative actors include public and private bodies operating in Nigeria with the resources capable of identifying the potential for agricultural waste. Such potential includes benefits to the end-users and other stakeholders, with the resource capacities to bring the utilisation of agricultural waste as building materials to fruition. Furthermore, most of the policies developed and the agenda created in level 1 have direct impacts on this level in the form of implementation. Thus, the present study suggests that all organisations involved in the implementation of policies should develop the strategy needed to collaborate for the effective utilisation of agricultural waste as building materials.

The strategy involved at this level, as identified from the literature and data analysed, are detailed in the following paragraphs. Firstly, an orientation programme should be developed to create awareness about the viability of products created from the use of agricultural waste. This should mainly be carried out in Nigeria by the National Orientation Agency. In this organisation, a sub-department should be convened to address awareness and orientation programmes for farmers and the other groups and organisations identified as potential collaborating units for the successful utilisation of agricultural waste as building materials.

Secondly, the product innovation system that enhances the utilisation of agricultural waste as building construction material should be developed. This can be created via the Council of Innovation and Management in conjunction with the Colleges of Innovation and Management. The developed product innovation system could be used to develop a standard system to encourage the innovation of agricultural waste as building materials and based on the experiences of other developing and developed countries.

Furthermore, in Level 2, networking amongst organisations and ministries that oversee the creation of basic amenities could provide the foundation for veritable developments and so many other activities that will enhance the utilisation of agricultural waste for building construction purposes. Thus, the Ministry of Information must be the key organisation to promote any networking.

It is argued that the organisational and administrative levels of the proposed framework provide a platform for the successful utilisation of agricultural waste for building construction purposes. It is also noted that this level often influences the trajectories of entrepreneurial

activity in every industry. Examples of the organisational bodies that populate this level of the proposed framework are regulatory bodies, and the Ministries of Agriculture, Works and Housing, and Science and Technology.

However, organisational progression and innovation ideas require adequate funding to move from the proposal to the implementation stage. This is discussed in the next subsection.

5.2.3 Core Level 3: Funding and Management

This level considers the funding and management drivers (for both privately and publicly funded institutions). In every aspect of global development, funding is one of the major drivers for every field of management and development; thus, without funding, there is no development. This level of the innovation management framework follows for the identification and consideration of the organisation involved in the implementation of government policies and agendas. Furthermore, private and public organisations become involved at this level through the identification of financial organisations, the search for R&D grants, and any other activities to enhance the utilisation of agricultural waste as building materials. The funding and grants could be provided by private or public organisations involved in the funding of innovation activities. Also, this level allows for the identification and selection of the institution to be funded and managed. This level is where the funds appropriate for institutions of higher learning, public and private research institutes, business parks, agricultural research centres, vocational training institutes, universities, business incubators, farmers, manufacturers, etc., are disbursed, administered and managed to achieve the set goal of the utilisation of agricultural waste for construction purposes.

While innovation is central to most businesses, funding is core to most innovation efforts. Funding, as used in the present study, encompasses the funded regimes required to transform creative ideas into innovations. UNESCO (2010) observes that, in less developed and often poorer countries, accessing funds for R&D related activities is often problematic and is, therefore, a key barrier to the implementation of continuous innovation.

Furthermore, the ability to effectively manage the innovation process often stems from ensuring stable funding and funded regimes. This links with the second element of the 'Core Level 3 stage', namely its management, which involves the ability to organise and supervise

the innovation process to ensure the set goals are achieved. (Ortt & van der Duin, 2008) observe that, whilst understanding how to best capture and manage innovation is essential at a time when innovation is an almost obligatory survival strategy, it is also risky because it may lead to the demise of an organisation. (Bessant, Lamming, Noke, & Phillips, 2005) remark that, whilst there are no guaranteed formulae for success in what is inevitably a risk-based activity, the convergence of experience around successful innovation management routines has given rise to a 'good practice' model which embeds some key guidelines or design principles for the effective management of innovation. As discussed, finance is the bedrock of most innovation and management; however, when funding is confirmed, it is important to consider the innovation objectives and collaboration amongst the key players involved in R&D. This also requires the consideration of other activities that assist in the process of utilising agricultural wastes as building materials, which will be discussed in the next subsection.

5.2.4 Core Level 4: R&D and Collaboration

This level allows the government policy drivers, organisational drivers, and all other key stakeholders to liaise with various private and public research and development institutions to research how agricultural waste can be developed into sustainable products that are useful for the construction industry. One of the most significant aspects of this level is the collaboration amongst different professional bodies to share ideas, gather information, identify factors, collect data, carry out new product development stages, analyse data, present and exhibit findings and prototype products, and carry out the product evaluation processes. This demonstrates that there is a positive association between extensive collaboration and innovations. Collaboration with external parties tends to be beneficial for the firm, not only in terms of technological innovations but also in many other areas, such as product innovation. However, both the firm and external party benefit from accessing the resources that they lack, without the need to develop the desired input internally or acquire a partner. This is particularly important in countries with apparent resource poverty, such as Nigeria. The literature on collaboration focuses on a wide range of topics, including the selection of partners, the formation of the alliance, its evolution, the governance structure, and the performance consequences for firms entering such alliances (Ozmel et al., 2016). In

terms of the proposed framework, extensive collaboration among the identified innovation stakeholders in the utilisation of agricultural waste as building materials will not only ensure the availability of adequate resources but also the technical knowledge and relevant marketing expertise to generate awareness of the creation of innovative building materials from agricultural waste. Having discussed R&D and collaboration, there is a need to link with the industries and sectors that will implement the use of agricultural waste as building materials. This is discussed in the next subsection.

5.2.5 Core Level 5: Industries and Sectors

The industries and sectors involved at level 5 comprise the agricultural and manufacturing sectors and the construction industry. This is the final level of the proposed framework and involves the delivery of the expected product from agricultural waste materials. This is the stage where farmers in the agricultural sector become fully involved when they have been properly oriented toward the potential that lies in the use of agricultural waste as building materials. Furthermore, farmers would be trained on how to manage and package agricultural waste material for the manufacturing industry to adopt. From this, the manufacturing industry develops new sustainable building materials after proper design and the development of the production process. From this, the manufacturing industry supplies the building materials for onward delivery to the construction industry. Furthermore, the building construction industry can liaise directly with the manufacturing industry to supply the construction firm. After usage, the construction industry evaluates the benefit and gathers other professional feedback about the durability and effectiveness of the product in terms of its economic value for the industry. This is the stage at which the materials produced from agricultural waste are fully adopted, utilised and managed.

5.3 The validation and Enhancement of the Initial Framework

The initial proposed framework was developed from the findings from the literature review, semi-structured interviews, and the questionnaire survey. To validate the framework in terms of its significance and applicability to real-life practice, a validation questionnaire was designed and sent out to 11 different stakeholders within the field of agriculture, manufacturing, engineering and construction and also focus group of 8 professionals two groups were used to further validate the initial framework. However, to select the

professionals for the validation process, criteria were identified and applied to approach suitable professionals. These were as follows:

- They should have at least 10 years of experience of construction, engineering, and manufacturing in Nigeria.
- The professional should currently be working in a field that has a direct contribution to sustainable development and will thus assist in the utilisation of agricultural waste in Nigeria.
- The professional should have good knowledge of social and economic sustainability, and organisational/administrative understanding, and an appreciation of research and development for economic growth.

The validation questionnaire together with the framework and guidelines were emailed to the 11 selected professionals. They were asked to rate the framework in terms of its comprehensiveness, user-friendliness, logic and flow, and its value-adding potential. They were also asked to provide any additional comments on the above areas or to offer any general comments that might help to further improve the proposed framework. The validation questionnaire was based on a five-point Likert scale similar to that used to collect quantitative data for the main study. This helped to enable consistency in the data and findings. The questionnaire survey method was chosen to enable the rapid collection of responses from the selected professionals who were located in busy ministries and organisations across Nigeria (Appendix G provides a sample of the validation questionnaire). The responses were analysed using Relative Importance Index to determine the level of importance of each question asked and understand the quality of the validated framework. According to (J. W. Johnson & LeBreton, 2004) explanation, Relative Importance index is often desired when the explanatory aspects of regression analysis are of interest as the proportionate contribution each interviewee makes to validate activities in an organisation. All 11 professionals responded to the questionnaire survey, and the results obtained are shown in *Table 27* and the outcomes further analysed in the following sub-sections.

Table 27: Validation questionnaire survey results for the proposed framework

Validation Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Relative Importance Index (RII)
Clarity of content	4	7	0	0	0	0.87
Anticipated usefulness of the proposed framework	4	7	0	0	0	0.87
Simplicity of the framework	4	2	5	0	0	0.78
Ability of the framework to accommodate real life requirements	3	5	2	1	0	0.78

However, to calculate RII, these variables are needed; W= Likert ranking depending on several weights assigned by each respondent, N = number of respondents to each weight, A = Highest Likert ranking and N_A = the total number of respondents.

$$RII = \frac{\sum (W \times N)}{AN}$$

5.3.1 Clarity of Content

For the proposed framework to be accepted for the innovation management of agricultural waste as building materials, users needed to be able to understand the content. Thus, participants needed to identify any vagueness and be able to interpret the structure and guidance that leads to the utilisation of agricultural waste for building construction purposes. From the results illustrated in Table 27, respondents were asked to confirm whether the content was clear enough for adaptation and adoption; 0.87 of the respondents RII shows that the content was sufficiently clear and comprehensible. Four of the 11 professionals strongly agreed that the framework was sufficiently clear and comprehensive, and no vagueness was identified, while the remaining seven practitioners agreed that the framework content was clear enough. Thus, nobody disagreed or indicated neutrality about the content. Therefore, the content of the framework was confirmed as clear and understandable by those

expected to adopt it. This suggests that the framework is sufficiently clear and comprehensive for adaptation by all key stakeholders.

5.3.2 Simplicity of the Proposed Framework

Based on the responses about the simplicity of the proposed framework for usage, four participants strongly agreed that the framework would be simple to apply in practice, whilst a further two individuals agreed that the framework would be simple to adopt. This suggested that it could add value to the level of awareness and utilisation of agricultural waste for building construction purposes in Nigeria and the delivery of sustainable socio-economic development. However, five respondents selected 'neutral' in considering the simplicity of the framework. Nevertheless, none out of 11 respondents strongly disagreed or disagreed that the framework would be simple to use to assist in the utilisation and development of agricultural waste as building materials in Nigeria. Therefore, the result indicated that RII of 0.78 considered the proposed framework simple to use at different levels. However, not every professional agreed with the statements, thus opportunity was given for respondents to offer comments or suggestions to clarify their replies as shown in the next subsection.

5.3.3 The Ability of the Framework to Accommodate Real-life Requirements

The suitability of the framework to accommodate real-life requirements had not yet been discussed in the study. Therefore, the respondents were asked if the framework is would be practically useful for real-life projects, and three of the 11 respondents strongly agreed that the framework would meet such needs. Moreover, five agreed that the framework would meet the needs of the real-life application for sustainable development in the construction industry in Nigeria. Nevertheless, two of the respondents selected neutral in response to this question, although no respondent strongly disagreed or disagreed that the framework could meet real-life requirements. However, with the RII of 0.78, the framework would be expected to meet the real-life requirement.

5.3.4 Anticipated Usefulness of the Framework

When the respondents were asked about the anticipated use of the framework for the future, four of the 11 respondents strongly agreed and seven agreed that the framework would be expected to be used in the future; this is potential because no research has yet developed a

framework to assist in the utilisation of agricultural waste as building construction materials. No respondent selected neutral, and nobody strongly disagreed or disagreed that the framework would not be used in future. Thus, with 0.87 RII from the respondents is an indicator that the framework would be useful in future; therefore, the framework would be acceptable for future use. As such, the results show that the framework content is clear, simple to use, can potentially meet future requirements, and be used in the delivery of sustainable building materials from agricultural waste in Nigeria.

5.3.5 Comments by Respondents from different Professionals

Despite the positive quantitative outcomes of the validation survey, some of the respondent professionals suggested improvements in the collaboration links of the framework. They indicated that linking the agricultural sector and manufacturing industry to core level 2 would enable the key stakeholders in both sectors to stay informed about up-to-date administrative policies and information that would help to speed up economic development in Nigeria and curtail corruption. Also, these linkages would inform farmers and other professionals in the agricultural sector about how to manage and preserve some of the waste generated. Similarly, there was a suggestion to create linkages between industries and research and development to generate links and knowledge sharing, as discussed in the research findings. Feedback mechanisms were also suggested between the industries and the government to enable the feedback of findings from the construction industry in Nigeria. Another suggestion was to create a market between the industry and the research and development level to encourage easy access to agricultural waste via an established market. Given these suggestions, the proposed framework was then refined to reflect these valuable and important suggestions from professionals after the focus group validation. The focus group validation report is detailed in the next subsection.

5.3.6   Focus Group Validation

Focus group originated from sociology, but now, it is used intensely in the marketing field, and also, it has been growing in popularity in another area. Historically, Robert Merton published the first work using Focus Group in social science. Later, Paul Lazarsfeld and others introduced this technique in marketing and economics (Morgan, 2013). In 1993, Tull and Hawkins studied this subject and described Focus Group as a type of in-depth interview

accomplished in a group, whose meetings present characteristics defined concerning the proposal, size, composition, and interview procedures. The main focus or object of analysis is the interaction inside the group, where participants influence each other through their answers to the ideas and contributions during the discussion (Freitas et al., 1998) Furthermore, the facilitator inspires discussion with comments or subjects, at the time with pre-determined questions. The fundamental data produced by this method are the transcripts of the group discussions and the moderator later reflect and annotate the transcripts to be in line with the intent of the activities. The general characteristics of this FG research method are advisable for generating ideas for validation of framework, models; investigation or action in new fields; for generating hypotheses based on the perception of the participants; to evaluate different research situations or study populations; and lots more(Morgan, 2013). FG is particularly suited to be used when the objective is to understand better how people consider an experience, idea, or event because the discussion in the FG meetings is effective in supplying information about what people think, or how they feel, or on the way, they act (Morgan, 2013).

