EVALUATION OF THE EFFECTIVENESS OF THE USE OF LOCAL BUILDING MATERIAL FOR BUILDING CONSTRUCTION IN MAIKUNKELE LOCAL GOVERNMENT AREA IN NIGER STATE

BY

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MATRIC NO: 2007/27300BT

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SEPTEMBER, 2012

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A PROJECT SUBMITED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND SCIENCE EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,NIGER STATE

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY [B.TECH] DEGREE IN INDUSTRIAL AND TECHNOLOGY EDUCATION

SEPTEMBER, 2012

CERTIFICATION

I SULEIMAN ABDULLAHI, with Matriculation Number 2007/27300BT an undergraduate student of the department of Industrial and Technology Education Department wishes to certify that the work embodied in this research project is original and has not been submitted in part or full for any other higher diploma or degree of this or other university.

…… ……

Name signature/date

APPROVAL PAGE

This project has been read and approved as meeting the requirement for the award of B.Tech in (Building Technology) Education, Industrial and Technology Education, School of Science and science Education, Federal University of Technology Minna, Niger State.

…… ……

Supervisor Signature & Date

…… ……

Head of Department Signature & Date

…… ……

External Examiner Signature & Date

DEDICATION

I humbly wish to dedicate this project to Almighty Allah through whose grace and mercy, I have survived till date. Also I want to dedicate this work to the family of Suleiman's my wonderful family, for their warmest love and support both financially and spiritually, may Allah bless and protect us (Amen).

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Unto Him who is able to make all things possible be the glory honour and praise for making this project a reality. My utmost appreciation goes to my supervisor Mallam W.B. Kareem for his constructive criticism, encouragement and suggestions right from the beginning of the project to the final stages. I am thankful to MallamAbdul Bello Kagara, and Dr Engineer P.A Omozokpia in FUT Minna for their tremendous support during my project analysis. Many thanks go to my friend Philip Sunday, Abdul Bello and Hamza D Sanifor assisting and advising throughout the period of my project.

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Abstract

The study was carried out to identify the evaluation of the effectiveness of the use of local building materials in Maikunkele local government Niger state. The purpose of the study was to Identify the factors limiting the use of local building materials in this locality, Determine how resident living in locally built housing environment perceive sustainable housing, Examine the modes of application involved in the use of local building material for building construction . Three research questions and three hypotheses were formulated to guide the study. A survey research design was used for the study. The study was carried out in Maikunkele in Niger state. A total of 50 comprising of 30 residence and 20 masons was used as the population for the study. A structured questionnaire was developed by the researcher and was used for data collection. The instrument was validated by three lecturers in the department of industrial technology education, federal university of technology Minna. The data collected was analysed using mean and standard deviation while, the t-test statistic was used to test three hypotheses at 0.05 level of significance. The findings of the study revealed that discussed 10 factors limiting the use of local building materials in this locality which were found for effective use of local material in these locality.Recommendations were made based on the findings, and suggestions were also made for further research

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CHAPTER I

INTRODUCTIONS

Background of study

The history of housing is inseparable from the social, economic and political development of human kind. The problem of providing adequate housing has long been a concern, not only for individuals but for government as well. In most of our urban centres the problem of housing is not only restricted to quantity but to the poor quality of available housing units. The result of which is manifested in overcrowding in houses and as well increases pressure on available infrastructural facilities. Rapid growth in population creates problems toward adequate and efficient supply and distribution of basic utilities and services for the city inhabitants.

A recent World Bank report noted that two of the most critical urban development issues facing Nigeria are the financing of urban infrastructure and the institutional arrangements for housing delivery in urban centres. The provision of basic utilities and services particularly housing, is partly the responsibility of the government, which has been handicapped in recent times by declining financial resources, political instability and many other factors.In some United Nations reports (UNCHS, 1985; UNCHS, 1992; UNCHS, 1992), the building materials sector was split into three production groups: Modern or conventional building materials which are materials based on modern conventional production methods like concrete, steel and glass; traditional production methods are those materials that have been in local production from ancient times using small-scale rudimentary technologies, e.g. laterite, thatch, straw, stabilised mud, and raphia palm; and innovative materials which are materials developed through research efforts aimed at

providing alternatives to import-based materials e.g. fibre-based concrete, Ferro-cement products etc.

However, despite the general popularity of both the modern and innovative building materials in the market, there exist calls for the return to traditional materials, referred to in this study as local building materials. Amongst the reasons advanced for these calls are high cost of both the modern and innovative building materials and their inadequate supply in the market (UNCHS, 1990; Lilly and Wai, 2001). Furthermore, the need to revert to IBM is also traceable to prevalent dictates of some neo-global concepts vis-à-vis sustainability, and the use of biodegradable and renewable materials (Mahgoub, 1997; Adams, 2000, Mourshed, 2000; Peakstoprairies, 2005). This has led to the creation of global political agendas and researches on the potential for wide application of local building materials.

In Nigeria for example, the establishment of the Centre for Earth Construction Technology (CECTech) by the National Commission for Museums and Monuments and the French Embassy in Lagos is effort toward promoting the use of earth technology as a partial or complete substitute for block work, flooring etc. The Raw Materials Institute and the Directorate for Food, Roads and Rural Infrastructure (DFRRI) was also set up by government to encourage the utilisation of local building materials in the construction of buildings. DFRRI was the first to initiate the use of local raw materials in the construction of roofing sheets in Nigeria. The problem of housing has become an everyday discussion in all quarters of the public and private services of the developing countries of Africa.

Despite Federal Government access to factors of housing production, the country could at best expect 4.2% of the annual requirement from her. Substantial contribution is expected from other

public and private sectors. It should be acknowledged that private sector developers account for 83 of urban housing (Federal Office of Statistics, 1999). Unfortunately, the private sector is saddled with numerous problems which make supply always fall far short of demand. Of these, the most limiting is Finance. Various studies have, at different times, revealed the problems of housing production. Agbola (1987) Okpala and Onibokun (1986) recognised finance as part of housing problems but ranked land and building materials higher. Why local materials? Many benefits that are offered by earth construction are often underutilized in the developed world where the use of local material (IM) as a low-embodied material is often the case (Middendorf, 2001).Historically, IM has been the most widely known and used building material in construction and probably has been the most important of all building materials (Legget, 1960). According to Middendorf (2001) recorded cases of the use of earth bricks dates back to Mesopotamia "around 8000 BC". Recent reports indicated that, about half of the world's populations are still living in earth buildings (McHenry, 1984; EBAA. Australia). Of all urban housing units worldwide there are about 25 % that does not conform to building regulations while 18% are considered non-permanent structures (Habitat, 2001). Local material as a building material is available everywhere and exists in many different compositions. It is most efficiently used in developing countries to house the greatest number of people with the least demand. However, it must be noted that earth buildings are not a phenomenon only of the Third World countries, but also in developed countries (EBA New Zealand, 1998).

