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DEVELOPMENT OF A FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN AN URBAN AREA IN NIGERIA

By

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PREFACE

My interest in earthen architecture began as a child in my native country Nigeria. Despite the fact that I grew up to be fed with wrong notion that earth buildings are for the poor, I was still not deter in my passion to know more about this technique. This influenced my decision to study architecture in the University.

My training as an Architect in the University did not fully meet my initial expectations in terms of earthen architecture. However, this did not deter my determination to explore this area of speciality after my graduation. Fortunately, my first job upon graduation was with a construction firm that had a vision of earth construction and its conservation, and that was how my journey towards the promotion of earthen architecture in Nigeria began.

In practice, we were faced with sceptics who believed that earthen architecture no longer had a place in contemporary Nigeria and those that believe that the material could still be used since it is cheaper. We were part of the second group and as such our first major projects were under estimated, since we believed that the material was very cheap. With variation in cost on almost all our projects we had to critically analyse the situation and this led to some findings that contribute to my interest on this thesis subject. Our discovery was that earth buildings were built at minimal or no cost traditionally because the construction was through communal labour or self-built. As a consequence the cost was never calculated. Furthermore, the cost of material was considered to be free, since it was usually manually sourced within close proximity to the construction site. In addition to these factors is the fact that these traditional earth buildings were built without architects or engineers that needed to be paid huge consultancy fees. These factors coupled with other overheads associated with modern construction contributed to the current high cost of earth construction. Consequently, our initial experience in earth construction as a private entrepreneur was not too successful. Only very few clients were ready to spend huge sum of money to construct new buildings using the traditional technique, as a consequence most of our building projects we were involved with, were constructed of Compress Earth Bricks (CEB). The notion was that the CEB technique is more durable than the traditional techniques of *tubali*, cob, wattle and daub and the adobe block. However, this notion is not always true, with this conviction, I developed interest in adobe buildings most especially the repair of existing ones. This interest led to this PhD thesis.

ABSTRACT

Building with earth is still a living practice in Nigeria most especially in the northern region. Pear shaped sun-dried earth brick (*tubali*) was used traditionally by the Hausa in northern Nigeria. However, the use of *tubali* has ceased to exist in favour of the adobe blocks in both the urban and rural settlements in Nigeria. Sabon Gari, the study area is one of the urban areas in this region with buildings constructed with adobe. However, these adobe buildings are in deplorable conditions and in dire need of repair.

Sabon Gari in Kaduna was selected as the thesis' study area because of its strategic location and the dual function which the adobe buildings serve (i.e. residential and commercial purposes). This provided an opportunity to study the effect of the two activities on adobe building in an urban area. 20 compounds with buildings constructed with adobe blocks were selected and thoroughly examined. In the course of this study it was identified that the major factors inhibiting the repair of these buildings are social factors. This thesis therefore argued that with an appropriate framework these social factors can be corrected. Consequently, the adobe building in Sabon Gari can be repaired. This informed the decision to develop a repair framework through participatory approach involving the adobe building's stakeholders, which include tenants, landlords, architects, masons and the planning authority.

In the course of the development of this repair framework, this thesis draws on, and contextualises its argument on the fact that tried and tested repair strategies exists at international levels, which can be adapted to the situation in Sabon Gari. Consequently, ideas from relevant building repair literature, Terra conferences papers, earthen architecture conservation projects and adobe building repair projects were critically analysed and used in developing the proposed repair framework for Sabon Gari.

To ensure the sustainability of the framework, which is one of the research aims, the content of the framework was validated by some of the stakeholders interviewed at the inception of this research. This proposal was amended based on the stakeholders' recommendations and now has the input and approval of the stakeholders.

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ABBREVIATIONS and ACRONYMS

ABU	*Ahmadu Bello University, Zaria, Nigeria.*
ADB	*African Development Bank.*
ADC	*Abuja Development Control*
ATBU	*Abubakar Tafawa Balewa University, Bauchi, Nigeria*
BHSC theory	*Boulding and the Hierarchy of Systems Complexity theory*
BoQ	*Bill of Quantities*
CEA	*Centre for Earthen Architecture, University of Plymouth, UK.*
CEB	*Compressed Earth Bricks.*
CECTech	*Centre for Earth Construction Technology, Jos, Nigeria.*
CRATerre-ENSAG	*Centre Internationale de la Researches en Architecture de Terre- Ecole Nationale Superiore d'Architecture de Grenoble, France (International Centre for Earth Construction, Superior National School of Architecture, Grenoble, France).*
C:SoC	*Churches: Symbol of Community*
FRN	*Federal Republic of Nigeria*
GCI	*Getty Conservation Institute, Los Angeles, USA.*
ICCROM	*International Centre for Study of the Preservation and Restoration of*

Cultural Properties, Rome, Italy.

ICOMOS *International Council on Monuments and Sites.*

KASUPDA *Kaduna State Urban Planning and Development Authority*

KEPA *Kaduna State Environmental Protection Agency*

LCA *Life Cycle Analysis*

LCC *Life Cycle Cost*

MDG *Millennium Development Goal*

MLC *Max Locks Centre, University of Westminster, the United Kingdom*

MOTNA *Museum of Traditional Nigerian Architecture.*

NBRRI *Nigerian Building and Road Research Institute.*

NCCM *National Commission for Museum and Monument (Nigeria).*

NPC *National Population Commission*

OAU *Obafemi Awolowo University, Ile-Ife, Nigeria*

UNDP *United Nations Development Programme*

SDLC *Systems Development Life Cycle*

SPAB *Society for Protection of Ancient Buildings.*

TERRA *This is an acronym for the International Conference for the Study and Conservation of Earthen Architecture. The word 'Terra means building earth in Spanish*

UNESCO *United Nations Educational, Scientific and Cultural Organisation.*

UNESCO-WHC *United Nations Educational, Scientific and Cultural Organisation-World Heritage Centre.*

GLOSSARY OF TERMS

General Key Terms

- **Adobe:** Adobe is a precast sun–dried earth block or brick to which straw is added, either shaped by hand or moulded with formwork in its plastic state.
- **Adobe building**: In this thesis adobe building is refer to building made from rectangular adobe block, unlike the traditional adobe buildings that were constructed from handed moulded, pear shaped adobe brick called *tubali* in Hausa.
- **Cob**: A technique of earth building that entails mixing of earth, straw and water to plastic state that is easily workable to construct a mass walls or fence.
- **Framework**: In the context of this thesis a framework is a plan of action or a strategy that is required in the repair of adobe building (De Wit & Meyer, 2004:24).
- **Harem**: is the women's section in the house, often a courtyard surrounded by walls high enough to shield the women from outside intrusion as well as for privacy.
- **Hausa**: a tribe and language spoken in the northern Nigeria, They constituent about 40% of the population in the north.
- **Repair**: The definition of building repair in the Burra Charter on conservation for places of cultural significance (Australian ICOMOS, 1990) is use in this thesis. In this charter repair is define as the act of restoration (e.g. returning of dislodged gutters) and that of reconstruction (e.g. replacing decayed gutters) (Australian ICOMOS, 1990:2).
- **Sandcrete block**: This term refers to concrete block in Nigeria.
- **Sustainable**: In the context of this thesis sustainability means all action that is appropriate in terms of economic viability, social enhancement and environmentally friendliness in the course of adobe building repair.

Key Terms in the Proposed Repair Framework for Contemporary Adobe Building in Nigeria

- **Easement:** The rights and privileges a building enjoys over adjoining buildings and infrastructure as contain in the Nigerian Town and Country Planning Act of 1986 (NITP, 1987:3).

- **Harem:** The interior courtyard of a building in Islamic architecture, which use by women in purdah for domestic chores and relaxation as required under the Islamic law.

- **Land lord:** This shall mean the legal owner of the adobe building to be repaired.
- **Occupants:** The people living in the adobe building to be repaired this includes both the land lords and tenants.

- **Person in charge:** This shall mean the building professional that is commissioned by the land lords or tenants to carry out adobe building repair. The person in charge of adobe building repair shall be an architect, civil engineer, builder etc. as specified in the Nigerian Building Code (FRN, 2006:v) and also discussed in section 6.2 in chapter six. The qualification and requirement of person that can be commissioned to carry out adobe building repair are discussed in greater in part three of the framework.
- **Purdah:** Act of secluding women from men other than family relationships practice by the Moslems.

- **Stakeholders:** This shall mean land lords, tenants, person in charge of repair, neighbours, government officials responsible for building regulations and other people that the building may have direct or indirect effect on their lives.
- **Tenant:** This shall mean the occupant of adobe building who is not the legal owner of the building but living in the building through mutual agreement with the land lord or his/her representative upon agreed monthly rental fees and other conditions that are attached to tenement in the Nigerian tenement law.

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CHAPTER ONE

INTRODUCTION

'Dancing rhythm must change with change in the tune of the drumming[1]

- Nigerian indigenous proverb

1.0. The Thesis in Brief

Earth was used traditionally in Nigeria for construction of buildings (Guillaud, et. al., 1995:17). The variation in weather and climate between various regions in Nigeria is responsible for the varying soil geology in these regions. In response to these geological differences various traditional techniques evolved (Dmochowski, 1990, vol.1:vii). Cob technique was used in the south west region, wattle and daub in the south east, while the pear shaped sun-dried earth bricks (*tubali*) was used in the northern Nigeria. However, earth construction has been on the decline in Nigeria since the early 1970s due to the preference of factory processed building material (Guillaud, et al., 1995:17). The rate of decline in earth construction in the north is not as much as in the south (Ogunsusi, et. al, 1994:12). However, the traditional *tubali* has been replaced with the adobe block technique in the north. This technique is widely used by those that could not afford concrete building in both the rural and urban settlement in northern Nigeria. According to Osasona (2010:11) the adobe technique is gradually becoming popular even in the south (see also appendix 1.4.2b). It was however identified in the course of this research that although adobe is currently being used in construction of buildings, there is still the negative perception that the technique and earth construction in general in Nigeria is for the poor (see appendices 1.4.5a; 2.2.2; 2.2.3 and 2.2.4). Consequently, buildings constructed with earth are poorly executed and hardly maintained. The adobe buildings which are mostly affected are those recently built. The situation is even more critical in the non traditional urban area as identified in the course of this study (see chapters four and five). This thesis therefore focused on how to repair the adobe building in an urban area.

[1] This proverb translates in Hausa as: *'idan kidi ya chanza dole rawa ya chanza'.*

Sabon Gari being a non traditional area in an urban settlement was chosen as the study area of this thesis. Using questionnaires and interviews data relating to the repair of adobe building was generated in Sabon Gari. 20 compounds with adobe buildings were selected in Sabon Gari and their conditions were critically surveyed. The findings from this study reveal that the factors that are hindering the repair of these buildings are more of social than technical issues (see chapter four and appendix 1). Furthermore, an additional study of traditional areas in three towns of Zaria, Offa and Akamkpa (in the north, south west and south east regions respectively) was carried out using a similar methodology as in Sabon Gari (see chapter five and appendix 2). Figure 1.1 is the map of Nigeria showing the location of the three towns. The findings from these three urban areas reveal that although the earth buildings in these towns also requires repair, the causal factors are not the same as Sabon Gari. For example, the buildings in Sabon Gari are occupied by tenants and landlords, while the buildings in the three cities are occupied by their respective owners. The consequence of occupancy type is that decision in relation to the building repair can be easier in the latter than in the former.

Other critical finding in Sabon Gari is the frequent remodelling of the adobe buildings for commercial and residential purposes using inappropriate material (see chapter four). Furthermore, this frequent remodelling is being carried out without the approval of KASUPDA, which is the building regulatory agency in Kaduna State (see chapter six). More importantly, is the fact that the repair of adobe building is not included in the Nigerian Building Code. As a consequence the construction and repair of adobe building are being carried out without official recognition and approval.

This thesis therefore argued that the adobe building in Nigeria deserve equal attention as any other construction technique in Nigeria. The study also maintains that the adobe building in Sabon Gari can be repaired if the knowledge exists. As a consequence a repair framework for the adobe building in Sabon Gari is developed in chapter eight.

To ensure the sustainability of repair in the study area (Sabon Gari), a participatory approach was used in the development of this framework. The participatory approach involves the identification of stakeholders in the adobe building in Sabon Gari from the inception of the research. The stakeholders are the adobe building tenants and landlords, masons, architects, engineers, plumbers, electricians and carpenters in Sabon Gari, as well as the staff of KASUPDA and the Kaduna State's Rent Tribunal. The stakeholders were interviewed during the field survey in July and August 2006 in Kaduna, Nigeria. Thus, the research problems were identified in collaboration with these stakeholders. Furthermore, the first draft of the repair framework was validated by some of the stakeholders. The feedback received from the stakeholders was used in amending the final version of the repair framework presented in chapter nine.

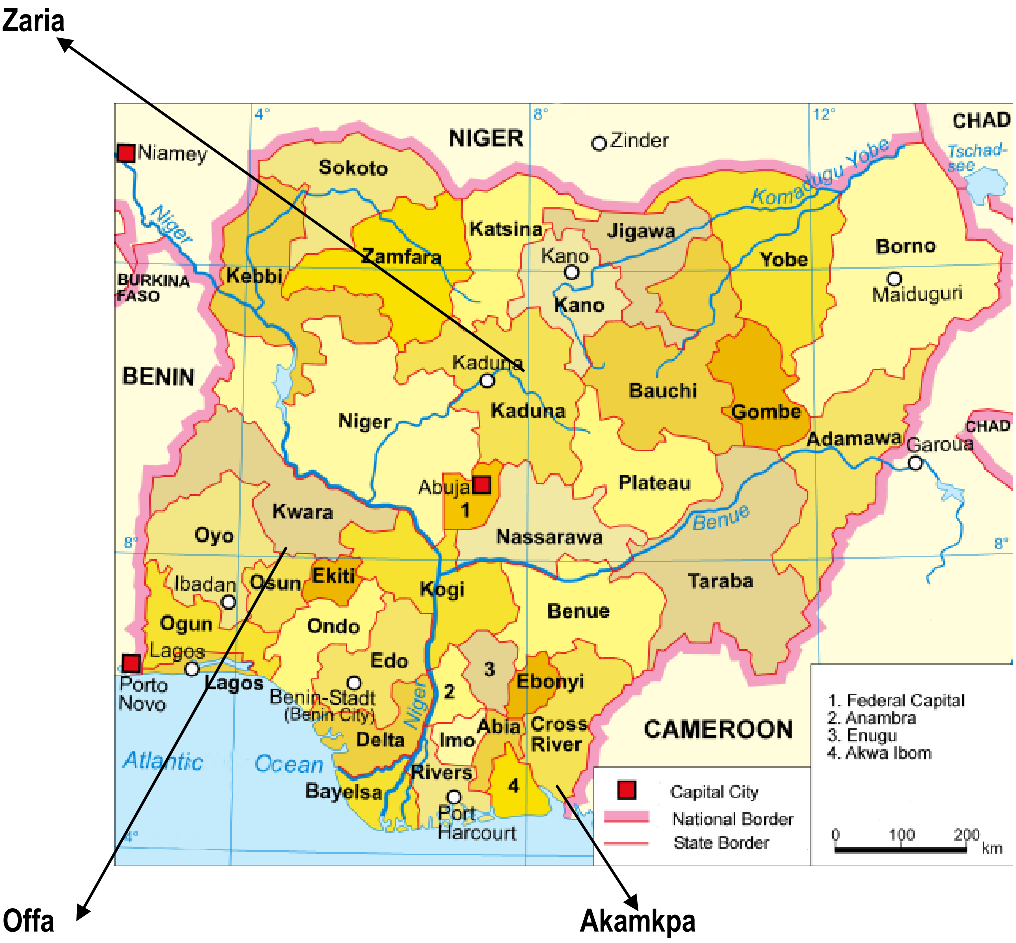

Figure 1.1: Map of Nigeria showing the 36 States, Federal Capital, the City of Kaduna and the three urban area

Source: http://upload.wikimedia.org/wikipedia/commons/d/d2/Nigeria_political.png, accessed on 13th May, 2009

1.1. Definitions of Key Terms

The following key terms are defined in the context of this thesis:

1.1a. Sustainable: Sustainability means all action that is appropriate in terms of economic viability, social enhancement and environmentally friendliness. In the context of this thesis therefore sustainable repair means the repair of adobe building that is economically viable, socially acceptable and with minimal or no negative impact on the environment.

1.1b. Building repair: The act of returning a building to an acceptable condition through renewal, replacement or mending of worn, damaged or decayed parts.

1.1c. Framework: In the context of this thesis a framework is a plan of action or a strategy that is required in the repair of adobe building.

1.1d. Adobe: Adobe is a rectangular sun-dried unstabilised earth block. An adobe building is therefore referred to building constructed from rectangular adobe block.

1.1e. Tubali: Pear shaped sun-dried unstabilised earth brick.

1.1f. Compound: A group of buildings in one plot of land, belonging to one person that is being referred to as the landlord.

1.2. The Study Area

The thesis' study area is Sabon Gari in Kaduna, Nigeria. Sabon Gari in Hausa means 'New Town'. Just as the name suggest the area is mostly inhabited by settlers that are not indigenous to the town, while the indigenes lives in traditional settlements called cities, e.g. Zaria city, Kano city, etc. On the contrary, there is no area in Kaduna called Kaduna city. This is because Kaduna was founded in 1911 by the British imperial government, thus there is no area in any part of the present day Kaduna that was or still in habitat by indigenes. The name Sabon Gari is not unique to Kaduna, as these areas can be found in many towns and cities in Nigeria, e.g. Zaria, Kano, Ibadan, Ife, etc. (Schwerdtfeger, 1982:12). The composition of the inhabitant of Sabon Gari settlements in all these towns and cities remains heterogeneous, comprising of migrants from different part of the country (Theis, et. al. 2002:D4). For example, over 90% of the adult population in Sabon Gari, Kaduna were not born in Kaduna, but migrated from all over Nigeria as at 2002 (Theis, 2002:12).

The centrality of Sabon Gari, Kaduna, coupled with the fact that it is the commercial nerve centre of the city of Kaduna, as well as its proximity to the administrative areas (see figure 1.1), made this segment of the city attractive to the non indigenes that are predominately traders and private entrepreneurs. The city's central market, shopping malls, printing and publishing companies, etc. are all located in Sabon Gari. Because the migrants from southern states of Nigeria never consider living in Kaduna permanently they found it more comfortable living in this mixed use zone of the city (Sabon Gari). The location of the area provides these southern migrants the convenience of residing and doing business in the same place, which eliminates daily transport to work places.

In terms of educational facilities, Sabon Gari is host to several primary and secondary schools. These schools are within walking distances that children do not have to commute to school. There are seven Government's owned primary schools in Maiduguri Road, Gwari Road, Bida Road, Adamawa, Ogbomosho Road, Constitution Road and Daura Road, as well as significant number privately owned (Bowden & Maconachie, 2003:7). No any other part of the city of Kaduna has the same high number of Governments primary schools as Sabon Gari. Furthermore, the area shares boundary with Tudun Wada were the Polytechnic and the General Hospital are situated (see figure 1.1). These two institutions are situated at the boundary between Sabon Gari and Tudun Wada, which is also within walking distance for the residents of Sabon Gari. The availability of these facilities as well as opportunities for businesses is some of other major factors why buildings in Sabon Gari are in high demand.

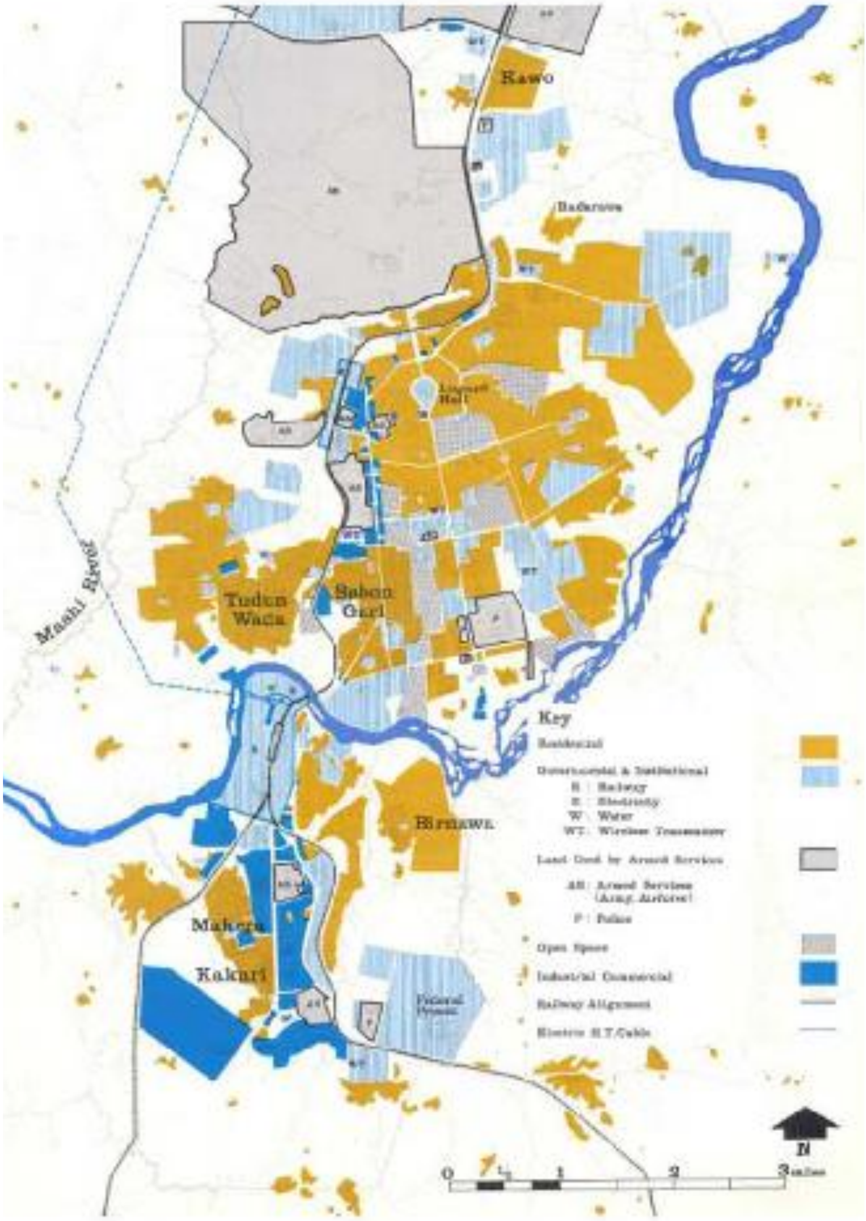

*Figure 1.2: Kaduna land use map showing Sabon Gari (the study area) and the remaining segments of the city. (**Source**: Max Lock Centre Report, prepared by - Theis, et. al., 2002).*

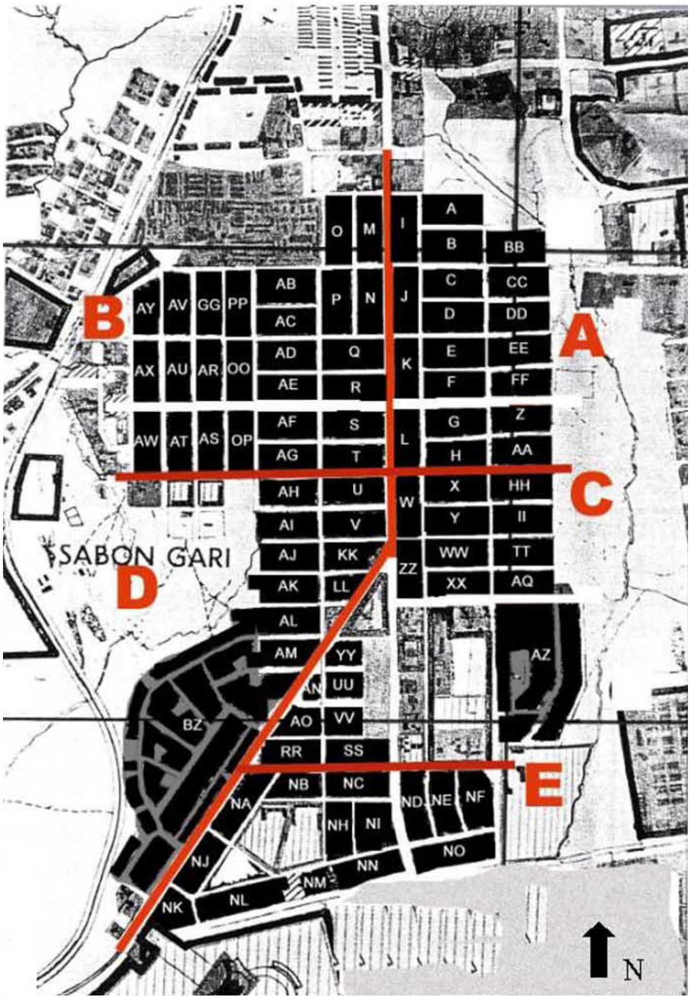

*Figure 1.3: Layout plan of Sabon Gari. Note the rectangular pattern grid layout. (**Source**: Max Lock Centre Report, prepared by – Theis et. al., 2002)*

1.3. Factors Influencing the Choice of Sabon Gari, Kaduna as the Thesis' Study Area

Apart from the factors already discussed above other critical issues influenced the choice of Sabon Gari in Kaduna as the study area includes:

1. The uniqueness of Kaduna as the only city in Nigeria that was not originally founded by one particular ethnic group (Theis, et al., 2003:34). This is reflected in the population of Sabon Gari being heterogeneous, comprising of various ethnic groups from across the country. Being the capital of the least developed region in terms of education, technology and commerce, the city of Kaduna has been a major attraction of labour from other regions since the its creation in 1911 (Theis, et al., 2003:D4). As a consequence, appropriate repair of the buildings could have

ripple effects in other part of Nigeria through the migrants, when they eventually returned to their native States.