To further validate the initial proposed framework developed from the findings from the literature review, semi-structured interviews and the questionnaire survey, a focus group was convened comprising eight professionals who are stakeholders in the process of utilising agricultural waste as building materials. Thus, before the meeting, the initial framework was sent to each participant with a detailed explanation of the problem that the framework was designed to solve. From this, it was possible to seek further insight into the development of the framework.

To validate the framework, focus group discussions were established to obtain insight and ideas for further development or corrections. Gathering practitioners from different fields in construction, manufacturing, academia, agriculture and Government organisations provided an optimal way to validate the collaborative innovation management framework and assist in the utilisation of agricultural waste as building materials. After careful consideration, this proved to be a viable option. The researcher could manage and gather greater insight from different practitioners/stakeholders from different fields at the same time, whilst difficulties in moderating the discussion group would elicit a greater understanding of what

practitioners/stakeholder thought about the framework. Practitioners from different fields would be able to share their views on the same subject from different angles. As such, the group comprised of practitioners/stakeholders who were identified during the research (Table 28). Each session lasted over three hours and was successful both invalidating the identified and highlighting new elements.

The background information and group responses to questions were discussed as follows.

Table 28: Background information about the composition of the focus group

Focus group background information	
Group profile	
Number of participants	8
Professional profile	1 Trained Civil Engineer 2 University Lecturers (PhD) Holders 2 Production Manager 1 Farmer 1 Director Ministry of Works and Housing
Organisation Category	Construction Industry Academic organisation Manufacturing industry Non-governmental organisation Government establishment
Experience in the field	Advanced

5.3.6.1 Group responses to questions

After the initial introductions, the researcher (who assumed the role of focus group facilitator), gave participants a brief presentation on the overall aim of the research project and the purpose of the focus-group. He handed participants a copy of the framework, which had initially been sent to them, and some of the notable outcomes and comments from the previous validation. Furthermore, the participants were then asked to take a moment to study the framework and think about its competence and format, its usability and its clarity. Afterwards, participants were asked to comment on or, if possible, make suggestions on how

the framework could be improved. All the participants in the focus group were brief about the purpose of the meeting and they all expressed their appreciation for the research as a whole and its competency-based approach. They considered the framework the first step in the quest to solve the problem of the shortage of housing units in Nigeria. Afterwards, responses were made to the questions, the participants also offered comments and observations. The responses are discussed in the next subsections.

5.3.6.2 The Competence and clarity of the framework

The focus group participants deemed the framework a step in the right direction towards the innovation and utilisation of agricultural waste as building materials. Two participants mentioned that the first step in achieving the research goal is the development of a collaborative innovation management framework that helps all stakeholders to understand the level of their organisational involvement in the delivery of agricultural waste for building construction purposes. Furthermore, on the competency of the framework, one participant pointed out that Level 1 of the organisational structure determines how successful the implementation of the framework will be in the area of policymaking and implementation methods. Also, three participants emphasised that the Government can proceed in the implementation of the policy in form of bye-laws and regulations on the number of imported building materials allowed into the country; this can be achieved by involving the Standard Organisation of Nigeria and other parastatals that can enforce the regulations promulgated by the government. One of the significant responses by the group was the clarity and simplicity of the framework. However, there were some comments and observations made by the group about making it user-friendly. These will be discussed in the comments and observations in the next subsection.

5.3.6.2 Usability of the framework

The group believed that all stakeholders involved have a lot to benefit from areas, such as knowledge sharing, inter-organisation technology sharing, and a lot more. Five participants categorically pointed to academic organisations as one area to benefit most from the collaborative framework in terms of research and development with other research organisations, like the Incubation Centre. They further added agricultural institutions and

farmers in terms of income generation and farm waste management. However, they pointed out that some of the organisations that need to be properly placed are the National Orientation Centres (NOC), and the media organisations in terms of disseminating information to rural farmers. In general, the group agreed that the framework is usable and will benefit all stakeholders in the long term. To further validate the framework, the group were asked about its viability in accommodating real-life requirements. The responses are discussed in the next subsection.

5.6.3.3 Real-life requirements of the framework

Having discussed the usability of the framework, the group were asked about the real-life requirements in terms of its practical usage in real-life projects. The group expressed satisfaction with the usage of the framework in real-life projects. Six respondents considered the usage of the collaborative innovation management framework for the current National purposes. They further explained that, if the framework can be presented in the appropriate organisations with a significant influence on the present political party, it is likely to be adopted as the national collaborative innovation management framework. The reason for this is that no other research in Nigeria is dealing with a collaborative innovation management framework. Having discussed the questions with the group and documented the responses (as shown in sections 5.3.6.1, 5.3.6.2, and 5.3.6.3), the group were asked to make comments and observations on how the framework can be improved. Their comments and observations are discussed in the next subsection.

5.3.6.4 Focus group comments and observations

The experts participating in the validation exercise fully adopted the principles of the research project and were satisfied with the linkage of the levels of the organisational structure. They readily adhered to the idea that a collaborative innovation management framework in the area of agricultural waste innovation and management is one of the major steps needed to awaken agricultural waste utilisation as building materials in Nigeria. The group further explained that, by implementing this kind of framework, the numerous advantages that it offers will add to the economic development of Nigeria and help in the global campaign for sustainable development. The group, however, commented on each level of involvement and

collaboration (in particular the 'key activities' that were expected to be undertaken), given that this could be undertaken as research in future. Furthermore, the group suggested that all levels of the framework should have a unified organisation wherein all the collaborative activities within each level have been documented and dispatched to the next level of the framework for easy information sharing amongst organisations. The final suggestion made by the group was the introduction of a market collaboration centre in form of an organisation that deals with both the raw material from farmers, manufactured building materials from agricultural waste and design and development outlets to research products from agricultural waste. This facilitates easier collaboration between levels 4 and 5. Moreover, they suggested this should be a level on its own. In general, the focus group expressed satisfaction with the framework and hoped it would help in the sustainable development programme and economic development of Nigeria.

5.3.7 Final Framework Development

The conceptual framework was the subject of finding from the relevant literature that supports the utilisation of agricultural waste. However, the proposed framework design was developed through findings semi-structured interview and questionnaires survey of data collected that been analysed using qualitative and quantitative analysis (mixed method). Further in this research, the proposed framework collaborative innovation management framework is then subjected to validation by the development of validated questionnaires that ask question about the clarity and simplicity of the proposed framework. Also, questions were asked about the ability of the proposed framework to accommodate real-life issues. Having received the feedback from the questionnaire validation process, the proposed framework was validated further using the focus group method of validation within stakeholder organisations and feedback was sought. After careful study, the feedbacks and recommendations, the final collaborative innovation management framework that assists in the utilisation of agricultural waste as building material was developed as shown in in the next subsection. Figure 16 shows the final framework that was developed and adjusted to assist in the utilisation of agricultural waste as building construction materials in Nigeria.

Figure 16: Final proposed collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials

5.4 Summary

This chapter presented a discussion on the proposed framework to fulfil the aim and objectives and answer the research questions for this study. The initial data was obtained from a literature review, semi-structured interviews with ten professionals, and questionnaire responses from 102 professional stakeholders in various fields who were identified as having a vested interest in the utilisation of agricultural waste for building construction purposes. Evidence from the results suggested that, in Nigeria, there is no innovation management framework or structure to assist in the utilisation of agricultural waste for building construction purposes, even though the literature and primary data

established that there are potentially untapped benefits inherent in agricultural waste that could contribute towards sustainable development in Nigeria. The chapter further presented a discussion on the key components of the proposed framework and the description of the framework.

Also, the validation results obtained via a questionnaire survey that was disseminated to 11 stakeholders was presented and discussed. Overall, the respondents agreed that the proposed framework was comprehensive, user-friendly, logical, flowed well and has value-adding potential if applied to real-life practice to assist in the utilisation of agricultural waste for building construction purposes. Nevertheless, there were also some key suggestions from professionals that included the following: Improving the collaboration links within the framework and adding feedback mechanisms between government/politicians and industries/sectors. Furthermore, there was a need to introduce the market to enable the feedback of findings from the Nigerian construction industry in Nigeria. Based on these suggestions, the proposed initial framework (in Figure 15) was defined as shown in Figure 16). The next and final chapter concludes the study, limitations, and offers recommendations based on the findings.

Chapter 6.0 CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS TO THE STUDY

6.1 Introduction

This chapter aims to provide a concluding summary of the findings and to outline the limitations and any recommendations for consideration. The chapter commences with a review of the research process and a summary of the objectives. It then provides recommendations for possible improvements in terms of practice, policy, and study. The final part is the contribution to knowledge and the limitations to the research.

6.2 A Review of the Research Process

The study commenced with an introductory chapter that delivered the view of the researcher on critical issues on the deficit of housing unit that focuses on the high cost of building materials. To start probing this issues of housing deficits in line with material cost, a review of the literature which suggested that the delivery of a sustainable product from agricultural waste for building construction purposes in Nigeria is still deficient in terms of its national innovation system, national innovation management and awareness about the potential within agricultural and construction industries both in context of product and management. This conclusion was deduced by comparing Nigeria's approach with those of other developing and developed countries around the world.

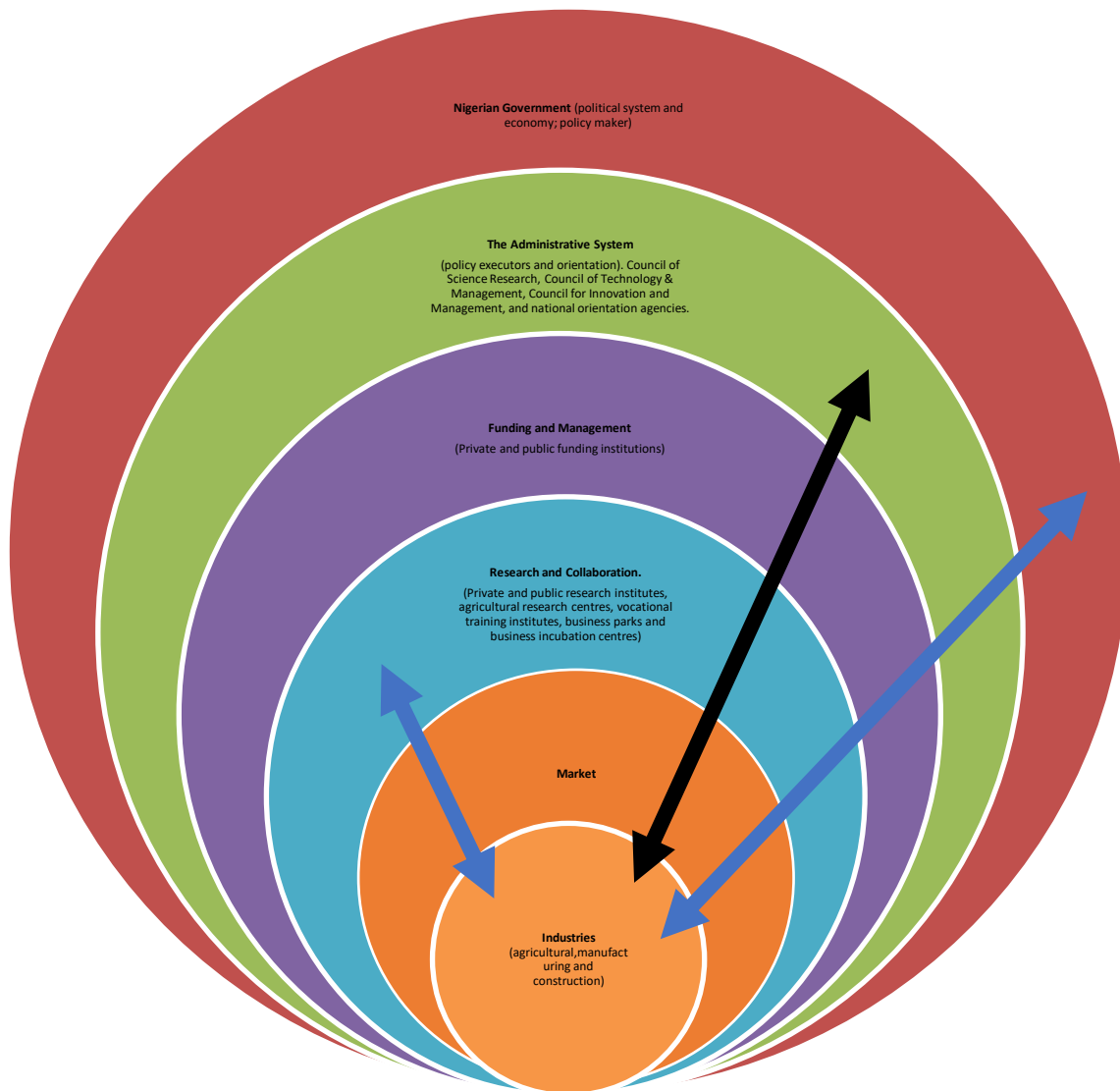However, the study aimed to develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials for sustainable development in Nigeria and to reduce housing deficit through the reduction in building material cost by using agricultural waste as building materials or raw material to produce new building material. The study achieved the above aim through the development of a collaborative framework having identified lack of private and public organisational framework that unite all relevant stakeholders to assist in the utilisation of agricultural waste as building material in Nigeria. This means a framework of linkages between the private and public sector in dealing with Governance, policies, administrative systems, funding and management, research & development/collaboration, and industries. Also, finding from data analysis shown that until a management structure in the form of a framework is in place, to achieve this innovative goal will be difficult.

To develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials, the following objectives were outlined:

I.   To investigate the benefits associated with the utilization of agricultural waste as building materials.

II. To explore the factors responsible for the non-utilisation of agricultural waste as building materials.

III. To establish the critical success factors which enable the improved utilisation of agricultural waste as building materials.

IV. To develop a collaborative innovation management framework that assists in the utilisation of agricultural waste as building materials.

V.   To validate the developed collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials.

Furthermore, to achieve the aim and objectives of this study, a research question was developed following the analysis of all relevant literature. This was designed to consider some of the areas that the literature did not address. To answer the research question and achieve the aim and objectives, data were collected, documented and analysed from in-depth semi-structured interviews, which were conducted with ten key stakeholders. These interviewees were identified through reviewed literature that identified various organisations involved in achieving the development of a product from agricultural waste for sustainable construction purposes in Nigeria. Batch A questionnaire survey was conducted at the same time with 155 professionals drawn from organisations involved in the development and delivery of sustainable products from agricultural waste for construction purposes in Nigeria using exponential non-discriminative snowball sampling

In total, 102 respondents returned the questionnaire survey within 8 weeks. Further, another batch of 155 questionnaires was sent using the same distribution method as batch A. Within 9 weeks a total of 109 respondents returned the questionnaire survey, which indicated an acceptable response rate of 68.06%. The information from the literature review and the results obtained through the analysis of the semi-structured interviews and questionnaire survey resulted in the development of the initial conceptual framework. The initial framework

was further validated through a questionnaire survey with 11 other professionals who contributed to the development of the final framework for the study and this was validated further using focus group of professional in the stakeholder organisations that will assist in the utilisation of agricultural waste as building material in Nigeria.

6.3 Summary of the Objectives and Question

This section presents the processes and main findings and conclusions of the respective objectives of the study. Following a thorough review of the literature and exploration of the issues with key players through semi-structured interviews and a questionnaire survey, the present study outlined the processes undertaken to address the objectives together with a summary of the conclusions.

6.3.1 Research Objectives 1

Objective one of this study examined the literature on the benefits associated with the utilization of agricultural waste as building materials. From the literature reviewed, there is benefit that is associated with the utilisation of agricultural waste material in construction industries. This benefit does not limit to developing countries, it also cut across developed countries. The literature reviewed that agricultural waste could be processed into liquid fuels or combusted/gasifier to produce electricity and heat. Moreover, in recent times agricultural waste has been used for various commodities and products. For example, palm kernel shell (PKS) can be used to develop an automobile brake pad as a substitute for asbestos and can also be grounded to powder and used to make ceiling boards and roofing material to help reduce asbestos materials. In the construction industry, the agricultural waste product from PKS, rise husk possesses significant potential as a raw material to produce building cement. Also, from the questionnaire and semi-structured interview, the analysis of both reveals, the main benefit and opportunities associated with the utilisation of agricultural waste as building material in Nigeria are:

- Cost-effectiveness and help in the development of extra housing unit,
- Improved accessibility,
- Generation of employment,
- Creation of economic activities,

- Improved waste management practices,

The next subsection explored the factors responsible for the non-utilisation of agricultural waste as building materials.

6.3.2 Research Objectives 2

- Having explored the literature for objective 1, then objective 2 explore the literature on the factors responsible for the non-utilisation of agricultural waste as building materials. The key findings indicated that there are: Institutional challenges, ranging from a lack of mutual information sharing in private and public sector partnerships, issues with R&D, inadequate industrial partnerships, bad organisational structure, finance, and so on. Furthermore, infrastructural challenges, such as the lack of basic amenities, inadequate research centres, whilst socio-economic challenges include political instability, the ethnic bias in policymaking, corruption, and the marginalisation of the agricultural sector in favour of the oil sector. Finally, legal challenges include the lack of laws to safeguard waste management and agricultural waste innovation and the dearth of innovation policy in Nigeria. Also, the finding from the semi-structured interview and questionnaire shared the same sentiment as the literature with a strong emphasis on government and non- availability to fund and grants for research purposes. Also, below are the highlight of factor that responsible for non-utilisation of agricultural waste as.
- Lack of private investors' interest in innovative approaches for managing agricultural wastes.
- Government support system.
- Complacency from the government due to its crude oil earnings.
- Traditional beliefs and culture.
- Lack of effective research and knowledge transfer and bad organisational structure.
- Lack of appropriate policies.
- No organisational framework amongst collaborating sectors.

The next subsection discussed the critical success factors that enable the improved utilisation of agricultural waste as building materials.

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6.3.3 Research Objectives 3

Having explored the literature on the factors responsible for the non-utilisation of agricultural waste as building materials. This subsection explored the relevant the critical success factors that enable the improved utilisation of agricultural waste, literature explored the factors that enable utilisation of agricultural waste as building material in construction, agricultural sectors and private and public organisation and this factors then further analysed to derive at CSFs that enables utilisation of agricultural waste as building material. These CSFs include government support for innovative approaches, private investors' interest in innovative approaches for managing agricultural waste, the government support system, complacency from the government due to crude oil earnings, traditional beliefs, effective research and knowledge transfer structures and the development of appropriate policies. With the establish critical success factors that enable the improved utilisation of agricultural waste as building materials the next subsection discusses the last two objectives which are development and validation of a collaborative innovation management framework that assists in the utilisation of agricultural waste as building materials.

6.3.4 Research Objectives 4 and 5

Objectives four of this thesis proposed a framework that provides a structured organisational level of involvement of all key stakeholder's organisations that would be involved in the process of assisting in the utilisation of agricultural waste for construction purposes. The first organisation identified to be involved in this process is the Government followed by Government ministries at the second stage, funding institutions at the third stage, research institutes at the fourth stage, and industries at the final stage in developing the collaborative innovation management (as a descending ladder) framework to assist in the successful utilisation of agricultural waste as building materials.

After the proposed framework developed, the researcher took a further step to validate the framework in terms of its significance and applicability to real-life practice, where validation questionnaire was designed and sent out to stakeholders within the field of agriculture, manufacturing, engineering and construction. The proposed framework was further validated using focus group of 8 professionals divided into two groups to rate the framework in terms of its comprehensiveness, user-friendliness, logic and flow, and its value-adding potential and

also asked to provide any additional comments on the above areas or to offer any general comments that might help to further improve the proposed framework. The responses achieved from the focus group were then analysed using the Relative Importance Index to determine the level of importance of each question asked and understand the quality of the validated framework.

6.4 General summary

Following the literature review and the analysis of the semi-structured interviews and questionnaire data, the findings were used to address the research question and meet objectives one, two and three. However, the key findings drawn from objectives indicates that various opportunities inherent in agricultural waste innovation. These include an increase to the employment rate, a reduction in the cost of imported foreign products for construction purpose, a reduction in the housing deficit by the provision of cheaper, readily accessible and sustainable building materials, and an improved and extended innovation system to encourage more innovation management programs.

The findings from both the literature and data analysis also revealed in the objectives that there are characteristics that define the organisational structure, culture, and framework. This includes the method of decision-making, namely whether decisions are made by a few senior managers (centralisation) or by many employees (decentralisation). It also includes the method of communication, whether top-down or lateral and the grouping of roles, tasks and functions, the number of management levels and the organisational capacity and size. Moreover, further characteristics include the span of control and whether this is considered narrow or wide, based on the number of people under the manager, and the line of authority in the company, as firms with rigid chains of command are understood to be more bureaucratic and centralised. Meanwhile, the factors affecting organisational structures include the organisational environment, human resources, the organisational strategy, and technology.

6.5 Research Question

This section presents the summary of the findings and analysis derived through the semi-structured interviews and a questionnaire survey to address the research question developed after the relevant literature had been reviewed and documented. This question was developed to understand the views of key stakeholders in Nigeria with a pivotal role in the implementation of the framework that aims to assist in the utilisation of agricultural waste for building materials. To address this question, qualitative data were collected through semi-structured interviews, and quantitative data were gathered via a questionnaire survey. The data analysed, and discussions are outlined in sections 4.3 through to 4.5.

In past years, agricultural waste has been used in Nigeria for many purposes, such as domestic and foundry uses, and mixed as additives for concrete; however, this has not been fully utilised for building construction purposes despite its suitability in developing a sustainable product for the construction industry. To understand the reason behind the non-utilisation of agricultural waste as building materials in Nigeria and how best this can be addressed, interviewees and questionnaire participants were asked questions, and below are a few key findings drawn from the data collected:

- There is little or no support from the Government and policymakers in the area of policymaking and regulations.
- Complacency exists amongst the Government and private investors towards the development of a standard innovation management framework that collaborates stakeholder in public and private sector for effective utilisation of agricultural waste as building material.
- Traditional beliefs and the culture of farmers and others about local material production act as impediments.
- No policies currently exist to support the usage of agricultural waste for building construction purposes.
- Inadequate or no funding is available from private and public fund providers.
- There is little to no research and development strategy in existence.

Further sub-question was raised about the best approach to enables and improve the utilisation of agricultural waste as building materials in Nigeria. The key findings drawn from the data collection indicate that:

- The Government should incentivise the public about the potential usage of agricultural waste for building construction purposes.
- The Government should develop research and development centres and provide adequate funding.
- The Government should develop an innovation management framework that supports the usage of agricultural waste for building construction purposes.
- There should be an improved approach to policy and planning.
- The Government should develop, amongst other initiatives, a national innovation system.

6.6 Research Contribution to Knowledge

Building construction is entirely dependent on materials in all forms. In the case of Nigeria's construction industry, these materials are often sourced from all over the world. For instance, Nigeria is one of the largest importers of stone-coated roofing tiles from New Zealand. This is not a problem when viewed on its own. However, when considered together with the continuing crash in the value of the local currency (the naira) relative to key foreign currencies and coupled with the extant foreign exchange controls in Nigeria, which makes it challenging to reliably source for forex required for the importation of raw materials, it becomes a pertinent problem. This is often the key reason for the high cost of building materials in Nigeria. Given this problem, this research has shown from the review of relevant literature that to achieve the usage of agricultural waste as building material there is a gap in the organizational structure on the process that leads to utilization and delivery of agricultural waste material for building construction purposes in Nigeria that needed to be addressed. This shows that economic sustainability through the usage of locally manufactured building construction material from agricultural waste in Nigeria still lacks organizational structure, awareness, the understanding, knowledge, innovation framework and system to deliver products for building construction purposes despite the availability and potential in

agricultural waste materials. Therefore, undertaking this research has helped to fill the gaps identified in the literature review and contribute to knowledge in both theory and practical.

6.6.1 Theoretical Contribution

The literature review revealed a gap in the organisational structure regarding the utilisation and delivery of agricultural waste materials for building construction purposes in Nigeria. This revealed that there is a high potential for agricultural waste products for Nigeria economic sustainability through the usage of locally manufactured building materials from agricultural waste in Nigeria. However, the system and structure to facilitate the usage lack organisational structure, awareness, a deeper understanding, knowledge, and innovation framework for the products for construction purposes. Therefore, this research has helped to fill the gaps identified in the literature review through the development of organisational innovation management framework to assist in the development of agricultural waste as building material. This framework is expected to benefit professionals and other stakeholders involved in waste management and other relevant fields.

Also, the research contributes to the general knowledge on innovation by extending both the innovation system and innovation management system in the area of engaging government to develop innovation management policies on using agricultural waste as construction material. This was achieved by broadening the arguments towards the establishment of an effection organisational innovation system. Moreover, the research also makes significant contributions to knowledge in the general area of waste management and the specific area of agricultural waste management by broadening and refining the existing body of literature in these areas. Also, this study has contributed to theoretical knowledge in the development of a theoretical innovation management framework that provides a source and reference document for future research. The achievement of the aim has also contributed to the further refinement of academic knowledge concerning innovation management frameworks for the utilisation of agricultural waste for construction purposes.

6.6.2 Practical Contribution

This research was undertaken to address the area of building material shortages in Nigeria and to offer alternative local sources to acquire building materials for construction purposes to reduce problems associated with the importation of expensive foreign building material in Nigeria. This expensive foreign material is one of the reasons for shortages of housing units in Nigeria, as this product is not affordable for the middle and lower class. Therefore, this research potentially contributes on a practical basis to the substantial reduction in the demand for forex (required for importing building materials) in Nigeria and to the significant savings for the Nigerian State through internal economic development. Furthermore, the development an effective collaborative innovation management framework that assists in the utilisation of agricultural waste as the raw material for building will be a significant step towards exploiting the potential that agricultural waste management holds for Nigeria's economy, especially for youth employment and sustainable development. This will help to broaden the knowledge and understanding of practitioners and other stakeholders on the delivery of economic sustainability and affordable materials production from agricultural waste, which thus helps to reduce the country's housing deficit. Another practical contribution is in the area of housing delivery, individual and private builders will easily have access to locally produced material at an affordable cost and most of these materials are made of green product that also enhances sustainable development and reduces global warming.

6.7 Recommendations

Drawing on the summaries of these findings, some key recommendations can also be suggested to improve future works (in terms of practice, policy, and study concerning the utilisation of agricultural waste as building materials. These recommendations are based on the overall findings of this research study, and are as follows:

I. All stakeholders in the delivery of agricultural waste materials for building construction purposes should consider the long term and overall benefits associated with the utilisation of agricultural waste for building construction purposes, and sustainable development and economic growth in Nigeria.

II. All the key players involved should endeavour to acquire adequate or additional knowledge to enhance their understanding and skills in the delivery of agricultural waste for construction purposes. For example, regular attendance at seminars, workshops, and other programs, which assist in the effective delivery of the required product.

III. Councils and agencies should gain a good understanding of what the Government's policy initiative on profitability is seeking to achieve, as this would enable them to focus their policies and practices on ways to enhance the use of agricultural waste as construction materials.

IV. Policymakers and regulatory bodies should put in place sustainability training programs to enable practitioners to acquire and enhance the sustainability knowledge and skills that will equip them to adequately deal with socio-economic sustainability issues on this product. Clients (both public and private sector) should also be encouraged to participate in such training programs to enhance their knowledge and awareness of the main components of agricultural waste for building construction purposes.