Statement of Problem

The main drawback of soil material is the need for continuous maintenance and the lack of durability and resistance to water (Bahar et al., 2004). Most researchers done in this area has always focused on processed durability or strength. All aspects should be considered to produce sustainable, durable, safe and environmental friendly homes and buildings. However, earth construction suffers from shrinkage cracking, low strength and lack of durability (Bahar et al., 2004; Guettala et al., 2006). In addition, most earthen materials are unsuitable for homes of more than two stories, as they are unable to carry the load of the super structure walls. The sub structures need to be thicker than the super structure in the same building. Thus, labour costs would be very high indeed (Farnsworth, 1999). The challenge of modern and new requirements, the need for sustainable low cost buildings to house people and the lack of knowledge in this area justify the need for more research to be focused on the strength and durability of earth block.

Purpose of the Study

This research project is aimed to:

1- Identify the factors limiting the use of local building materials in this locality.

2- Determine how resident living in locally built housing environment perceive sustainable housing.

3- Examine the modes of application involved in the use of local building material for building construction in this locality.

Significance of the Study

Actually, most developing countries are facing a real housing deficiency (Harison and Sinha, 1995). Therefore, there is an urgent need to construct and build houses that are more durable at a low cost. In this regard, clay masonry has a long and illustrious record of providing durable and attractive buildings for the low income earner. Recently, the technology of traditional earth construction has undergone considerable developments that have enhanced earth's durability and quality as a construction material for low-cost buildings (Adam and Agib, 2001). Buildings made from earth materials can be a way towards sustainable management of the earth's resources. They can be put in place using simple machinery and human energy. Earth buildings avoid high-energy costs in the initial manufacturing and construction period, in their use as homes, and eventually in their recycling process (Temeemi& Harris, 2004).

Scope of the study

This study will focus on factors limiting the use of local building materials in Maikunkele local

government of Niger State, how resident living in locally built housing environment perceive sustainable housing, with respect to identify the modes of application involved in the use of local building material for building construction in this locality.

Assumption of the study

The following assumptions are made to guide this study;

1. Response from residents and masons who live in old Maikunkele form the basis of investigation on the material use for construction in this locality to determine the effective use of the materials use in constructing their home.

2. The utilization of questionnaire will be adequate and suitable for collection of necessary information needed for this study.

Research questions

The study shall answer the following Research questions:

1. What are the factors limiting the use of local building materials in this locality?

2. How do residents living in locally built environment perceive sustainable housing?

3. What are the modes of application involved in the use of local building material for building construction in this locality?

Hypothesis

The following hypothesis were developed and tested at 0.05 level of significance

1. There will be no significant difference between the mean responses of residents and masons regarding the factors limiting the use of local building materials in this locality.
2. There will be no significant difference between the mean responses of residents and masons regarding how residents living in locally built environment perceive sustainable housing.
3. There will be no significant difference between the mean responses of residents and masons regarding the modes of application involved in the use of local building material for building construction in this locality.

CHAPTER II

Review of Related Literature

This chapter present the review of related literature of this study. The review is organized under the following sub – headings:

1. Building materials
2. Raw (Natural) Building Materials
3. Earth bag Construction
4. Earthen Construction (clay bricks, rammed earth)
5. Bamboo
6. Stone
7. Timber
8. Processed Building Materials

Building Materials

It is widely recognized that mud, bamboo, stone and timber are some of the main local materials used for shelter since time immemorial. The naturally occurring local materials exhibit variations in physical properties and also contain numerous types of impurities. Unsuitability of soils, slow setting of lime, poor reactivity of raw clays, early decay of bamboo, etc. makes these traditional materials functionally inadequate in terms of durability and the high cost of maintenance. The California bearing ratio CBRI has developed a rich knowledge base and infrastructures for improving the performance of these locally available materials. Good quality of bricks have been produced from inferior soils (black, red, marine clays, etc.) using admixtures such as rice husk ash, fly ash, colliery waste, etc. A rapid setting lime from magnesium limestone and activated lime pozzolana mixture using raw clay have been developed for plastering, mortars and concretes. The utilization of stone in masonry blocks has been made using odd shapes and

sizes of stone and a lean cements and mortar for hilly regions. Researches on the secondary source of plantation timber (rubber wood, poplar and other forest wastes) indicate its possible use as substitutes for wood lumber through seasoning and preservative treatments. The pre-treatment of bamboo against moisture swelling and termite decay has been attempted with a positive result to encourage the enhanced use of bamboo mats/boards/sheets in rural housing. In the field of resins from renewable resources, cashew nut shell liquid (CNSL) has assumed significance as it is available in large quantities in India. Polymerized CNSL has been promoted for making expansion crack joint filler with coconut pith, polymer concrete, concrete coatings with epoxy and as a diluent for polyester resin in making low cost boards. Adhesive developed from fruits/barks/leaves of plants is being promoted for the bonding of facades. Rosin obtained from distillate of lisa of pine trees was tried for the modification of unsaturated polyester resin to be used as a matrix for composites.

A house cannot be built without the fundamental knowledge of building materials and construction (Stulz&Mukerji, 1981, p.X). The analysis of particular local conditions will determine where materials are most suitable for their used. Furthermore, the era / time when materials and techniques were/ are mostly used will determine whether they could be classified as traditional or contemporary.

Raw (Natural) Building Materials

Raw natural building materials have been used before the modern processed building materials were used and before industrialisation took place. Many cultures have found their own way to improve their life by utilising structures, which were traditionally built with raw materials (Bryan, 1985, p.25-29). Construction methods have been passed on from generation to

generation among different cultures, thus traditional construction methods vary from country to country and even within some countries (YVBSG, 2001, p.1). Traditional techniques involve local labour and the use of available natural raw materials such as earth, soil, natural fibres, natural rubber, stones and timber. The advantage of natural raw materials is based on environmental principles (renewable, energy efficient, recyclable) and social involvement (self-construction, family and community working together). Disadvantages of natural raw materials are their dependence on local availability, water absorption, and resistance to natural hazards, such as hurricanes, earthquakes etc., resistance to eventual impacts, contamination susceptibility (soluble salts, biological agents, etc.) and social acceptability (Lindberg, 1998, bilaga 2; Stulz, &Mukerji, 1981, Ch.1).