2. The city was founded and designed in the 20th century by the British administrators. The spatial planning of the city was therefore European in style, i.e. grid pattern unlike traditional cities that have cluster layouts (see figure 5.2 in chapter for layout plan of the traditional city of Zaria). Though the planning was modern, earth was used for construction of most of the earliest buildings in Sabon Gari (Theis, et. al., 2002:3). Thus, the uniqueness of Sabon Gari as a settlement with modern layout but with buildings originally constructed of earthen material provides the opportunity of proposing a strategy for the repair of earth buildings in such a setting.

3. The city is centrally located and easily accessible by road, rail and air. In addition, Kaduna is a meeting point of the two major rail lines in Nigeria (Lagos to Kano and Port Harcourt to Kano) which gave the city another name: '*Kaduna Junction'*. Furthermore, major highways to Lagos from Maiduguri, Kano, Katsina, Sokoto, etc. all in the north intersect in Kaduna. Thus, the centrality and accessibility made Kaduna a meeting point for travellers from other part of the northern states travelling to the southern states. The city of Kaduna has always been a major influence in various human endeavours in the northern Nigeria, being the administrative capital of the defunct northern region. It is this influence that this thesis intends to explore by proposing a repair strategy for Kaduna with the hope that the effect will spread to other northern cities and villages in Nigeria.

4. Sabon Gari was originally designed as the strangers' settlement[2] and this initial concept still remains to this day. Thus, the proposed framework could be useful to other towns and cities in Nigeria because of the multi-attributes characteristics of these adobe buildings in Sabon Gari.

5. The mixed used (residential and commercial) of the adobe buildings in Sabon Gari provides an opportunity to analysed and proposed solutions for the repair of mixed use adobe buildings.

6. The strategic location of Sabon Gari as the central business district of Kaduna (see figure 1.2) and the presences of these buildings in the area can influence attitudinal change in favour of adobe buildings if a sustainable repair strategy is developed.

1.4. Justification for the Study

Shelter is second to food and clothing in terms of basic human needs (UNHabitat, 2008:12). However, meeting human's need for shelter is capital intensive, which even the developed countries are struggling to meet this need (UNHabitat, 2010:2). The continous dwindling of Nigeria economy in recent years has made it increasingly difficult for majority of Nigerians most especially those in urban centre to own a house or to maintain the existing ones (Osasona, 2010:4). In an attempt for affordable buildings the adobe technique has increasingly become popular in both the urban and rural areas in Nigeria (Ogunsusi, et. al., 1994:5). However, this is out of necessity not choice. This led to dispassionate attitude towards the care and maintenance of these buildings. Furthermore, the dearth of skilled artisans and the lack of earthen architectural knowledge among the Nigeria building professional meant that the buildings are often repaired using inappropriate material most especially cementious material.

It is obvious that repairing any kind of building could be more cost effective than building new one. This economic advantage can even be greater with earth building if carefully plan and executed. For example, earthen material can be recycled (Avrami, 2010:328), thus there may be less need of buying

[2] Settlers (migrants) not originally from Kaduna and most especially none Hausa speaking migrants from south and central region of Nigeria are refer as strangers and Sabon Gari was designed as the area for these group of migrants.

material during repair. Furthermore, there is the psychological and emotional attachment humans have to buildings they live in for a long time (Olotuah, 2008:11). Of which demolition and rebuilding could displace people temporarily or permanently, which could have damaging effect on those displaced. Displacement will also affect businesses, education of children, social life, etc. (as in the case of Sabon Gari), which cannot be monetary compensated. In terms of ecology, repairing existing building will not have further negative impact on the environment.

Despite these advantages, the repair of adobe building in Sabon Gari is unrealistic unless if appropriate action is taken. In the course of this research it was identified that examples of good repair practices exist around the World that can be adaptable to the situation in Sabon Gari. As a consequence, this thesis explores this existing know-how to develop a repair framework for adobe building in Sabon Gari.

Although the majority of the occupants of the adobe building in Sabon Gari are transient settlers, the buildings were meant to be permanent. Evidence to this claim is the use of corrugated iron as against the traditional thatch or earth for roofing of these buildings. The fact that this expensive roofing material was originally used for many of these adobe buildings implies that the original intention was that these buildings should remain permanent. Thus, the decision to develop a repair framework is justified.

1.5. Study's Aim

The aim of this thesis is to develop a framework that can be used for sustainable repair of adobe building in Sabon Gari, Kaduna. The developed framework is a guideline on a sustainable process to follow when embarking on the repair of adobe building. It was therefore designed to meet the social and economic aspirations of the people using these buildings and within the limit of the local environment.

1.6. Study's Objectives

The above aim was achieved in this thesis as follows:

I. Review of relevant literature. This review was aimed firstly at presenting bodies of knowledge on the subject, secondly, identifying the gap in the literature, and third, defining the thesis' contribution to knowledge in earthen architecture. The review is presented chapter two.

II. Refinement of thesis' aim and presentation of the research methodology. Theories and concepts were used to further articulate the research aim and to present the research methodology in chapter three.

III. Identification of appropriate study area. Sabon Gari was chosen and the adobe buildings were critical studied. The field survey data in Sabon Gari is critically analysed in chapter four.

IV. Study of earth buildings in urban areas in three cities in Nigeria. The field survey data in the urban areas in Zaria City, Offa and Akamkpa was critically analysed in chapter five.

V. Critical appraisal of construction framework in Nigeria. The Nigeria building regulations and the construction industry in general were critically appraised in order to identify the legislative and industrial place of adobe building in Nigeria. This appraisal is presented in chapter six.

VI. Formulation of a structure for proposed repair framework. This was achieved in chapter seven by critically analysing good practices in building repair in different countries around the World and relevant strategies were adapted to the situation in Sabon Gari. Factors considered in the selection of the strategies used in structuring the proposed framework are economic, social and environment issues relating to Sabon Gari.

VII. Development of the framework. The proposed repair framework was developed in chapter eight using the structure formulated in chapter seven.

VIII. Validation of the framework. The repair framework was validated by some of the stakeholders as earlier explained in section 1.1. The amended framework is presented in chapter nine.

IX. Critical reflection and recommendation for further research. The limitations of the repair framework were identified and recommendations on how to effect them were proposed as part of future research in chapter ten.

CHAPTER TWO

LITERATURE REVIEW

At the present time the quality of earth construction has deteriorated considerably, because traditional know-how has been forgotten or is lacking. On the other hand certain solutions which may have been suitable in the past are no longer feasible because of changing economic circumstances and technologies.
- Houben & Guillaud (1994:245)

2.0. Introduction

Houben & Guillaud (1994:245) identified the decline or loss of traditional knowledge and the inappropriateness of this traditional know how in some instances as the major factors affecting the quality of earth construction in general (see the above quote). These factors invariably affect the level of care of the existing earth buildings nowadays. Despite the acknowledgement that not all the traditional techniques are currently appropriate, earth buildings repair strategies available in literature are mostly conceived with the notion that these buildings are traditional. Thus critical factors which manifest on non traditional earth buildings due to the changing social and economic circumstances (noted in the above quote) are often neglected, which makes these strategies inadequate. Examples of these changes that are unique to the adobe buildings in Sabon Gari are: ownership, remodelling, mix use, etc. (see section 1.4 in chapter one). Unfortunately the literature on repair of traditional earth buildings did not address these issues. Furthermore, maintenance is often favoured as against repair in literature on earthen architecture (Houben & Guillaud, 1997:245). In some instances repair and maintenance are discussed simultaneously (e.g. Hughes, 1984; Seeley, 1987; etc.); which could suggests that both activities must take place at the same time. However, Chudley (1981:1) explained that building repair is different from maintenance. This point is explained in greater detail in section 2.1 below. Furthermore, in the course of this research it was identified that maintenance is no longer feasible in Sabon Gari due to some of the reasons already mentioned above and briefly explained in chapter one and in greater details in chapter four. Thus, the focus of this thesis is building repair only.

As a consequence of the above limitations, this chapter is in four parts. The first part contains the definitions of repair, maintenance, building repair and building maintenance from dictionary and other scholarly literature. This is aimed at defining and clarifying the difference between repair and maintenance that are often misconceived to be the same (Chudley, 1981:1). The second part contains review of literature on modern buildings. This is aim at identifying the character and key considerations in the repair of recent (modern) buildings, as well as how these considerations are relevant to the adobe buildings in Sabon Gari. The third part contains the review of literature on earth building repair in general and the adobe buildings in particular. The fourth part is the review of literature on sustainable architecture.

The central aim of this review therefore, is to first of all review literature pertinent to the thesis and to identify the gap in literature in order to define the scope and the original contribution this thesis is making to the field of earthen architecture.

2.1. Definitions and Distinctions between Building Repair and Maintenance

The Oxford English Dictionary defines repair as:

> *'the act of restoring to a sound or unimpaired condition; or the process by which this is accomplished; or the result attained as a consequence of intervention' (Simpson & Weiner, 1989:627).*

In the context of building, both CIOB (1982:2) and Watt (2007:219) adopted the BS 8210 (1986) definition of repair, which defines building repair as:

> *'restoration of an item to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts'*

The key words in the above definitions are 'restoring' (in the first definition) and 'restoration' (in the second), both words are derived from the word 'restore' which means bringing something back to original condition (Simpson & Weiner, 1989:627). Thus, building repair is an act of renewal of deterioration or mending of buildings in state of disrepair.

Maintenance on the other hand is defined in the Oxford dictionary as:

> *'the action of upholding or keeping in being (a cause, right, state of things, government, etc.); the state or act of being upheld or sustained; that which upholds; or means of sustentation' (Simpson & Weiner, 1989:225).*

In the context of building, both Seeley (1987:1) and Watt (2007:219) adopted the BS 3811 definition of maintenance, as:

> *'the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function'.*

The phrase 'the action of upholding or keeping in being' in the first definition implies preservation. Thus, maintenance is an act of preservation or preserving a cause, right of things, state of things, etc. in acceptable condition. On the contrary, the above definition of building maintenance included restoration (restore), which from the definition of the word means the act of repair (see Simpson & Weiner, 1989:625). Despite the clarity in the definitions of the two words (i.e. repair and maintenance), the above definition of building maintenance and other authors included repair as part of maintenance, e.g.: CIOB (1982:2), Smith (1993:1) and Douglas (2008:12). However the aim of maintenance is to preserve the building. In order to clarify this contradiction, Chudley (1981:1) traced the origin of the word 'maintenance' to French word 'maintenir' which means 'to hold' or to preserve. Chudley (1981:1) therefore argued that the common conception that building maintenance is always synonymous to repair is not true. He concluded that repair is different from maintenance and both activities can be carried out independently of the other. Table 2.1 below summarises the differences between building repair and maintenance.

		Building Repair	**Building Maintenance**
1.	**Definition**	Reinstatement of part or parts of building to acceptable condition through mending	Preventive measure towards retention of building to acceptable state that it can

		of worn, damaged or decayed parts of the building (Watt, 2007:219).	perform its function (Chudley, 1981:1)
2.	**Causes**	Accident, wear and tear, misuse, inappropriate material and technique; lack of maintenance; failure of part; etc. (Hill, 2010:3)	Acceptable wear and tear; daily uses; etc. (Douglas, 2008:12)
3.	**Aim**	Building repair is aimed at correcting decay or damage (Doran, et. al. 2009: 3)	Building maintenance is aimed at preventing decay or damage (Seeley, 1987:3).
4.	**Nature**	It can be accidental or unpredictable. It may also require urgent attention (emergency) to avoid collapse	It is predictable, can therefore be planned
5.	**Frequency**	Building repair is a specific task conducted only when there is defect and it is within a time frame	Building maintenance is a continous process
6.	**Examples**	Replacement of leaking roof; mending of cracks on walls; screeding of cracked floor; etc.	Daily cleaning (sweeping, mopping, etc.); repainting of walls, ceiling, etc.; periodic cleaning of drains; etc. (Ahluwalia, 2008:12)

Table 2.1: Differences between building repair and maintenance

There is also distinction between the term maintenance and repair in Nigerian traditional earthen architecture. Moughtin (1985:67) noted that repair of earth building was seldom required in northern Nigeria because of culture of maintenance. He identified that planned preventive maintenance and scheduled maintenance were common. He explained that maintenance work which is mostly the reapplication of water proof render to earth roof, walls and other exposed part of the buildings were carried out at the beginning of every rainy season. This type of maintenance as described by Moughtin (1985) is a planned and schedule maintenance (see Seeley, 1987:2), which is aimed at preserving the building so as to avoid repair. Schwerdtfeger (2008:50) and Olotuah (2010:43) noted that this practice of planned and schedule maintenance have seized to exist in contemporary Nigerian. As a consequence, this thesis identifies building repair as a separate activity from maintenance.

Building repair is not included in the Nigerian Building Code, however in the development control manual of the Development Control Department (DCD), Federal Capital Territory (FCT) Abuja, building repair is classified as either minor repair or major improvement works (DCD, FCT, 2008:58). On the other hand maintenance of existing buildings (see FRN, 2006: 361; section12.1.1) and conservation of listed buildings (see FRN, 2006:427; section 13.22) were included in the post construction requirements in the Nigerian Building Code. Although there was no defined boundary of what building maintenance should entails in this building code, however, it contains description of how to carry out maintenance of various elements of buildings such as chimney, beam holes, party walls, adjoining roofs, etc. Sections e.g. sections 12.1.2.3 and 12.1.2.6, contains maintenance requirements for adjoining properties and party walls respectively. These are prevailing issues that were identified during condition survey of the adobe buildings in Sabon Gari. Thus, are considered in the proposed repair framework in chapter eight.

For above the reasons and those already explained in sections 1.3 and 1.4 in chapter one, this thesis is limited to building repair and the adobe building in Sabon Gari is consider as recent or modern building not traditional. Consequently literature on modern (recent) building repair is reviewed below.

2.2. Modern or Recent Buildings

Adobe construction in many countries is synonymous to traditional architecture. In the US for example adobe technique has been in existence for more than hundred years in areas such as New Mexico (Taylor, 1993:590). However, the adobe block technique is a more recent introduction in Nigeria (Guillaud, et. al., 1995:17). Being recently built, the adobe building in Nigeria most especially those in the urban settlements like Sabon Gari are faced with challenges that are not peculiar to traditional earth buildings. Thus, the repair of this type of adobe building cannot be implemented using the traditional knowledge alone. As a consequence literature on modern buildings is reviewed in this section.

The distinction between traditional and non traditional (modern) buildings differs from one country to another. For example, Chandler (1991:10) considers buildings constructed in the UK from around 1919 (just after the First World War) as modern. On the other hand, Saint (1999:16) considered all buildings constructed in the UK in the twentieth-century as modern. While some authors such as Ellis et al. (1975:3) classified buildings as ancient, nineteenth-century, and twentieth-century buildings. In the context of Nigeria, buildings are often classified as modern or traditional based on material and technique. For example, Dmochowski, (1990) described the traditional buildings in Nigeria based on the material and technique of construction, without reference to date or period of construction. Other literature such as Guillaud, et. al. (1995:17) and Barrera (1997:47) assumes that all buildings constructed in Nigeria with unstabilised earthen material are traditional, while those constructed from factory process material such as concrete are modern.

The only attempt at classification of Nigerian architecture in general based on period of construction and style as far as the author is aware was by Prucnal-Ogunsote (1993). In her thesis, Prucnal-Ogunsote (1993:17) classified buildings constructed in Nigeria from the late 1930's as modern. However, the adobe block technique was neither included in this group nor in any other group in Prucnal-Ogunsote's thesis. Although Dmochowski (1990, vol. 2:3.5) identified that the Nupe in Central region of Nigeria used earth bricks for construction of their traditional buildings, however, his description of these bricks shows that they are not the same as adobe block. He described the Nupe earth brick as small and irregular in shape and size, unlike the adobe blocks that are big with regular shape and uniform sizes as described by Guillaud, et. al. (1995:61). In their study of earth buildings in Plateau State in Nigeria, Ogunsusi, et. al. (1994:29) identified that the adobe block technique is a recent innovation in the state. They further explained that the adobe block has become the most widely used technique in both the rural and semi urban settlement in the state for those that cannot afford concrete blocks. Similarly, Guillaud, et. al. (1995:17), Barrera (1997:47), Ogunsusi (1997:29), Thierry (1997:17) all identified that the adobe block technique is a recent introduction in Nigeria and has become the mostly widely used earth construction technique in both the rural and urban settlements.

Buildings are also classified in terms of building character. For example, Saint (1996:16 to 28) identified and explained six characteristics that distinguish modern buildings as:

I. **Number**: Saint (1996:16) explained that there are more existing modern buildings than traditional ones. This is because more buildings were constructed in recent times than in the past. Furthermore, age have resulted in old buildings become obsolete or deteriorates and several have to be demolished.

II. **Techniques**: Saint (1996:17) further argued that the pace and manner of construction in the 20th Century made it possible to construct more buildings than in the past. He therefore pointed that this difference in technique has rendered older conservation philosophies irrelevant in the conservation of modern buildings. Watt (2007:23) also noted that the technique of construction of modern buildings differ from the traditional types, thus the approach to repair cannot be the same.

III. **Intention**: Saint (1996:20) further argued that the purpose (intention) of which modern buildings were constructed are not the same as for the traditional buildings. He explained that modern buildings are mostly design for multi functional purposes or larger capacity. These factors accelerate the rate of wear and tear in modern building and also its repair.

IV. **Performance**: Saint (1996:22) argued that modern buildings are not design to have the same longevity only unlike traditional ones, due to high demands, cost and speed of construction. As a consequence repair or conservation of modern buildings may involve replacement instead mending because the component may have shorter life expectancy in comparison to traditional buildings.

V. **Viability**: Saint (1996:24) explained that modern buildings are designed for specific function that is still viable today. Unlike those built in the past that requires adaptation because social issues have made the original functions obsolete, e.g. Church buildings. He is therefore of the opinion that adaptation may not be a key issue in conservation or repair of modern buildings.

VI. **Appeal**: Saint (1996:27) is explained that because there are more modern buildings, they are less appealing unlike the traditional buildings that are fewer. As a consequence, there is always the tendency to be more sympathetic to the conservation of traditional buildings instead of modern ones.

The strategy for repair of modern building also differs from the traditional types. For example, Chandler (1991) in his book on the repair and refurbishment of modern buildings identified and discussed the following nine issues:

I. Identification of period of construction

II. Causes of deterioration

III. Condition survey or diagnosis

IV. Possible repair options

V. Documentation

VI. Viability of repair in terms of cost

VII. Work programming (schedule)

VIII. Case studies

IX. Decision on whether to repair or replace

The difference between traditional and modern buildings from the above literature is that in the later data (e.g. date of construction, drawings, past interventions, etc.) on the building is often limited. Consequently, literature on repair of traditional buildings most especially earth buildings always includes research into building history (e.g. McHenry, 1984:12; Crosby, 1987:33; Alaamandour, 2003:10; Baca, 1993:256; Watt, 2007:23; etc.). This research often involves archives, libraries, local planning authorities, etc. (McHenry, 1984:12). Not all earth buildings are traditional, neither is all historical nor of cultural significance, however, conservation philosophy is often applied in their conservation. For example, Keefe (2005:164) recommended minimal intervention, with the assumption that all earth buildings are traditional. On the other hand, modern buildings are assumed to have all relevant document, thus requires no historical research as demonstrated in Chudley (1981); Chandler (1991); Doran, et. al. (2009); etc. This is the dilemma in the context of the adobe building in Sabon Gari. This is because the buildings are recently built but have no documented records expected of modern building.

The only available record on the adobe buildings in Sabon Gari is in the two studies conducted on the city of Kaduna (which included Sabon Gari) by the Max Lock Centre (MLC), University of Westminster in 1965 and 2002 (Theis, et al. 2003:17). However, this record is generic, thus detail record of individual building still need to be generated when carrying out repair of any of these buildings in Sabon Gari. As a consequence, historical research needs to be included in the repair strategy for adobe buildings in Sabon Gari, in addition to other factors relating to modern building repair.

2.3. The Adobe Building and its Repair

The review of literature relating to adobe building is divided into two sections, i.e.: review of literature on adobe in building and its repair in Nigeria and review of literature from global point of view.

2.3a. The Adobe Building and its Repair in Nigeria: There are literature on adobe technique in Nigeria, however, this literature are descriptive with little or no technical input. Ogunsusi, et al. (1994:24) identified two types of earth buildings masonry in Nigeria: the pear or conical shaped earth brick *(tubali)* and the rectangular adobe block. According to Schwerdtfeger (1982:74), Moughtin (1985:100) and Dmochowski (1990, vol.1: 1.4) traditionally the Hausa in northern Nigeria used the *tubali* to construct buildings. Dmochowski (1990, vol.1: 1.4) described *tubali* as a pear or conical shaped sun dried earth brick made from mixture of lateritic soil, straw and water. Dmochowski (1990, vol.1: 1.4) further explained that the soil mixture is worked to plastic state after consistent mixing and remixing before the brick is shaped by hand. Ogunsusi, et al. (1994:24) described the rectangular adobe block (which is not traditional to the Hausa) as a parallelepiped moulded earth block made from plastic mixture of earth, straw and water using rectangular mould. Thus, the major difference between the two is in shape, which manifest as a result of the rectangular mould used in the production of the later. Dmochowski (1990, vol. 2:3.4) noted that the Nupe tribe in the central region of Nigeria were using the rectangular earth bricks as walling material. However, Dmochowski (1990, vol. 2:3.4) described the Nupe bricks as small and irregular in size, thus not the same as the rectangular adobe block, which is bigger and regular in size. Similarly, according to Dmochowski (1990, vol. 1:1.16) the Kanuri in the north east of Nigeria used fired clay bricks as walling material. Just as the case of the Nupe, the Kanuri technique is not also discussed in greater detail and this may be as a result of the fact that both tribes are among the relatively small ethnic groups in Nigeria. Furthermore, Alonge (1994:3) and Prucnal-Ogunsote (2007:3) stated that the adobe technique was used in the construction of early Afro-Brazilian styled buildings by the early freed slaves that returned to Lagos from Brazil in the late nineteenth Century. However, no detailed description of the construction was given in this literature. Similarly, Osasona (2008:4) in her paper on the use of earthen material for building in Ijebu-Ode (south west, Nigeria) noted that the adobe block technique is nowadays mostly used for contemporary buildings for majority of the people that cannot afford concrete blocks in rural and semi urban settlements in south west Nigeria. This confirms the use of the rectangular adobe block not only in the northern region but in the south west. Furthermore, Prucnal-Ogunsote (1993:3) proposed that the used of rectangular adobe block has been influenced by the Arabs in North Africa. That came to northern Nigeria through the Sudan and Sahelian countries, notably Mali and Niger dating back to the 15th Century. However, from available literature the adobe block technique is recent. It might not have been influenced by the trans-Saharan movement that occurred between the 15th and early 19th Centuries as postulated by Prucnal-Ogunsote's claim. Dmochowski (1990, vol.1:1.39) also contest this argument. The conclusion from this literature review is that traditionally the *tubali* were used by the Hausa (see Dmochowski, 1990, vol.1:1.4) and the adobe blocks was more recent.

According to Ogunsusi, et al. (1994:24) the use of rectangular adobe blocks for construction of buildings became popular in Nigeria due to the economic decline in the 1980s. Thus, it could be that this technique became disused by the Nupe (central region), the Kanuri (north east region), the Yoruba in Lagos, and possibly other tribes across Nigeria, but revived in the 1980s. However, it is certain that the technique was popular much earlier than in the 1980s. Evidence to this claim is studies conducted by the Max Lock Centre (MLC), which was already mentioned above. In these studies' reports it was documented that majority of the buildings in Sabon Gari and some other part of the city of Kaduna were constructed using the adobe block (Theis, et al. 2003:17). It is therefore clear that the use of adobe block in the study area started earlier than 1965. However, this technique cannot be considered as traditional but recent in the study area. The technique is however an alternative to both the traditional and the concrete block (modern) techniques. Similarly, since there is no enough documented evidence to show that this technique is traditional to the study area, nor to any other culture, the technique cannot be consider as traditional in Nigeria. In this thesis therefore adobe construction in Nigeria is refer to earth construction using the rectangular adobe blocks.