V. Legislation should be introduced to drive key players to adequately adapt and implement social and economic factors, which enhance the use of agricultural waste for construction purposes. Enforcing compliance with such legislation will enable and ensure key players to promote the social and economic sustainability factors in their regeneration policies and practices.

VI. Adequate funding/financial support should be made available for research and development institutes by both the private and public sector of the economy. Also, individuals should provide funding and finance to promote the socio-economic sustainability of agricultural waste innovation as building materials.

VII. Incentives and reward schemes should be introduced to encourage stakeholders, especially farmers and manufacturing industries, to give adequate priority to the adoption and implementation of the policies that encourage the utilisation of agricultural waste for construction purposes.

VIII. Policymakers and other regulatory bodies must give adequate support for all players to adopt systematic and well-structured innovation management processes to execute their sustainable product development programs.

6.8 Recommendations for future work

I. There are opportunities for future research studies to be conducted to further explore the level of involvement amongst key stakeholders in the utilisation of agricultural waste for building construction purposes; this would be particularly valuable at the four main levels of involvement.

II. The present study focused on the development of a collaborative innovation management framework to assist in the utilisation of agricultural waste for construction purposes in Nigeria. In future, the research methodology adopted for the present study could be employed to study how a collaborative innovation management framework could be adapted for the application to different contexts and countries.

III. Although selected industry practitioners validated the framework and the focus group, it is recommended that future studies look at how it could be applied in practice.

IV. The unit of analysis for the study focused on the utilisation of agricultural waste in the production of material for construction purposes in Nigeria. Future studies could also adopt a unit of analysis involving other waste that could be similarly utilised in the production of building materials in Nigeria.

6.9 Limitations of the study.

As with other research studies, there were limitations involved in the development of an innovative collaborative framework to assist in the utilisation of agricultural waste as building materials, although attempts were made to maintain an awareness of the limitation to minimise any negative effects on the research outcomes.

One of the limitations of this research is the limited access to stakeholders within the selected four sectors (i.e. Government agricultural, manufacturing and construction), even though there are so many stakeholders to be contacted. The reason for this was the restricted accessibility from the upper levels of the hierarchy of sectors which prompted this study to adopt a snowball sample method. Maybe another method would have offered more findings for the research. Also, it took almost 5 months before the focus group could be assembled because all the participant was not from the same organisation and the same area. With time constrain in mind on the project submission

Another limitation is conflict arising from cultural bias and other personal issues from some of the farmers which limit access to few farmers for the survey. Also, in the area of manufacturers, they are reluctant to express themselves in other to safeguard their businesses which I believe can explore more in future studies

REFERENCES

Abeysundara, U. Y., Babel, S., and Gheewala, S. (2009). A matrix in life cycle perspective for selecting sustainable materials for buildings in Sri Lanka. Building and environment, 44(5), 997-1004.

Abiola, R. and Oladele, R. (2000). Management Implications of Trends in the Construction Costs in Nigeria from 1989-1999. The Quantity Surveyor, 30, 35-40.

Aciu, C., and Cobîrzan, N. (2013). Use of agricultural products and waste in the building materials industry. 6(15).

Adedeji, Y. (2002). Achieving affordable housing in South-West Nigeria through Local building material. J. Environ. Technol, 1(2), 15-21.

Adedeji, Y. (2010). Technology and standardised composite cement fibres for housing in Nigeria. J. Niger. Inst. Archit, 1, 19-24.

Adenuga, O. A. (2013). Factors affecting quality in the delivery of public housing projects in Lagos State, Nigeria. International Journal of Engineering and Technology, 3(3), 332-344.

Adeoti, J. O. (2005). National innovation system and environmental sustainability of firms in Nigeria. Paper presented at the paper for Globelics Africa 2005 Conference, Tshwane University of Technology, South Africa.

Adner, R., and Kapoor, R. (2010). Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. 31(3), 306-333.

Adner, (2006). Match your innovation strategy to your innovation ecosystem. 84(4), 98.

Agamuthu, P. (2009). Challenges and opportunities in agro-waste management: An Asian perspective. Paper presented at the Inaugural Meeting of First Regional 3R Forum in Asia. Tokyo, Japan.

Agarwal et al., (2014). Management practices of Australian manufacturing firms: why are some firms more innovative? , 52(21), 6496-6517.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. 45(3), 425-455.

Aigbodion, V. et al., (2010). Development of asbestos-free brake pad using bagasse. 32(1), 12-17.

Akinlo, A. E. (2012). How important is oil in Nigeria's economic growth? Journal of sustainable Development, 5(4), 165.

Akinyemi, A. I., and Isiugo-Abanihe, U. C. (2014). Demographic dynamics and development in Nigeria. African Population Studies, 27(2), 239-248.

Akotia, J. K. (2014). A framework for social and economic sustainability benefits evaluation of sustainable regeneration projects in the UK. University of Salford,

Al-Marahleh, G. (2005). Production of light weight ceramics tiles from local materials. 2(2), 778-783.

Alston et al., (2010). The shifting patterns of agricultural production and productivity worldwide: Midwest Agribusiness Trade Research and Information Center.

Amaratunga, D. et al., (2002). Quantitative and qualitative research in the built environment: application of "mixed" research approach. 51(1), 17-31.

Amodu et al., (2007). Evaluation of pearl millet accession for yield and nutrient composition. 7(2), 379-383.

Andersson, K., Dickin, S., and Rosemarin, J., (2016). Towards" Sustainable" Sanitation: Challenges and Opportunities in Urban Areas. 8(12).

Anumba, C. J., Baugh, C., and Khalfan, M. M. (2002). Organisational structures to support concurrent engineering in construction. 102(5), 260-270.

Aprianti, E., Shafigh, P., Bahri, S., & Farahani, J. N. (2015). Supplementary cementitious materials origin from agricultural wastes–A review. Construction and Building Materials, 74, 176-187.

Arayela, O. (2005). Laterite Bricks: Before, now and hereafter.

Argote, L., Ingram, P., Levine, J. M., & Moreland, R. L. (2000). Knowledge transfer in organizations: Learning from the experience of others. 82(1), 1-8.

Arvanitis, S. (2008). Explaining innovative activity in service industries: Micro data evidence for Switzerland. Econ. Innov. New Techn., 17(3), 209-225.

Atkin, B., Winch, G., Slaughter, E., Slaughter, E., & Slaughter, E. (1999). Innovation in the Construction Sector. In Whitley, R, and Kristensen, 1996.

Atkin, B., Winch, G., Slaughter, E., Slaughter, E., & Slaughter, E. (2009). Innovation in the construction sector. In Whitley, R, and Kristensen, 196.

Aubert, J.-E. (2004). Promoting innovation in developing countries: a conceptual framework.

Ayedun, C., & Oluwatobi, A. (2011). Issues and challenges militating against the sustainability of affordable housing provision in Nigeria. 1(4), 1-8.

Bank, W. (2006). Enhancing agricultural innovation: how to go beyond the strengthening of research systems: World Bank.

Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. Journal of management, 27(6), 643-650.

Barrett, P., Abbott, C., Sexton, M., & Ruddock, L. (2007). Hidden innovation in the construction and property sectors. RICS Research paper series, 7(20), 1-21.

Becker, W., & Dietz, J. (2004). R&D cooperation and innovation activities of firms—evidence for the German manufacturing industry. 33(2), 209-223.

Bessant, J., Lamming, R., Noke, H., & Phillips, W. (2005). Managing innovation beyond the steady state. 25(12), 1366-1376.

Bevir, M. (2012). Governance: A very short introduction: OUP Oxford.

Bientema, N. M., & Stads, G.-J. (2005). Investing in Sub-Saharan African agricultural research: recent trends. Retrieved from

Blaikie, N. (2007). Approaches to social enquiry: Advancing knowledge: Polity.

Blayse, A. M., & Manley, K. (2004). Key influences on construction innovation. Construction Innovation, 4(3), 143-154.

Blayse, A. M., & Manley, K. (2004). Key influences on construction innovation. 4(3), 143-154.

Bogdanov, B., Markovska, I., Hristov, Y., Georgiev, D., & technology. (2012). Lightweight materials obtained by utilization of agricultural waste. 64.

Bosch-Sijtsema, P. M., & Postma, T. (2009). Cooperative innovation projects: Capabilities and governance mechanisms. 26(1), 58-70.

Bossink, B. (2004). Managing drivers of innovation in construction networks.

Brouwer, J., & Powell, J. (1998). Increasing nutrient use efficiency in West-African agriculture: the impact of micro-topography on nutrient leaching from cattle and sheep manure. 71(1-3), 229-239.

Bruce, J., Poobalan, A. S., and Smith, W. C (2004). Quantitative assessment of chronic postsurgical pain using the McGill Pain Questionnaire. 20(2), 70-75.

Burnley, S. J. (2007). A review of municipal solid waste composition in the United Kingdom. 27(10), 1274-1285.

Burton-Jones, A. (2001). Knowledge capitalism: Business, work, and learning in the new economy. OUP Catalogue.

Carayannis, E. G., & Campbell, D. F. (2009). 'Mode 3'and'Quadruple Helix': toward a 21st century fractal innovation ecosystem. 46(3-4), 201-234.

Chaiprasert, P. (2011). Biogas production from agricultural wastes in Thailand. 63-65.

Chan, A. P., Chan, D. W., Chiang, Y. H., Tang, B.-S., Chan, E. H., & Ho, K. S. (2004). Exploring critical success factors for partnering in construction projects. 130(2), 188-198.

Chandy, R. K., & Tellis, G. J. (2000). The incumbent's curse? Incumbency, size, and radical product innovation. Journal of marketing, 64(3), 1-17.

Chapman, S. D. (2002). Hosiery and knitwear: four centuries of small-scale industry in Britain, c. 1589-2000: Oxford University Press Oxford.

Cheney, G., Christensen, L. T., Zorn Jr, & Ganesh, S. (2010). Organizational communication in an age of globalization: Issues, reflections, practices: Waveland Press.

Cheng, E. W., Li, H., & Love, P. J. (2000). Establishment of critical success factors for construction partnering. 16(2), 84-92.

Chesbrough, H. (2003). Open innovation. In: Boston: Harvard Business School Press.

Chia, R. (2002). Philosophy and Research. 1.

Clark, K. B., & Fujimoto, T. (1991). Product development performance: Strategy, organization, and management in the world auto industry. 409.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. 13(1), 15-42.

Collis, J., & Hussey, R. (2013). Business research: A practical guide for undergraduate and postgraduate students: Macmillan International Higher Education.

Cooper, R. G. (1999). The invisible success factors in product innovation. 16(2), 115-133.

Cooper, R. G. J. M. (1999). The Invisible Success Factors in Product Innovation. 16, 115-133.

Costopoulos, N. G., & Newhouse, H. K. (1987). Building material manufacturing from fly ash. In: Google Patents.

Cox, A., & Thompson, I. (1997). Fit for purpose contractual relations: determining a theoretical framework for construction projects. European Journal of Purchasing and Supply Management, 3(3), 127-135.

Cox, A., & Townsend, M. (1998). Strategic procurement in construction: towards better practice in the management of construction supply chains: Thomas Telford Publishing.

Creswell, J., & Poth, C. (2017). Qualitative inquiry and research design: Choosing among five approaches: Sage publications.

Creswell, J. W. (2009). Research designs: Qualitative, quantitative, and mixed methods approaches.

Creswell, J. W., & Zhang, W. (2009). The application of mixed methods designs to trauma research. 22(6), 612-621.

Cummings, J. L., & Teng, B.-S. (2003). Transferring R&D knowledge: the key factors affecting knowledge transfer success. 20(1-2), 39-68.

Davenport, T. H. (1993). Process innovation: reengineering work through information technology: Harvard Business Press.

Davis, K. (2008). Extension in sub-Saharan Africa: Overview and assessment of past and current models, and future prospects. 15(3), 15-28.

Dew, N. J. (2007). Abduction: a pre-condition for the intelligent design of strategy. 28(4), 38-45.

Diaz III, J., & Hansz, A. (2007). Understanding the behavioural paradigm in property research. 13(1), 16-34.

Dobni, C. B. (2008). Measuring innovation culture in organizations: The development of a generalized innovation culture construct using exploratory factor analysis. 11(4), 539-559.

Dodgson, M., & Bessant, J. R. (1996). Effective innovation policy: International Thomson Business Press.

Drew, S. A. (2006). Building technology foresight: using scenarios to embrace innovation. European Journal of Innovation Management, 9(3), 241-257.

Drucker, P. F. (2002). The discipline of innovation. Harvard business review, 80, 95-104.

Duan, S., Fokoue, A., Srinivas, K., & Byrne, B. (2011). A clustering-based approach to ontology alignment. Paper presented at the International Semantic Web Conference.

Dubai, S. (2011). The role of government in supporting entrepreneurship & SME development.

Easterby-Smith, M., Golden-Biddle, K., & Locke, K. (2008). Working with pluralism: Determining quality in qualitative research. 11(3), 419-429.

Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2012). Management research: Sage.

Egan, J. (2002). Rethinking construction accelerating change-a consultation paper by the strategic forum for construction.

Egbu, C., Botterill, K., & Bates, M. (2001). The influence of knowledge management and intellectual capital on organizational innovations. Paper presented at the Proceedings of the 17th Annual Conference of the Association of Researchers in Construction Management (ARCOM).

Egbu, C., Sturges, J., & Gorse, C. (2000). Communication of knowledge for innovation within projects and across organisational boundaries. Paper presented at the Proceedings of the 15th International Project Management World Congress.

Ekboir, J. (2012). How to build innovation networks. 44-51.

Ekboir, J. M., Dutrénit, G., Martínez, G., Vargas, A. T., & Vera-Cruz, A. O (2009). Successful organizational learning in the management of agricultural research and innovation. 162.