Earth bag Construction

Earth bag housing is a simple form of earth-based construction wherein large bags are filled with granular material, compacted and laid horizontally in a running bond to form the core of a wall system. Polypropylene bags are currently favoured by the earth bag building community for their strength, resistance to decay, and affordability, but natural materials such as burlap have also been used. Barbed wire is typically laid in between each course of earth bags to provide shear strength, as the friction between successive courses of bags is low, especially when polypropylene bags are used. After a wall is completely stacked, a plaster skin is applied to both the interior and exterior wall surfaces, to a thickness of several centimetres. This skin consists of several layers of varying composition, which can be either earth-, lime- or cement-based plasters (Hunter &Kiffmeyer, 2004). The purpose of the plaster skin is to protect the earth bags from environmental degradation, as well as to add strength and stiffness to the wall system. Some test structures have also been built using unplaster soil-filled cotton hoses (Minke, 2006), and though

this test program did not use the term “earth bag”, the basic principles of the construction technique are largely identical to earth bag construction.

Since soil composition can vary significantly from one site to another, there is some question about how the properties of earth bag structures vary with changes in the composition of bag fill. Soil particles are typically divided into clay, silt and sand based on particle diameter and composition. There are several different classification systems, but the Unified Soil Classification System is widely accepted, and is used for testing by the American Society for Testing and Materials. According to the Unified Soil Classification System (USCS), silt and clay particles are those with diameters less than 0.075mm, sand particles have diameters between 0.075 and 4.75 mm, and gravel particles have diameters between 4.75 and 76.2 mm (Das, 2005).

This system does not differentiate silt and clay particles based on diameter, but rather on the minerals which make up the particles. Silt particles are generally quartz-based, whereas clay minerals are made up of complex aluminium silicates (Das, 2005). For all types of earthen construction, the fraction of soil made up of clay particles is particularly important since clay acts as a binding agent. Higher clay content results in higher cohesion, since clay particles typically have a net negative charge that attracts positively charged particles to their surface (Das, 2005). However, clay also displays certain properties which are undesirable for earthen construction. Specifically, it has a tendency to swell and shrink with high or low moisture contents, respectively. The amount of volume change between a saturated and dry clay can be anywhere from 100% to 2000%, depending on the specific clay minerals present (Hunter &Kiffmeyer, 2004).

Earth bag housing is a promising technology for a number of reasons. The two most significant reasons in the context of this project are its low cost and low-tech nature. Both of these properties are crucial in ensuring applicability in a development context as developing nations have, in almost all cases, limited access to financial resources and skilled labour. Unfortunately, while anecdotal knowledge on earth bag construction has been well developed over the past thirty years, this has not been matched by efforts to study the material in a quantitative fashion consistent with other structural engineering materials. As such, the practice of earth bag construction is currently based on many "rules of thumb" and unsubstantiated best practices which, while well meaning, may not result in the safest, most efficient use of materials. To date, laboratory testing of earth bag technology has been virtually non-existent. In terms of compressive strength, no peer-reviewed studies have been published, though the results of one testing effort, an undergraduate research project conducted at West Point Military Academy, have been published online (Dunbar &Wipplinger, 2006).

Earthen Construction (clay bricks, rammed earth)

Earthen construction is the oldest known construction technology used by humans, with archaeological evidence showing that it has been used for at least 9,000years (Minke, 2006). Despite its ancient origins, earth construction continues to be one of the most prevalent forms of housing technology in the world, with approximately 30% of the world's population living in earth-based housing (Moquin, 2000). As with early straw bale housing in Nebraska, the historic prevalence of earthen construction throughout much of the world is due primarily to the widespread availability of soil, as well as the comparatively limited availability of other housing materials such as timber. Its availability, as well as its low cost compared to modern, heavily processed building materials (such as steel and concrete), has ensured its longevity as a building

technology. Earthen construction is a broad term which encompasses many different building technologies centred on the use of soil. The most common type of earthen construction is adobe brick housing. The term “adobe” can be used to denote a style of earthen construction, as well as to denote an individual brick made from clay-rich soil, typically formed and left to dry in the sun without compaction or additional baking. When soil is used to make bricks which are then mechanically compressed prior to construction, they are usually referred to as “compressed earth blocks”. Cob walls are a type of structure formed by mixing clay-rich soil with fibrous material such as straw, forming the resultant material into clumps (“cobs”), and packing them together to form a monolithic wall. Finally, rammed earth is another system which dispenses with modular soil units in favour of one monolithic soil structure. This is achieved by constructing forms to enclose the wall volume, and then filling the formwork with soil one layer at a time, with each layer being tamped before the next one is poured.

Despite the variety of ways in which earth can be used as a construction material, the structural behaviour of earth housing is generally governed by a few key material properties. The most important property of soil, from a structural perspective, is its grain size distribution. A soil’s relative percentage of clay, silt, sand and gravel greatly affects the mechanical strength of the soil. As a structural material, soil can be thought of as being roughly analogous to concrete, with clay particles acting as the binder (cement), and silt and sand acting as the aggregates. Earth is further analogous to concrete insofar as it is capable of achieving significant compressive strength, but can carry essentially no tensile loads (Minke, 2006). In general, the strength of a soil being considered for use in earthen construction is proportional to its clay content, and inversely proportional to its silt content (Moquin, 2000). This is due to the microscopic structure of clay particles, which consists of many thin plate-like particles with strong inter-particle

binding forces. As soils become richer in clay, they become stronger due to an increase in these binding forces. However, after a certain point, increases in clay become detrimental to a soil's structural suitability, as swelling and shrinkage cracking increase with clay content (Minke, 2006). In general, clay contents of around 20-30% are desirable, with higher clay content being likely to result in excessive swelling and cracking, and lower clay content likely to result in insufficient compressive strength (Moquin, 2000).

Earth-based buildings are particularly attractive from a fire-resistance perspective. Earthen walls are typically quite massive, with large thermal storage capacity, which suggests their ability to transmit excess heat in the case of a fire would be low. In addition, earth-based walls do not burn readily, further suggesting that if a fire were to start in an earth-based house, it would not propagate quickly, if at all. Very few studies have been conducted on the fire resistance of earthen walls, probably due to their extremely incombustible nature. However, studies commissioned by Rammed Earth Constructions, an Australian housing contractor, have shown a 250mm thick rammed earth wall to have a 4-hour fire resistance rating based on Australian testing standards (Rammed Earth Constructions, 2007). This meets the most stringent fire resistance rating requirements specified for non-combustible firewalls in the National Building Code of Canada (CCBFC, 2005).

In contrast to its excellent fire resistance, earthen construction is highly vulnerable to earthquake damage. Adobe in particular, classified as unreinforced masonry, is extremely susceptible to damage as a result of seismic forces (Tolles et al., 2000). However, it is possible to design earthen structures to minimize susceptibility to seismic forces. A thorough discussion of the seismic behaviour of earthen structures is presented by Minke (2001), along with design guidelines which aim to reduce the risk of seismic damage. The guidelines are summarized into

three distinct strategies for designing the structural system of a house, each of which follows a different approach to ensuring seismic resistance:

1. Walls and roof should be stiff, heavily reinforced and strongly connected to ensure that no deformation occurs as a result of seismic forces.