As far as the author is aware and from the available publications, there is no literature building repair in Nigeria. Available literature on Nigerian architecture is descriptive with emphasis on traditional buildings. The only technical literature is on construction of buildings using CEB. Table 2.2 is the summary of major publications on architecture in Nigeria.

Apart from lack of literature on the repair of adobe building in Nigeria, the information in the official document (i.e. the Nigerian building Code) is not only deficient but misleading. For example, it was specified in the Building Code that the moulding of adobe blocks must be under the shade to minimise cracking (see FRN, 2006:349; section 10.23.1.3). However, this is not the practice in Nigeria (see Guillaud, et al. 1994:17). Another inappropriate recommendation in the building code is the recommendation for use of cementious rendering on sun dried adobe wall (see FRN, 2006:349; section 10.23.1.5:i). This practice has been identified not only to be deficient but could have disastrous consequence on adobe wall (see Ashurst & Ashurst, 1995:98). Third, it was recommended that brick press used in fabrication of CEB can be use to produce adobe blocks to achieve a more durable brick (see FRN, 2006:349; section 10.23.1.7:i). However, it has been scientifically proven through laboratory experiment that mechanical compaction achieved from brick press cannot improve the performance of adobe block except if it is being stabilised with material of high binding strength such as cement, tar, lime, etc. (Dugelay, et al., 2004:7). Furthermore, mechanical compression of the wet mix use in making adobe block is not possible. This implies that the information in the Nigeria building Code is not only limited but incorrect. As a consequence the review in section 2.3.1 below will include literature on earth building repair from around the world.

	Author	Year of Publication	Title of Publication	Publishers	Aim of the Publication
	Traditional Nigerian Architecture				
1.	Schwerdtfeger, F. W.	1982	A Comparative Study of Traditional African Cities of Zaria and Ibadan, Nigeria, and Marrakech, Morocco.	Ethnographica, London	Analytical study of traditional architecture of 3 cities (2 in Nigeria and the third in Morocco)
2.	Moughtin, J.C.	1985	Hausa Architecture	Ethnographica, London	Descriptive study of traditional Hausa architecture
3.	Dmochowski, Z.	1990	An Introduction to Nigerian Traditional Architecture. Volumes 1, 2 and 3.	Ethnographica, London	Descriptive study of traditional Nigerian architecture (3 volumes, i.e. north; south west and central; and south east regions respectively).
4.	Schwerdtfeger, F. W.	2008	Hausa Urban Art and its Social Background: External House Decorations in a Northern Nigerian City	LIT Verlag, Berlin	Descriptive analysis of traditional wall finishes in a traditional Nigerian city
5.	Saad, H. T.	1981	Between Myth and Reality: Aesthetics of Traditional Architecture in Hausa land	Doctoral Degree Thesis. The University of Michigan, USA	Doctoral Degree (traditional Nigerian architecture)
6.	Nsude, G. C.	1987	The Igbo Traditional Architecture	PhD Thesis Submitted to the Thames Polytechnic, London	Doctoral Degree (traditional Nigerian architecture)
7.	Mouhammed-Oumar, A. A.	1997	*Gidaje*: The Socio-Cultural Morphology of Hausa Living Spaces.	PhD Thesis. University College London	Doctoral Degree (traditional Nigerian architecture)
	Contemporary Nigerian Architecture				
8.	Ogunsusi, et al.	1994	The Centre for Earth Construction Technology (CECTech)	CRATerre-EAG, France*	Report on institutional initiative on contemporary earthen architecture in Nigeria
9.	Guillaud, et al.	1995	Earth Construction Technology: Materials, Techniques, and Know-how for New Architectural Achievements	CECTech, Jos*	To highlight the potentials of earth construction in Nigeria and the CECTech's initiatives towards the use of earth in contemporary architecture in Nigeria.
10.	Ogunsusi, et al.	1994a	Compressed Earth Bricks Masonry – Bonding, Volume 1	CECTech, Jos*	Technical guide on CEB construction
11.	Ogunsusi, et al.	1994b	Compressed Earth Bricks Masonry- Brick Production, Volume 2	CECTech, Jos*	Technical guide on CEB construction
12.	Ogunsusi, et al.	1994c	Compressed Earth Bricks Masonry- Building Systems, Volume 3	CECTech, Jos*	Technical guide on CEB construction
13.	Nnok et al.	1995	Compressed Earth Bricks Masonry - Quality Control, Volume 4	CECTech, Jos*	Technical guide on CEB construction
14.	Ogunsusi, et al.	1995	Compressed Earth Bricks Masonry- Construction, Volume 5	CECTech, Jos*	Technical guide on CEB construction
	Building Code				
15.	Federal Republic of Nigeria	2006	National Building Code	LexisNexis Butterworths, South Africa	Government official document on building regulations in Nigeria.

***Note**: Publications with asterisk (*) were published by CECTech*

*Table 2.2: Major publications on earthen architecture in Nigeria (**Sources:** CECTech, Field Survey and Personal communication).*

2.3.1. Earth Building Repair

Most of the published literature on earthen architecture focuses upon history and construction techniques. The earliest of such historic account was a publication on adobe building published in Germany in 1764 (Guntzel:, 1986:23, in: Minke, 2006:62). This was followed by two publications of adobe construction manual in 1787 and 1790 (Minke, 2006:64). Several other publications on earth construction technique have been published in recent times. Notable of these publications includes: Houben & Guillaud (1994); Norton (1997); Morton (2008); etc. The discussion on the repair of earth buildings in all these publications often assumed that earth buildings are old and as noted in section 2.2 conservation philosophies are often recommended. Consequently, the review of literature on earth building repair below is constituent literature on modern building repair and literature on earth building repair, conservation and rehabilitation.

2.3.1a. Historical research: Doran, et. al. (2008:1) specified the following 13 questions to be answered before proceeding for repair of an existing building:

I. What is the building for?

II. How old is the building?

III. Who designed it?

IV. What were the original soil's conditions like?

V. What kind of foundations has it got?

VI. How was it designed?

VII. Has its use altered?

VIII. Has it always looked like this?

IX. What type construction is it?

X. What loads was it designed for?

XI. Is it listed or otherwise protected?

The last question is not relevant to this thesis because the buildings are neither listed nor protected. However, the remaining questions are critical and required when carrying out the repair of the adobe buildings in Sabon Gari. But as stated in section 2.2 such data for earth buildings are always difficult to find. This is because existing earth buildings in many countries of the World dated back to hundreds of years. Taylor (1993:590) noted that most adobe buildings in the US are not well documented because the buildings are old and mostly abandoned or neglected for sometimes and in some cases altered using inappropriate material. He noted that generation of data for such buildings for the purpose of repair or conservation requires search through archives, local authorities, library etc. Where such data are not adequate or not documented, various data collection strategies were used. Some of these strategies are summarised in table 2.2 below.

Data collection strategy	Source
Use of old photographs of the buildings to compare the level of alteration or deterioration with what is remaining of the buildings	Oliver & Hartzler (2000:78) and Bedaux, et. al. (2000:201)
Oral accounts (interview)	Jayhani & Omrani (2003:542)
Study of other surviving buildings	Jerome (2003:319)
Review of literature that delve upon the architecture of the area where the building is located	Azad (2003:31)
Laboratory testing of sample of material from the building to be repair	Jerome (1993:381) and Politis (1993:387)

Table 2.3: Examples of data collection strategies for the repair of earth buildings

As stated earlier in section 2.2 above, data on the adobe buildings in Sabon Gari can only be generated from oral account from the past and present occupants due to none availability any document relating to the buildings. All but with the exception of laboratory testing of material are considered in the proposed framework.

2.3.1b. Earth building classification: According to Warren (2000:361) there are wide range chorological time frames between various earth structures, but can be classified as follows:

- Antiquity: structures whose original usage has disappeared.

- Currently viable: these are buildings of indeterminate age.

- Modern and foreseeable: These are modern buildings and those that are yet to be built.

Despite the importance of date in the repair and conservation of buildings, earth building is usually classified according to technique of construction (e.g.: Houben & Guillaud, 1994:4; Keefe, 2005:10; Watt, 2007:57; etc.). This is because according to Houben & Guillaud (1994:108) and Rael (2009:9) climatic conditions which vary from one region to another determines soil chemistry and this determines earth building types. As a result of this regional variation earth construction can only be classified according to technique.

Houben & Guillaud (1994:4) classified earth construction techniques into 12 groups. These groups were further subdivided into another 7 categories (see Houben & Guillaud, 1994:5). They however stated that the most popular techniques worldwide nowadays are adobe, rammed earth and compressed earth bricks (CEB). However, every country with culture of earth construction has its classification. For example, Keefe (2005:12) identified 4 distinctive types of traditional earth construction in Britain as: wet mix laid in situ (cob and mud wall); mud and stud; clay lump; and rammed earth. In Nigeria, *tubali*, cob and wattle and daub were used traditionally according to Dmochowski (1990, vol.2:vii). The adobe block technique is a recent inclusion, which according to Ogunsusi, et al. (1994:24) became popular in the 1980s, while the CEB was later introduced by CECTech in the early 1990s.

Archaeological evidence is sometimes being used to determine period in which earth building was constructed (e.g. Berge, 2000:123). However, Garrison (ND[3]:10) suggested that building usage or changes in building fabric can give a good clue of the period in which an adobe building is constructed or repaired respectively. He stated that in the US, the use of square nails or change from square to

[3] ND: No date (year of publication unknown)

round nails can inform the person that is carrying out the inspection the period the adobe building is constructed or when it was last repaired. Other clues according to Garrison (1998:10) could be traced to some components used in the building, for example Victorian hinges, details of carpentry finishes, windows, doors, etc.

According to Watt (2007:15) building in general can be classified for the purpose of repair based on age, stylistic influence, material or manner of construction. Other classifications of modern buildings are already discussed in section 2.2 above. However, none of these earlier classifications (i.e. Ellis et. al., 1975:3 and Chandler, 1991:9) is similar to Nigerian classification. For example, Chandler, 1991:9 argued that buildings constructed within the same period in a particular region or country tends to have similar architectural character, material and technology, thus repair issues are most likely similar. This assumption may be applicable in the UK where buildings construction process is regulated. The situation is not similar in the study area, Sabon Gari. This is because the buildings in this area are owned by individuals, use for varying purposes, and subject to continous change (see Theis, et al. 2003:5 and chapter four).

2.3.1c. Causes of deterioration in earth buildings: Houben and Guillaud (1994:4) noted that the performance of building is aided by favourable climatic conditions. Furthermore, Keefe (2005:131) explained that the durability and longevity of an earthen wall depend on both the soil type and the degree of care (maintenance) accorded it. Consequently, knowledge about the material and maintenance history of the building is crucial in earth building repair. Consistent presence of moisture in earth wall is identified as the major cause of deterioration in earth buildings (Hughes, 1984:192; Houben & Guillaud, 1994:246; Warren, 1999:35; Keefe, 2005:131; etc.). Other causes of deterioration of earth buildings in general are summarised in table 2.3 below.

	Cause of deterioration	Author(s)
1.	Stresses on the material resulting in failure such as in	Houben & Guillaud (1994:248); Warren (1999: 35);

	timber component or loss of bearing of harder components e.g. arches, lintels, etc.	Keefe (2005:131)
2.	Consistent presence of moisture in earth walls	Hughes (1984:192); Houben & Guillaud (1994:248); Warren (1999: 35); Keefe (2005:131)
3.	Building on a poor site	Houben & Guillaud (1994:248)
4.	Poor design	Houben & Guillaud (1994:248)
5.	Poor construction (material and technique)	Houben & Guillaud (1994:248); Keefe (2005:131)
6.	External factors such as action of living organisms, rodents, insects, plant parasites, etc.	Houben & Guillaud (1994:248); Keefe (2005:131)
7.	Basal erosion due to salinity and or friction	Warren (1999: 35)
8.	Vertical cracks caused by differential movement	Warren (1999: 35)
9.	Later alterations and interventions	Keefe (2005:131)

Table 2.4: Causes of deterioration of earth buildings

In the case of adobe building, Morton (2008:53); Tolles, et al, (2000:7) and Norton (1997:23) noted that the masonry nature of this type of earth construction requires the joints are being filled with mortar in its plastic. They noted that if the mortar constituent is stronger than that of the block, the latter will crack. Similarly, a weaker mortar mix may result in cracks, which creates a line of weakness which may result in further damage to the wall. Tolles, et al, (2000:7) noted that one of the resultant effects of cracks mentioned above is moisture penetration, which is dangerous to earth building.

Furthermore, there are varying opinions on the degree of deterioration specific to adobe buildings. For example, Morton (2008:111) noted that serious defects are rare in earth masonry (adobe construction), but this may occur due to high moisture content or inaccurate mortar mixing. Garrison (ND:11) on the other hand, noted that the cause of deterioration in adobe building is complex. He noted that cracks and the presence of moisture are the two major causes of deterioration and these are the symptoms to first look for when doing a condition survey. Garrison (ND:11) also agreed with both Morton (2008:53) and Tolles, et al, (2000:7) explanation of the effect of inappropriate mortar on adobe wall.

According to Ogunsusi (1997:31) lack of maintenance is assumed to be the major cause of earth building decay in Nigeria. As far as the author is aware, there has never been any scholarly study of the causes of deterioration in both the traditional earth building and the adobe building in Nigeria. As a consequence, it is not possible to conclude that all the causes of deterioration in earth buildings in Nigeria are the same as above. The causes of deterioration of adobe buildings in Sabon Gari were therefore investigated and discussed in chapter four (see also appendix 1.2a for condition survey data).

2.3.1d. Condition survey or diagnosis: According to Ahluwalia (2008:17) building condition survey is a process of systematic diagnosis and prognosis of the condition of a building. Hughes (1984:192) explained that repair can only be carried out in earth buildings only after careful consideration and analysis of the previous interventions, only then the study of the existing condition, the location of defects, and most importantly the understanding of all mechanisms of the defects can commence. Keefe (2005:159) and Hughes (1984:192) identified six items each to be recorded during the condition survey and are listed in table 2. 4 below:

	Items to be recorded (surveyed)	Author(s)
1.	Architectural form and history	Hughes (1984:192)
2.	External environment (Macro and micro, i.e. orientation, elevation, topography, etc.)	Keefe (2005:159) and Hughes (1984:192)
3.	Description of the building (doors, windows, floors, walls, technique, etc.)	Keefe (2005:159) and Hughes (1984:192)
4.	Materials (both macro and micro)	Hughes (1984:192)
5.	Structural system	Hughes (1984:192)
6.	Maintenance and repair history (including any major alterations or extensions)	Keefe (2005:159)
7.	Condition of and description of observed failures and defects	Keefe (2005:159)
8.	dampness survey	Keefe (2005:159)
9.	analysis and testing of earth sample taken from the building to be repaired	Keefe (2005:159)
10.	Use and abuse and predicted future changes	Hughes (1984:192)

Table 2.5: Items to be recorded during condition survey

In the case of adobe technique, Garrison (ND:9) stated that holistic inspection of building leads to holistic understanding of the building. He therefore recommended a systematic inspection process that will involve top to bottom; inside out; south to north; east to west and counter clockwise inspections. Furthermore, Garrison (ND:9) identified 13 tools that are required for carrying out condition survey, these are: flashlight, ice pick or pocket knife, claw hammer or small crow bar, tape measure, camera, screw driver, pliers, torpedo level, paper bags, clip board, paper and pencil, 7 x 50 binoculars and plumb bob. He also recommended the following tools for complex projects that require special analysis: moisture meter, hand-held microscope, colour chips or charts and tell-tales (crack monitors). Furthermore, Garrison (ND:9) noted that although adobe building inspection should be holistic, however the following features in the building must be inspected: roof sheathing, rain disposal, roof structure, bearing or exterior walls, openings (doors and windows), exterior features (e.g. chimneys, porches, etc.), the interior (including room walls, floors, ceilings, stairs, fire place, etc.), and mechanical, plumbing and electrical systems, as well as the landscape.

Keefe (2005:159), Hughes (1984:192) and Garrison (ND:12) concluded that repair can only be carried out after a thorough condition survey, which provides understanding of the past, present and defects' causal mechanisms. Consequently, Watt (2007:145) recommended that condition survey should only be conducted by experienced Building Surveyor and if possible in collaboration with other experienced building professionals, as well as past and present occupants. There is no Building Surveying profession in Nigeria, thus, adobe building condition survey can only be conducted by experienced person with knowledge of adobe technology. However, experienced building professionals with knowledge of earthen architecture are limited in Nigeria due to numerous problems identified in chapters four, five and six.

2.3.1e. Possible repair options: Keefe (2005:164) acknowledged that practical knowledge in the repair of earth buildings is limited. As a consequence, his repair options are generic rather than specific. Keefe (2005:164) as well as Warren (1999:192); Hughes (1984:194); etc. therefore recommended conservation philosophy of minimal intervention in earth building repair. Similarly, Kareem (2003: 371) noted that it is critical to be firm when making a choice of technique in earth building repair; this is because often times the person carrying out repair is faced with critical decision of what to repair and what to replace. He therefore advised that in repair of earth buildings the parts with intrinsic values and those parts that are not of much value should be decided from the onset. Norton (1997: 10) on the other hand concluded that the best method of repair of earth building is by learning from surviving traditional buildings through observation and research.

Houben & Guillaud (1994:300) and Ashurst & Ashurst (1995:99) recommended practical guide to choice of earth building repair options. The first option is to tackle the cause of deterioration thus, providing a lasting repair, while the second is to deal with the symptoms, thus allowing the defects that are destroying the core of the structure to remain. The first option is always the best.

Morton (2008:114) explained that repair and maintenance of earth masonry (adobe) for routine wear and tear are simple. However, repair of such complex defects like external structural movements, major water damage, etc. will require specialist advice. Morton (2008:114) and Ashurst & Ashurst (1999:109) suggest that broken or cracked blocks should be repaired by cutting out the deteriorated blocks and replace with another of similar material composition. Minke (2006:104) advised that when filling cracks and joints the dry surface should be pre-treated. The pre-treatment involves making the surface rough and then wetting it with water so as to serve as key and to prevent rapid dehydration that will occur if dry and wet surfaces come into contact.

According to Morton (2008:115) repair of worn surfaces and splashing can be difficult to repair, because such actions are usually caused by abrasion. The remedy is to identify the source of this abrasion before replacement of worn surface.

Hughes (1984:196) concluded that since repair work concerns an existing building, the properties of the material cannot be changed, thus the only option is to understand it. As a consequence, repair can only be effective if the condition survey described above contains detail understanding of the testing of the building material composition.

2.3.1f. Documentation: McHenry (1984:23), Hughes (1984:222), Rua (1993:205) and Garrison (ND:12) recommended that record of all activities in the course of repair should be documented and a final report should be published at the end of a project. Garrison (ND:12) specified that a detailed report should contain the following: the historical background of the building; technical description of the building; condition survey, technical description of the repair, and recommendation for future actions. In terms of modern buildings, Chandler (1991:78) recommended ten different documents required in modern building repair and are listed in table 2.3 below.

BUILDING REPAIR DOCUMENTS	
Content of Document	**Type of Report**
Initial report	Preliminary inspection report
Full structural report	Condition survey and repair proposal report
Analysis and evaluation options based on life expectancy	
Social and economic factors analysis	
Brief on remedial works	
Contracts documents	Tender documents
Priced specifications	
Programme plan	
Record of actual work done	Post repair report
Valuation of records of payments	
Formulation of building log book	

Table 2.6: Building repair documents

Despite the importance of documentation in building repair, it will be a great challenge in Sabon Gari. This is because the majority of the occupants of these adobe buildings and the few existing earth building masons are not literate (see chapter four), thus cannot prepare any of the above document. The only alternative to the above problem is to employ someone else to carry out all the documentation at additional cost to the project, which may not economically viable.

2.3.1g. Viability of repair in terms of cost: Hughes (1984:192) predicted that earth building will continue to be constructed without predetermined (projected) life expectancy. Consequently it is only through quality maintenance and repair that safety can be assured and total or partial failure be avoided. Thus, the condition of the building as assessed during the condition survey will determine whether it is viable to be repaired or not. Garrison (ND:12) explained that the condition survey report will determine the viability of the repair.

Several authors (e.g. Houben (2001:23) and Anger, et al., 2008: 58) are of the opinion that earth construction in general should be cost effective because building earth is the most abundant material in the earth crust. Similar assumption is made in Nigeria, for example, Ezeji & Nwankor (2008:260) are of the opinion earth construction in Nigeria should be cheap. They argued that the major material (earth) can be sourced locally, sometimes within the construction site or in close proximity to the site and at little or no cost. However, cost should not be the only determinant of viability. There must be other considerations, such as environmental degradation associated with the burrowed pits where the soil is sourced (Schwerdtfeger, 1982:15). A good example is recycling of earth, which was suggested by Rua (1993:205) and Pujal (1993:244). This is a more sustainable and realistic option in Sabon Gari and it is consider in the proposed repair framework in chapter eight.

2.3.1h. Work programming: Hughes (1984:222) proposed that earth building repair and maintenance project should be designed in five phases. Phase one is the survey; phase two should involve the analysis of the survey; phase three is further research; the phase four is the actual repair implementation, while in phase five entails preparation and publication of report.

It was noted from the review of projects reported in the Terra conferences papers (see section 2.3.9 and appendix 3) that repair and conservation of earth building followed similar trend as proposed by Hughes above. However, phases one to three were considered as pre implementation phase (see Achenza, 2003:1; Alaamandour, 2003:10; etc.). Phase four was considered as implementation phase (see Jerome, 2000:144); while the fifth phase was the post implementation phase (see Fiero, et. al., 2000:31). Furthermore, the post implementation phase is more elaborate in the projects presented in the Terra conferences proceedings. Some of the strategies included in the post implementation phase in the Terra projects include site monitoring (Fiero, Matero & Rivera, 2000:31); publication of project as conference and journal papers, as well as book publication (Taylor, 1993:590; Alva, 1993:639); development of certified conservation course (Taylor, 1993:590); etc. The review of Terra conference papers is discussed in greater details in section 2.3.1i.

Furthermore, safety of building and humans are considered of optimum importance in the repair of earth building. As a consequence Keefe (2005:164) advised that should a diagnostic survey reveal evidence of either structural defect or high levels of dampness, that part of the building should be stabilised before further works commences on site. Similarly, Caperton (1987:13), Nardi (1987:71) and

Pujal (1993:244) specified consolidation of earth building before actual conservation. They explained that consolidation includes, cleaning, drying up moist walls, cleaning up blocked drains, propping up of major structural elements, etc. Ahluwalia (2008:11) emphasised the important of safety during building repair and also enumerated the catastrophic consequences of building collapse, which could include any or more these: loss of lives, injuries, damage of adjoining properties, infrastructures, etc.

Chandler (1991:119) therefore suggested that buildings partially or fully occupied could face restrictions, such that work may only be allowed from Monday to Friday between 8 am and 5 pm, i.e. when it is anticipated that the occupants will be at work. Furthermore, Chandler (1991:123) stressed that programme of work must be realistic and supply of material and equipment delivery must correlate with the flow of work on site. Scheduling of work is critical and complex issue in the repair of adobe building in Sabon Gari considering the fact that the buildings are used for both commercial and residential purposes. Thus the timing of work has to be agreed between the person in charge of the repair and the occupants of the building. But the optimum priority as already identified above should be the safety of humans (both occupants and customer or clients patronising the businesses) as well as the building and the adjoining buildings and infrastructure.

2.3.1i. Case studies: In his paper on the repair and maintenance of earth buildings Hughes (1984:199) noted that there was dearth of well documented projects on earth building repair from existing literature. However, the situation have slightly improved today, thus, there is literature that included projects on repair and conservation (e.g.: Keefe (2005), Warren (1999); McHenry (1984); etc.). Similarly, conservation and repair projects have been documented and presented in the Terra conferences since 1972. 148 papers were identified from 6 Terra conferences' proceedings occurring in 1987, 1990, 1993, 2000, 2003 and 2008 and reviewed (detailed analysis of this review is presented in appendix 3). 43 of these papers focus upon repair and conservation projects. It was identified from the review that conservation philosophises such as minimal intervention (Azghandi, 2003:48); use of like material (Nardi, 1987:71; Pujal, 1993:244; Rojas & Crocker, 2000:419; and Ebrahimi, 2003:133) etc. were employed in the repair of these buildings (see table 2.4). Furthermore, the conservation philosophies influence the repair strategies at pre implementation, implementation and post implementation stages (see example in figure 2.1). Although different solutions were proffered and claimed to be successful in these project reports, however, each project has its unique problems and contexts, thus the solutions are different. There is no universal solution to building repair because according to Watt (2007:2) no two buildings are the same. The lesson learnt from these project reports is that although there are both generic and unique problems associated with these earth buildings, the process of their repair requires thorough investigation not assumption.