Ekperiware, M. C., & Olomu, M. O. (2012). Effect of oil and agriculture on economic growth in nigeria.

Enweremadu, C., & Ojediran, J. (2004). Evaluation of energy potential in husks from soy-bean and cope.

Eriksson, P., & Kovalainen, A.,(2008). Qualitative research evaluation.

ESCAP, U. (2006). What is good governance.

Evbuomwan, B., Agbede, A., & Atuka, M. (2013). A comparative study of the physico-chemical properties of activated carbon from oil palm waste (kernel shell and fibre). 2(19), 75-79.

Ezeigwe, P. C. (2015). Evaluation of the causes of housing problems in Nigeria: a case study of Awka the capital city of Anambra State. 93.

Eziefula, U. (2018). Developments in utilisation of agricultural and aquaculture by-products as aggregate in concrete–a review. 7(1), 19-45.

Factbook, C. (2017). The world factbook. See also: https://www. cia. gov/library/publications/the-world-factbook.

Farr, J. L., & West, M. A. (1990). Innovation and creativity at work: Psychological and organizational strategies: Wiley.

Feder, G., Just, R. E., & Zilberman, D. J (1985). Adoption of agricultural innovations in developing countries: A survey. 33(2), 255-298.

Field, S., Kuczera, M., & Pont, B. (2007). Organisation for Economic Co-operation and Development (2007).

Firth, L., & Mellor, D. (1999). The impact of regulation on innovation. European Journal of Law and economics, 8(3), 199-205.

Fischer, M. D. (2008). An ethnographic study of turbulence in the management of personality disorders: An interorganisational perspective. Imperial College London,

Flikkema, M. J. (2008). Service Development and New Service Performance: A conceptual essay and a project-level study into the relationship between HRM practices and the performance of new services.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. 12(2), 219-245.

Forcada, N., Fuertes, A., Gangolells, M., Casals, M., & Macarulla, M. J. (2013). Knowledge management perceptions in construction and design companies. 29, 83-91.

Freeman, C. (1995). The 'National System of Innovation'in historical perspective. 19(1), 5-24.

Freeman, C., & Soete, L. (1997). The Economics of Industrial Innovation. Retrieved from

Freeman, C., (1995). The'National System of Innovation'in historical perspective. 19, 5-24.

Freitas, H., Oliveira, M., Jenkins, M., & Popjoy, O. (1998). The Focus Group, a qualitative research method. (010298), 22.

Fromhold-Eisebith, M. J. E. P. S. (2007). Bridging scales in innovation policies: How to link regional, national and international innovation systems. 15(2), 217-233.

Fund, I. M. (2017). Report for selected countries and subjects.

Ganiron Jr, T. U., Ucol-Ganiron, N., & Ganiron III, T. (2017). Recycling of waste coconut shells as substitute for aggregates in mix proportioning of concrete hollow blocks. 77(2), 107-123.

Gann, D. M., & Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: the construction of complex products and systems. Research policy, 29(7-8), 955-972.

Gleave, A. P. (1992). A versatile binary vector system with a T-DNA organisational structure conducive to efficient integration of cloned DNA into the plant genome. Plant molecular biology, 20(6), 1203-1207.

Glossop, C. (2008). Housing and economic development: Moving forward together: Housing Corporation.

Gnyawali, D. R., & Madhavan, R. (2001). Cooperative networks and competitive dynamics: A structural embeddedness perspective. Academy of Management review, 26(3), 431-445.

Gordon, C. M. (1994). Choosing appropriate construction contracting method. Journal of construction engineering and management, 120(1), 196-210.

Govindarajan, V., & Trimble, C. (2012). Reverse innovation: Create far from home, win everywhere: Harvard Business Press.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. Strategic management journal, 17(S2), 109-122.

Gulati, R., Nohria, N., & Zaheer, A. (2000). Strategic networks. Strategic management journal, 21(3), 203-215.

Hall, A. (2006). Public-private sector partnerships in an agricultural system of innovation: concepts and challenges. 5(1), 3-20.

Hall, A., Sulaiman, V. R., Clark, N., & Yoganand, B. (2003). From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. 78(2), 213-241.

Hall, K. D., Guo, J., Dore, M., & Chow, C. C. (2009). The progressive increase of food waste in America and its environmental impact. PloS one, 4(11), e7940.

Hansen, H., & Zöld, A. (2001). Ecobuild–Environmentally friendly construction and building.

Hanusch, H., & Pyka, A. (2007). Elgar companion to neo-Schumpeterian economics: Edward Elgar Publishing.

Hardie, M., & Newell, G. (2011). Factors influencing technical innovation in construction SMEs: an Australian perspective. Engineering, Construction and Architectural Management, 18(6), 618-636.

Hatch, M., & Cunliffe, A. J. O. T., 2nd ed., Oxford. (2006). A brief history of organization theory. 41.

Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. Administrative science quarterly, 9-30.

Ho, Y.-S., & Ofomaja, A. E. (2005). Kinetics and thermodynamics of lead ion sorption on palm kernel fibre from aqueous solution. 40(11), 3455-3461.

Hoang, P. (2011). Business & Management: Ibid Press.

Hodges, R. J., Buzby, J. C., & Bennett, B. (2011). Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. 149(S1), 37-45.

Homburg, C., & Pflesser, C. (2000). A multiple-layer model of market-oriented organizational culture: Measurement issues and performance outcomes. 37(4), 449-462.

Ibem, E. O., Anosike, M. N., & Azuh, D. E. (2011). Challenges in public housing provision in the post independence era in Nigeria. Journal of Human Sciences, 8(2), 421-443.

Ibhadode, A., & Dagwa, I. J. (2008). Development of asbestos-free friction lining material from palm kernel shell. 30(2), 166-173.

Ibironke, O. (2004). Building economics (Birnin-Kebbi, Nigeria: TimlabQuanticost).

Ihuah, P. (2015). Building materials costs increases and sustainability in real estate development in Nigeria. 4(3), 218-233.

Ijigah, E., Oloruntoba, K., & Mohd, H. (2012). Towards Accomplishing Millennium Development Goals (MDGs) In Abuja FCT Nigeria: The Project Management Consultants Roles,". International Journal of Research in Management & Technology, 414-424.

Inder, D., & Rivera, M. (2007). Scope creep-A lethal project disease thoughts on prevention and cure.

Iyer, B., & Davenport, T. (2008). Reverse engineering Google's innovation machine. 86(4), 58-68.

Iyoha, M. A., & Oriakhi, D. (2002). Explaining African economic growth performance: the case of Nigeria. Revised Interim Report on Nigerian Case Study, Prepared for the African Economic Research Consortium Research Project, Explaining African Economic Growth Performance.

Jackson, D. (2011). What is an innovation ecosystem. 1.

Javed, S. (2015). Impact of Top Management Commitment on Quality Management. 5(8).

Jekayinfa, S., & Omisakin, O. (2005). The energy potentials of some agricultural wastes as local fuel materials in Nigeria.

Jogaratnam, G. (2017). How organizational culture influences market orientation and business performance in the restaurant industry. 31, 211-219.

Johnson, J. W., & LeBreton, J. M (2004). History and use of relative importance indices in organizational research. 7(3), 238-257.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. 1(2), 112-133.

Jones, M., & Saad, M. (2003). Managing innovation in construction: Thomas Telford.

Kalu, C., Modugu, W., & Ubochi, I. (2009). Evaluation of solid waste management policy in Benin metropolis, Edo State, Nigeria. 10, 1-7.

Kam-Sing Wong, S. (2014). Impacts of environmental turbulence on entrepreneurial orientation and new product success. European Journal of Innovation Management, 17(2), 229-249.

Kamara, J. M., Augenbroe, G., Anumba, C. J., & Carrillo, P. M. (2002). Knowledge management in the architecture, engineering and construction industry. 2(1), 53-67.

Karjust, K., Kübarsepp, J., & Otto, T. (2019). Modern Materials and Manufacturing 2019 (MMM 2019, Baltic Conference).

Kaur, M., & Singh, J. (2015). Agricultural Waste Utilization in Civil Engineering. 170.

Kiessling, T., Isaksson, L., & Yasar, B. (2016). Market orientation and CSR: Performance implications. 137(2), 269-284.

Kilpatrick, D. (2000). Definitions of public policy and the law.

Kim, C., Kim, H., Han, S. H., Kim, C., Kim, M. K., & Park, S. H., (2009). Developing a technology roadmap for construction R&D through interdisciplinary research efforts. 18(3), 330-337.

Kissick, D., Leibson, D., Kogul, M., Bachmann, J., Anderson, J., & Eckert, J. (2006). Housing for all: essential to economic, social, and civic development. Paper presented at the prepared for the World Urban Forum III, Vancouver.

Klerkx, L., Hall, A., & Leeuwis, C. (2009). Strengthening agricultural innovation capacity: are innovation brokers the answer?

Klerkx, L., van Mierlo, B., & Leeuwis, C. (2012). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions.

Kline, S. J. (1985). Innovation is not a linear process. Research management, 28(4), 36-45.

Koetzier, W., & Schorling, C. (2013). Key Points to Consider when Developing an Innovation Strategy.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. Organization science, 3(3), 383-397.

Korres, G. M., (2013). The European national and regional systems of innovation. 85-98.

Kotler, P. (2002). Marketing places: Simon and Schuster.

Küçük, M., & Demirbaş, A. (1997). Biomass conversion processes. 38(2), 151-165.

Lawson, B., & Samson, D. (2001). Developing innovation capability in organisations: a dynamic capabilities approach. International journal of innovation management, 5(03), 377-400.

Litie Njie, T., Teku Fon, L., & Awomodu, G. (2008). Top management commitment and Empowerment of employees in TQM implementation.

Liu, H., Wang, M., Skibniewski, M. J., He, J., & Zhang, Z. J. F. o. E. M. (2014). Identification of critical success factors for construction innovation: From the perspective of strategic cooperation. 1(2), 202-209.

Lundvall, B.-A. (1985). Product innovation and user-producer interaction. 19.

Lundvall, B.-Å. (1992). User-producer relationships, national systems of innovation and internationalisation. In National systems of innovation: Towards a theory of innovation and interactive learning (pp. 45-67): Frances Pinter Publishers Ltd.

Lundvall, B.-Å. (2010). National systems of innovation: Toward a theory of innovation and interactive learning (Vol. 2): Anthem press.

Lundy, M., Le Borgne, E., Birachi, E. A., Cullen, B., Boogaard, B., Adekunle, A., & Victor, M. (2013). Monitoring innovation platforms.

Macdonald, S., & Headlam, N. (2008). Research Methods Handbook: Introductory guide to research methods for social research: Centre for Local Economic Strategies.

Madurwar, M. V., Mandavgane, S. A., & Ralegaonkar, R. (2014). Development and feasibility analysis of bagasse ash bricks. 141(3), 04014022.

Madurwar, M. V., Ralegaonkar, R. V., & Mandavgane, S. (2013). Application of agro-waste for sustainable construction materials: A review. 38, 872-878.

Mahoney, J. T., & Pandian, J. R. (1997). The Resource-Based View Within the Conversation of Strategic Management. Resources, Firms, and Strategies: A Reader in the Resource-based Perspective, 204.

Makinde, O. O. (2014). Housing delivery system, need and demand. 16(1), 49-69.

Manley, K. (2008). Implementation of innovation by manufacturers subcontracting to construction projects. Engineering, Construction and Architectural Management, 15(3), 230-245.

March-Chorda, I., Gunasekaran, A., & Lloria-Aramburo, B. (2002). Product development process in Spanish SMEs: an empirical research. 22(5), 301-312.

Martin, J. F., Pineda, R. M. A., Manaay, J. A., Handa, S. R. A., & Ocreto, A. B. (2008). Design and development of charcoal briquetting machine. 16(2), 85-90.

Martinez-Moyano, I. (2006). Exploring the dynamics of collaboration in interorganizational settings. 4, 69.

Mattessich, P. (2005). Collaboration: What Makes It Work.

Maxamadumarovich, U. A., Obrenovic, B., & Amonboyev, M. J., (2012). Understanding the innovation concept. 3(3), 19-26.

McDonough, J., & McDonough, S. (2014). Research methods for English language teachers: Routledge.

Messick, D. M., & Mackie, D. M. (1989). Intergroup relations. 40(1), 45-81.

Metz, H. C. (2009). Aera Handbook Series: Nigeria-A Country Study.

Mezzourh, S., & Nakara, W. A. (2012). New Business Ecosystems and Innovation Strategic Choices in SMEs.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). Qualitative Data Analysis: A Methods Sourcebook.

Minghua, Z., Xiumin, F., Rovetta, A., Qichang, H., Vicentini, F., Bingkai, L., . . . Yi, L. (2009). Municipal solid waste management in Pudong new area, China. 29(3), 1227-1233.

Mintzberg, H. (1979). An emerging strategy of" direct" research. 24(4), 582-589.

Mintzberg, H. (1989). The structuring of organizations. In Readings in Strategic Management (pp. 322-352): Springer.

Mogbo, T. (2001). The construction sector and the economic growth of Nigeria, 1981–95. The Quantity Surveyor, 35, 8-11.

Morgan, D. L. (2013). Focus Groups as Qualitative Research.

Mortensen, P. S., & Bloch, C. W. (2005). Oslo Manual-Guidelines for Collecting and Interpreting Innovation Data: Proposed Guidelines for Collecting and Interpreting Innovation Data: Organisation for Economic Cooporation and Development, OECD. 32-76

Mukhtar, M. M., Amirudin, R., & Mohamad, I. J.,(2016). Housing delivery problems in developing countries: a case study of Nigeria.

Nam, C. H., & Tatum, C. B. (1997). Leaders and champions for construction innovation. Construction Management & Economics, 15(3), 259-270.

Nam, C. H., & Tatum, C. B., (1997). Leaders and champions for construction innovation. 15(3), 259-270.