2. Walls and roof should be well connected, but also ductile enough to deform under seismic loads. This deformation absorbs seismic energy without causing failure. This strategy requires the use of a "ring beam" which caps the wall system and must have wall-to-beam and beam-to-roof connections of adequate strength.

3. Walls are designed with a ring beam as in strategy, but roof is supported by columns which are structurally independent of the wall system. This allows the wall system and roof system to vibrate independently in accordance with their different resonant frequencies.

Bamboo

Bamboo is widely used as a construction material around the world, with an estimated 800,000 people currently living in bamboo structures (De Boer &Bareis, 2000).In addition to housing, it is also commonly used to make access scaffolding and bridge constructions shown in fig 2.2 in Southeast Asia (Chung & Yu, 2002). There are several reasons why bamboo is an attractive material for construction. Specifically, its mechanical properties, growth characteristics, and availability all make it well suited to housing applications in developing countries, particularly those located at latitudes where it is commonly found. However, there are several factors which may inhibit bamboo's suitability for design, depending on context. This section will discuss the strengths and weaknesses of bamboo as a structural material, specifically in a housing context. Bamboo is a type of giant grass which produces a woody stem, called the Culm (Ghavami, 2005). The Culm itself is a bio composite. In general, natural fibrous materials are composed of

strong ligno-cellulosic fibres surrounded by a matrix of hemicelluloses and lignin (Mohanty et al, 2002).

Bamboo species are generally found between 40° northern and southern latitudes (Daiglis, 1999). In its native habitat, it grows extremely quickly, often reaching its maximum height in only a few months, with maximum mechanical strength typically obtained after 3-6 years, depending on species (Chung& Yu, 2002). It is prized as a material with a relatively low environmental impact, mostly due to this high growth rate and its renewable nature. However, given its somewhat limited geographic distribution, the environmental impact of transportation should be considered when using bamboo. In some cases, shipping costs and environmental impacts may completely offset the environmental benefits of using bamboo over more conventional building materials. Structurally, there are two ways in which bamboo can be utilized. It may be left whole or flattened for use as a structural member in and of itself (Chung & Yu, 2002, De Boer &Bareis, 2000), or it may be used as fibrous reinforcement in composite materials (Ghavami, 2005; Li et al., 1995; Daiglis, 1999).In quantitative terms, bamboo compares favourably with the conventional structural materials of wood, steel and concrete. Chung and Yu (2002) conducted a series of compression and bending tests for two common species of bamboo, namely *Bambusapervariabilis*(Kao Jue) and *Phyllostachyapubescens*(Mao Jue), with the intent of determining characteristic values for bamboo strength in bending and compression.

Stone

The oldest and most commonly used building material, Three geological groups of stones can be found: igneous (E.g. granites, volcanic stones), sedimentary (E.g. sandstone, limestone) and metamorphic (E.g. slates, marble, quartzite). Some of the uses are:

• *Igneous*, such as granites use for walls, floors, cladding, plinths and stairs.

• *Sedimentary*, such as Limestone use for cement production; sandstone use for walls, floors, cladding, plinths and stairs.

• *Metamorphic*, such as marbles for windows, floors and finishing; slates for decoration; quartzite for floors, paving and stairs.

Exploitation techniques and equipment varies, harder rocks need more sophisticated machinery. Stones constructions do not required maintenance but availability can make a cost difference. Durability depends on thermal performance and resistance to chemicals. (Ghavami, 2005)

Applications:

• Foundations, Floor, walls, some type of roof structures, all with or without mortar.

• Crushed or shaped stones for masonry

• Gravel and stone chipping as aggregates

• Granules for surfacing bituminous felt

• Powder for extending paints

Stone and brick are examples of building materials made from earth. Stone can even be acquired on site in some cases. New stone and bricks are more expensive for both materials and labour, but are very long lasting and durable, and require little or no maintenance. A brick exterior never needs to be painted. Earth materials such as brick and stone also regulate temperature and humidity changes inside your home. They are excellent thermal masses and prevent large fluctuations in the climate inside your house. Bricks and stones are also recyclable. Used bricks often have a ‘weathered’ appearance that some people find attractive. Broken or crushed bricks can be recycled and made into new bricks, or can be used in landscaping.

Timber

Timber has been used as fuel and for construction purposes. Timber is a very complex material. There are many species with different properties (resistance, hardness, stiffness and density). Timber is suitable for any kind of construction, but it needs knowledge and guidance to achieve good results. Timber is classified as:

• Hardwoods from broad leaves trees usually deciduous

• Softwoods from coniferous trees, found in temperate zone.

Special treatments must be performed to limit the content of water (drying process) and fungus attack (chemical treatment). From environmental point of view deforestation causes irreversible damage to the ecosystem, thus, large scale used of timber must be accompanied by reforestation programs. Timber main products are: pole, sawn, plywood, block board, glue-laminated board, particleboard, fibreboard, wood-wool slabs and sawdust (Ghavami, 2005).

Applications:

• Complete or partial building and roof frames structures

• Structural and non-structural floors, walls, ceilings or roofs

• Insulating panels

• Doors and windows frames, door leaves, blinds, shutters, sun-screens, window sills, stairs, framework for concrete and similar building elements

• Furniture and other non-construction elements

Processed Building Materials

Processed building materials refer to materials (which could be natural or man-made) such as concrete, Ferro-cement and other fibre cement mixers, glass, metal, polymers and recycled materials. "Processed materials" are substitutes for raw materials and are generally regarded as more technologically developed/advanced, with altered chemical, mechanical or physical properties. The choice between processed- and natural raw materials should always be based on local requirements. The advantages of processed building materials are: specialised applications, improved properties, higher productivity and timesaving during construction. The disadvantages of processed building materials are: failure to meet the realities of local conditions and a high base cost for manufacturing/processing and transport (Spence &Cook, 1983, Preface). Assessment of advantages/disadvantages of processed materials can have economical, technical and environmental approaches, e.g. environmental impact in manufacturing can be justified if the final product is durable (KTH & NTNU, 1998, Melby, p.17). It can be appreciated that, through time, conventional processed materials such as cement, steel and plastic have already been combined with natural raw materials for building purposes, but it has become necessary to allow technology to influence the use of non-conventional / alternative and recycled materials.

CHAPTER III

METHODOLOGY

This chapter describes the design of study, area of study, target population and sample, instrument for data collection, validation of the instrument, and administration of instrument, method of the analysis and decision rule respectively.