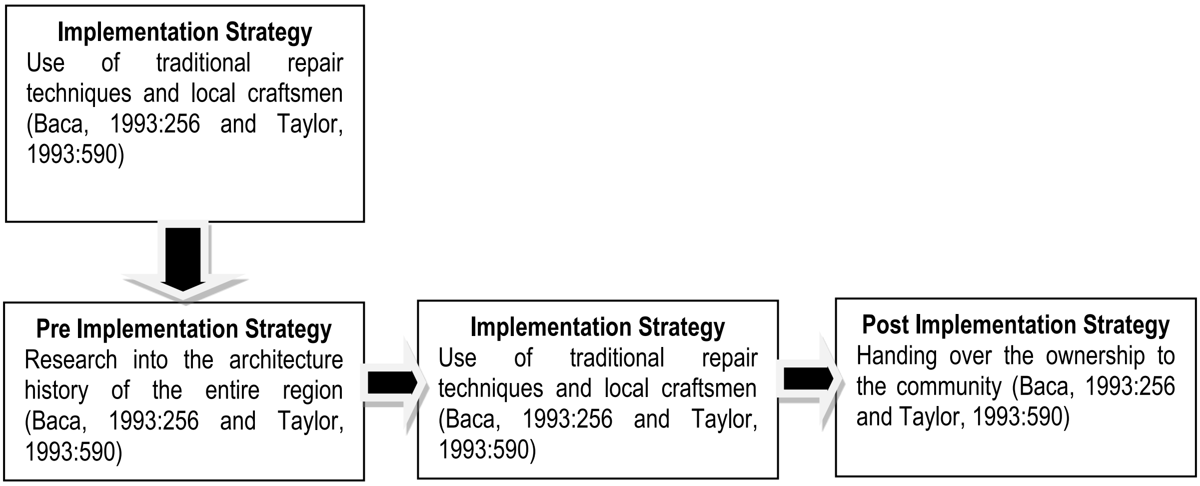

Figure 2.1: Example of how repair philosophy influences repair strategy in two of the projects published in the proceedings of Terra 1993

2.3.1j. Critical evaluation: According to Ogunsusi (1997:30) in many part of the world and in Nigeria it is common for earth building to be demolished and replaced with buildings made from concrete blocks. He added that when these buildings are being repaired cementious material is often used. Barrera (1997:48) explained that demolition and repair of earth building using none compatible material is due to prejudice, ignorance or lack of repair skills. Keefe (2005:128) however gave three reasons why earth buildings need to be conserved and these are equally applicable to repair. First, earth building should be repair on socio-economic grounds. This is because of the value of such buildings to their owners and to the entire nation as part of total housing stock. Second, earth buildings in good condition are capable of providing healthy and comfortable living environment for both humans and animals. Third, it can provide a unique sense of identity because of its distinctive architectural style, which differs from buildings made from other materials.

Joffroy (1997:19) identified various ecological, economic, psychological, cultural and human advantages that earth buildings in Nigeria possesses, which other building material may not have. He pointed out that unfortunately many Nigerians do not recognises these advantages. He therefore stressed the need for more public awareness, in order to reduce the current trend of inappropriate repair and demolition. And this is the intention of this thesis.

2.4. Sustainability and the Built Environment

According to Du Plessis (2000:1) the last decade of the 20th Century saw several international charters and declarations which played a significant role in the attempt to create a new world order that is embodied by sustainability. Based on Pepper (1986:1) concept of ecology and the environment, it is appropriate to conclude that the present concept of sustainable development has its extraction from environmentalism ideologies which was popularised through the oldest known environmental group, the British Commons, Open Spaces and Footpaths Preservation Society, which dated back to 1865. Du Plessis (2006:4) listed in chronological order important publications with sustainability ideology that influenced the current sustainability agenda, these are: Rachel Carson's '*Silent Spring*' (1962); Kenneth Boulding's '*Spaceship Earth*' (1966); Schumacher's '*Small is Beautiful'* (1973); the Club of Rome's '*Limits to Growth'* (1975); the *Brundtland's Report* (1987) and UN's *Agenda 21* (1992). However, the Brundtland Report of 1987 provided a common international platform for the global sustainable development agenda. In this UN sponsored report commonly referred as: '*Our Common Future'* or simply *'the Brundtland Report'* sustainable development is defined as the ability to meet today's need without compromising the ability of the future to meet the same need (WCED[4], 1987).

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[4] WCED: World Commission on Environment and Development

2.4.1. Sustainable Development and Sustainability: As simple as the above definition of sustainable development is, it is not without some controversies. For example Reid (1995: xv) believed that the definition is too sketchy and indistinctive. Furthermore, Munda (2005:953) argued that the term sustainable development is a contradiction. Both authors argued that every development requires environmental resources, thus in any developmental process natural resources are being taken, thereby compromising the environment's sustainability. Sanya (2007: 18) however elaborated that the term development can be either quantitative or qualitative, e.g. attaining social equity can be termed as sustainable development. According to Edwards (2005:11) sustainability is the means of attaining sustainable development. This implies that sustainability is a process (system), while sustainable development is the goal (product). The cardinal determinants towards achieving this goal (sustainable development) are effort at improving the environment, economy and social factors. Adams (2006:1) used diagrammatic illustration (figure 2.2) to explain how sustainable development is at the confluence of three constituent parts of social, economic and environment factors. Thus, these three factors are interrelated and it is only by attaining sustainability in all the three that sustainable development can be achieved. He used the Boulding Hierarchy of Systems Complexity (BHSC) which is derived from systems theory[5] to explain this relationship.

On the other hand, Ott (2003:5) argued that both economic and societal (social) factors should be constrained by environmental limits in order to achieve sustainable development, i.e. the environment resources and capacity should dictate the other two factors. Thus, economic and social factors are the sub systems, in the system, which is the environment (see figure 2.3).

[5] Systems theory: the application of the systems theory in sustainable development, its application and BHSC are explained in greater details in chapter three

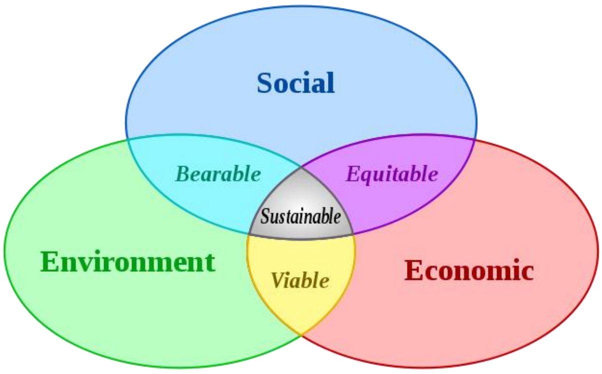

Figure 2.2: Corporative intersection of the three pillars of sustainable development (Adams, 2006:2)

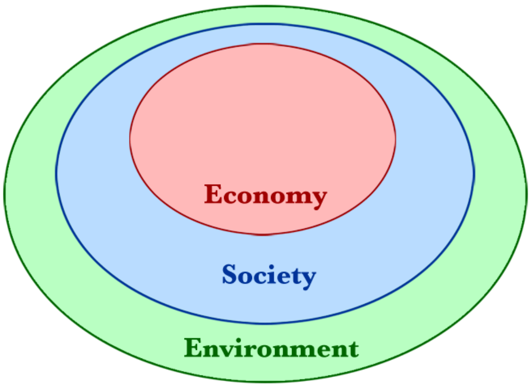

Figure 2.3: Sustainable development with the economic and social factors constrained by the environmental limits (Ott, 2003:4)

The first illustration represents a school of taught that are of the opinion that these three factors are of equal importance to attaining sustainability, while the second depicts the environmentalists ideology that strongly believe that humankind must live within the capacity of its immediate environment. Just as the definition of the sustainable development, both concepts have become subject of debate among the scholars and stakeholders in sustainable development. However, if as recommended in various reports such as Brundtland, Agenda 21, etc. that attaining sustainability requires commitment, encouragement, and assistance (see Du Plessis, 2005:18), both social and economic factor are required just as the environment. This is because commitment at all levels requires first and foremost understanding of the need to be sustainable and this is a social not environmental issue. Unfortunately the level of awareness and the willingness at present in Nigeria is still very low, even at governmental level. This is evident in the newly published Nigerian Building code, where no mention of sustainability in the entire document. This is a social factor that requires high level lobbying, which will also cost money (i.e.

economic factor), such that it is only the government that can facilitated it, through document such as the Building Code.

Critique of present models of sustainable development such as Du Plessis (2005:8), Sanya (2007:28), etc. are of the opinion that the whole ideas are western (developed nations) models and cannot work in developing countries. In fact Du Plessis (2005:8) blamed the developed nations of trying to impose their ideologies, which she strongly believe will not work in developing countries most especially those in Africa. Perhaps it is in response to the criticism that the United Nations Commission for Sustainable Development (UNCSD) started encouraging regional policies geared towards attaining sustainability in accordance with regional needs (UN ESC, 2004:4). South Africa is taken the lead in Africa towards attaining this goal and in 2002 the UN Summit on Sustainable Development was held in Johannesburg, South Africa (Edwards, 2005:8). South Africa has also been hosting conferences on strategies for a sustainable built environment since 1999 (McIntosh & Fourie, 2000:2). However based on the available literature from these initiatives, there seems not to be much deviation from the western models that is a subject of criticism. For example, Du Plessis (2000:7) and (2008:1) conclusion is that creating sustainable human settlements and societies requires new paradigm that combines and transcends the duality represented by the western mechanistic worldviews and a new model that involves systemic worldviews. If this is the solution it means we are still where we are and for the developing countries to move forward they still need the much criticised western model, thus the debate continues.

2.4.2. Sustainable architecture: Although the overall framework for sustainable development encompasses every aspect of human development and the entire planet earth, construction (building and infrastructures) has been the major source of consumption of resources and carbon emission. According to Edwards (2005:3) 50% of all the world resources consumed across the planet are used in construction. Consequently, this area has received greater attention in the sustainability discourse, the table 2.4 below summarises various UN documents that serves as pathway or aimed at supporting sustainability in the built environment from 1948 to date.

	Document and Agreements	Year	Source
1.	The Universal declaration of human Rights (UN)	1948	Sanya (2007:20)
2.	Stockholm Conference on human Environment (UK)	1972	Edwards (2005:8)
3.	The UN Vancouver Declaration on Human Settlements, Habitat I	1976	Sanya (2007:20)
4.	Geneva Convention on Air Pollution (UN)	1979	Edwards (2005:8)
5.	World Conservation Strategy (IUCN[6])	1980	Edwards (2005:8)
6.	Helsinki Protocol on Air Quality (UN)	1983	Edwards (2005:8)
7.	World Commission on Environment and Development (UN)	1983	Edwards (2005:8)
8.	Montreal Protocol on Ozone Layer (UN)	1987	Edwards (2005:8)
9.	Our Common Future (Brundtland Report) (UN)	1987	Sanya (2007:20), Edwards (2005:8)
10.	The UN Global Strategy for Shelter to the Year 2000	1988	Sanya (2007:20)
11.	Green Paper on the Urban Environment (EU)	1990	Edwards (2005:8)
12.	Earth Summit (Rio) (UN)	1992	Edwards (2005:8)
13.	Agenda 21	1996	Sanya (2007:20)
14.	Habitat II Conference, Istanbul (UN)	1996	Edwards (2005:8), Sanya (2007:20)
15.	Kyoto Conference on Global Warming (UN)	1997	Edwards (2005:8)
16.	CIB[7] Agenda 21 on Construction	1999	Sanya (2007:20)
17.	The Hague Conference on Climate Change (UN)	2000	Edwards (2005:8)
18.	CIB Agenda 21 for Sustainable Construction in Developing Countries. (UN's Johannesburg Summit on Sustainable Development)	2002	Odhiambo & Wekesa (2010:65)
19.	Regional and specialised initiatives	2002 to date	UN ESC (2004:4)

Figure 2.7: Important milestones towards achieving global sustainability in architecture and environment

Edwards (2005:9 &19) proposed that to attain sustainability in architecture, social, technological and environmental factors must govern design, material and construction of buildings. If the whole idea about sustainability is the concern for development that considers what we do and how we do it (Du Plessis, 2006:1) then economic factor is of paramount importance to sustainable architecture and this is omitted in Edwards' concept. According to Sanya (2007:28) most of the publications on sustainable architecture are produced by authors from the developed European nations and the US and they only focus on issues that affect those nations and these are mostly environmental issues. Thus, such models are not appropriate for developing nations most especially those in Africa (Nigeria inclusive), where poverty (economic) and other social issues are more dominants, thus requiring urgent attention. Consequently, socio-economic factor should determine the policies and type of technology to be adopted in developing countries.

Furthermore, Brown (2007)[8] noted that many sustainable development goals can be achieve through attitudinal change instead of expensive and sophisticated technology. Brown (2007) stressed that by

[6] IUCN:
[7] CIB: International Council for Research and Innovation in Building and Construction

understanding social and cultural issues particularly in countries in the southern hemisphere many sustainability issues will be resolved, thus stressing the importance of socio-cultural factors in achieving sustainability. Brown's suggestion is typified in Fathy's Gourna project in Egypt, because it was achieved based on the understanding of the socio-culture of the people (Fathy, 1973:4). All that Fathy did in this project is to revive the vernacular architecture of the Nubian (Fathy, 1973:1). Although the phrase appropriate technology was used in Fathy's Gourna project, instead of sustainable architecture (Fathy, 1973:4). However, Fathy (1973:xv) clearly stated that the approach to Gourna project is much more than technical issues that architects' are concern with, rather an approach that includes social, cultural, complexity, delicacy, economic and even political (i.e. relationship with the government and the ministry officials). James Steel, in: Rael (2009:13) described Fathy's visionary ideas on sustainable architecture as follows:

> *'Fathy is perhaps the earliest, clearest example of a sustainability-oriented architect we can find. Every sustainable principle you can mention or want to talk about, Fathy wrote about, thought about, built, gave us living examples of. That is why his work is important.'*

Similarly, Farmer (1999:9) is also in support of vernacular architecture and is of the opinion that vernacular architecture is what is presently refers as sustainable architecture. He defines vernacular architecture as architecture that was conceived and delivered within the limitation of the native environment that produced it. He argued that humans have drifted from the main roots of architecture which use to be firmly rooted to natural world. Consequently, this drift has generated the unsustainable practices that are prevalent today. However, he recognised the limitation of vernacular architecture in our present contemporary society. He therefore concluded that it is the duty of the architects to develop a new concept of architecture by learning from traditions but at the same time considering present societal need.

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[8] Centre for Sustainable Futures (CSF), University of Plymouth Lecture series. Titled: Sustainable Communities – Challenges and Lessons from the South. Presented by Robert Brown.,

Although Farmer (above) argued in favour of vernacular architecture his definition tends to limit it to traditional architecture. Osasona (2008:3) on the other hand defines vernacular architecture as the architectural style that is used for ordinary houses as opposed to large official or commercial buildings. This implies that vernacular architecture is not limited to buildings of the past but it encompasses existing architecture that is unique to specific area, region, town, etc. As a consequence the adobe buildings in Sabon Gari can be termed as vernacular architecture of that area.

2.4.2a. Sustainable earthen architecture: Wojciechowska (2001:4) stated that earthen architecture is part of the vernacular architecture in majority of the countries of the world. She concluded that it can promote the revival and or survival of construction cultures and other social issues associated with sustainable architecture. Wojciechowska (2001:4) supported her argument in favour of earth with list of some of the sustainable advantages of this material. This list includes: availability of material locally and in abundant quantities; uses less energy in production and in use; available at little or no cost; and it reduces carbon emission thereby protecting the environment. Similarly, Houben & Guillaud (1994:7) and Orbasli (2008:139) explained that earthen architecture has the qualities to improve the unsustainable practices in building industry around the world since it blends technology with nature.

There are several examples of earthen architectural initiatives which aimed at blending the traditional concepts with the contemporary needs for example: *Green planning* (Brink, 2008:22); *Low cost housing project* (Ebsen & Ramboll, 2002:1); *Straw bale house* (Raymond, 2008:89); *Stabilised earth buildings* (Zami & Lee, 2008:1); etc. On the other hand, Stulz & Mukerji's (1993) book titled '*Appropriate Building Materials: a Catalogue of Potential Solutions*', explored many materials and techniques that are considered to be natural, uses locally sourced and less expensive technology.

In the case of improved earth construction, Zami (2008:1); Raymond (2008:89); Mani & Chattopadhyay (2007:154), etc. argue for the use of stabilised earth bricks to achieve sustainability in architecture. However, all the authors are proposing construction of new buildings using new methods that they believe are sustainable. None of the literature considers the repair of existing earth buildings. As novel as these approaches are as claimed by these authors it requires the consumption of more material in comparison to repair. Furthermore, stabilised earth construction is not sustainable in Nigeria as earlier discussed.

2.4.2b. Sustainability assessment tools: According to Brandon, 1987 in: Spedding (1987:153) in efforts to make existing and new buildings more sustainable a methodology for measuring sustainability of buildings was developed using the concept of Life Cycle Assessment (LCA). According to Edwards (2005: 113) LCA is use to evaluate the environmental performance of building from construction through its entire life expectancy. There are other environmental evaluation models similar to LCA such as Sustainability Assessment Model (SAM), Eco-Management and Audit Schemes (EMAS), Building Research Establishment for Domestic Buildings (BREDEM), (see Edwards, 2005: 117-123); Greencalc, Eco-Quantum (Hendricks, 2001:60-70), Sustainable Building Assessment Tool – SBAT (Gibberd, 2006:64); etc. Although sustainability assessment model is beyond the scope of this thesis, however, these tools may be used in assessing the sustainability of adobe building before and after repair.

2.4.2c. Sustainable earthen architecture in Nigeria: According to Ogunsusi, et al. (1994:6) the Franco-Nigeria collaborative programme sponsored by the French Government was aimed at promoting the use of earth as a sustainable building material for contemporary buildings in Nigeria. Ogunsusi, et al. (1994:6) noted that this programme led to the establishment of CECTech in 1992, with the technical assistance of CRATerre-EAG, France. Guillaud, et al. (1995:113) noted that the aspirations of Nigerian populace towards improved technique of building informed the decision by CECTech to introduced and promote CEB technique, with the conviction that the technique can meet this aspiration as well as being cost effective. A study conducted by the author in 2004, indicated that although CEB technique was initially embraced by few Nigerians who could afford the cost of cement (which is require to stabilised the CEB) and the brick press (Shittu, 2004:55). However, the study reveals that the enthusiasm quickly dwindled because the technique is not as cheap as anticipated.

The implication of this finding from this study is that addressing social factors without consideration for the economy is not sustainable in a developing country like Nigeria where poverty level is high. Furthermore, the assumption by CECTech that CEB is the ultimate solution to Nigerian needs, resulted in a biased against the traditional technique most especially adobe technique. Consequently, all the literature published by CECTech is either on the CEB technique or historical account of traditional techniques with strong arguments in favour of the CEB technique (see table 2.1 for lists of CECTech's publications).

However, the research into the viability of CEB technology in Nigeria started long before the Franco-Nigerian collaboration and the establishment of CECTech. For example, Ola (1978:145) and (1986:425) conducted a series of research projects on the geotechnical properties and behaviour of stabilised lateritic soils in Nigeria. In the first research the geotechnical properties of stabilised (cement, lime, and bitumen stabilisers) the Nigerian lateritic soil where tested for suitability for road construction. One of the conclusions from this first research is that stabilised lateritic soil can be use for production of bricks in Nigeria. It also identified from this study that moisture movement in stabilised earth bricks is more when compared with movement burnt bricks. Furthermore, it was concluded that cement stabiliser is more economically viable for building construction in Nigeria in ratio of 5% cement. In the second research, test was carried out on the engineering properties of stabilised compressed soils from 4 towns in Nigeria (2 in the north and the other 2 in the south). One of the findings from this research is that most of soil used for earth construction by the local people in these 4 towns contains clay minerals of kaolinites group with some quartz (Ola, 1986). One of the conclusion reached from this research is that the effect of compaction on the 4 soil samples far outweighs the effect of cement stabilisation because the clay fraction in this soil are between 30 and 40%. This implies that the adobe building can be as durable as any other material if suitable soil is used.

There was no follow up to the above studies as far as the author is aware. Similar research was also conducted by NBRRI[9] in 1985 according to Guillaud, et al. (1995:109). The NBRI's research resulted in construction of a prototype building in 1988 using CEB. However, neither the research nor the construction project was published.

2.4.3. Sustainable repair of earth buildings: According to Avrami in: Rainer, et. al. (2010:328) the argument for the continuity of earthen architecture, its conservation and repair are often centred on its various advantages that are considered to be sustainable. Rael (2008:9); Minke (2006:196); Keefe (2005:128); Houben & Guillaud (1994:7) etc. are of the opinion that earth buildings posses all the attributes required in sustainable architecture. Consequently, there is need for their repair and conservation, which are more sustainable than building new ones. Furthermore, Watson, in: Hurd & Gourley (2000:50) noted that the desire to attain sustainability, the conservation of traditions and evolution of new styles are some of the factors that inspire the contemporary use of earth in architecture globally.

However despite these justifications for the repair and conservation of earth buildings, according to Dugelay, et al. (2004:10) there is general misconception in Nigeria and around the world of earth construction as material for the poor. And as already stated above in several instances they are often demolished and replaced with buildings constructed from modern material (e.g. concrete) that are considered to be more durable. Warren (2000:1) noted that use of earth in construction of new building in has been refrained for social rather than technical reasons. The perception of individuals and groups of earthen architecture and other alternative materials has meant that such sustainable solutions to repair and conservation are not popular in developing countries such as Nigeria. It is therefore necessary for more research that will address these social issues with economic advantages in developing countries.

[9] NBRRI: Nigerian Building and Road Research Institute

Despite these numerous advantages and sustainable attributes of earthen architecture some of which were identified in section 2.4.2, it can be unsustainable where the know-how does not exist. This is demonstrated in various unsustainable practices such as use of cementious material for repair (Shittu, 2004:6, see also chapter four). Barrera, (1997:47) noted that in the quest for improvement of earth buildings, materials that are perceived to be more durable such as cement is used in the course of repair with the intention of improving the performance of these buildings. Unfortunately the consequences of these actions are often disastrous. As a consequence Barrera, (1997:47) calls for more research on the sustainability of repair and remodelling of earthen buildings so as to meet contemporary needs and aspirations of the people.

Going back to Sanya's explanation in section 2.4.1, which suggest that the word 'development' should be seen in sustainable development premise as a qualitative attribute rather than quantitative. In the context of architecture therefore, development could be a change in attitude in care and maintenance of existing building, rather than demolition and rebuilding. Consequently, repair, maintenance and conservation of existing buildings could be more sustainable than construction of new buildings with attitudinal change. Wood, (2003:21) is of the opinion that repair of building constructed with material that have low carbon footprint such as earth will be even more sustainable. Orbasli (2008:45) explained that because earthen material can be recycled, material can be source from that which has fallen from the building that is to be repaired. She stressed that recycling eliminates transportation, preserves material, minimise time and money, as well as having no further negative impact on the environment.

Based on the above assertions it is therefore appropriate to argue in favour of the sustainability of earth construction where the know-how exists. But unfortunately there is limited knowledge on this subject among the people that live in this type of building in Nigeria. Furthermore, all the above literature on sustainable architecture and sustainability of earth building are geared towards construction of new buildings, which amounts to consumption of new material. Thus, it is the argument of this thesis that repair of building made from adobe technique, which is already identify as sustainable can be more sustainable. Unfortunately, this aspect of sustainability has so far been neglected.

2.5. Discussion

In this chapter relevant literature pertinent to earth building repair in general and adobe building in particular was reviewed. Similarly, literature on sustainability discourse as it relates to earth building repair was also reviewed. It was identified from the review that although building repair is often synonymous to maintenance, the two are not the same. Building repair is carried out with sole aim of mending defects or replacing missing or worn out parts, while maintenance is aimed at preventing deterioration. Having realised that maintenance is not feasible in the study area, the focus shifts to repair, hence the decision to develop a repair framework. However, as can be discern from this review, literature on adobe building repair is limited and where available conservation philosophies are often applied with the assumption that all earth buildings are old and of cultural significant. However, this is not the case with the adobe buildings in Sabon Gari. As a consequence repair strategy for modern buildings was adopted as an outline for this review.

Available literature indicated that traditional techniques that are efficient but requires frequent maintenance are often disregarding nowadays in favour of repair techniques that are believed to reduce this frequency of repair. Unfortunately however, this practice has led to many disastrous consequences. The dilemma is that due to urban pressure (as with the case of the study area) it is not possible to revert to these effective traditional techniques. And as far as the author is aware there is no literature that addresses adobe building repair issues in urban context. Thus, this thesis is aim at bridging this gap.

It was identified from the literature review that the traditional earth construction technique differs from adobe block technique in Nigeria and as a consequence the repair issues are different. Thus, critical examination and understanding of the similarity and differences between these two techniques can be of value in developing appropriate repair framework for the latter.

The errors in the National Building Code on earth construction in Nigeria and the lack of repair guidelines in this official document shows the lack of awareness about this subject even at governmental level. This therefore calls for holistic approach that will also involve the government in the proposed building repair framework.