Naoum, S. (2012). Dissertation research and writing for construction students: Routledge.

Nations, U. (2013). World Population Ageing 2013. In: United Nations Publ.

Nelson, R. R. (2013). National Innovation Systems: It is. In Regional Innovation And Global (pp. 19-34): Routledge.

Nigeria, F. G. o. (2009). Report of the Vision 2020 National Technical Working Group on Housing. In: FGN Abuja.

Nonaka, I., & Takeuchi, H. (1996). The knowledge-creating company: How Japanese companies create the dynamics of innovation. Long range planning, 4(29), 592.

Nwachukwu, C., & Emoh, F. (2010). Project management indexes: a policy thrust to the realization of vision 2020 in housing construction and development in Nigeria. 2(7), 37-60.

Obi, F., Ugwuishiwu, B., & Nwakaire, J. (2016a). Agricultural waste concept, generation, utilization and management. 35(4), 957–964.

Obi, F., Ugwuishiwu, B., & Nwakaire, J. (2016b). Agricultural waste concept, generation, utilization and management. Nigerian Journal of Technology, 35(4), 957–964.

Obi, F., Ugwuishiwu, B., & Nwakaire, J., (2016c). Agricultural waste concept, generation, utilization and management. 35(4), 957–964.

OECD. (2002). Frascati manual 2002: Proposed standard practice for surveys on research and experimental development: OECD.

Ogunlana, S. O., Promkuntong, K., & Jearkjirm, V. J. (1996). Construction delays in a fast-growing economy: comparing Thailand with other economies. 14(1), 37-45.

Ogunsemi, D. (2013). The use of enough quality and quantity materials for building a durable edifice. A Lecture delivered at Campus Transformation Network, Federal University of Technology, Akure.

Ogunwusi, A. (2013). Green investments required in the forest products industry in Nigeria. 3(3), 51-63.

Ogunwusi, A. J. C., & Research, E. (2014). Agricultural waste pulping in Nigeria: Prospects and challenges. 6(10), 101-110.

Ohuocha, C. (2014). Nigeria surpasses South Africa as continent's biggest economy. In: Reuters.

Okafor, F. O. J. C., & Research, C. (1988). Palm kernel shell as a lightweight aggregate for concrete. 18(6), 901-910.

Okereke, P. (2003). Construction Materials: Testing and Quality Control in Tropical Climate. Owerri, Nigeria: Crown Publishers Ltd.

Okhuysen, G. A., & Bechky, B. A. (2009). 10 coordination in organizations: An integrative perspective. 3(1), 463-502.

Okoroigwe, E., & Saffron, C. (2012). Determination of bio-energy potential of palm kernel shell by physicochemical characterization. 31(3), 329–335.

Oladeji, J. J., & Technology. (2012). Comparative study of briquetting of few selected agro-residues commonly found in Nigeria. 13(2), 80-86.

Oladipo, F., & Oni, O. (2012). Review of Selected Macroeconomic Factors Impacting Building Material Prices in Developing Countries–A Case Of Nigeria. Ethiopian Journal of Environmental Studies and Management, 5(2), 131–137.

OLADIRAN, O. (2015). Investigating the Use of Local Materials for Building Construction. Journal of Sustainable Technology, 6(2).

Olanipekun, E., Olusola, K., & Ata, O. J. (2006). A comparative study of concrete properties using coconut shell and palm kernel shell as coarse aggregates. 41(3), 297-301.

OLAWUMI, O. R., & OYEWOLE, A. O. (2018). Public expenditure on agriculture and output growth in nigeria.

Oliver, C. (1990). Determinants of interorganizational relationships: Integration and future directions. 15(2), 241-265.

Olutoge, F. A., Quadri, H. A., & Olafusi, O. S. (2012). Investigation of the strength properties of palm kernel shell ash concrete. 2(6), 315-319.

Onuah, F. (2007). Nigeria gives census result, avoids risky details. Reuters. In.

Ortt, J. R., & van der Duin, P. A. (2008). The evolution of innovation management towards contextual innovation. 11(4), 522-538.

Ozmel, U., Yavuz, M. D., Gulati, R., & Trombley, T. E. (2016). The Effect of Inter-firm Ties on Performance in Financial Markets.

Ozorhon, B., Abbott, C., Aouad, G., & Powell, J. (2010). Innovation in construction: A project life cycle approach. Salford Centre for Research and Innovation in the Built Environment (SCRI) Research Report, 4, 903-1012.

Ozorhon, B., Abbott, C., & Aouad, G., (2013). Integration and leadership as enablers of innovation in construction: Case study. 30(2), 256-263.

Ozorhon, B., Karatas, C. G., & Demirkesen, S. J., (2014). A web-based database system for managing construction project knowledge. 119, 377-386.

Padilla-Pérez, R., & Gaudin, Y. J., (2014). Science, technology and innovation policies in small and developing economies: The case of Central America. 43(4), 749-759.

Pallant, J. (2010). SPSS Survival Manual, 4th edn, Maidenhead. In: Open University Press.

Pappu, A., Saxena, M.,& Asolekar, S., (2007). Solid wastes generation in India and their recycling potential in building materials. 42(6), 2311-2320.

Patel, P., & Pavitt, K. (1994). National innovation systems: why they are important, and how they might be measured and compared. 3(1), 77-95.

PAVITT, K. J. R. P. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory. 13, 343-373.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. Strategic management journal, 14(3), 179-191.

Pinto, J. K., & Covin, J. G. J. T. (1989). Critical factors in project implementation: a comparison of construction and R&D projects. 9(1), 49-62.

Porter, M. E. (1998). Clusters and the new economics of competition (Vol. 76): Harvard Business Review Boston.

Preissl, B. (2000). Service innovation: what makes it different? Empirical evidence from Germany. In Innovation systems in the service economy (pp. 125-148): Springer.

Prodan, M., Lupu, C., Nălboc, I., Szollosi-Moța, A., & Munteanu, C. (2017). Microelements influence on coal oxidation and the environmental pollution implications. environmental engineering & management journal (eemj), 16(6).

Rahman, S. H. A., Endut, I. R., Faisol, N., Paydar,(2014). The importance of collaboration in construction industry from contractors' perspectives. 129, 414-421.

Rajalahti, R., Janssen, W., & Pehu, E. (2008). Agricultural innovation systems: From diagnostics toward operational practices: Agriculture & Rural Development Department, World Bank.

Raut, S., Ralegaonkar, R., & Mandavgane, S. (2011). Development of sustainable construction material using industrial and agricultural solid waste: A review of waste-create bricks. 25(10), 4037-4042.

Ravitch, S. M., & Riggan, M. (2016). Reason & rigor: How conceptual frameworks guide research: Sage Publications.

Reichstein, T., Salter, A. J., & Gann, D. M. (2005). Last among equals: a comparison of innovation in construction, services and manufacturing in the UK. Construction Management and Economics, 23(6), 631-644.

Remenyi, D., Williams, B., Money, A., & Swartz, E. (1998). Doing Research in Business and Management: An Introduction to Process and Method: SAGE.

Report, F. (2008). The State of Food and Agriculture. Biofuels: Prospects, Risks and Opportunities.

Rivera-Huerta, R., Dutrénit, G., Ekboir, J. M., Sampedro, J. L., & Vera-Cruz, A. O., (2011). Do linkages between farmers and academic researchers influence researcher productivity? The Mexican case. 40(7), 932-942.

Rogelberg, S. G., & Stanton, J. M. (2007). Introduction: Understanding and dealing with organizational survey nonresponse. In: Sage Publications Sage CA: Los Angeles, CA.

Rogers, E. M. (1995). Diffusion of Innovations: modifications of a model for telecommunications. In Die diffusion von innovationen in der telekommunikation (pp. 25-38): Springer.

Rohrbeck, R., Hölzle, K., & Gemünden, H. G,(2009). Opening up for competitive advantage– How Deutsche Telekom creates an open innovation ecosystem. 39(4), 420-430.

Rubens, N., Still, K., Huhtamäki, J., & Russell, M. G., (2011). A Network Analysis of Investment Firms as Resource Routers in Chinese Innovation Ecosystem. 6(9), 1737-1745.

Rumelt, R. J. M. Q. (2011). The perils of bad strategy. 1(3).

Rutten, M. E., Dorée, A. G., & Halman, J. I. (2009). Innovation and interorganizational cooperation: a synthesis of literature. Construction Innovation, 9(3), 285-297.

Sabiiti, E., Bareeba, F., Sporndly, E., Tenywa, J., Ledin, S., Ottabong, E., . . . Drake, L. (2004). Urban market garbage: a hidden resource for sustainable urban/peri-urban agriculture and the environment in Uganda.

Sabiiti, E. N. (2011). Utilising agricultural waste to enhance food security and conserve the environment. 11(6).

Samila, S., & Sorenson, O. (2010). Venture capital as a catalyst to commercialization. 39(10), 1348-1360.

Samila, S., & Sorenson, O. J. R. P. (2010). Venture capital as a catalyst to commercialization. 39(10), 1348-1360.

Sarantakos, S. (2012). Social Research: Macmillan International Higher Education.

Sarantakos, S. (2013). Social research . Cape Town. In: South Africa: Palgrave Macmillan.

Saunders, M. (2012). Choosing Research Participants. 35.

Saunders, M., & Lewis, P. (2012). Doing research in business & management: An essential guide to planning your project: Pearson.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students: Pearson education.

Saunders, M. N., & Lewis, P. (2012). Doing research in business & management: An essential guide to planning your project: Pearson.

Schlager, E. (2007). A comparison of frameworks, theories, and models of policy processes. 2, 293-319.

Schumpeter, J. A. (1934). The Theory of Economic Development (translation of second German edition by Redvers Opie). Cambridge, MA, Harvard University.

Seaden, G., & Manseau, A. (2001). Public policy and construction innovation. Building Research & Information, 29(3), 182-196.

Sexton, M. (2003). A supple approach to exposing and challenging assumptions and path dependencies in research. Paper presented at the 3rd International Postgraduate Research Conference.

Sexton, M., & Barrett, P. (2003). A literature synthesis of innovation in small construction firms: insights, ambiguities and questions. Construction Management and Economics, 21(6), 613-622.

Shane, J. S., Molenaar, K. R., Anderson, S., & Schexnayder, C. (2009). Construction project cost escalation factors. 25(4), 221-229.

Sheil, D., Casson, A., Meijaard, E., Van Noordwijk, M., Gaskell, J., Sunderland-Groves, J., . . . Kanninen, M. (2009). The impacts and opportunities of oil palm in Southeast Asia: What do we know and what do we need to know? (Vol. 51): Center for International Forestry Research Bogor, Indonesia.

Skibniewski, M. J., & Zavadskas, E. K.(2013). Technology development in construction: a continuum from distant past into the future. 19(1), 136-147.

Slaughter, E. S. (2000). Implementation of construction innovations. Building Research & Information, 28(1), 2-17.

Somsuk, N., Srithongkul, K., Wessapan, T., & Teekasap, S. (2008). Design and Fabricate a Low Cost Charcoal Briquette Machine for the Small and Micro Community Enterprises. Paper presented at the CDAST2008 Conference, Pitsanulok, Thailand.

Sonnino, A., Dhlamini, Z., Santucci, F. M., & Warren, P. (2009). Socio-economic impacts of non-transgenic biotechnologies in developing countries: the case of plant micropropagation in Africa: Food and Agriculture Organization of the United Nations (FAO).

Spielman, D., (2005). Innovation systems perspectives on developing-country agriculture: A critical review.

Sridach, W. (2010). The environmentally benign pulping process of non-wood fibers. Suranaree Journal of Science & Technology, 17(2).

Stanley, C. U., Ogbuagu, G. O., & Okechukwum F. E. (2014). An Appraisal of the Sources, Quantities and Prices of Imported Building Materials in Nigeria. International Journal, 2(9), 871-889.

Subbiah, A. (2012). An investigation of the factors influencing the success of construction planning for the 2012 Olympic stadium: An ethnographic study. Paper presented at the Proceedings of the 28th Annual ARCOM Conference.

Suberu, R. T. (1991). state and local government reorganizations in Nigeria. Ibadan& Bordeaux: IFRA/CEAN,(Trauvaux et Documents No. 41) 40pp. ISSN, 298, 8879.

Sujauddin, M., Huda, S., & Hoque, A. R. (2008). Household solid waste characteristics and management in Chittagong, Bangladesh. 28(9), 1688-1695.

Sumathi, S., Chai, S., & Mohamed, A. J., (2008). Utilization of oil palm as a source of renewable energy in Malaysia. 12(9), 2404-2421.

Sundbo, J., & Gallouj, F. (2000). Innovation as a loosely coupled system in services. International Journal of Services Technology and Management, 1(1), 15-36.

Sunding, D., & Zilberman, D. (2001). The agricultural innovation process: research and technology adoption in a changing agricultural sector. 1, 207-261.

Taiwo, A., & Adeboye, A. (2013). Sustainable Housing Supply in Nigeria Through the Use of Indigenous and Composite Building Materials. Civil and Environmental Research, 3(1).

Tassey, G. J.,(2010). Rationales and mechanisms for revitalizing US manufacturing R&D strategies. 35(3), 283-333.

Taylor-Bianco, A., & Schermerhorn Jr, J. (2006). Self-regulation, strategic leadership and paradox in organizational change. 19(4), 457-470.

Taylor, S. S., Fisher, D., & Dufresne, R. L. (2002). The aesthetics of management storytelling: a key to organizational learning. 33(3), 313-330.

Teddlie, C., & Tashakkori, A. (2009). Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences: Sage.

Thum-Thysen, A., Voigt, P., Bilbao-Osorio, B., Maier, C., & Ognyanova, D. (2017). ECONOMY.

Tidd, J. (2001). Innovation management in context: environment, organization and performance. International Journal of Management Reviews, 3(3), 169-183.