Research Design

To achieve the objectives of this research, descriptive survey was adopted because it involves the use of questionnaires and interviews to determine the opinion of the respondentsof the resident and mason in this community. Therefore short interview sessions were held with most of the respondents, because most of them cannot speak English.

Area of Study

This study covers the entire Maikunkele area. Maikunkele, is an excellent example of the rural-recreational area and is located in Bosso local government of Niger state with covering land area of about 932768km and about 170,123,740 population as at 2011 (tageo.com 2011). Not only is the area partly rural, it also has a unique population demographic with a growing number of seasonal residents who have cottages within the community.

Population of Study

The target population for this study is made of 30 resident and 20 masons in building with locally made materials in this selected area.

Sample of the Study

A random sampling (RS) was employed in the selection of the sample for the study to sample the effective usage of locally made materials for construction giving a total number of 0ne hundred and seventy personnel. The sample of the study is made up of resident and masons. This method is used to give every person in the population equal chance of being selected into the sample. Therefore a total of 50 questionnaires was distributed.

Instrument for Data Collection

The instrument used for the data collection was a structured questionnaire developed by the researcher. It consisted of two part in which the first indicate the introductory part of the respondent and the second part was divided into three sections A,B and C. All items are to be responded to by indicating the appropriate respondent's best perception using four point rating scales. Strongly agree (SA) Agree (A) Disagree (DA) Strongly Disagree (SD).

Validation of the Instrument

To ensure validity of the instrument, a draft copy of the questionnaire was submitted to three experts in department of Industrial and Technology Education, Federal University of Technology Minna before administering it to respondents.

Method of Data Analysis

The analysis of data for the research questions and hypothesis were accomplished using the mean and t-test. The mean was used to determine the degree of acceptance or rejection in research question while t-test was used to test the hypothesis of two groups of respondents at 0.05level of significance.

The four point rating scales developed are as follows:

Strongly agree	SA=4
Agree	A=3
Disagree	DS=2
Strongly disagree	SD=1

The formula

$$X = \frac{\Sigma FX}{N}$$

Where $\bar{X}$ = Mean

F = Frequencies if each response option

X = Weight of response options

N = Number of respondents to the items

The mean of response options was computed with the formula

$$x = \frac{\Sigma FX}{N}$$

Where X = mean

Σ = summation

Therefore the mean value of the 4 point scale is:

$$X = \frac{4+3+2+1}{4} = \frac{10}{4} = 2.5$$

Decision Rule

The mean of 2.50 was used as decision point for every questionnaire item, consequently, any item with mean respondent of 2.50 and above was considered to be agreed and any item with

response of 2.49 and below was equally considered as disagreed in section a, b and c. the t-test was used to test the hypothesis at 0.05 level of significant to compare the mean response of the groups. A critical value of ±1.96 was selected based on the degree of freedom at 0.05 level of significant. Therefore any item with t- calculated value less than the critical was regarded as not significant. While any item with calculated value equal or greater than the critical was regarded as significant.

CHAPTER IV

Presentation and Data Analysis

This chapter deals with the presentation and analysis of data with respect to the research questions and hypothesis formulated for this study, the result of data analysed for the research questions were presented first followed by those of the hypothesis tested for study.

Research question 1

What are the factors limiting the use of local building materials in this locality?

Table 1, mean responses of residents and mason on factors limiting the use of local building materials in this locality.

N_1=30, N_2=20

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_t$	Remark
1	Local materials such as clay and timber easily absorb water when used on water logged areas.	3.67	3.65	3.66	Agreed
2	Stones used for local buildings are not usually cut to workable size before they are used.	3.74	3.55	3.65	Agreed
3	Stones not always easily available.	3.54	3.46	3.5	Agreed
4	Materials like clay contain numerous amounts of impurities.	3.67	3.65	3.66	Agreed
5	Some local materials such as timber and bamboo are not resistant to eventual impacts.	3.47	3.59	3.60	Agreed
6	Early decay of bamboo.	3.74	3.55	3.65	Agreed
7	Slow setting of lime in stones.	3.60	3.59	3.60	Agreed
8	Local materials compared to modernized materials vary in physical properties.	3.54	3.59	3.57	Agreed
9	Local materials require more labour to work with.	3.60	3.59	3.60	Agreed
10	Local building materials like clay suffer shrinkage and cracking.	3.67	3.65	3.66	Agreed

N_1=Number of Residents N_2=Number of Mason X_1=Mean of Residents X_2= Mean of Mason $X_{t=}$ Average mean of Residents and Masons.

Table1. The data presented in table 1 revealed that the respondents agreed with all the items with mean score ranging between 3.5 – 3.67. This signifies that all the factors limited the use of local building materials in this locality.

Research Question 2

How do residents of modern housing perceive locally built housing and its environment?

Table 2, mean responses of residents and mason on how residents of modern housing perceive locally built housing and its environment.

N_1=30, N_2=20

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_t$	Remark
1	Doubtful durability and life span of the indigenous building materials.	3.54	3.46	3.5	Agreed
2	Locally built houses have low aesthetic value.	3.60	3.59	3.60	Agreed
3	People tend to live in an alternative housing to show their status in the society thereby making locally built house non-commercially viable.	3.67	3.65	3.66	Agreed
4	People believe that local house lack standards.	3.54	3.59	3.57	Agreed
5	Locally built houses do not have specification.	3.74	3.55	3.65	Agreed
6	Locally built houses are looked on as archaic.	3.67	3.65	3.66	Agreed
7	Locally built houses are looked on as if they are for low income group.	3.8	3.78	3.79	Agreed

N_1= Number Residents N_2= Number of Masons $X_{1=}$ Mean of Residents $X_{2=}$ Mean of Masons$X_{t=}$ Average mean of Residents and Masons.

Table2. The data presented in table 2 revealed that the respondents agreed with all the items with mean score ranging between 3.5 – 3.8. This signifies that all the residents living in modern housing don't prefer living in locally built house and its environments.

Research Question 3

What are the modes of application involved in the use of local building material for building construction in this locality?

Table 3, mean responses of residents and mason on the modes of application involved in the use of local building material for building construction in this locality

N_1=30, N_2=20

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}t$	Remark
1	Materials such as bamboo can be used for simple suspension bridges.	3.74	3.55	3.65	Agreed
2	Bamboo and timber can be used for scaffolding and formwork in building construction.	3.54	3.59	3.57	Agreed
3	Local materials such as timber and bamboo can be used as fencing materials on building construction sites.	3.80	3.78	3.79	Agreed
4	Stones can be used for pavements, slabs and gutters.	3.54	3.46	3.50	Agreed
5	Stones can serve as aggregates when preparing concrete for building foundations.	3.60	3.59	3.60	Agreed
6	Stones obtained locally are primary elements in cement production.	3.67	3.65	3.66	Agreed
7	Timber in local building construction can be used for doors, windows and furniture's.	3.74	3.55	3.65	Agreed

N_1= Number Residents N_2= Number of Masons $X_{1=}$ Mean of Residents $X_{2=}$ Mean of Masons $X_{t=}$ Average mean of Residents and Masons.