Records of the past intervention and documentation of repair were identified as being vital in the repair and continuous survival of earth building repair in general. However, these can only succeed where such documents are recognised, prepared and preserved. This is not the case with the study area. Consequently, a more sustainable approach must be developed in the proposed repair framework, which shall ensure that repair and other intervention on adobe building are well documented and preserved in the study area. Furthermore, a methodology for investigating the history of the adobe building where such record does not exist is required in the proposed repair framework.

Several causes of deterioration of earth buildings were identified. Of which neglect and moisture from rain and other sources were identified to be the major causes of earth building deterioration. The major cause of deterioration that is unique to adobe building was identified as weakness of the mortar joints. However, these are all technical issues that were already addressed in the literature. Stigmatisation is one of the major social issue mentioned in the literature, however there are other social issues that are unique to the study area, which must be addressed in unique way in the proposed repair framework.

Other critical issues that the above review did not address are building ownership, legal issues relating to building repair, and finance. These are issues identified in the course of the field survey which need to be address in the proposed repair framework. Consequently, literature on building maintenance strategy and conservation strategy shall be critically appraised with the aim of identifying relevant strategies that can be use to address these vital issues.

The importance of case studies of earth building repair projects was stressed, as a consequence, the projects reported in the Terra conference papers were analysed (see table 2.2 and appendix 3). Having realised the importance of case studied from this literature review, other earth building repair and conservation project shall be further analysed in the course of the development of the proposed repair framework.

Literature on sustainability pertinent to architecture and earth building was reviewed. However, all the argument in favour of earth building as being sustainable geared towards construction of new buildings, which amount to consumption of natural resources. However, there is no literature on sustainability of earth building repair, thus this thesis intends to fill this gap. This is because repair of earth building could even be more sustainable than the repair of other types of building and construction of new ones.

2.6. Scholarly Reflection and the Thesis Expected Contribution to Knowledge

Having identified the gaps in literature on repair of earth building in general, the lack of literature on repair of non traditional adobe building repair in Nigeria, and the lack of literature on sustainable repair of adobe building, this thesis aimed at bridging these gaps. Thus, the aim of this thesis is to develop a sustainable framework for the repair of adobe building in Sabon Gari urban settlement. Critical to achieving this aim is the understanding of the problems in the study area and identifying sustainable repair strategy that will address all the problems identified in the course of the research. Consequently, the field survey data were critically analysed to enhance the understanding the adobe building in Sabon Gari.

Various research needs were identified in the review. One of these needs is the issue of stigmatisation or biasness against earth building. It is the intention of this thesis that by repairing existing buildings this stigma could be gradually erased in the area and this could also have effect in other part of Nigeria.

Above all, the proposed framework shall be guided by the socio-economic issues that were identified during the fieldwork. Thus, the materials and techniques to be proposed will be guided by these factors.

This is because it has been ascertained by scholars such as Warren (2000:1) that the issues militated against the acceptance of earthen architecture are more of social not technology issues. Furthermore, Sanya (2007:28) and Brown (2007) identified that solutions to attaining sustainability in architecture and in other areas of human endeavours in the developing nations such as Nigeria are not necessarily through the means of technology, but by addressing socio-economic problems. The thrust of this proposed framework therefore is first, to understand this socio-economic issues, second, address them and third use these solutions as a guide towards the choice of repair material and technique to adopt in the framework.

CHAPTER THREE

RESEARCH DESIGN

'Nothing can be understood in isolation. All systems theory is therefore in a sense explanatory structure intended to correspond to something in the real world

- Lars Skyttner (Skyttner, 1996:69)

3.0. Introduction

This chapter is aimed at explaining the process through which the research progresses from its objective to the study outcome. The chapter consists of brief discussion on the motivation for the thesis, description of the data collection strategy, the methodology for data analysis, discussions on the theory and concept used in the data analysis and in the development of the proposed framework.

Having identified from the literature review in chapter two the lack of scholarly literature for the repair of adobe building in Nigeria, this study aimed at developing a framework that will enable a sustainable repair of this type of building. As a consequence data are generated from field survey and literature in order to achieve the goal of the thesis.

3.1. Research Motivation and Assumption

Easterby-Smith, et. al. (2008:14) identified three reasons that motivate research project, these are:

- opportunity for further learning
- means for personal growth and advancement, and
- a channel for enhancing managerial skills.

This PhD research is no different because the above three factors are among the motivations that influenced the author to at the inception of this study, as shall be explained below.

3.1a. Research motivation: The initial inspiration for the research came from the author's childhood experience and experience in practice, as well as earlier study for DPEA dissertation. It was this early life experience that inspired the author to study architecture and later a Master's degree (DPEA) in earthen architecture. In practice, the author was able to designed and construct earth buildings. However, with exception of one building (which was a mixture of CEB and adobe shown in figure 3.1) the remaining earth buildings constructed by the author were made of CEB (see examples in figure 3.2

and 3.3). This was because of the clients' preference for CEB over the unstabilised earth techniques. However, the high cost of cement required in stabilising the CEB meant that fewer clients could afford this preferred technique. As a consequence only a total of 6 buildings were realised by the author in eight years. This is small when compared with the 18 buildings designed and constructed with the concrete blocks within the same period.

The low client's patronage in earth construction experienced in practice inspired the author to choose earth construction entrepreneurship as the topic for the DPEA (Master) degree dissertation at the School of Architecture, Grenoble, France in 2004. The author's attention was drawn to the adobe buildings particularly those in Sabon Gari during the field survey for this dissertation. A study conducted by the Max Lock Centre, University of Westminster on the City of Kaduna was also instrumental in the choice of Sabon Gari (Theis, et. al., 2002).

Critical findings from the DPEA dissertation that partly inform this PhD thesis are:

- None of the entrepreneur interviewed have designed or constructed a building using adobe technique
- All the entrepreneurs interviewed agreed that adobe technique is still in use in Nigeria and is cheaper than CEB, thus more economically viable
- The entrepreneurs however, identified that the social stigma attached to adobe technique, and the poor quality of some of the existing adobe buildings are reasons why adobe is not popular in Nigeria (Shittu, 2004:56).

3.1b. Research assumption: Creswell (2007:19) explained that assumptions reflect researcher's stance on a particular research subject. In this PhD thesis, the last of the dissertation findings listed above led the author to the following assumptions:

- that the negative perception of adobe technique in Nigeria could be erased if the existing adobe buildings can be repaired

- the adobe buildings in Sabon Gari have a potential to influence positive change in Nigeria if the buildings can be appropriately repaired, because of the strategic location of the area
- the adobe building in Sabon Gari can be repaired if appropriate framework exists.

Figure 3.1: A school building designed and constructed by the author in Kaduna between 1997 and 2000. The author used CEB and also experimented on the use of adobe blocks with unstabilised earth rendering as well as the use of ferrocement and concrete on CEB walls and domes

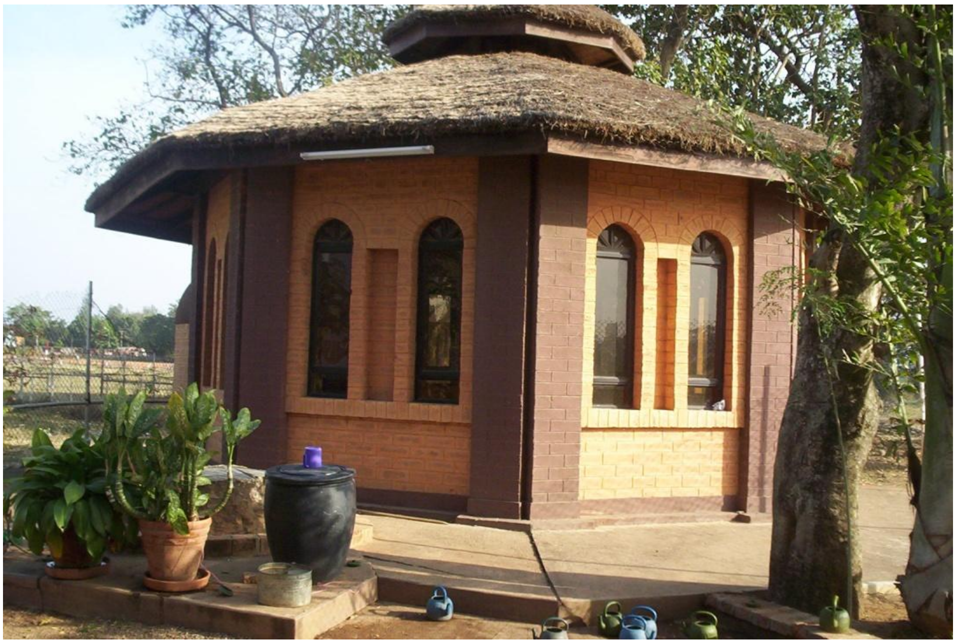


Figure 3.2: A Mosque designed and constructed by the author in 1999 in Kaduna using CEB walls and thatch roof

Figure 3.3: A sit-out designed and constructed by the author in 2000 in Kaduna using CEB walls and thatch roof

3.2. Research Paradigm

Creswell (2007:19) explained that research assumptions are shaped by paradigms or worldviews of the subject. Creswell (2007:19) define research paradigm or worldviews as a basic set of beliefs that guide action. The worldviews on the repair of adobe building is presented in the literature review in chapter two and appendix 3. Creswell (2007:19) also identified four types of paradigm as: post positivism, constructivism, advocacy / participatory, and pragmatism. The set of beliefs guiding this thesis is the advocacy / participatory. This study is advocacy / participatory because literature on the subject relating to the study area or Nigeria in general does not exist (see chapter two). Thus, worldviews on the subject are from other countries. As a consequence the author aimed at advocating a change through participatory approach involving the stakeholders. The stakeholders in this research are the adobe building occupants, landlords and tenants in Sabon Gari, as well as architects, engineers, masons, building inspection personnel, policy makers etc. in Kaduna. The proposed change presented in the repair framework in chapter eight is developed in response to data generated during the fieldwork using relevant worldviews on the subject.

3.3. Research Questions

The research assumptions presented in section 3.1 above, worldviews on adobe building repair reviewed, and the data generated during the field surveys in 2006 (see appendices 1 and 2) led to the to a central question. This central question is further divided into 7 sub questions as recommended by Creswell (2007:107). These questions are therefore critically examined and presented below.

3.3a. the Research Central Question

The central question that this thesis aimed at addressing is: 'what are the appropriate steps to follow in the sustainable repair of adobe building in an urban area such as Sabon Gari, Kaduna?'

The response to this question requires dividing this question into sub questions and these are presented below.

3.3b. the Research Sub Questions

I. **What are the worldviews on sustainable repair of adobe buildings in Nigeria and in other countries around World?**

The review of literature presented in chapter two and the data generated during the field surveys in 2006 (see appendices 1 and 2) presents the worldviews on sustainable repair of adobe in Nigeria and from around the world. As stated earlier in this chapter and in section 2.6 in chapter two the positive worldviews in literature on the subject are from other countries. Thus, the proposed repair framework intends to fill this gap in literature.

II. **Why is the adobe building in Sabon Gari a good choice for a case study?**

As earlier explained the DPEA dissertation and the Max Lock Report were the motivating factors for the study of adobe building repair and the choice of Sabon Gari respectively. The economic importance of Sabon Gari to the inhabitant of Kaduna in general and those living in the area in particular was highlighted in the Max Lock Report (Theis, 2002:21). Similarly, the adobe buildings in Sabon Gari are used as both residence and business premises for the landlords and tenants in this area. This dual function and the strategic location of Sabon Gari are the motivating factors for the choice of the buildings in this area. The study area and justification for its choice were explained in greater details in see sections 1.3 and 1.4 in chapter one.

III. What is the current state of the adobe buildings in Sabon Gari?

Two studies were conducted by the Max Lock Centre (MLC) on the City of Kaduna, the first in 1965 and the second in 2002. The 2002 report provided an initial insight into the transformation of the adobe buildings in Sabon Gari between 1965 and 2002 (Theis, 2002:14; see also table 4.1 in chapter four). In the 2002 studies, 33 compounds were ascertained to have retained their original walling material (adobe) as noted during the first study by the same centre (i.e. MLC) in 1965 (Theis, 2002:14). 20 out these 33 compounds were therefore selected for this PhD research. The criteria for selection of these compounds are: first the compound must be use for both residential and commercial activities. Second, the compound must still retain its original adobe blocks. The state of these buildings as at 2006 when the field survey was conducted is presented in chapter four. The data recorded during the survey of these buildings in Sabon Gari are also attached in appendix 1.

IV. How are existing earth buildings in urban areas in Nigeria being repaired?

Through participatory approach, three towns in Nigeria with specific areas with earth buildings were identified based on the recommendation of 2 architects and an engineer from CECTech Jos. 10 cities in the north, 3 in the south west and 4 in the south east were recommended (see appendices 2.1.1a; 2.1.1b and 2.1.1c). A city each was selected from the 3 regions in Nigeria. Zaria was selected from the north because the 3 CECTech's staff recommended the city. Based on the same reason Offa was selected from the south west, while Akamkpa was selected from south east. The existing earth buildings in these urban areas in these 3 cities were studied with aim of identifying relevant strategies that can be adapted to the buildings in Sabon Gari. The findings from these studies are presented in chapter five.

V. Where is the place of the adobe buildings in current Nigeria building industry?

The Nigerian Building Code, the Kaduna State building regulation and the practice of various building professional bodies in Nigeria were critically analysed. This is aimed at identifying how the current Nigerian building legislation affects the repair of adobe building and the role of the building professionals in this regard. The findings from this analysis are presented in chapter six.

VI. What other adobe building repair strategies exists that can be sustainable in Sabon Gari?

The repair strategies identified from literature review in chapter two as well as other strategies relevant to the adobe building repair in Sabon Gari were critically analysed in the context of the problems identified in the study area. A theoretical structure for repair of adobe building in Sabon Gari was formulated from strategies derived from this analysis. A theoretical structure for a framework for sustainable repair of adobe was derived from analyses of various building intervention strategies in literature was developed in chapter seven.

VII. What are the appropriate repair strategies that are sustainable in the repair of adobe building in Sabon Gari?

Using the theoretical structure derived in chapter seven a repair framework for adobe building in Sabon Gari is designed in chapter eight. Two types of framework are developed. The first option is a comprehensive plan of action designed to involve the landlord and tenants as well as other stakeholders in the planning and implementation of adobe building repair in Sabon Gari. The second option on the other hand is designed for self-help (DIY) repair, which will involve one person making all the decisions and carrying out of the repair. Thus, it is assumed in the second option that the person that will take this responsibility must be knowledgeable in the repair of adobe building. Similarly, the person must be the landlord. This second option is in line with tradition practice whereby individuals were responsible for construction, maintenance and repair of their buildings (Schwerdtfeger, 1982:21). Both options are grounded in theories and worldviews on building repair in relation to the adobe building Sabon Gari. The difference between the two is that the second option is brief and without all the dialogue between the landlord and tenants. Although this second option could be faster to implement than the first, the disadvantage however is that the success and failure depends on one single person, thus the risk is higher. Other advantages and disadvantages of the two options are discussed in chapter eight.

VIII. How sustainable is the proposed framework?

Since this thesis is meant to be participatory, the proposed framework was summarised and another questionnaire was designed and sent to the stakeholders earlier involved in the data generation. The summary of the proposed framework is a feedback from the author to the stakeholders, while the second questionnaire (see sample in appendix 4) is aimed at attesting the validity of the proposed framework by the stakeholders. The questionnaires' responses are critically analysed and the proposed framework earlier designed in chapter eight is amended to include the relevant contributions from the questionnaire's respondents. Both the questionnaires analyses and the amended framework are presented in chapter nine.

Table 3.1 below is the summary of the structure of the thesis developed in response to the research questions.

Structure of the Remaining Part of the Thesis				
	Research Question	**Aim(s) and value to the research**	**Methodology employed in responding to the question**	**Location in the thesis**
1.	What are the worldviews on sustainable repair of adobe buildings in Nigeria and in other countries around World?	To have theoretical knowledge on the subject and to identify the thesis' contribution to knowledge in earthen architecture	Literature review	Chapter two
2.	Why is the adobe building in Sabon Gari a good choice for a case study?	To critically examine value of these buildings to the occupants and the impact their repair on the adobe building in Nigeria	Review of DPEA dissertation and the Max Lock Centre (MLC) Report	Chapter four
3.	What is the current state of the adobe buildings in Sabon Gari?	To study the current condition of the adobe building in Sabon Gari	Field survey	Chapter four
4.	How is existing earth building in urban areas in Nigeria being repaired?	To identify repair strategy that may be appropriate to Sabon Gari	Field survey	Chapter five
	Where is the place of the adobe buildings in current Nigeria building industry?	To identify how the current building legislation affects the repair of adobe building in Sabon Gari	Critical analyses of: - the Nigerian Building Code - Kaduna State building regulation - the role of each professions in the Nigerian building industry building	Chapter six
5.	What other adobe building repair strategies exists that can be sustainable in Sabon Gari?	To identify repair strategies from around the world that can appropriate to the study area and other part of Nigeria	Critical analysis of relevant literature and appropriate strategies.	Chapter seven
6.	What are the appropriate repair strategies that are sustainable in the repair of adobe building in Sabon Gari?	To develop a sustainable repair framework of adobe building in Sabon Gari	Use of theoretical structure developed in chapter seven	Chapter eight
7.	How feasible is the proposed framework?	To test the validity of the proposed framework	1. Use of questionnaire 2. Analysis of responses 3. Amendment of the initial framework based on the questionnaires'	Chapter nine

			responses	

Table 3.1: Structure of the remaining part of the thesis

3.4. Research Method

Research method is the means of moving from the research questions (problems) to the research solutions (Dawson, 2006:14). Creswell (2007:2) identified three types of research methods, namely, qualitative, quantitative and mixed research. In qualitative research the researcher explodes attitude, behaviour and experiences by generating data using interviews or focus group discussions (Dawson, 2006:14). In quantitative research the researcher generates statistical data by means of large-scale survey research (Dawson, 2006:14). Mixed designed as the name suggest is a combination of the two methods (Creswell, 2007:4). Dawson (2006:16) warned that no research method is better than the other, thus the choice depends on the type of research.

Groat & Wang (2002:6) noted that architecture is a multi disciplinary profession it therefore requires inter-disciplinary research methods. Groat & Wang (2002:14) therefore proposed seven research methods for architecture related research. These are: interpretive-historical; qualitative; correlation; experiment and quasi-experiment; simulation; logical argumentation; and correlation and case study (see Groat & Wang, 2002:88-95). They however explained that the choice of methodology depends on the research aim, thus, agreed with Dawson (2006:16) that no research method is better than the other (Groat & Wang, 2002:3).

The inter-disciplinary nature of architectural research also manifests in this thesis because of the nature of the subject of study, which involve dealing with humans, buildings, legislation and other related issues. The qualitative research method using grounded theory approach as described by Creswell (2007:9-93) and Strauss & Corbin (1998) is therefore employed in this thesis. This research method involves the generation of theory using data collected in the course of a particular research (Dawson, 2006:19). The theory in this research is the framework developed in chapter eight and the amendment in chapter nine, which is generated from data collected from the stakeholders at the inception and in the later part of this research. The methodologies for generation of data, the analysis of data and methodology used in developing this theory (framework) are explained in section 3.4.1 below.

3.4.1. Research strategies: The strategies employed in the three stages of this research, i.e. data collection, data analysis and in the formulation of the proposed framework are explained below.

3.4.2. Data collection strategy: CECTech Jos was recognised from the inception of this thesis as a major resource based for data on the thesis' subject, being the only earthen architecture research centre in the country. Consequently, the author commenced the fieldwork from the centre in July 2006 (see appendix 2.2). The stakeholders (see section 3.2) were also interviewed. Furthermore, questionnaire was administered to a represented of the 20 compounds surveyed in Sabon Gari and the buildings' conditions were surveyed (see appendices 1.0, 1.1, 1.2 and 1.2a). Similarly, the earth buildings in Zaria City, Offa and Akamkpa were also inspected and representatives of the occupants in each of the buildings were interviewed (see appendices 2.2, 2.3, and 2.4).

Interviews, questionnaires and condition survey (observation) were used as the three medium of data collection during the field surveys to ensure the validity, reliability and accuracy of the data as much as possible where necessary. This form of triangulation of data generation as illustrated in figure 3.4 is part of the participatory approach in this thesis. The questionnaire was designed by the author based on the initial understanding of the subject. However, the semi structured interviews allowed the stakeholders to express other issues not included in the questionnaire. Similarly, the condition surveys of the buildings were conducted with the collaboration and input of the occupants. The detail discussion of data collection using the three research tools are presented below.

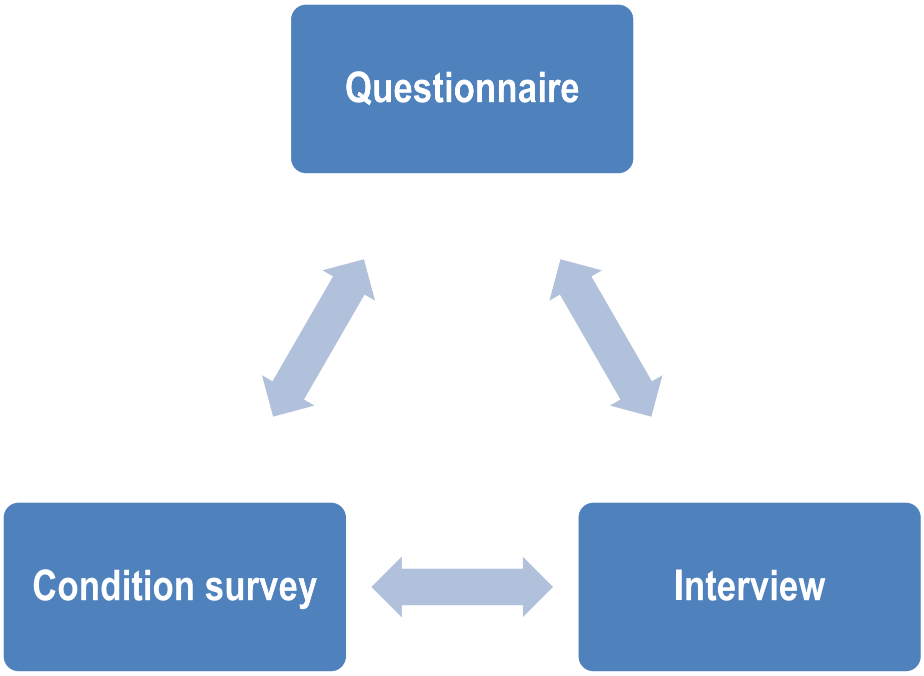


Figure 3.4: Triangulation of data collection strategy

3.4.2a. Interviews: The author interviewed three staff of the centre (i.e. the director who is an architect, an engineer and another architect) (see appendix 2). The aims of the interview at CECTech were: first, to identify the research and project executed by the centre on adobe building repair. Second, to gather personal information on individuals involved in research on the repair of adobe building in Nigeria. Third, to identify urban areas in Nigerian cities with adobe buildings, that can be used as case studies in this research. Finally, the author was in CECTech to identify if the centre is aware of any recent repair of adobe building in Nigeria that is carried out using appropriate material and techniques.

It was identified from the interview in CECTech that most of the research and projects executed by the centre were on CEB technique. The centre has never carried out repair or research on adobe building but they have constructed demonstration building using both CEB and adobe as walling materials. Furthermore the author was able to trace the three PhD thesis, however, they all delve upon traditional Nigerian architecture (see table 2.1 in chapter two), thus are not relevant to this thesis. As earlier explained in section 3.3b.iv the centre recommended 10 cities with earth buildings, out which 3 were selected. The centre is not aware of any recent repair of adobe building in Nigeria. See appendix 2 for detail on the interview in CECTech Jos.

The following were interviewed in Sabon Gari and in the City of Kaduna:

- 26 persons (10 landlords and 16 tenants) from the 20 compounds surveyed, with at least 1 person from each compound (details attached in appendix 1.4.5a)
- 2 architects, 1 retired mason, 1 concrete block mason (formerly earth building mason); a staff of KASUPDA, and the Chief Judge of Kaduna State Rent Tribunal (see appendix 1.3 for personal details of these interviewees and their responses)

The initial intention was to interview all the landlords and at least one tenants from each of the rented buildings as part of the participatory approach to this thesis. However, not all the 20 compounds were owned by one person. 3 of the compounds are owned by a family (brothers and sisters), having inherited the buildings from their parents. And none of the siblings lives in these 3 compounds. 7 other landlords are not residing in the buildings surveyed, thus, it was only possible to interview 10 (see appendix 1.4.5a).

The following were interviewed in Zaria City:

- 1 architect, 1 student of architecture, 5 earth building owners (see table II.b in appendix 2.2 for personal details and detail interviews' responses)
- A representative from each of the 20 earth buildings surveyed (see table II.c in appendix 2.2 for personal details and detail interviews' responses).

The interview in Zaria City also involved the discussion on the traditional *tubali* and adobe construction, as well as the differences between the two. This is therefore discussed in greater details in chapter five. Hand recorded interviews' responses are summarised and also attached in the appendix 2.2.3.