Tidd, J., Bessant, J., & Pavitt, K. (2005). Managing innovation integrating technological, market and organizational change: John Wiley and Sons Ltd.

Tolbert, P. S., & Hiatt, S. R. (2009). On organizations and oligarchies: Michels in the twenty-first century.

Toole, T. M., Chinowsky, P., & Hallowell, M. R. (2010). A tool for improving construction organizations' innovation capabilities. Paper presented at the Construction Research Congress 2010: Innovation for Reshaping Construction Practice.

Toor, S., & Ogunlana, S. (2005). What is crucial for success: Investigating the critical success factors and key performance indicators on mega construction projects. Paper presented at the Singapore Project Management Institute Annual Symposium.

Tumuhairwe, J. B., Tenywa, J. S., Otabbong, E., & Ledin, S. (2009). Comparison of four low-technology composting methods for market crop wastes. Waste Management, 29(8), 2274-2281.

Tunji-Olayeni, P. (2008). Factors affecting cost of construction in Nigeria.

Tunji-Olayeni, P., Lawal, P. O., & Amusan, L. M., (2012). Developing infrastructure in Nigeria: Why is the cost so high. 3(11), 257-262.

Ugwu, K., & Agbo, K. J.,(2013). Evaluation of binders in the production of briquettes from empty fruit bunches of Elais guinensis. 2(4), 176-179.

Usman, N., Said, I., & Yahaya, A. Z. (2012). Indolent Disposition towards ICT acceptance among practising Quantity Surveyors in Nigeria. Acta Technica Corviniensis-Bulletin of Engineering, 5(2), 75.

Van der Panne, G., Van Beers, C., & Kleinknecht, A. J., (2003). Success and failure of innovation: a literature review. 7(03), 309-338.

Van Teijlingen, E. (2014). Semi-structured interviews. Paper presented at the PGR Workshop December.

Veshosky, D. (1998). Managing innovation information in engineering and construction firms. Journal of Management in Engineering, 14(1), 58-66.

Von Zedtwitz, M., & Gassmann, O. (2002). Market versus technology drive in R&D internationalization: four different patterns of managing research and development. 31(4), 569-588.

Wan, D., Ong, C. H., & Lee, F. J, (2005). Determinants of firm innovation in Singapore. 25(3), 261-268.

Watanabe, C., & Fukuda, K. (2006). National innovation ecosystems: the similarity and disparity of japan-us technology policy systems toward a service oriented economy. 6(1).

Wathne, K., Roos, J., & Von Krogh, G. (1996). Towards a theory of knowledge transfer in a cooperative context. Managing Knowledge-Perspectives on cooperation and competition, 55-81.

Wiklund, J., & Shepherd, D. (2003). Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. Strategic management journal, 24(13), 1307-1314.

Winch, G. M. (2003). How innovative is construction? Comparing aggregated data on construction innovation and other sectors–a case of apples and pears. Construction Management and Economics, 21(6), 651-654.

Worldometers, W. (2017). Nigeria Population. Retrieved fromwww. worldometers. info/world-population/nigeria-population/[12.082015].

Yakub, A., Salawu, A., & Gimba, S. (2012). Housing delivery via housing cooperatives as a tool towards achieving national development; An empirical study In S. Paper presented at the Laryea, SA Agyepong, R. Leiringer, and W. Hughes,(Eds.) Procs 4th West Africa Built Environment Research (WABER) Conference.

Yang, M.-L., Wang, A. M.-L., & Cheng, K.-C. J. T. (2009). The impact of quality of IS information and budget slack on innovation performance. 29(8), 527-536.

Yanqi, H., & Hongling, W. (2010). Characteristics of Agricultural Biotechnology R&D in Canada and the Enlightenment to Our Country. 14, 016.

Yin, R. (2003). Design and methods. 3.

Yin, R. (2014). Case study research: design and methods 5th ed.

Yin, R. K. (1994). Discovering the future of the case study. Method in evaluation research. 15(3), 283-290.

Yin, R. K. (2009). Case study research: Design and methods. Sage publications.

Yin, R. K. (2017). Case study research and applications: Design and methods: Sage publications.

Yusof, N. A. B., Shafiei, M. W. M., Said, I., & Abidin, N. Z. (2010). Factors influencing firms'readiness towards innovation in house building industry: a multi-dimensional construct. international journal of organizational innovation, 2(3).

Zainal, Z. (2007). Case study as a research method.

Zwikael, O. J. (2009). Critical planning processes in construction projects. 9(4), 372-387.

APPENDIXES

APPENDIX A: College Ethics Panel - Ethical Approval Form for Post-Graduates

A PGR is defined as anyone undertaking a Research rather than a Taught master's degree, and includes for example MSc by Research, MRes by Research, MPhil, and PhD. The student must discuss the content of the form with their dissertation supervisor who will advise them about revisions. A final copy of the summary will then be agreed, and the student and supervisor will 'sign it off'.

The signed Ethical Approval Form and application checklist must be forwarded to your College Support Office and, an electronic copy MUST be e-mailed to the contacts below at your College Support Office.

CASS: Deborah Woodman – d.woodman@salford.ac.uk

CHSC: Jill Potter - j.potter@salford.ac.uk

          Rachel Shuttleworth - r.shuttleworth@salford.ac.uk

CST: Nathalie Audren-Howarth –n.audren@salford.ac.uk

The forms are processed online therefore without the electronic version, the application cannot progress. Please note that the form must be signed by **both the student and supervisor**.

Please refer to the 'Notes for Guidance' if there is doubt whether ethical approval is required

The form can be completed electronically; the sections can be expanded to the size required.

Name of Student: ODEWOLE ABOLADE

Name of Supervisor: PROF. CARL ABBOTT and Dr. CHUKA UDEAJA

School: Built Environment (SoBE)

Course of study: PHD full time

Name of Research Council or other funding organisation (if applicable):

1a. Title of proposed research project

The Development of a Collaborative Innovation Management Framework to Assist in the Utilisation of Agricultural Waste as Building Material in Nigeria.

1b. Is this Project Purely literature based?

NO

2. Project focus

The research will focus on developing a framework to facilitate the awareness introduction and implementation of innovation of agricultural waste as building material in Nigeria construction industry.

3. Project objectives

> (i) 1.   To critically review relevant literature on innovation and innovation management approaches in the context of the agricultural sector and construction industry.

(ii) To critically investigate the benefits associated with the utilization of agricultural waste as building materials in Nigeria.

(iii) To critically explore the factors responsible for the non-utilisation of agricultural waste as building materials in Nigeria.

(iv) To establish the critical success factors which enable the improved utilisation of agricultural waste as building materials in Nigeria.

(v) To develop a collaborative innovation management framework that assists in the utilisation of agricultural waste as building material

(vi) To validate the developed collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials.

4.   **Research strategy**

(For example, outline of research methodology, what information/data collection strategies will you use, where will you recruit participants and what approach you intend to take to the analysis of information / data generated)

The research will adopt the case study research strategy within which it will employ research methods/techniques such as questionnaire survey, observation and interviews in different region in Nigeria where there are abundant of agricultural waste deposit i.e. Southwest, Southeast and South region of Nigeria for data collection and analysis of the traditional, cultural and contemporary identity and believe about agricultural waste usage for construction material. As pointed out by (Yin, 1994) when focusing on contemporary phenomena, the case study method will emerge as the most suitable research strategy.

Within the case study areas in Nigeria, the questionnaires and interviews methods will be adopted. While questionnaires with the local people and professionals will be carried out through online and hand in tools such as Survey and mails, the interviews and observation sessions are organized by the researcher with the professional staff from the public and private organizations within the case study areas. The interviews will be carried out in a semi-structured mode.

5.   **What is the rationale which led to this project?**

(For example, previous work – give references where appropriate. Any seminal works must be cited)

The cost of building materials used in construction industry worldwide takes up to 45% proportion of the total construction cost. The building material cost to be use in any building project must be properly estimated before the commencement of the project. However, without proper planning, controlling of the flow and usage of the materials when the project is on-going may possibly increase the construction material cost. In view of that, this research aims to develop a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials in Nigeria. The innovated material will replace the high cost material; therefore, reduce the cost of building construction project.

This study envisages to research on process of managing innovation from agricultural waste into a low-cost building construction material. Furthermore, agricultural waste has been proved to as suitable sustainable resources for the production of building construction material to achieve reduction in construction costs, reducing dependence on higher-cost alternatives. When the innovation is managed and implemented it is expected to be affordable building material for economically disadvantaged communities and help to improve rudimentary living conditions. Innovation management of agricultural waste stream produces positive environmental side effects since waste incineration and considerable air pollution is avoided. Therefore, the managed building material is expected to provide a tangible contribution to reducing the estimated deficit of 17 million low-cost dwellings in Nigeria. (Unpublished Agu,2009)

Ironically, with Nigerian population of over 170 million population in 2013 and shortage of 17milllion low cost housing deficit in urban area, not to consider the recently claimed by The Deputy Governor, Financial System Stability, of the Central Bank of Nigeria, that about 63 million Nigerians are not living in proper houses due to under-development in the housing sector. Some of the challenges of poor housing development in Nigeria include poor incentives for the provision of affordable housing, inadequate budgetary allocation, and

prevalence of unskilled local personnel, economy recession, artisans in the building industry, poor land administration, non-availability and high cost of building materials. There is a great need for innovation of low cost, sustainable building material that is affordable to them. Urban and rural dwellers to reduce the shortage of housing and construction cost in Nigeria. (Source Channel News Nigeria, 2009)

Recently, research has shown significant usage of agricultural waste for Biogas productions to generate energy for industries, briquette as charcoal, active carbon for purification of water, and brake pads for automobile industries, with little research on innovation management of agricultural waste into a sustainable building construction material. In addition, utilisation and innovation of agricultural waste can significantly reduce the amount of pollution entering the air and water and keeps waste out of incinerators, which can pollute the air and create ash residue.

According to Tidd et al,2009, usage of products made from other material other than waste have wasted taxpayers' money, cost consumers more, both at the point of purchase and by limiting product options and dampened the development of resource-saving technological innovations. Furthermore, technologies have made it possible to use resources without danger of wearing them out. And as for the space necessary to dispose of solid waste by traditional methods, garbage generated at current rates for the next 1,000 years could be contained in a landfill just 100 yards deep and 35 miles square. Agricultural waste is expected to solve the challenge of high cost of building construction material problems in Nigeria. Using methods such as eco-industrial innovation and product design that can be produced through CNC machine. All this approach must follow a well-structured framework and guidance to be able to achieve the expected result.

By implementing the expected framework and guidance, it is assumed that agricultural waste making it to our landfills or the ones that is creating environmental nuisance littering around farmlands will be greatly eliminated and reduce cost of building construction material. This research is expected to help waste management agencies to focus more energy and time studying how agricultural waste will not make it to landfills anymore but make it to factories. An innovative conscience society can preserve the earth for many generations to come, when aim and objectives of managing innovation of agricultural waste into building construction material is achieved

6.   **If you are going to work within a particular organisation do, they have their own procedures for gaining ethical approval**

(For example, within a hospital or health centre?)

NO meet *their requirements?*

Are you going to approach individuals to be involved in your research?

YES

If YES – please think about key issues – for example, how you will recruit people? How you will deal with issues of confidentiality / anonymity? Then make notes that cover the key issues linked to your study

8. More specifically, how will you ensure you gain informed consent from anyone involved in the study?

The requirements of any individuals involved will be met by the following methods:

- Data security
    - All the data in a soft form will be kept in a password protected form. All the hard copies will be kept in a locked cabinet that will only be accessible to the researcher alone.
- Anonymity
    - All the participants will remain anonymous. At no point in this research will the identity be revealed to anyone regarding the participant. The participant identity is not required in the research instrument
- Informed Consent
    - There is a cover letter that will be provided when the participants are initially approached. They will have to sign the cover letter and give a copy back to the candidate.
- Voluntary

    All the participants will be informed that there is no pressure on them to participate. They are doing so completely voluntarily and may choose to

withdraw at any time. (Answer the question on how I intent to approach participant.)

Before any questionnaires that are being distributed and before the interviews, there will be a cover letter that will clearly state: the purpose of data collection; the process of data collection; how will the data be used; what measures are in place to ensure data security; when will the data be destroyed; the scenario of them changing their minds and deciding to withdraw from this study.

Participants will be asked to sign the consent section of the cover letter and return it to the researcher.

9. How are you going to address any Data Protection issues?

See notes for guidance which outline minimum standards for meeting Data Protection issues

10. Are there any other ethical issues that need to be considered? For example - research on animals or research involving people under the age of 18.

NO

11.(a) Does the project involve the use of ionising or other type of "radiation"

NO

(b) Is the use of radiation in this project over and above what would normally be expected (for example) in diagnostic imaging?

NO

To protect the individual's confidentiality, the following strategies will be applied:

- Each participant will be given a unique 'research code' that is known only by the researcher. This code is for ensuring the identity of the respondent remains anonymous and confidential.

- Participant details will be stored in password-protected files in a password-protected computer that can only be accessed by the researcher.

- Data collected, and data stored will also be protected using Data encryption called public key encryption to safeguard the data from intruder as only researcher would have means od decoding the data.

- The data from the interviews and questionnaires will be coded for the purpose of anonymity. The hard copy data will be stored in a locked filing cabinet within a locked room. The cabinet can be accessed only by the researcher.

- The soft copy data will be stored in a password-protected computer, accessed only by the researcher. Also, all data will be backed up and stored in another safe place in case of losing any piece of data i.e. in mobile storage (USB memory stick, or USB hard drive), where the identity of the respondent will be in 'research code' to maintain anonymity. The soft copy data files will also be password protected.

- All publications of data will be presented in a way so as to disguise the research participants.

- Data will be stored and archived for a minimum of 1 year, after the graduate award has been made, which is 2 years' time.

- After completion of the research the encrypted data will be removed from the computer and the store data degaussed so that no one has access to it.