Table3. The data presented in table 3 revealed that the respondents agreed with all the items with mean score ranging between 3.50 – 3.80. This signifies that all the modes of application mentioned are involved in the use of local building material for building construction in the locality.

Hypotheses 1

There is no significant difference between the mean responses of residents and masons regarding the factors limiting the use of local building materials in this locality.

Table 4, t- test analysis of Residents and Masons on thefactors limiting the use of local building materials in this locality

N_1=30, N_2=20

S/N	ITEMS	$S.D_1$	$S.D_2$	t-test	Decision
1	Local materials such as clay and timber easily absorb water when used on water logged areas.	0.48	0.48	0.16	NS
2	Stones used for local buildings are not usually cut to workable size before they are used.	0.45	0.5	1.55	NS
3	Not always easilyavailable.	0.5	0.5	0.6	NS
4	Materials like clay contain numerous amounts of impurities.	0.48	0.48	0.16	NS
5	Some local materials such as timber and bamboo are not resistant to eventual impacts.	0.49	0.5	0.08	NS
6	Early decay of bamboo.	0.45	0.5	1.55	NS
7	Slow setting of lime in stones.	0.49	0.5	0.08	NS
8	Local materials compared to modernized materials vary in physical properties.	0.5	0.5	0.37	NS
9	Local materials require more labour to work with.	0.49	0.5	0.08	NS
10	Local building materials like clay suffer shrinkage and cracking.	0.48	0.48	0.16	NS

N_1= Number Residents N_2= Number of Masons $S.D_1$= Standard Deviation of Residents $S.D_2$= Standard Deviation of Masons T= t- test of Residents and Masons. S= Significant, NS= Not Significant.

There is no significant difference in the mean response of Residents and Masons on the factors limiting the use of local building materials in this locality, from table 4 above all the items were accepted because they fall within t-value of ±1.96.

Hypothesis 2

There is no significance difference between the mean responses of residents and masons regarding how residents of modern housing perceive locally built housing and its environment.

Table 5, t- Test analysis of Residents and Mason on how residents of modern housing perceive locally built housing and its environment.

N_1=30, N_2=20

S/N	ITEMS	$S.D_1$	$S.D_2$	t-test	Remark
1	Doubtful durability and life span of the indigenous building materials.	0.45	0.5	1.55	NS
2	Locally built houses have low aesthetic value.	0.5	0.5	0.37	NS
3	People tend to live an alternative housing to show their status in the society thereby making locally built house non-commercially viable.	0.4	0.42	0.19	NS
4	Believe that local house lack standards.	0.49	0.5	0.08	NS
5	Locally built houses do not have specification.	0.5	0.5	0.6	NS
6	Locally built houses are looked on as archaic.	0.5	0.5	0.89	NS
7	Locally built houses are looked on as if they are for low income group.	0.48	0.48	0.16	NS

N_1= Number Residents N_2= Number of Masons $S.D_1$= Standard Deviation of Residents $S.D_2$= Standard Deviation of Masons T= t- test of Residents and Masons. S= Significant, NS= Not Significant.

There is no significant difference in the mean response of Residents and Masons on how residents of modern housing perceive locally built housing and its environment, from table 5 above all the items were accepted because they fall within t-value of ±1.96.

Hypothesis 3

There is no significance difference between the mean responses of residents and masons regarding the modes of application involved in the use of local building material for building construction in this locality.

Table 6, t- Test analysis of Residents and Mason on the modes of application involved in the use of local building material for building construction in this locality.

N_1=30, N_2=20

S/N	ITEMS	$S.D_1$	$S.D_2$	t-test	Remark
1	Materials such as bamboo can be used for simple suspension bridges.	0.5	0.5	0.6	NS
2	Bamboo and timber can be used for scaffolding and formwork in building construction.	0.49	0.5	0.08	NS
3	Local materials such as timber and bamboo can be used as fencing materials on building construction sites.	0.48	0.48	0.16	NS
4	Stones can be used for pavements, slabs and gutters.	0.45	0.5	1.55	NS
5	Stones can serve as aggregates when preparing concrete for building foundations.	0.5	0.5	0.37	NS
6	Stones obtained locally are primary elements in cement production.	0.4	0.42	0.19	NS
7	Timber in local building construction can be used for doors, windows and furniture's.	0.4	0.46	0.83	NS

N_1= Number Residents N_2= Number of Masons $S.D_{1=}$ Standard Deviation of Residents $S.D_{2=}$ Standard Deviation of Masons T= t- test of Residents and Masons. S= Significant, NS= Not Significant.

There is no significant difference in the mean response of Residents and Masons on the modes of application involved in the use of local building material for building construction in this locality, from table 6 above all the items were accepted because they fall within t-value of ±1.96.

Findings

The following are the principal finding of the study according to the research questions.

Findings related to the factors limiting the use of local building materials in this locality.

- Local materials such as clay and timber easily absorb water when used on water logged areas.
- Stones used for local buildings are not usually cut to workable size before they are used.
- Not always easily available.

Findings related to how resident of modern housing perceive locally built housing and its environment.

- Doubtful durability and life span of the indigenous building materials.
- Believe that local house lack standards.
- Locally built houses do not have specification.
- Locally built houses are looked on as archaic.

Findings related to the modes of application involved in the use of local building material for building construction in this locality.

- Materials such as bamboo can be used for simple suspension bridges.
- Bamboo and timber can be used for scaffolding and formwork in building construction.
- Stones can serve as aggregates when preparing concrete for building foundations.
- Timber in local building construction can be used for doors, windows and furniture's.

Discussion of findings

The major findings of the study were discussed in line with research questions and hypotheses. Research question one dealt with the factors limiting the use of local building materials in that locality.

The result obtained from (table 3) reveal that all the factors identified were correct which hinder the availability of local building materials in this locality. This finding was in line with the view of WHO noted inFOA (1990)

The finding relating to local materials such as clay and timber easily absorb water when used on water logged areas is in line with FOA (1990) which stated that Trees are living organisms and contain large amounts of water. Moisture content of wood in freshly harvested trees ranges from about 50 to 200% (weight of water per weight of dry matter). For reasons of dimensional stability, physical strength and resistance to biological decay organisms, it is necessary to reduce the moisture content of finished wood products to below 25%. This was traditionally achieved through air-drying under shelter for several months or years.