A Quantity Surveyor and six cob building owners were interviewed in Offa (see table II.e in appendix 2.3). The Quantity Surveyor was interviewed because the six cob building owners admitted not to have knowledge of cob construction. In fact only two persons were willing to be identified, thus the remaining 4 refused to give their names. They were therefore tagged 'respondent 3, 4, 5 and 6' respectively for identification purpose in this thesis. The four persons argued that earth building in general is for the poor, as such they do not want to be associated with it, despite the fact that they live in one.

The situation in Akamkpa is similar to that of Offa. None of the ten wattle and daub building owners agreed to give their names. They are therefore tagged Respondent 'A, B, C, D, E, F, G, H, I and J' for purpose of identification in this thesis. Two Architects that have worked in the south east region in general and Akamkpa in particular were also interviewed. Details of the interviews are analysed in chapter five, while the hand recorded interviews are summarised and attached in appendix 2.4.

3.4.2b. Questionnaire: Two sets of questionnaires were designed. The first was designed at the inception of this research (see appendix 1.0), which was aim at identifying the problems associated with the repair of adobe building in Sabon Gari. The second questionnaire was designed at the later stage of this research and is aimed at validating the proposed framework in chapter eight. The first questionnaire was designed based on the research questions stated in section 3.3. This was administered during the field survey in Sabon Gari to 20 representative of each compound selected for this study. Sample of this questionnaire is attached in appendix 1.0. The questionnaire analyses are also attached in appendix 1.1. Detail discussion on this questionnaire is presented in chapter four. The aim of using the questionnaire during the field survey is to accord the respondents the leverage to critically reflect on the questions posed before responding as well as not to influence the respondents' responses (Dawson, 2005:89).

The second questionnaire was designed based on the research question in section 3.3b.viii above, which is: 'how valid is the proposed framework?' The methodology adopted in administering this second set of questionnaire is explained in section 3.4.3d below.

3.4.3c. Condition survey: The 20 compounds with adobe buildings that were selected in Sabon Gari for this study were surveyed by the author with the input and collaboration of the occupants in August 2006. The data generated from this survey is attached in appendix 1.2a and detail analysis of the building conditions is presented in chapter four.

3.4.3d. Emails and telephones: Due to financial and time limitation it is not possible for the author to be travelling to Nigeria from the United Kingdom in order to continue the constant dialogue require in this type of research (Easterby-Smith, et al., 2008: 100). As a consequence emails and phone calls were used as means of communication with some of the stakeholders in the course of the research at the University of Plymouth.

Furthermore, the validation questionnaire was administered by phone. This second set of questionnaire was sent to the stakeholders in Nigeria through a friend (Samuel Bello). In order to ensure that the responses of the questionnaire are the true responses of the stakeholders, the author administered the questionnaire by telephone. Thus, each of the respondents was phoned and the questions on the questionnaire were asked while the author noted down the responses on another questionnaire (see appendix 4 for sample of one of the completed questionnaire). This unique approach to administering of questionnaire is one of the sustainable strategies adopted in the development of this framework.

3.5. Data Analysis Methodology

The methodology used in the analyses of data generated from the field survey is explained in this section. As stated earlier in this section 3.4, this thesis involve several interrelated factors such as humans, buildings, regulations, etc., of which sustainability can only be achieved if these factors are considered and accorded equal attention. As a consequence the data collected during the field survey is structured using the idea of system theory. Similarly, the data is systematically analysed and the thesis' outcome are presented using the same concept. This theory and its application in this thesis are explained below.

3.5.1. Systems theory and its applications: Systems theory is a multi attributes theory that was developed based on the assumption that a system is anything that is significantly enough to be called a name (Weinberg, 2001:4). Skyttner (1969:69) explained that because nothing exists in isolation system theory is use to analyse the several related constituents that made up the system in a coherent manner in order to understand the system in part and as a whole unit (see also Lejk, 1998 and the quote at the beginning of this chapter). As a consequence an object, organisation, action, culture, etc. can be called a system. The renowned scientist Albert Einstein in: Skyttner (1996:69) described the system theory as *'a theory that determines what can be observed…'* In scientific terms Ackoff (1960:10) visualises a system as a set of two or more elements that exhibit 3 conditions:

i. Behaviour of each element has an effect on the behaviour of the whole.

ii. Behaviour of the elements and their effects on the whole are mutually dependent.

iii. Whichever way the subgroups are formed, all have consequence on the behaviour of the whole, but none has an independent effect on the whole.

According Skyttner (1996:69) a system constitutes interrelated constituents called the sub systems and is affected by several external constituent called supra systems. The theory is therefore use for numerous purposes. Skyttner (1996:71) and Emery (1971:128) noted that the theory can be used in structuring a problem; for analytical purposes in strategic development; policy or framework formulations and other analyses that require systematic approach or hierarchal structuring.

For analytical purpose, a system is presented in a linear or cyclical pattern depending on the nature of the system (Namilov, 1981: 23). The linear concept represents a system that has an irreversible life span, i.e. cradle to crave pattern (Checkland, 1999:19). The cyclical concept on the other hand represents a system that have life pattern that can be renewed through repair, thus the system's life has a cyclical pattern. Skyttner (1996:58) stated that a system with cyclical life pattern has origin, life and transformation (i.e. from creation or birth, to existence, then repair and reuse). A cyclical life pattern is illustrated in figure 3.5 below.

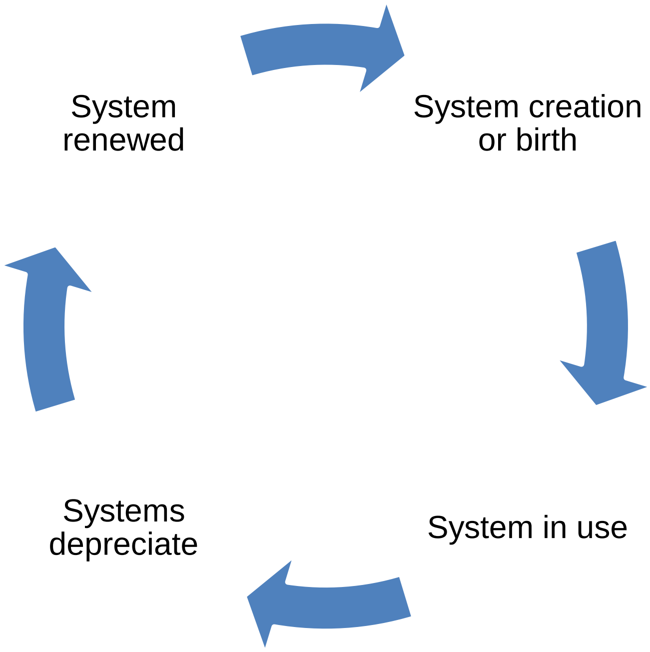
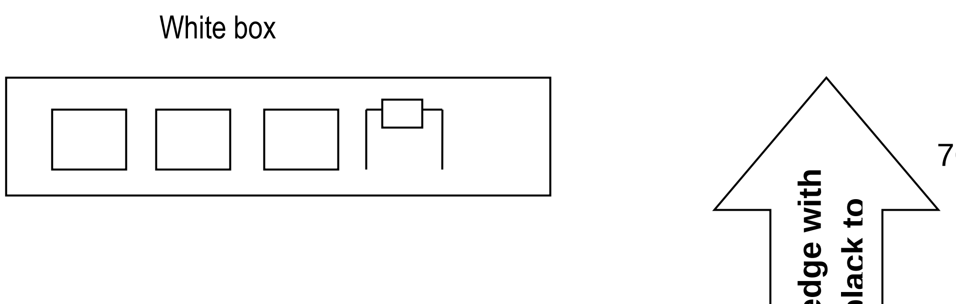


Figure 3.5: Cyclical system life pattern (Skyttner, 1996:58)

Wiener, 1983 in: Skyttner (1996:44) used analogical concept in system theory called 'the cybernetics concept' to present the operation mechanism of a system in three levels of black box, grey box and white box as illustrated in figure 3.6. The black box contains the system's input and output without any details of the internal process that produces the output. The grey box concept presents the system's input and output as well as internal transformation that produce the output, however the detail description of the process of this internal transformation is never presented. In white box concept, system is presented in greater detail, with its input, and description of internal process that transforms the input to the system to produce an output. The white box concept presents a system in a more comprehensive manner, making sure that no detail is omitted. The choice of any of the three concepts depends on the depth of information require about the system.



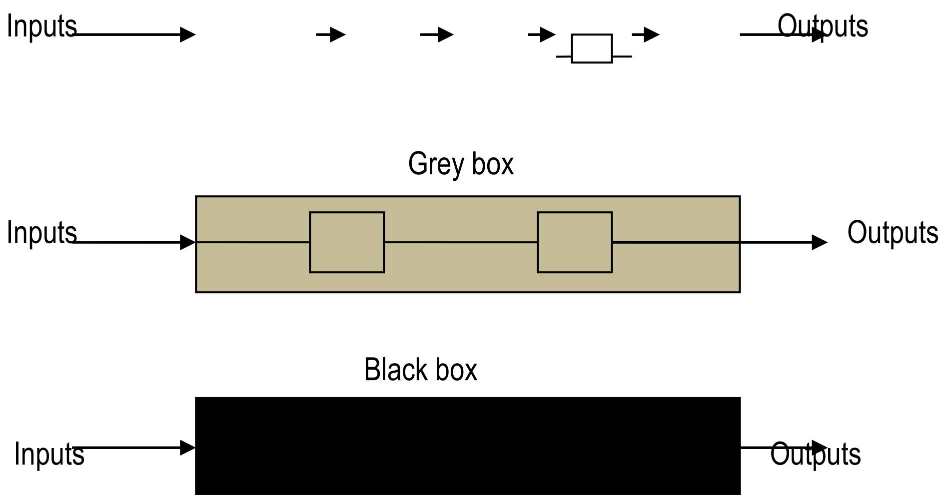


Figure 3.6: Conceptual presentation of a system using the cybernetics concept

The system theory is used in architecture for various purposes. For example, Sanya (2007: 34) utilised the concept of the system theory to analyse the sustainability of earthen architecture in Uganda. Similarly, Odhiambo & Wekesa (2010:65) applied the theory to analyse the sustainable options for housing for low income groups in developing countries. Both studies structure the subject of study into three hierarchal levels of system, sub systems and suprasystems. The three levels of systems hierarchy were analysed in relation to one another in both studies.

3.5.2. Application of system theory in this thesis: The above three concepts in system theory are use in this thesis. The hierarchal concept illustrated in figure 3.6 above is used in structuring and analysis of data in three levels. The cyclical concept of system life cycle is used as the central concept in the development of the repair framework in chapter eight. The cybernetics concept is used in presentation of the thesis. The SWOT analysis is use in analysis of the validation questionnaire in chapter nine. Table 3.3 is the summary of the description of the application of system theory in this thesis. The applications of system theory in this thesis are explained in detail below.

Application of System Theory in the Data Analysis and Thesis' Presentation	
Concept	**Application**
Hierarchal levels of system (see figure 3.7)	Structuring and analysis of the data in three levels.

Cyclical system's life pattern (see figure 3.5)	Central concept of the proposed framework
Cybernetics analogy (see figure 3.6)	Thesis presentation
SWOT analysis (TOWS matrix)	Analysis of validation questionnaire

Table 3.2: Application of concepts in system theory in the data analysis and thesis' presentation

3.5.2a. Structuring of data using the system theory: This theory is first used to present the thesis subject in three levels. Thus, the system in this thesis is the repair of adobe building in Sabon Gari. The sub systems are the tenants, landlords, materials and method of repair, etc. The supra systems on the other hand are the earth buildings in urban areas in other cities in Nigeria; building legislations in Nigeria which affects Sabon Gari; and the building profession in Nigeria as illustrated in figure 3.7 below.

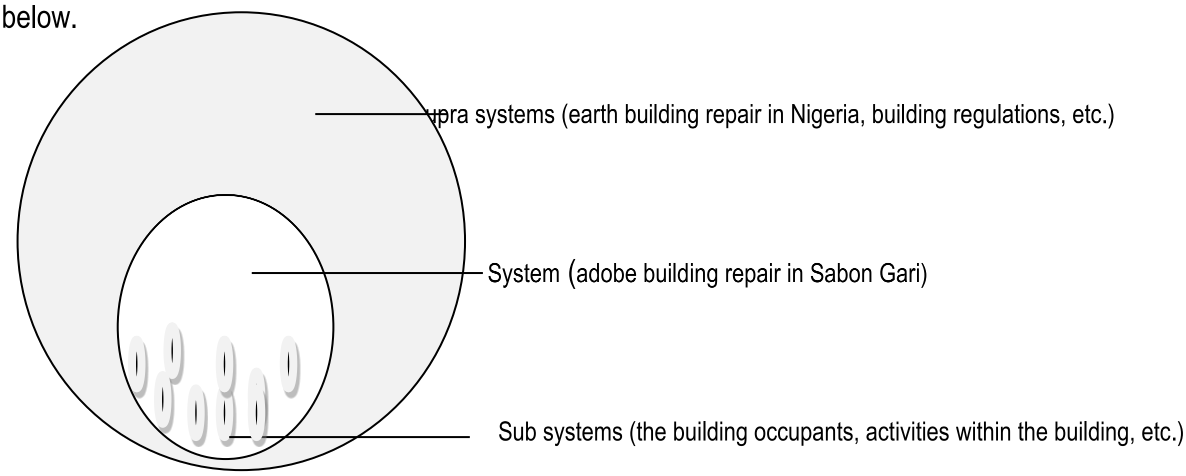


Fig. 3.7: The structure of research questions (problems) using the systems theory

The system (adobe building repair in Sabon Gari) is therefore discussed in relation to its subsystems in chapter four. The supra systems are also discussed in relation to the system and sub systems in chapters five and six. The system is subsequently presented as a whole in chapter seven. This is achieved by analysing the problems identified in chapters four, five and six in relationship to one another. This concept is also used in the analysis of sustainable or unsustainable issues at these three levels. The three criteria in sustainable discourse i.e. e social, economic and environment factors (see Adams, 2006:2) are used in these analyses. Thus, the social, economic and environmental issues (both positive and negative) relating to the adobe building repair in Sabon Gari are critically examined and presented as part of the conclusion in chapter four. Similarly, the sustainable practices identified in the three urban areas in Nigeria are critically examined in order to identify their relevance to the adobe building in Sabon Gari in chapter five. The sustainability issues is further analysed at national level in Nigeria by critically examining the building code, the building profession and other relevant building regulations in chapter six. Furthermore, relevant sustainable building repair strategies are critically examined from literature and projects published in Terra conferences proceedings as well as other related publications in chapter seven.

3.5.2b. Conceptualisation of proposed framework using the system theory: The hierarchal level of system was used in the design of the proposed framework in chapter eight. Based on the systematic analysis of findings in chapter seven the proposed framework is divided into three parts. Part one contains technical considerations in adobe building repair. Part two contains landlords and tenants' obligations, while part three focuses on the legal requirements. The three parts are conceived as sub systems in a system, such that they are interrelated and one part cannot be used without the others just as explained in the system theory in section 3.5.1.

Furthermore, the analogical representation of system's life in a cyclical pattern is also central to this thesis. The content of the proposed framework is developed using this idea. For example, recycling of material is preferred as against the use of new material in repair.

3.5.2c. Analysis of validation questionnaire using SWOT Analysis: The SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is another analytical methodology derived from the system theory (Dyson & O'Brien, 1998:23). It involves countering the weaknesses identified within the system with the strengths, while the threats are counter with the opportunities. This method of analysis is also called TOWS (Threats, Opportunities, Weaknesses and Strengths) matrix (Dyson & O'Brien, 1998:24) and it is used in chapter nine to analyse the validation questionnaire.

3.5.2d. Thesis presentation using the concept in the system theory: The cybernetics concept is also used in this thesis. The black box represents the summary of the proposed framework in chapter nine. The grey box represents the proposed framework in chapter eight, while the thesis as a whole represents white box.

3.6. Systemic Re-evaluation of Data

Data analysed in chapters four, five and six as explained above, is re-evaluated using Strauss & Corbin (1998:45) and Creswell (2007:161) concept at the end of each of these three chapters. The aim of this re-evaluation is to identify the following:

- central phenomenon of the findings
- the cause or causes of the findings
- how the affected people cope with the condition or conditions
- factors that led or shape the strategy employ to cope with the condition
- and the consequence of the strategy adopted

This methodology of data re-evaluation is represented diagrammatically in figure 3.3 below.

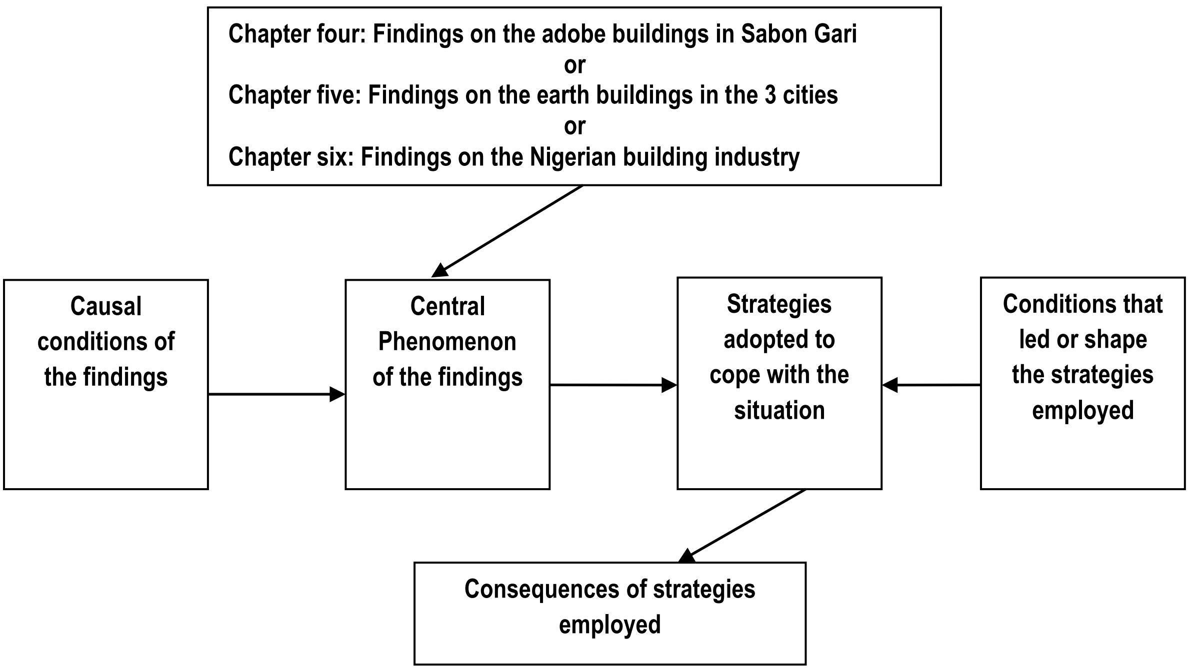


Figure 3.8: Re-evaluation of data analysed in chapters four, five, and six. Adopted from Creswell (2007:293)

3.7. Analysis of the Validity of the Proposed Framework

Being advocacy / participatory research the validity of the proposed framework is tested in chapter nine, before conclusion is drawn and recommendation proposed in chapter ten. The validation involved summarising the proposed framework and designing of another questionnaire, which were both sent to the major stakeholders in Nigeria. The summary of the proposed framework and the validation questionnaire are attached in appendix 4. The questionnaire is in two parts. The first part contains issues relating to the sustainability of the framework in terms of economic viability, social acceptance and impact on the environment. The second part contains questions relating to the strengths, weaknesses, opportunities and threats relating to the proposed framework.

The returned validation questionnaires were analysed using the TOWS matrix (SWOT analysis) in chapter nine. In the same chapter nine, the recommendations and suggestions from the validation questionnaire's responses are critically examined and addressed.

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3.8. Summary

In this chapter the process that is use in addressing the research problems identified from literature and field survey is discussed. The systems theory is use as a concept for the design of the theoretical structure of the proposed repair framework thus, the entire process is cyclical. This cyclical life of a system (adobe building repair) is to ensure that the sustainability factors that are desired are achieved. Being an advocacy / participatory research process, the research is designed such that the stakeholders and the researcher are in constant communication throughout the research process, despite the distance (i.e. the United Kingdom where the research analyses and writing up is being undergone and Nigeria where the study area and the stakeholders are). Furthermore, the stakeholders are considered in the validation of the proposal which ensures that no idea is imposed on them but the whole proposal is generated from the people and approved by them. Table 3.2 is the structure and summary of the research methodology use in this thesis.

CHAPTER FOUR

FIELD SURVEY 1

STUDY OF THE ADOBE BUILDINGS IN SABON GARI, KADUNA

….over one fifth of the people living in Kaduna had come from outside the North (i.e. northern Nigeria[10]) and over 90% of the adults had not been born in the town. This was way higher than most people thought.
Theis, et al. (2002:12)

4.0. Introduction

This chapter contains the findings from the field survey conducted in the study area, Sabon Gari, Kaduna in August 2006 (see figures 1.2 and 1.3 in chapter one for map of the study area). The survey was conducted by the author with the aim of studying the existing conditions of the adobe buildings in the study area, so as to develop a framework that can be use for the repair of these buildings.

As explained in sections 1.3 and 1.4 in chapter one, the unique characteristic of Sabon Gari in terms of ethnic composition and the dual nature of its adobe buildings are the reason for the choice of this part of Kaduna as the thesis' study area. For the purpose of this thesis, 20 compounds with buildings constructed with adobe blocks were therefore selected and study during the fieldwork. Data on the adobe in these 20 compounds were generated using questionnaire and interviews of the occupants of these buildings, as well as surveying the conditions of these buildings.

Using the structure proposed in section 3.5.1 and illustrated in figure 3.4 in chapter three, the findings from this fieldwork are presented in this chapter. The questionnaire sample and analysis; interviews notes and condition survey reports for the 20 compounds are attached in appendix 1.

4.1. Analysis of the Architectural and Spatial Design of Sabon Gari

In section 3.4 in chapter three the field survey methodology used for the study in Sabon Gari was explained. A thematic analysis (see Dawson, 2006:117) is used to analyse the field survey data in Sabon Gari. The analyses are presented in this chapter under two themes, i.e. architectural and spatial planning of Sabon Gari and the analysis of findings in the 20 compounds surveyed. These analyses are

[10] Authors' emphasis

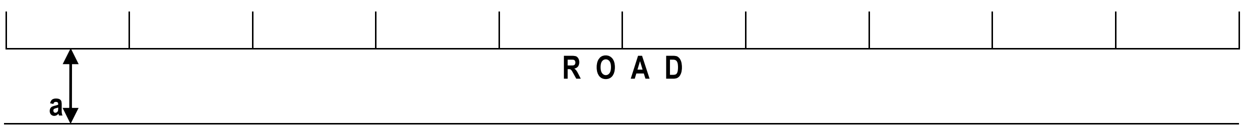
therefore presented below.

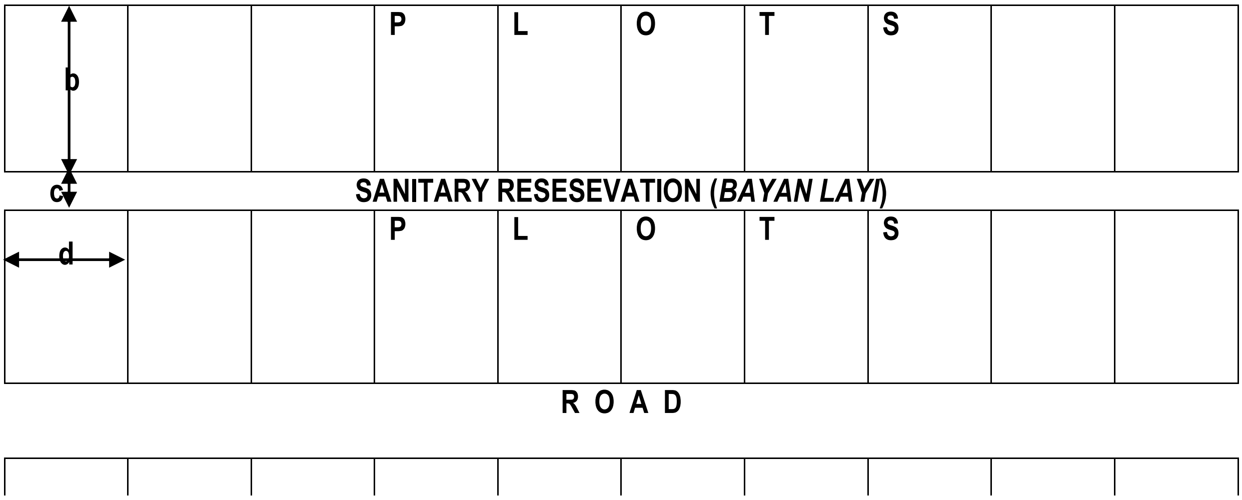
4.1.1. Architecture and Spatial Planning of Sabon Gari

The study of the adobe buildings in Sabon Gari can only be understood in relation to the architecture and spatial planning of the entire area. The architectural characteristic of the adobe building in Sabon Gari is therefore explained in this section in relation to the spatial planning of the area.