- All image collected using digital camera and other means will be used strictly for research purpose and with the consent of the participants. All image will be kept confidential in Password protected computer.

    The Images collected will be for clarification of some vital points about the research on agricultural waste dump, participant involvement in the usage of agricultural waste etc.

    No

(c) Does the project require the use of hazardous substances?
    NO

(d) Does the project carry any risk of injury to the participants?
    NO

(e) Does the project require participants to answer questions
    that may cause disquiet / or upset to them?
    NO

If the answer to any of the questions 11(a)-(e) is YES, a risk assessment of the project is required and must be submitted with your application.

12. How many subjects will be recruited/ involved in the study/research? What is the rationale behind this number?

Because the philosophical stance for this study is pragmatic and is using mixed methods as its methodological choice, this study will adopt both interview and questionnaire survey for data collection.

For the interviews required, there is no ideal number of interviews (Baker, 2008) determined and it depends on what one wants to obtain. Moreover, the importance of the various kinds of purposeful sampling used in qualitative research lie primarily in the quality of information obtained per sampling unit, not the quantity (Sandelowski, 1995). Therefore, 10 interviews will be conducted, which will cover two categories (3 interviews from government personnel; 7 interviews from private construction product manufacturing personnel and from farmers in the case study areas).

For the questionnaire-based survey, the sample size should be as many as possible. In most academic studies involving individuals or organisations' representatives, the reasonable response rate of questionnaires that are expected to be returned is 35% (Baruch and Haltom, 2008). Hence, 192 questionnaires will be distributed to the key players involve in the process.

13.   **Please state which code of ethics has guided your approach (e.g. from Research Council, Professional Body etc.).**

Please note that in submitting this form you are confirming that you will comply with the requirements of this code. If not applicable, please explain why.

Projects that involve NHS patients, patients' records or NHS staff, will require ethical approval by the appropriate NHS Research Ethics Committee. The University College Ethics Panel will require written confirmation that such approval has been granted. Where a project forms part of a larger, already approved, project, the approving REC should be informed about, and approve, the use of an additional co-researcher.

I certify that the above information is, to the best of my knowledge, accurate and correct. I understand the need to ensure I undertake my research in a manner that reflects good principles of ethical research practice.

Signed by Student

Print Name   ODEWOLE ABOLADE

Date 25/11/2015

In signing this form, I confirm that I have read this form and associated documentation.

Code of Ethics of University of Salford

I have discussed and agreed the contents with the student on _____

(Please insert date of meeting with student)

Signed by Supervisor_____

Print Name_____ _____

 Date_____

APPENDIX B- College Ethics Panel: Application Checklist.

Name of Applicant – ODEWOLE ABOLADE

Tittle of the Project: – The development of collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials in Nigeria.

The checklist below helps you to ensure that you have all the supporting documentation submitted with your ethics application form. This information is necessary for the Panel to be able to review and approve your application. Please complete the relevant boxes to indicate whether a document is enclosed and where appropriate identifying the date and version number allocated to the specific document (*in the header / footer*), Extra boxes can be added to the list if necessary.

Document	Enclosed? (indicate appropriate response)				Date	Version No.
Application Form	Mandatory			If not required, please give a reason		
Risk Assessment Form	Yes	No	Not required for this project	There are not any risks involved in our data survey.		
Participant Invitation Letter	Yes	No	Not required for this project			
Participant Information Sheet	Yes	No	Not required for this project			

Participant Consent Form	Yes	No	Not required for this project			
Participant Recruitment Material – e.g. copies of posters, newspaper adverts, website, emails	Yes	No	Not required for this project			
Organisation Management Consent / Agreement letter	Yes	No	Not required for this project			
Research Instrument – e.g questionnaire	Yes	No	Not required for this project			
Draft Interview Guide	Yes	No	Not required for this project			
National Research Ethics Committee consent	Yes	No	Not required for this project			

APPENDIX C - Participant Information Sheet

Research Title**: The Development of a collaborative innovation management Framework to assist in the Utilisation of Agricultural Waste as Building Materials in Nigeria**

I would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or would like more information. Take time to decide whether to take part.

This study is part of a PhD research; the research will focus on development of a collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials, which proposed to reduce the effect of housing deficit in Nigeria due to high cost of building construction material. The developed framework will help to facilitate awareness, introduction and implementation of innovation of agricultural waste into a building material.

What is the purpose of the study?

Develop a framework for professionals to guide them in creation of awareness, introduction and implementation of innovation of agricultural waste into building material.

Why have I been invited?

Three case study areas were chosen to be part of this study; your area is one of these. People residents in each area where there is abundant deposit of agricultural waste will be asked several questions in informal interviews because more reliable results could be obtained. Ten people will be interviewed.

Do I have to take part?

It is up to you to decide. We will describe the study and go through the information sheet, which we will give you. We will then ask you to sign a consent form to show you agreed to

take part. You are free to withdraw at any time after you have agreed to take part in the research, which does not have any effect on you whatsoever

What will happen to me if I take part?

- There is face to face interview via media
- This interview will happen twice within one year of the study.
- Each interview session will take 1 hour or above.
- Each interview could be recorded by audiotaping, the main reason for that is help the researcher to take more important notes through replay the interview.
- All electronic data will be password protected. While the hardcopy data will be store in safe and secure place with limited access by me. Also, all data will be backed and stored in another safe place in case of losing and piece of data.
- During the interview you will answer some questions. Your answers will be treated as qualitative data and will be analyse through one of analysis method.

What are the possible disadvantages and risks of taking part?

There are not any disadvantages or risks in this study.

What are the possible benefits of taking part?

We cannot promise the study will help you but the information we get from the study will help to increase the understanding the why agricultural waste has not being used as construction material and how it can be harness now to reduce housing deficit and high cost of building material due to foreign exchange earnings in Nigeria, also will help in development of framework that will create awareness ,introduction and implementation of innovation strategy to transform agricultural waste as building construction material in Nigeria.

What if there is a problem?

If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions.

Will my taking part in the study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential, and any information about you will have your name and address removed so that you cannot be recognised.

What will happen if I don't carry on with the study?

If you withdraw from the study all the information and data collected from you, to date, will be destroyed and your name removed from all the study files.

You have absolute right to withdraw from the study at any time that you deem it fit, which does not affect you in any way.

What will happen to the results of the research study?

All the results will be used to validate the initial conceptual framework. Part of the result will be published. You will not be identified in any report/publication unless you have given your consent.

Who is organising or sponsoring the research?

Salford University, Manchester. United Kingdom.

Contact details:

Researcher Name: ODEWOLE ABOLADE

Phone No: 07802824620

E-mail: A.O.Odewole@edu.salford.ac.uk

APPENDIX D - Research Participant Consent Form

Title of Project:

The Development of a Collaborative Innovation Management Framework to assist in the utilisation of Agricultural Waste as Building Materials in Nigeria

Ethics Ref No:
Name of Researcher: Odewole Abolade
(Delete as appropriate)

• **I confirm that I have read and understood the information sheet for the above study (version x- date) and what my contribution will be.**	**Yes**	**No**

• **I have been given the opportunity to ask questions (face to face, via telephone and e-mail)**	**Yes**	**No**

• **I agree to take part in the interview**	**Yes**	**No**	**NA**

• **I agree to the interview being tape recorded**	**Yes**	**No**	**NA**

• **I agree to digital images being taken during the research exercises**	**Yes**	**No**	**NA**

• **I understand that my participation is voluntary and that I can withdraw from the research at any time without giving any reason**	**Yes**	**No**

• **I understand how the researcher will use my responses, who will see them and how the data will be stored.**	**Yes**	**No**

• **I agree to take part in the above study**	**Yes**	**No**

Name of participant	………………………………………………………
Signature	……………………………………………………

Date	…………………………….

Researcher's e-mail address	**A.O.Odewole@edu.salford.ac.uk;wonderbola@gmail.com**

APPENDIX E- Questionnaire Sample

The Development of a collaborative Innovation Management Framework to Assist in the Utilization of Agricultural Waste Building Materials in Nigeria.

To help us provide benefits that meet your needs, please complete this survey and return it to (Odewole Abolade) in School of Built Environment, University of Salford, Manchester.

SECTION -1: General information.

Q1. Please state your current job title: …………………………………………

Q2. How long have you been involved (years of experience) …………………………?

SECTION – 2

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Agricultural Waste: In my opinion……					
The national government is utilizing agricultural waste effectively in Nigeria					
My regional government is utilizing agricultural waste effectively in Nigeria					
The government provides strong support for innovative approaches to the use of agricultural waste as building materials?					
Private investors provide strong support for innovative approaches to use agricultural waste as building materials?					

The inability to buy modern building materials has affected housing development nationally?					
The inability to buy modern building material has affected housing development in your region?					
There are potentials for using Agricultural waste for building material in Nigeria					
New building materials from Agricultural waste will be appropriate to Nigeria climate conditions?					
In my opinion, the main reasons for neglecting the potentials of agricultural waste as a raw material for building industry are……					
Lack of government involvement					
Poor policies & lack of government support					
Complacency from Government due to crude oil earnings					
Traditional beliefs & culture					
Lack of research into waste to wealth					
In my opinion, better building materials can be achieved by……					
Using local raw materials like					
Improved research about the potential agricultural waste has as raw material					
Improved policies and planning					
Do you agree that we should……?					
Take the innovation of managing Agricultural waste seriously					
Learn from other sectors about utilizing Agricultural Waste					
In your opinion, which of the following institutions can best help to create awareness about the potentials of Agricultural waste for building industry?					
National Government					
Manufacturing Industry					
Regional Government					

Success Rate: In your Opinion ……	High	Low	No Rate
How would you rate the success of Agricultural waste innovation for use as a building material?			
Can we learn from other sectors about utilizing Agricultural Waste?			
In your opinion, which of the following types of buildings in your city would suit the use of Agricultural waste as a building material….			
Local Residential buildings			
Modern Residential buildings			
Commercial Buildings			

In your view, which of the following marketplaces are attractive to launch the innovated product from Agricultural waste?	
Local market	
National market	
Regional market	
International market	

APPENDIX F- Semi – Structured Interview Sample

University of Salford Manchester, United Kingdom.

Date of interview ……………

PhD research topic: The Development of a Collaborative Innovation Management Framework to assist in the Utilisation of Agricultural Waste as Building Material in Nigeria

 Name of the researcher: Odewole Abolade

Name of the Supervisor: Prof. Carl Abbott and **Dr Chika Udeaja**

 Section A:

Agricultural Waste

1. **What are the traditional uses of Agricultural waste in your region?**

…..

....

1. **In your experience has Agricultural waste been fully utilised in the past 10 years in Nigeria.**

 Yes…………………………….

 No……………………………..

 Please explain: **………………………………………………………**

Section B:

Building and Construction Industry

 3. **What is your opinion on the suitability of agricultural wastes for building purposes in Nigeria?**

....
....
....
....

4. In your opinion, what are the factors affecting the use of agricultural waste as raw materials for construction in your region?

....

....

....

5. Do you think that advances in building technology affect the usage or otherwise of agricultural waste as materials for the constructed product?

....

....

....

Section C:

Innovation System

6. **What are your views about innovation system and new product/material development in Nigeria?**

....

....

....

7. Do you think that there is a viable innovation system currently in place in Nigeria to adequately exploit the potentials of agricultural waste as raw materials for the constructed product?

....

....

....

8. **Do you have any suggestions in terms of how to build a viable innovation system to adequately exploit the potentials of agricultural waste as raw materials for the constructed product?**

…..

....

....

APPENDIX G- Participant Invitation Letter

PhD research student
Room 346
School of Built Environment
3RD Floor, Maxwell Building,
The Crescent,
University of Salford, Salford
United Kingdom
M5 4WT
Tel: +44(0) 161 295 7305
Email: a.o.odewole@edu.salford.ac.uk

The Development of collaborative innovation management framework to assist in the utilisation of agricultural waste as building materials in Nigeria

Dear Madam/Sir,

My name is Odewole Abolade and currently studying PhD at the School of the Built Environment, The University of Salford in the UK under the supervision by Prof. Carl Abbott. As part of the validation process of my PhD study, you are kindly invited to validate the findings from my research titled "The Development of a collaborative innovation management framework to assist in the utilisation of agricultural waste as building material in Nigeria". The research aims to develop a framework to facilitate the awareness, introduction and implementation of managing innovation of agricultural waste into building materials.

Your cooperation is most essential as the deliverable of the case study could be beneficial to the future of the city. All responses to this questionnaire would be kept strictly confidential and will only be used for academic purposes only. Once an appropriate data collection will be completed and analysed, the original data will be shredded and destroy. Unless requested, the data collected may appear anonymously in the PhD dissertation and other related publications such as local and international journal. However, no personal details or details about the organisation will be disclosed.   Thank you.

Appendix H - Validation Questionnaires

- How would you rate the comprehensiveness of the framework? Please tick box that best represents your views below.

Highly Comprehensive	Comprehensive	Fairly Comprehensive	Slightly Comprehensive	Not comprehensive

- To what extent would you rate the user friendliness of the framework? Please tick box that best represents your views below.

Is user friendly to a very high extent	Is user friendly to a high extent	Is user friendly to some extent	Is user friendliness to a low extent	To no extent user friendly

- To what extent would you rate the logic and flow of the framework? Please tick box that best represents your views below.

Is logical and flows well to a very high extent	Is logical and flows well to a high extent	Is logical and flows well to some extent	Is logical and flows well to a low extent	To no extent logical and does not flow well

In your opinion, to what extent would this framework add value to your day-to-day practice in the delivery of socio-economic regeneration projects? Please tick box that best represents your views below.

Would add value to a very high extent	Would add value to a high extent	Would add value to some extent	Would add value to a low extent	To no extent add value to

- Please feel free to offer any additional comments on the above questions, or any general comments you may have on the subject matter that might help to improve the framework further.