Research question two dealt with how residents of modern housing perceive locally built housing and its environment

The result on table 4 showed that all the item identified are the factors militing the acceptability of locally built houses, this finding was in line with the view of Walker, (1999) who stated the reasons been social factors. Perception is one of the reasons for not accepting innovative solutions regarding materials and/or design. Beneficiaries/users have shown a negative attitude towards new solutions. The main reasons for this are:

• Lack of knowledge and information makes understanding of technical improvements more difficult; beneficiaries only trust what they have previously experienced (e.g. shape of houses, materials, etc.), any change is seen as lower quality

• Political statements have created high expectations regarding the quality of the dwellings, leading to a misunderstanding of the concept of "core house" upgrading

• Non-conventional materials for core wall systems are seen as "weak", causing distrust regarding the stability of the structure

The finding on locally built houses, having low aesthetic value this is in in line with Camila (2002) who stated that influences from foreign countries have refrained people from preserving and using traditional buildings materials and styles. Instead it has become preferred to live in houses similar to the middle and upper class society, which is the reason why concrete blocks are popular and more socially accepted.

The finding on durability and life span of indigenous building material is in view with Camila (2002) who stated that Durability of building depends on a variety of factors – the

design, construction methods, and purpose of the buildings, its aesthetics and the owner. The owner is the primary determinant on the lifespan of a building and that may also be affected by current and local fashions in architecture, lifestyles and economics. In addition, new materials which are being developed for exterior cladding, roofing and to replace preserved timber are difficult to assess as their durability and suitability for construction has not been proven over the long term.

Research question three dealt with the modes of application involved in the use of local building material for building construction

The result obtained from this research question reveal that the average mean response of the two group respondents is above 3.50. Indicating all the techniques needed to enhance the mode of application involve in use of local building material for building construction were all accepted. These finding revolves around issues like:

1. Materials such as bamboo can be used for simple suspension bridges.
2. Local materials such as timber and bamboo can be used as fencing materials on building construction sites.

The finding on Materials such as bamboo can be used for simple suspension bridges arein view with Wang and Shen, (1987).Who stated that Bamboo has a very long history with human kind. Its chips were used to record history in ancient China and it is also one of the oldest building materials used by human kind, for bridges suspension and extended to industrial applications due to advances in processing technology and increased market demand. It has also been widely used in building applications, such as flooring, ceiling, walls, windows, doors, fences, housing roofs, trusses, rafters and purling (Hardin *et al*., 2009). It is also used in construction as structural materials for bridges, water transportation facilities and skyscraper scaffoldings.

The finding on Local materials such as timber and bamboo used as fencing materials on building construction sites is in view with Janssen, (2000), there are several differences between bamboo and wood. In bamboo, there are no rays or knots, which give bamboo a far more evenly distributed stresses throughout its length. Bamboo is a hollow tube, sometimes with thin walls, and consequently it is more difficult to join bamboo than pieces of wood. Bamboo does not

contain the same chemical extractives as wood, and can therefore be glued very well. According to RMRDC (2004), the major uses in all the states are as scaffolding materials. Other uses include fencing, yam stakes, environmental amelioration, handicrafts and fuel wood. In the construction of story buildings, bamboo culms are used as pillars to provide temporary support for the decking. The use of bamboo for this purpose has opened up domestic trade for bamboo culms. Bamboo is also used in the construction of mud houses. In these areas, bamboo culms are used as frames to provide the skeleton for building. The mud is then used to cover the entire skeleton. Houses built this way usually have very straight walls, and they are stronger than mud houses built without bamboo. There are some situations where bamboo is used as poles for aerial antenna, electrification, rafters, fishing traps, etc. RMRDC (2004) further reported that the current uses of bamboo in Nigeria represent only a fraction of economic activities in the country. It has been traditionally used as fuel, food, for rural housing, shelter, fencing, tools, and various other purposes. In modern days, it is being used as industrial raw material for pulp and paper, construction and engineering materials, panel products, etc.

The hypothesis tested for this research question was accepted it show that there is no significant difference between the mean responses of the mason and the residence with regard to mode of construction with local building materials. The outcome is not new, because both the respondent, mason and house owners can identify things, that will lead to improvement of construction of local building skills needed by the mason and help improve in enhancement in mode of construction to help meet up with the challenges they could face as builders in future

CHAPTER V

Summary, Conclusion and Recommendation

Introduction

This chapter deals with the summary, the implication of this study and conclusion based on finding of the study and recommendation.

Summary of the study

This study has demonstrated that appropriate housing delivery strategy supported by adequate organizational capacity will provide tangible result in the provision of access to adequate and satisfactory housing. The purpose of this study was to Identify the factors limiting the use of local building materials in this locality, Determine how resident living in locally built housing environment perceive sustainable housing, Examine the modes of application involved in the use of local building material for building construction.

Related literatures were reviewed in the study. Mean, standard deviation and t-test were used as statistical tools to analyse the data collected from the respondents (masons and residents). A 50 item questionnaire was used as instrument for data collection which was analyse according to the research questions for this study. Three research questions were formulated and tested at 0.05 level of significance.

The study among others revealed that buildings in this locality using local material have been fading out due to civilization and the non-acceptability of the building by non-indigene settled there; also due to general believe that locally built houses have low aesthetic value. People tend to live an alternative housing to show their status in the society thereby making locally built

house non-commercially viable. To ensure a sustainable building using locally made materials all party must know the importance and the newest technology on ground in order to enhance the productivity of the construction with little or no stress and also the availability of these materials in a particular area.

The study also revealed that the respondents agreed with all the items with mean score ranging between 3.5 – 3.67. This signifies that all the factors limit the use of local building materials in this locality as presented in table 1. Table 2 revealed that the respondents agreed with all the items with mean score ranging between 3.5 – 3.8. This signifies that all the residents living in modern housing don't prefer living in locally built house and its environments which may be Lack of knowledge and information which makes understanding of technical improvements more difficult; beneficiaries only trust what they have previously experienced (e.g. shape of houses, materials, etc.), any change is seen as lower quality, Political statements also have created high expectations regarding the quality of the dwellings, leading to a misunderstanding of the concept of "core house" upgrading and Non-conventional materials for core wall systems are seen as "weak", causing distrust regarding the stability of the structure.