4.1.1a. The spatial layout of Sabon Gari and its effect on the adobe buildings: According to Theis, et al. (2003:D3) the city of Kaduna was conceived by the then British colonial administration in 1911. Thus, spatial layout of the earliest settlements (including Sabon Gari) is the European styled repetitive grid pattern as shown in figures 1.3 and 1.4 in chapter one. It was observed that this regimented and monotonous spatial layout differs from the traditional settlements that have irregular clustered layouts. Zaria City is a good example of a traditional settlement with clustered layout (see figure 5.2 in chapter five).

The standard plot size in Sabon Gari is fifteen metres (fifty feet) frontage and thirty metres (hundred feet) depth, with fifteen metres wide street reservations and another three metres (ten feet or 3.048 metres approximately) reservation at the back for sanitary purposes (see figure 4.1). It was however observed during the field survey that these sanitary reservations called *bayan layi* in Hausa are being used as refused dump, thus constituting a health hazard to the inhabitants. The provision of the *bayan layi* was also criticised in the MLC Report because of the same unhygienic conditions of these reservations (Theis, et al., 2003:68). This environmental nuisance could be the reason why *bayan layi* were eliminated in newer settlements such as Barnawa in Kaduna south (see figure 1.2 for location of Barnawa). Twenty plots makes up a cluster (i.e. ten plots facing a major road another adjoining ten facing another road on the opposite direction). Figure 4.1 is a sketch of a typical cluster in a layout in Sabon Gari, Kaduna.





Key
a = 15 metres; **b** = 30 metres; **c** = 3.048 metres; **d** = 15 metres (Not to scale)

Figure 4.1: Typical grid pattern layout plan in Sabon Gari, Kaduna

The buildings in Sabon Gari are mostly single storey and rectangular in plan. All the adobe buildings surveyed have rectangular plans and are single storey. The rectangular plan in Sabon Gari is influenced by the plots sizes, which is also rectangular. In addition, restriction of plot sizes to 15 metres by 30 metres as well as cost of these plots calls for optimum utilisation of space, of which rectangular plans seems to be the best option.

A plot in Sabon Gari originally consists of between 4 and 5 blocks of buildings to form a compound (see figure 4.2). Each compound is demarcated at the back and on both sides with perimeter wall mostly constructed with concrete blocks. However, plot frontage in Sabon Gari is defined by a block of building that is usually used for commercial purposes. The height of these perimeter walls ranges from 0.9 to 2.5 meters. The block of buildings behind those in the frontage are mostly used as residential blocks and are either on one side or both sides of the plot. The detached kitchen and toilet blocks are always at the rear. In 8 of the compounds however, the block of buildings at the rear are used for both residential and commercial activities in addition to the front shops.

Figure 4.2 is a conceptual diagram of a typical layout plan of a compound in Sabon Gari, while figure 4.3 is a layout plan of one of the compounds surveyed.

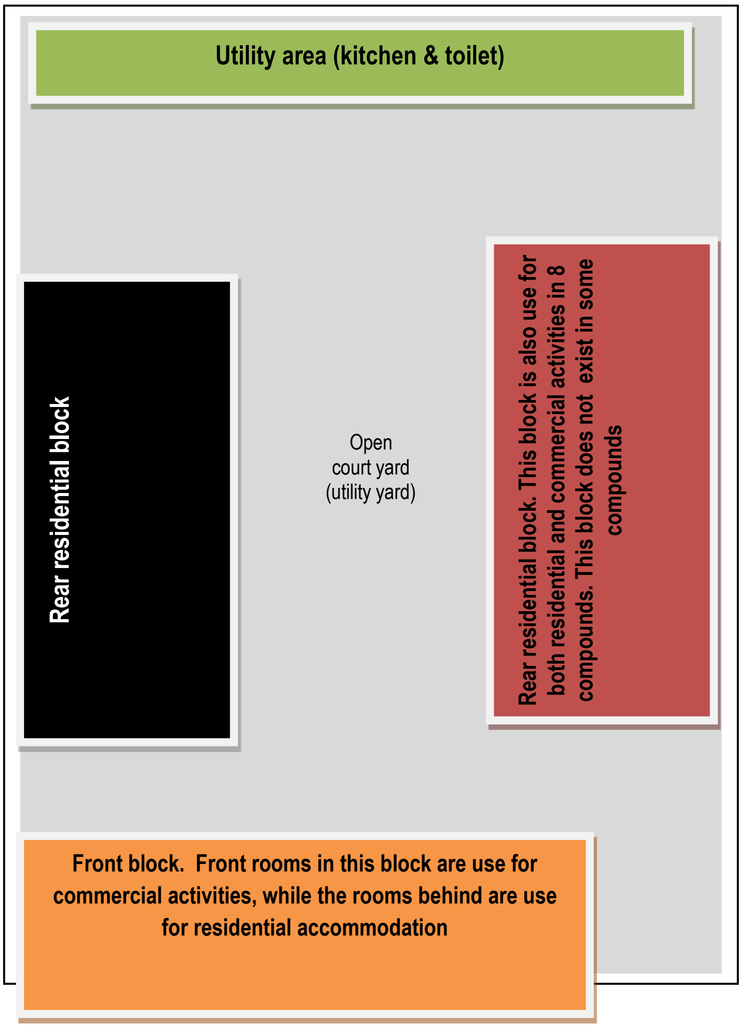


Figure 4.2: Conceptual layout plan of a typical compound in Sabon Gari

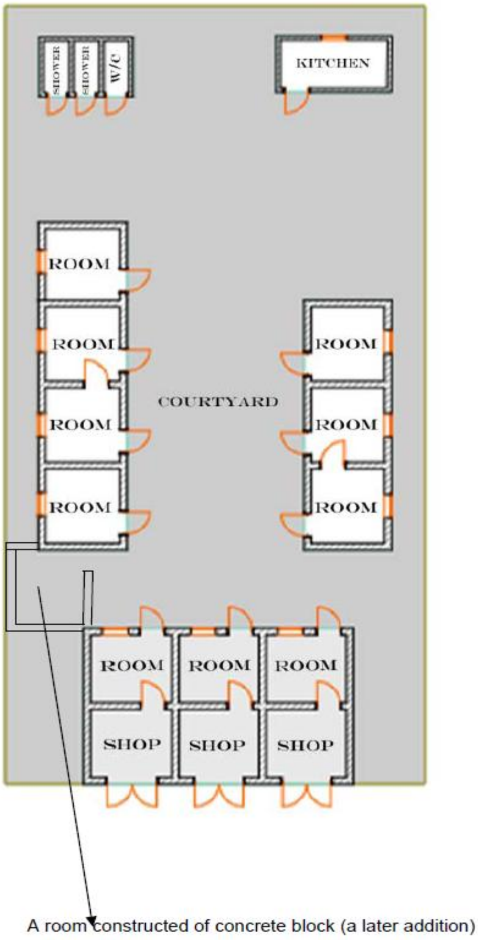
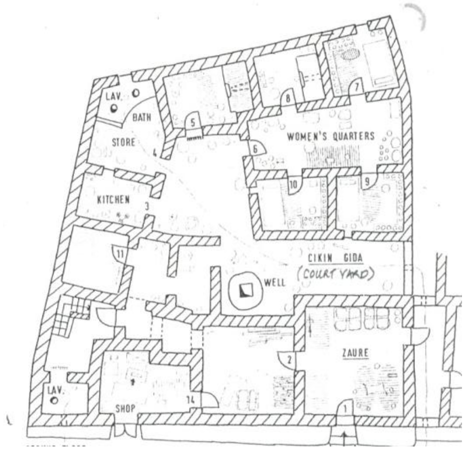
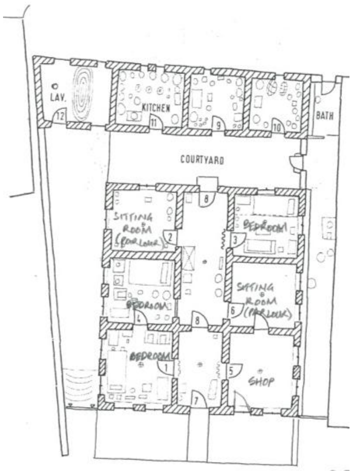


Figure 4.3: Floor plan of one of a compound surveyed by the author in Sabon Gari. The compound originally contain 5 blocks of adobe building but a room was later added between the block of building at the front and one of the side blocks. This later addition was constructed with concrete blocks.

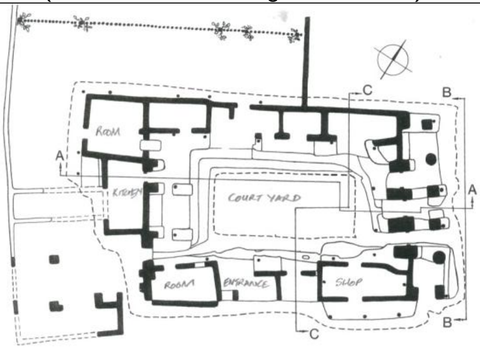
4.1.1b. Characteristic of buildings in Sabon Gari: The heterogenic nature of the population of Sabon Gari ensures that the architectural character reflects architecture of the major ethnic groups of the south west, south east and the northern regions. Figure 4.4 illustrates the similarity in plan form between one of the adobe building surveyed (which is typical of the adobe buildings in Sabon Gari) and the Hausa residential building in Zaria (north), Yoruba residential building in Ibadan (south west) and the Igbo residential building in Arochukwu area (south east). In all the four buildings, rooms were arranged to form an open central courtyard which is a common feature in Sabon Gari. The rooms are either square or rectangular in plan. Shop for retail trading is another common feature in all the three buildings shown in figure 4.4. The location shared utilities at the rear of the compounds is another common similarity.



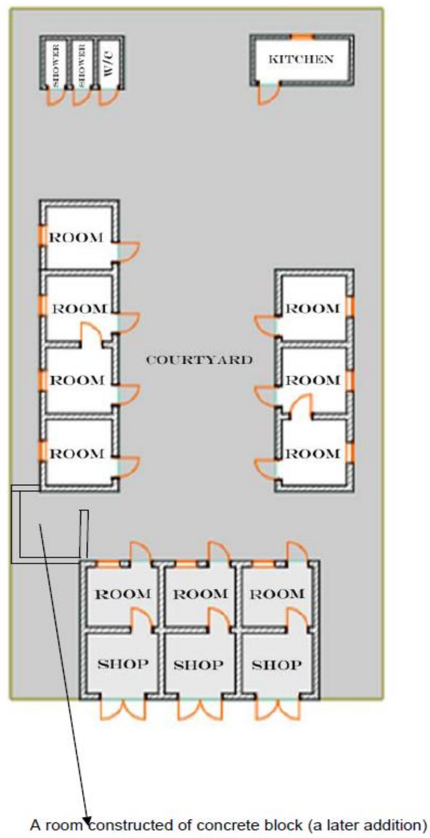
Floor Plan of a traditional Hausa residential building in Zaria, northern Nigeria
(**Source**: Schwerdtfeger, 1982:31)



Floor Plan of a traditional Yoruba residential building in Ibadan, south west Nigeria
(**Source**: Schwerdtfeger, 1982:128)



Floor Plan of a traditional Igbo residential building in Onitsha, south east Nigeria
(**Source**: Dmochowski, 1990, vol. 1:79)



Floor Plan of one of the buildings surveyed in Sabon Gari and is a typical example of the adobe buildings in this area, which is a modified Nigerian traditional Architectures

Figure 4.4: Comparative analysis of architectural styles

There are only very few buildings in Sabon Gari with *zaure* (see floor plan of Hausa traditional House in the previous page). *Zaure* is a common feature in Hausa traditional buildings and out of the 20 compounds surveyed only 1 has this feature (see figure 4.5). The function of the *zaure* is primarily to serve as a buffer between the central core (*cikin gida*) of residential building and the public (Hakim & Ahmed, 2006:11). Thus all male visitors not related to the family are restricted to the *zaure*. This important feature in Hausa architecture has been replaced with shops in Sabon Gari.

It was observed that the front blocks of the adobe buildings that are used as shops in Sabon Gari also provided the same privacy that the *zaure* provides in the 12 compounds that commercial activities were limited to the front blocks. Occupants of each compound shares kitchen and toilets that are always located at the rear of the compounds.

Figure 4.5: A Zaure (entrance reception room) in an adobe building in Sabon Gari

The major difference between the buildings in Sabon Gari and the traditional settlements is that in the former occupants of each compound that are tenants are not from the same family and ethnic group, while in the later compounds are owner occupier from the same extended family. Occupancy in traditional compounds is discussed in greater details in chapter five.

4.1.1c. Building material in Sabon Gari: Being one of the oldest settlements in Kaduna most of the residential buildings in Sabon Gari were originally constructed from adobe blocks but rendered with cementious material. Concrete blocks and reinforced concrete construction are currently use for new buildings mostly as a replacement for demolished adobe building. Therefore the present architectural characteristic of Sabon Gari is heterogeneous in terms of material usage, scale and architectural style. The results of this non uniformity are mixture of buildings of varying storey heights, sizes, uses and character. Figure 4.6 is a good example of this non uniformity of architecture in Sabon Gari.

Figure 4.6: Single storey mix use adobe buildings behind a 4 storeys hotel constructed with concrete in Sabon Gari

The roofing systems in Sabon Gari are mostly hipped roof made of corrugated iron sheets. All the 20 buildings surveyed have hipped roofs, thus all the four sides of the walls are protected by the roof overhangs. This type of roof is common with the Yoruba buildings (see Dmochowski, 1990, vol. 2:2.54). Theis, et al. (2002:17) noted that in an earlier study of Sabon Gari in 1965 that it was recorded that thatch and earth were used in roofing some of the buildings. However, none of the buildings has thatch in 2006. The thatch roofs have all been replaced with corrugated zinc, iron and asbestos sheets and few with concrete decking.

The changes in building materials in some of 98 compounds in Sabon Gari between 1965 and 2002 were recorded in MLC Report and it is presented in table 4.1 below and figure 4.7 (see also Theis, et al., 2003:18). It was however confirmed from the occupants that none of these 20 compounds surveyed in 2006 have undergone any change in terms of material since 2002.

CHANGES IN WALLING MATERIALS		NUMBER OF COMPOUNDS	%	CHANGES IN ROOFING MATERIALS		NUMBER OF COMPOUNDS	%
In 1965	**In 2002**			**1965**	**2002**		
Adobe	Adobe	33	34	Thatch	Zinc	14	14
Adobe	Cement blocks	40	41	Thatch	Asbestos	1	1
Adobe	Reinforced concrete	3	3	Thatch	Aluminium	2	2
Cement blocks	Adobe	None		Zinc	Zinc	77	79
Cement blocks	Cement blocks	18	18	Zinc	Asbestos	None	
Cement blocks	Reinforced concrete	None		Zinc	Aluminium	None	
Reinforced concrete	Adobe	None		Asbestos	Asbestos	None	
Reinforced concrete	Cement blocks	None		Asbestos	Aluminium	None	
Reinforced concrete	Reinforced concrete	None		Aluminium	Aluminium	None	
Record not available		4	4	Record not available		4	4
TOTAL		**98**	**100%**	**TOTAL**		**98**	**100%**

Table 4.1: Comparison of materials usage in buildings in Sabon Gari in 1965 and 2002
Source: *Theis, M. (2003:18)*

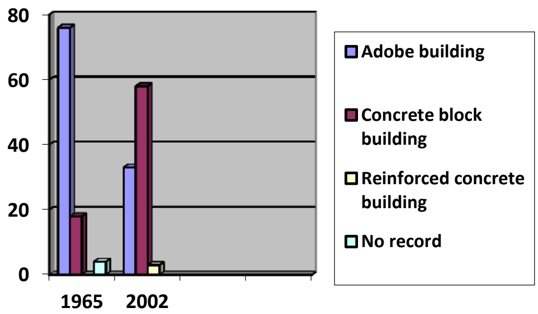


Figure 4.7: Changes in the use of building material between 1965 and 2002 in Sabon Gari
Source*: Theis, et al (2003:18)*

76 (75.55%) of the 98 compounds surveyed by MLC in 1965 have the entire building in the compounds constructed of with the adobe block. However, 43 of these have been replaced with concrete (40

concrete block and 3 reinforced concrete structures) as at 2002. The exact dates when the adobe buildings were demolished was not recorded in this report. The only known fact is that these changes occurred between 1965 and 2002. As stated in section 3.3b.iii, it is out of the remaining 33 compounds with the original walling material (adobe) that 20 were selected for this thesis.

4.1.1d. Changes in building sizes in Sabon Gari: Apart from changes in walling and roofing materials, it was also noted in the same report that 22 compounds out of 98 surveyed in 1965 have been expanded as at 2002 (Theis, et al., 2002:19). The increase in population in each of the compounds and the increasing demand for commercial purposes were the reasons for these changes (Theis, et. al., 2002:19). Although the exact number of blocks or rooms that were added was not stated, however, this type of remodelling was noted in the field survey in 2006 and is discussed in greater detail in section 4.2.3.

4.1.1e. Changes in utilities and service in buildings in Sabon Gari: 37 out of 70 compounds had both electricity and water in 1965 (Theis, et. al., 2002: 21). However, all the compounds had only one standing tap each, which was shared among the occupants in each of the compounds. Shared utilities still prevailed in 2002. It was recorded in the 2002 survey that 2 compounds had no electricity (see table 4.2).

Services available in the compounds surveyed in 1965			**Services available in compounds surveyed in 2002**		
Water and Electricity	Electricity only	Neither Electricity nor Water	Water and Electricity	Electricity only	Neither Electricity nor Water
37 compounds	30 compounds	1 compound	66 compounds	2 compounds	0
Total number of compounds surveyed in 1965	68 compounds		Total number of compounds surveyed in 1965	68 compounds	

Table 4.2: Comparative analysis of water and electricity supply in 68 compounds in Sabon Gari in 1965 and 2002
***Source**: Theis, et al. (2002:21)*

4.1.1f. Change of building purposes in Sabon Gari: It was noted in the MLC Report that there is an increase in commercial activities in Sabon Gari between 1965 and 2002. However, the intensity of this increase was mostly along the Ahmadu Bello Way (formerly King Edward Road), Lagos Street and Ibrahim Taiwo Road (formerly Market Road) (Theis, et. al., 2003:19). These roads are in red lines in figure 1.3 in chapter one. In 1965 it was recorded that only 25 compounds were used for commercial purposes, 72 compounds had no commercial units. However, it was noted that only 24 of the compounds surveyed in 1965 were still used as residential buildings in 2002. The survey of 2002 indicated that out of 98 compounds only 27 had no commercial activity, with 69 compounds accommodating 341 commercial units. It was explained in the 2002 report that the change in use of buildings in the 98 compounds surveyed was as a result of increase of commercial activities in this area between 1965 and 2002 (Theis, et. al., 2003:17). This change in use often entails remodelling of the buildings to accommodate these new activities. This remodelling do have consequences on the adobe building, this effects are identified in the field survey in August 2006 and are explain below.

4.2. Analysis of Findings in the 20 Compounds in Sabon Gari

The field survey in Sabon Gari conducted in August 2006 was aimed at finding the problems associated with the repair of adobe building in this area. The data generated using questionnaire, interviews and condition surveys of the 20 compounds with adobe buildings is critically analysed below.

4.2.1 Findings from the questionnaire responses: As explained in section 3.4.2a in chapter three, questionnaire was administered to a representative of the 20 compounds. Below is the analysis of the questionnaire's responses, (see also appendix 1.0 for sample of the questionnaire):

I. **Cultural identity of the landlords of the 20 compounds**: 2 questions (i.e. name of building and that of the owner) were asked in the questionnaire in order to ascertain the true identity of the landlords. It is a common practice among the Hausa to name buildings after the owner, the occupation of the original owner or the activities that were originally carried out in the building (see Schwerdtfeger, 2008:90). Buildings names can reveal not only the occupation of the original owners but their ethnicity, since ethnic groups in Nigeria have names that distinguish one from one another. Unfortunately only 1 building has a name and is called 'Gidan Chemist' because of the Pharmaceutical store in the building. However the name is not officially registered with KASUPDA and only very few (4 out 19 neighbours interviewed) knew the building with the name. Thus, the name was not recorded against the address.

From the names on the questionnaires' responses it was identified that only 1 compound belongs to Hausa from northern Nigeria, while the remaining 19 belongs to Yoruba and Igbo from southern Nigeria. This implies that the 19 (95%) of the current landlords are from regions where cob or wattle and daub techniques were traditionally used. Thus, limited knowledge on adobe technique exits among the landlords. The third question in the questionnaire was posed with aim of recording the addresses of the 20 buildings surveyed for proper identification and tracing the buildings in the future.

II. Building types: All the 20 respondents indicated that the buildings are single storey. This was also confirmed during the field survey (see section 1.4 in appendix I for the pictures of the buildings).

Building uses: All the 20 adobe buildings surveyed are used for both residential and commercial activities (mixed use).

III. Building occupants' status: 3 (15%) of the 20 compounds are occupied by landlords and their families, 10 (50%) are occupied by both landlords and tenants, while the remaining 7 (35%) are occupied by tenants only (see section 1.2 in appendix I). The aims of this question were first to ascertain the status of the occupants. Second, to compare the level of care accorded to compounds based on occupancy types (i.e. compounds occupied by landlords only, compounds occupied by tenants only and compounds occupied by tenants and landlords). This is because it was assumed that monetary gains from the monthly rent may be use in the repair of the buildings whenever the need arises.

IV. Building materials: 17 (85%) of the 20 compound have buildings with foundations made from adobe blocks, while the remaining 3 (15%) have concrete blocks foundation. Only 2 (10%) of the compounds have buildings with external walls rendered with earth render and internal walls rendered with cementious material. 13 (65%) have both internal and external cementious render, while the remaining 5 (25%) have both cementious and earth render externally and internally. 14 of these buildings with full or partial cementious render are oil painted externally and water based paints internally.

18 (90%) of the 20 compounds have buildings with roofs of corrugated zinc sheets, 1 has iron sheets, while 1 compound has an asbestos roof.

V. The repair of the adobe buildings in the 20 compounds: 12 (60%) of the respondents noted that it is the landlords' responsibility to carry out repair of the buildings, 3 (15%) indicated that it is the tenants' responsibility, while the remaining 5 (25%) indicated that it is both landlords and tenants' responsibility. The 3 respondents that indicated that it is the tenants' responsibility to carry out repair are landlords. The 12 that indicated that landlords should be responsible for the building's repair are tenants, while the remaining 5 that want shared responsibilities are landlords living in the same compounds with their tenants. These responses suggest that the two parties (landlords and tenants) may be protecting their interests. At the same time the responses of the 5 landlords living with tenants shows that the cohabitation has led to the understanding that repair should be a shared responsibilities. 16 (75%) of the respondents cannot remember when the buildings were last repaired. 4 other respondents (all landlords) indicated that the buildings were repaired every three to four years. However, the claim of these 4 respondents was later discovered during the interview not to be true (see section 4.2.2). The 4 later admitted that they cannot remember when the buildings were last repaired (see section 1.4.5a in appendix 1).

Only 1 of the 20 respondents indicated that they have the adobe building repair skills, however this respondent admitted during the interview to have never personally carryout the repair of his adobe building (see section 4.2.2). The lack of repair skills as indicated in the responses to the fifteenth question in the questionnaire did reflected in the response to the next question (question sixteen). In this is question, 19 indicated that they cannot carry out the repair of their buildings through self-help. Thus, only the same person that initially admitted to have the repair skill indicated that repair through self-help is possible.

Question seventeen was designed with the initial assumption that there are people that constantly repair their adobe buildings. However, the responses above signified the contrary. Consequently, the question should have been conditional, i.e.: 'who are you going to engage if you are to repair your adobe building?' Thus, the responses no longer have relevance.

VI. Availability of skilled professionals: 18 (90%) of the respondents do not know whether there are skilled professional in the repair of adobe building in Sabon Gari. The remaining 2 (10%) indicated that they have never carry out repair and as a consequence they have no idea. This shows that should any of the 20 respondents decides to carry out repair the person may have difficulty in finding competent person to carry out the job. Thus, the only possibility is that unskilled labour will be used.

VII. Availability of building earth: 14 (70%) of the respondents indicated that building earth is not readily available in Sabon Gari, while the remaining 6 indicated that the material is readily available. 8 (40%) of the respondents agreed that building earth has to be purchased, while the same number do not have any idea how to source the material. 3 (15%) of the respondents indicated that the material can be sourced within the neighbourhood. A respondent indicated that the material can be sourced in the burrowed pits.

Despite the indication by 3 respondents that earth can be sourced within the neighbourhood, no borrowed pit was identified within Sabon Gari during field work. Thus, the only source of building earth is either to buy or recycle from the existing where possible.

The summary of the questionnaire responses is presented in section 1.2 in appendix 1.