Conclusion

The study established that certain factors were required for the availability of local materials for construction; some factors militate against the actualization of constructing in these locality. It has shown that the adoption of different mode of application of these local materials can result in the provision of adequate housing for different categories of people at a very cheaper and affordable rate, which will in turn lead to improved quality of life among residents of public housing. The delivery system of local materials for housing projects can be vastly improved by

considering options for alternative design and techniques. These play an important role in the economic development for formal and informal sector. Technical sustainability, such as energy efficiency, diversification, life-cycle analysis of materials, control, responsibilities, impacts on nature and health, should receive more attention. Awareness on Social perception and attitude influence negatively on choice of design and material should be given due attention. In the pursuit of a sustainable society, improvements in the performance of the built environment have a considerable effect, and it is essential to have tools available to allow the relative performance of building designs to assessed Building professionals, architects and engineers, and artisans need to be trained and encouraged to use local materials wherever possible

Recommendation

• Promote designs with durable building materials to minimise maintenance

• Promote designs with building materials that offer possibilities of expansion

• Promote designs with affordable building materials

• Develop the potential use of local materials

• Avoid areas with clayey soil, torrential flooding or slopes in order to minimise costs for special foundations and damp proofing elements

• Raise the level of knowledge by the beneficiaries of alternative materials Facilitate an adequate supply of cost-effective building materials (de-concentrate the market by promoting competition)

• Promote investments in the local building and manufacturing industry

Suggestion for Further Study

The thesis exposes new areas of research that can be done, especially at a local level.

- Further studies on residents' perceptions of sustainable building could be undertaken. These could use different definitions of transitional residents and a larger sample size to capture that demographic
- Further research should be carried out on the effect of ageing on the crushing strength of fresh bamboo.
- Research into comparative analysis between locally built houses and conventional ways of building. Extensive research into the application areas of bamboo in Nigeria should be encouraged.

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Appendix B

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

QUESTIONNAIRE FOR THE EVALUATION OF THE EFFECTIVENESS OF THE USE OF LOCAL BUILDING MATERIAL FOR BUILDING CONSTRUCTION IN MAIKUNKELE LOCAL GOVERNMENT AREA IN NIGER STATE

Please give candidate response to the questions contained in the questionnaire to provide data for this study. The information provided will be used confidentially.

SECTION A

Personal data

Please read the questionnaire items carefully and tick (✓) the response appropriately in each item.

Masons ( ) Resident ( )

The response categories are:

Strongly agreed :……..…(SA)

Agreed :……...(A)

Disagree :…….(D)

Strongly Disagree :……..(SD)

SECTION B

Research question 1

What are the factors limiting the use of local building materials in this locality?

S/NO	ITEMS	SA	A	D	SD
1	Local materials such as clay and timber easily absorb water when used on water logged areas.				
2	Stones used for local buildings are not usually cut to workable size before they are used.				
3	Not always easily available.				
4	Materials like clay contain numerous amounts of impurities.				
5	Some local materials such as timber and bamboo are not resistant to eventual impacts.				
6	Early decay of bamboo.				
7	Slow setting of lime in stones.				
8	Local materials compared to modernized materials vary in physical properties.				
9	Local materials require more labor to work with.				
10	Local building materials like clay suffer shrinkage and cracking.				

SECTION C

Research question 2

How do residents of modern housing perceive locally built housing and its environment?

S/NO	ITEMS	SA	A	D	SD
1	Doubtful durability and life span of the indigenous building materials.				
2	Locally built houses have low aesthetic value.				
3	People tend to live an alternative housing to show their status in the society thereby making locally built house non-commercially viable.				
4	Believe that local house lack standards.				
5	Locally built houses do not have specification.				
6	Locally built houses are looked on as archaic.				
7	Locally built houses are looked on as if they are for low income group.				

SECTION D

Research question 3

What are the modes of application involved in the use of local building material for building construction in this locality?

S/NO	ITEMS	SA	A	D	SD
1	Materials such as bamboo can be used for simple suspension bridges.				
2	Bamboo and timber can be used for scaffolding and formwork in building construction.				
3	Local materials such as timber and bamboo can be used as fencing materials on building construction sites.				
4	Stones can be used for pavements, slabs and gutters.				
5	Stones can serve as aggregates when preparing concrete for building foundations.				
6	Stones obtained locally are primary elements in cement production.				
7	Timber in local building construction can be used for doors, windows and furniture's.				

APPENDIX C

Formula

Mean X = $\frac{\sum fx}{\sum f}$

$\overline{X}$ = Mean

$\sum$ = the sum of

X = the score

F = the frequency by each point in the scale

Standard Deviation

SD = $\sqrt{\frac{\sum f(x-\overline{x})}{\sum f}}$

$\overline{X}$ = Mean

$\sum$ = the sum of

X = the score

F = the frequency

T-test formula

$$\frac{x_1 - x_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

X_1 = Mean score of Residence

X_2 = Mean of Mason

S_1^2 = Variance of Residence

S_2^2 = Variance of Mason

N_1 = Number of Residence

N_2 = Number of Mason

Hypothesis, I; Item 1, standard deviation for Residence response

XFFxx- $\bar{x}$	**$(x-\bar{x})^2F$ $(x-\bar{x})^2$**		$\bar{x}$	$\bar{x}$	$\bar{x}$
4	10	40	0.33	0.1089	1.089
3	5	15	-0.67	0.4489	2.2445
2	0	0	-1.67	2.7889	0
1	0	0	-2.67	7.1289	0
Total15553.3335					

$\overline{X}$ = $\frac{\sum fx}{\sum f}$ S_1^2 = $\frac{\sum f(x-\overline{x})}{\sum f}$ SD_1 = $\sqrt{\frac{\sum f(x-\overline{x})}{\sum f}}$

$\overline{X}$ = $\frac{55}{15}$ S_2^1 = $\frac{3.3335}{15}$ SD_1 = $\sqrt{\frac{3.3335}{15}}$

$\overline{X}$ = 3.67 S_2^1 = 0.22 SD_1 = $\sqrt{0.22 = 0.47}$

Hypothesis I; Item 1, Standard Deviation for Mason response

			$\bar{x}$ **XFFxx- $\bar{x}$**	$\bar{x}$	**$(x-\bar{x})^2F$ $(\overline{x}-\bar{x})^2$**
4	0	0	1.97	3.8809	0
3	80	240	0.97	0.9409	75.272
2	40	40	-0.03	0.0009	0.036
1	35	35	-1.03	1.0609	37.1315

Total155	**315**	**112.4395**

$\overline{X} = \frac{\sum fx}{\sum f}$ $S_1^2 = \frac{\sum f(x-\overline{x})}{\sum f}$ $SD_1 = \sqrt{\frac{\sum f(x-\overline{x})}{\sum f}}$

$\overline{X} = \frac{315}{155}$ $S_2^1 = \frac{112.4395}{155}$ $SD_1 = \sqrt{\frac{112.4395}{155}}$

$\overline{X} = 2.03$ $S_2^1 = 0.72$ $SD_1 = 0.85$