4.2.2. Key Findings from the Interviews

This section contains key findings from the interviews not included in the questionnaire. As explained in section 3.4d in chapter three, 42 people were interviewed of which 36 are occupants of the buildings surveyed (see section 1.2 in appendix I for details of persons interviewed). These findings are discussed below:

I. Advantages of the adobe buildings: Despite serving dual functions (residential and commercial), 21 (80.77%) of the 26 tenants and 10 (100%) of landlords of the adobe buildings stated that cost of rent is lower than buildings made from concrete blocks (see section 1.6 in appendix I). They stated that some of their friends or relations living in buildings made from concrete in Sabon Gari pay higher monthly rents.

1 of the occupant stated that he decided to remain in the adobe building first and foremost because of his business. Second, because he realised that the room sizes in concrete buildings are smaller. Third, the concrete buildings are generally more congested, thus the shared facilities, i.e. toilets and kitchen are usually over stretched and always in unhygienic conditions. He also stated that the congestion of these concrete buildings means that monthly bills for electricity and water are higher, since the bills are shared equally in respective of individual consumption.

To confirm some of the above claims, 5 buildings made from concrete blocks were inspected. The rooms in 5 buildings made of concrete were measured. The minimum size of the room in adobe building was found to be bigger in size than any of the rooms in 5 buildings constructed of concrete blocks. The minimum size of the adobe rooms is 3.65 metres in length and 3.65 metres width (3.65 X 3.65m), while 4 of the rooms made from concrete are 3 metres in length and width (3 X 3m). 1 of the rooms is 2.9 X 2.5m. The possible reason for this difference is that the adobe buildings were constructed when Nigeria was still using the imperial system of measurement. 3.65 metres is 12 feet, which is a whole number and more convenient for the builders during setting out. On the other hand the concrete buildings might have been constructed when Nigerian have changed from imperial to metric system of measurement. Nigeria changed from imperial to metric system in 1972 (BEC, 1990:12). For the same reason explained above and in order to conform to the sizes of corrugated iron sheets that are also in metric, the rooms were decreased to standard sizes of 3 X 3m. The size of the corrugated iron sheet is 1.8 X 0.9m. The hygienic conditions of the two types of buildings are the same. The toilets are not clean, while the kitchens are not only unclean but the walls were filled with soot from the smoke from the firewood use for cooking. Furthermore, both buildings are congested. There is an average of 3 persons per room in both the 20 compounds with adobe buildings and the 5 compounds with concrete buildings.

The same 21 persons agreed that the adobe buildings are more comfortable than the buildings made of concrete. They stated that the interior of the former is warmer in the night when the external temperature is low and cooler when it is hot outside. They stated that this is a big advantage because the room temperature is naturally controlled, thus they do not require an air conditioner. Moreover an air conditioner will require electricity in constant supply in Nigeria in general.

2 architects (Mohammed & Nuhu) interviewed identified the availability of material and simplicity of construction as some of the advantages of adobe construction (see section 1.7 in appendix I). Mohammed stated that there is a big clientele for the repair of adobe buildings if suitable repair solutions can be found, he stressed that the present approach is not appropriate.

Other advantages pointed out by the interviewees are those already in literature, such as the thermal comfort (Avrami, 2010:328); lower cost of construction in comparison to other materials (Guillaud, et. al., 1995:58); etc.

II. The popularity of adobe technique: According to Mohammed and Nuhu the use of adobe blocks have become very popular such that it is also been use in the southern regions. Figure 4.8 is a picture of an adobe building in Ogoja in Cross River State in south east region taken by Nuhu in 2005. Nuhu acknowledged that the close similarity with concrete blocks in terms shape and method of masonry as well as lower cost are possible reason why adobe block is being used intensively in Nigeria. This claim could not be physically ascertained during the field survey. However, Osasona (2009:4) also confirmed the adobe is now being used in south west Nigeria.

Figure 4.8: Adobe building in Ogoja, Cross River State, south east Nigeria. This is an evidence of the popularity of this technical in the southern region
©Nuhu (2006)

 III. Lack of tenancy agreement: The 36 occupants of the 20 compounds stated that they did not sign any tenancy agreement when they first moved into their respective buildings (see section 1.8 in appendix I). They only had a verbal agreement on the cost of the monthly rent and mode of payment. Thus, both parties (landlords and tenants) have no written contractual agreement. The lack of this tenancy agreement has led to uncertainty about responsibilities for the buildings' care, with both parties blaming one another. This is manifested in the questionnaire responses in section 4.2.1.V above. The landlords are of the opinion that the tenants economically benefits from the use of the buildings. In addition to the economic benefits, the landlords are of the opinion that the tenants contributes to the accelerated deterioration of the buildings by using the buildings for dual purposes. Thus the tenants should be absolutely responsible for any repair. On the contrary, the tenants stated that landlords constantly benefits financially from the monthly rents, as a consequence they should be able to repair the buildings whenever it is required.

8 tenants expressed that the landlords exploit their desperation to remain in Sabon Gari by habitually

increasing the rents annually. They (the 8 tenants) explained that they have no choice but to agree to the new rate because of the strategic location of the area for business and as a residential area. Furthermore, the 8 tenants stated that whenever they forced the landlord to carry out a repair they ended up indirectly paying for it. They stated that the landlords will ask them to pay for it, with the promise that the amount will be deducted from the rents. However, the landlords will end up increasing the rent at the end of the year to cover for the cost of the repair. None of the 5 landlords challenged or denied these claims. They however justified their actions on the fact that the inflation rate in Nigeria is high and these buildings are their main or even the only source of income.

1 of the tenant lamented that after complaining to his landlord for more than a year, he was forced to bear the cost of replacing a broken window and a door, because the room became insecure (see section 1.9 in appendix 1). However, the tenant still preserves the old door and window because he has the intention of removing the ones he paid for and refixing the old ones whenever he is moving from the building. When reminded that this could affect the building structurally, he admitted to be aware but not bothered with whatever consequence might follow later.

This is a very critical issue that need to be addressed in the proposed framework to protect the interest of the two parties.

IV. Negative perception and stigmatisation: Nuhu (an architect) is of the opinion that there is a general perception that adobe building is for the poor because it is not durable (see section 1.7 in appendix I). As a consequence cementious render is use as a cover up of the perceived non durable material. Nuhu is therefore of the opinion that the popularity of adobe (discussed above) is not out of choice but due to the financial inability of the people to use the technique to build using the preferred material (concrete). 17 of the 36 occupants shared this sentiment (i.e. adobe is for the poor) but expressed that they are contented living in the adobe building in Sabon Gari for its economic advantage and convenience. On the contrary both Nuhu and Mohammed are of the opinion that this perception is wrong. They stated that the deplorable states of the adobe buildings in Sabon Gari are as a result of a lack of care not because of the inferiority of the material or the technique as perceived by these 17 interviewees.

V. Non chalant attitude to repair: The 36 occupants of the adobe buildings interviewed expressed that they are not satisfy with condition of the adobe buildings they are living in. However, the 26 tenants expressed that any improvement on the buildings will result in rent increase and they do not wish that to happen. Thus, they are of the opinion that the buildings should not be repaired except it is no longer safe for habitation. Similarly, the 10 landlords are of the opinion that the buildings can remain unrepaired as long as the tenants are not complaining and the buildings are structurally safe. The possibility of fatality should any of the building collapse was pointed out to the interviewees by the author. The 36 interviewees stated that such incidence has never occurred in Sabon Gari and they insisted that it can never happen. These responses signify attitudes of hope but deliberately overlooking the reality on ground.

VI. Scarcity of skilled artisans: Nuhu and Mohammed are of the opinion that the traditional earth masons should be use in the repair of adobe buildings. They argued that the use of like material is the best repair option, but that the current conventional masons do not have any knowledge of earthen architecture. Nuhu lamented that there are no skilled artisans with the adobe building repair skills in Sabon Gari. He noted that skilled artisans can only be found in villages or in traditional urban settlement such as Zaria city where adobe is still use extensively. Nuhu is however, of the opinion that bringing artisans from villages will be very expensive, thus, none of the landlords will be willing to venture on such expensive expenditure.

On the contrary Abdullahi Hammai (a mason) and Adebisi Opadokun (a retired mason) both living in Sabon Gari stated that there are masons in the area that have the knowledge of the adobe construction (see section 1.11 in appendix I). However, none of them are currently practicing the trade due to lack of patronage. Hammai stated that he originally started as an adobe masons, however he had to change to concrete block masonry when there was no longer jobs. Opadokun confirmed Hammai’s claim, he stated that he also had to change to concrete block masonry in the mid 1970s, before retiring in the late 1980s (he is not sure of the exact year). Hammai stated that he is willing to revert to adobe masonry if there are enough jobs to sustain him. Both Hammai and Opadokun confirmed that there are adobe building masons in the newly developed areas in the outskirt of Kaduna (e.g. Rigasa, Sabon Tasha, Gonin Gora, etc.) where adobe is still use extensively. They are therefore of the opinion that these masons can carry out repair using appropriate material and techniques.

The above findings reveal that the problem with skilled artisan in adobe building in Sabon Gari is that of ignorance of whom to contact and where to contact the right person. Both landlords and tenants therefore need to be informed of the availability of skilled artisans in other part of the city.

VII. Possible adobe building repair options in Sabon Gari: Hammai and Opadokun are of the opinion that cementious rendering is inappropriate for these adobe buildings. They both suggested the use of like material for the repair of the adobe buildings. Hammai further suggested the use of traditional earth render made by stabilising earth mixtures with organic additives. He suggested the use of *karo* (gum Arabic), *makuba* (pounded locust bean leaves), *dafara* (wild vine plant) and *shuni* (dye residue obtain from the traditional dye pits) as stabilisers for the adobe wall render. Although these materials were traditionally used by the Hausa in northern Nigeria, none of the 36 occupants of the adobe buildings have knowledge of the materials. Hammai explained that the materials can only be found in farms in agrarian settlements and not in Sabon Gari.

Hammai and Opadokun stressed that although the traditional strategy of planned preventive maintenance is better than repair, this is no longer feasible in Sabon Gari (due to reasons already discussed above). They therefore suggested that a repair option that will improve the building performance and at the same time eliminate frequency of maintenance should be developed.

Nuhu argued that Nigerian architects and engineers (including him) have limited knowledge of the adobe technology. He therefore suggested that the repair of the adobe buildings in Sabon Gari requires collective effort of architects, engineers, traditional masons, government, etc.

VIII. Lack of enforcement of building regulations: All the 20 adobe buildings have undergone one form of remodelling or expansion (this is discussed in greater details in section 4.2.3). However, the 10 landlords and 23 tenants that experienced these changes on the buildings acknowledged that these were carried out without approval from the Kaduna State Government's development control office the KASUPDA. Thus, by law these modifications are illegal.

One of the officials of KASUPDA (Musa Abdulkarim) was interviewed on this matter. Abdulkarim stated that all building projects (construction, renovation, repair, etc.) in Kaduna State require permission from KASUPDA before execution. He stated that the following documents are required for planning approval:

i. a written application stating the landlord's intention

ii. three copies of architectural drawings

iii. and or three copies each of structural, mechanical and electrical drawings

iv. application fee which is determined by the magnitude of the project

v. site analysis report

Abdulkarim however admitted that KASUPDA often ignore small projects such as renovation, remodelling and repair most especially in areas such as Sabon Gari and other areas inhabited by low and middle income people. He argued that many of the inhabitants of these areas that enjoy this leverage are poor and that is the major reason why they build with adobe in the first instance. He further pointed out that most of these buildings lack basic amenities i.e. electricity and pipe borne water, thus they enjoy nothing from the government and as a consequence should not be forced to pay any developmental fee. He however agreed that Sabon Gari is different from other areas with adobe buildings, thus, KASUPDA should be more involve in the supervision of projects such as repair in the area. It was pointed out to Abdulkarim that these neglected areas such as Rigasa, Gonin Gora, etc. may soon develop like Sabon Gari, and it might be too late to correct mistakes caused by lack of KASUPDA's supervision. His response is that government do carry out urban renewal projects to correct such mistakes. This could imply that the government might deliberately ignore developments in outskirts of towns and cities and later demolish the buildings in the new of urban renewal programme. Urban renewal is costly and always controversial in Nigeria. Past attempts in Nigeria had generated a lot of criticism and protests by those that were displaced. A good example is the Abuja (the federal capital) urban renewal project that has resulted in litigation and condemnations by international organisations such as UNHabitat (UNHabitat, 2011:30). There is therefore great possibility that people in Kaduna will object to any government urban renewal programme, bearing in mind the unsatisfactory manner in which previous attempts were executed. The responses noted during the interview of Abdulkarim are attached in appendix 1.4.3.

IX. Ignorance of the law: According to Irmiya Samson, a Magistrate at the Kaduna State Rent Tribunal (see section 1.10 in appendix I) all the issues relating to the landlords and tenants could have been avoided if there was a written tenancy agreement signed by the two parties when the tenants move into their respective buildings. Samson stated that the tenancy agreement should include the duties and responsibilities of both parties as well as the penalty for defaulting. He stated that the Rent Tribunal was established by the Kaduna State Government purposely to resolve such cases, however, only very few cases are reported.

Samson suggested that the people of Sabon Gari need to be educated on the need to seek permission from KASUPDA before embarking on any repair or remodelling of the adobe building. He stated that the building is protected from demolition without compensation by law once permission is not granted by KASUPDA. Moreover, he is of the opinion that the project will be better planned and executed with a planning permission.

X. Repair or replace? All the 36 occupants of the adobe buildings, 2 architects and 2 masons interviewed agreed that the adobe buildings in Sabon Gari should be repaired instead of demolishing and rebuilding. They all cited the economic importance of these buildings to both the tenants and landlords as the major reason why the buildings should be repaired. 26 of the interviewees (all tenants) stated that once the buildings are demolished they will be replaced with concrete buildings and they (the former tenants) will never be allowed to return. They gave examples of adobe buildings demolished in the area and replaced with bigger shopping malls made of concrete. However these new shopping malls were later rented out to rich and powerful people not to the former tenants.

10 of these 26 tenants also stated that they are already attached to their buildings, such that moving from away even if it is temporarily will affect them emotionally. Furthermore, the 26 tenants also stated that moving from the building may affect their children's education. This is because buildings are in high demand in Sabon Gari, thus they are of the opinion that if they have to move they will not be able to get another building in Sabon Gari. Thus, it means they have to change the children's school should they move to another area of the city. 10 tenants also stated that moving out of Sabon Gari will affect their spouse's jobs.

All the 36 occupants of the 20 compounds favoured any intervention that will enhance the quality of the building as long as it does not displace them. Thus, the 2 architects, 2 masons and 12 tenants suggested that repair should be carried out gradually and on weekends when most of the shops are closed.

4.2.3. Condition Survey Analysis

The defects observed from the condition survey of the 20 adobe buildings in Sabon Gari are divided into three categories, namely:

a. defects associated with the building components

b. defects associated with humans' activities

c. defects associated with external sources.

4.2.3a. Defects associated with the building components

All the defects that were observed to be as a direct result of failure from the buildings were either due to ageing or neglect and are explained below.

I. Roof Leakage: Leakages were noted in 4 compounds. These leakages have resulted in dampness on the walls and ceilings in these buildings. The ceiling of a room in one compound has rotten and needed to be replaced. The cause of the leakages in 2 compounds could be attributed to long term neglect. This is because at least 1 of the occupants have lived for more than 20 years in these 2 compounds and they testified that the roofing sheets have rust when they moved in and never been repaired since they moved into the compound. It might be that the 2 roofs have not been repaired for a longer period. Another probability is that the 2 roofs has never undergone any repair since their constructed and the available record shows that buildings are at 41 years old as at 2006 (i.e. 2006 – 1965).

Inappropriate repair could be the reason for the leakages in the other 2 compounds. It was noticed in these 2 other compounds that some of the roofing sheets have been replaced recently with new ones but the leakage still persists. The difference between the old and new roofing sheets can be distinguished from the physical appearance of the two. The old sheets have corroded, while the new once are still shining (see figures 4.9 and 4.10).

Figure 4.9: Adobe building with sagged roof, replaced roofing sheets, two sealed doors and cement based rendering. Note also the steel container use as part the building extension.


Figure 4.10: Interior of a house with leaking roof. Note the stained ceiling cause by the leakage

II. Sagging of roof members: The 4 buildings with leaking roofs have also sagged as a result of warping of the timber trusses. The possible causes of this warping could be ageing and excessive moisture from the leaking roofs. This is because it was ascertained by the author through physical inspection that the sizes of the roof trusses are adequate by Nigerian standard (i.e. 150 x 100mm). The sagging resulted in undulated roofs, which interrupts even flow of rain water and eventually the roofing sheets started to rust (see figures 4.9). These roofs sagging could have been avoided if the leakages were mended, thus, the defect is as a result of lack of maintenance.

III. Deterioration of timber: Visible vertical cracks and failure of the cementious render were noticed at the top of doorways of 7 buildings. The cause of these defects was identified as the failure of the timber lintels. *Azara* (trunks from palm trees) was originally used for the lintels (Dmochowski, 1990, vol. 1:1.2). However, according to the occupants these were later changed to timber lintels as part of the remodelling of the buildings. The use of timber is foreign to the Hausa architecture. *Azara* was preferred for two reasons, first, because of the scarcity of timber in the region and second, the presence of termites that attack the timber in buildings. However, *azara* is not susceptible to termite attack unlike timber. Thus, the use of *azara* was indigenous and sustainable, because it is readily available locally at affordable cost, unlike timber that is only available in southern Nigeria. Unfortunately this indigenous solution was neglected in subsequent remodelling of these 7 buildings.

Traditionally, arches were introduced on openings wider than 900mm (Dmochowski, 1990, vol. 1:1.24). Openings in the adobe buildings in Sabon Gari were therefore originally limited to 900mm. However, the spans of the lintels were increased during the remodelling, because shops and other commercial activities require wider doors. The original doors were therefore replaced with wider once of between 1200 and 2400mm widths and the *azara* replaced with timber lintels. The resultant effect of this action is the bending of timber lintels due to the use of under size timber and excessive point loadings (see figure 4.11).

Figure 4.11: A partially deformed timber lintel caused by excessive loading. Note the cracked cementious rendering

Although timber is now commonly use in buildings in the north, the failure of the material in the 4 buildings have proved that *azara* is superior, thus it uses should continue. However, Opadokun noted that in the 1960s and 1970s timber were treated with a chemical pesticide commercially called Gamaline 20, but this has to be reapplied every 10 years to repel termites. This pesticide although protects the timber, is harmful to humans, animals, plants as well as the environment. Opadokun however noted that many of the timber used in the recent buildings' remodelling in Sabon Gari were either not treated or treated with diluted Gamaline 20. He explained that artisans now use kerosene (paraffin) to dilute the pesticide to maximised profit, which shortened the life span of the treated timber to about 2 years.

4.2.3b. Defects associated with previous interventions

I. Basal erosion: 17 of the 20 compounds surveyed have their buildings are affected by erosion at the base of the walls. This erosion is accelerated by the cementious render in all the 17 buildings. The erosion in 14 out of these 17 buildings is caused by rain water from the roof as a result of lack of guttering (which is not common in Nigeria) and the lack of appropriate drainage system (see figure 4.12). The other 3 compounds with buildings not affected by basal erosion have external earth render. In fact 2 of these 3 compounds have both internal and external walls rendered with earth. This confirms that cementious render accelerates the rate of erosion on the wall base of these buildings.

Figure 4.12: Accelerated basal erosion on adobe wall due to lack of drainage and the application of cementious render

II. Wall cracks: The defects noted on the adobe walls are as a result of cementious rendering and remodelling of some of the buildings from residential to commercial, or from one commercial activity to another (the defects caused by remodelling are explained separately below). 16 of the adobe building with cementious render have cracks and the wall have shown visible effect of damp. Examples are shown in figures 4.12, 4.14, 4.15 and 4.16. The oil base paints that were applied to the exteriors of these buildings might have contributed more to the severity of this damp since the paint forms another impermeable layer that will not allow the moisture to escape just as with the cementious material.

Human and animal activities were also observed to have contributed to the cracking of the cementious render and subsequently the erosion of the walls, most especially at the base. This erosion was more severe on 2 buildings with only cementious render at the base in comparison with those that have cementious rendering on the entire wall.

III. **Floor cracks:** All the 20 compounds surveyed have floors made from rammed earth hardcore and finished with cementious screed. Cracks were noticed in all the floors. The cracks are due to lack of strong flooring that could with stand wear and tear. The thickness of the cementious floor screeding in 3 buildings is just 25mm, while in another 2 the thicknesses are 35mm. The floor thickness of the remaining 15 buildings could not be ascertained because the cracks have not got through to the rammed earth hard core filling. Unfortunately, because of the restriction in photographing the interior of these buildings the floor defect can only be illustrated by the author as shown in figure 4.13. According to the occupants, the cracks have been patched up on numerous occasions, but continued to reappear.

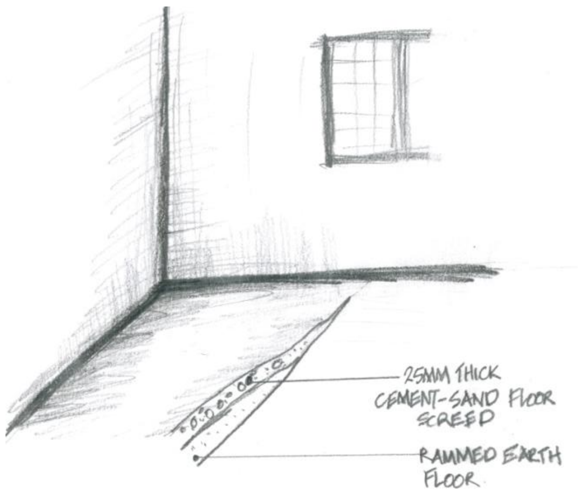


Figure 4.13: Cracks on cementious screed floor of adobe building

4.2.3c. Defects associated with remodelling

20 buildings surveyed have at least 1 room remodelled for use other than what it was originally intended for. The conversion from residential to commercial or from one commercial uses to another usually entails remodelling to meet the new needs. Various effects of remodelling were observed during the survey and are explained below.

Figure 4.14: An adobe building with cementious rendering. Note the iron grills and the dampness on walls due to the rendering

I. Damp associated with wall signs: Telecommunication, food and beverages companies do advertise their products and services on walls of residential buildings. Many buildings not only those made from adobe in Sabon Gari carry these adverts, because of the high financial reward. 4 adobe buildings have these adverts. The walls were rendered with cement base material and painted to allow the advert to be written in oil paint. The effects of both cement base rendering and oil paints on adobe wall can be seen in figure 4.14 above.

Figure 4.15: Adobe building with canopy, new doors, filled up window opening and new extension with lean-to roof at the far end

IIa. Walls cracks by the new doors: In all the 20 compounds surveyed at least 2 rooms that have been converted to commercial units have had the original doors changed. As explained in section 4.2.3a:III above this entails the introduction of bigger doors and replacement of the old azara lintels with those of timber. Apart from the defects associated with the timber lintels, cracks were also observed at the connections between the doors and the existing walls in 18 buildings (see figures 4.11, 4.12, and 4.15).

IIb. Wall cracks by the new windows: New windows were introduced in 3 of the converted shops which entail the same process as fixing of doors explained above. Cementious material was used to patch up the chiselled walls. Positions of windows were altered in 5 shops so as to accommodate the new doors that are wider in width. This action resulted in the use of cementious material for fixing of the new windows and for sealing of the old opening. Cracks were observed in these two areas cause by lack of adhesion between the old and new material.

Furthermore, in 20 of the shops that were in the middle (sandwiched by other rooms on both sides) windows had been totally eliminated (see figure 4.15). This alteration resulted in interior spaces without ventilation except from the door, thus, becoming uncomfortable whenever the doors are shut in the night. This lack of ventilation in these shops is another cause of dampness particularly in the month of August when the relative humidity is high and rainfall is heaviest (see Ogunsote, 1991:22).

IIc. **Wall cracks in areas where electrical appliances were introduced**: The introduction of electrical fittings such as ventilation fans (mostly ceiling fans) and other appliances requiring new wiring, sockets, switches etc. usually accompanied remodelling and conversions. In the process of installing these electrical services, the adobe walls were hacked off and patch up with cementious mix. Cracks were noticed in 2 buildings in which electrical fittings were installed. This is not only an eye sore as can be seen in figure 4.16 below, but can affect the structurally stability of the adobe walls.

Figure 4.16: The effect of electrical installation and government services (road, drainage, etc.) on adobe buildings

III. Moisture on walls from leaking water supply and sanitary pipes: Some of the commercial activities require water, e.g. restaurants, barbers and hairdressing saloons, etc. Holes are usually bored into the adobe walls to accommodate pipes and other fittings in the process of introducing plumbing appliances. This action has the same consequences as the fitting of electrical appliances on walls in addition to leakages from improperly fit joints. Leakages were noticed in 2 buildings. In these 2 buildings the entire bottom part of the wall where the pipes were fixed was very damp, which may lead to the collapse of that part of the building or the entire building if not repaired.

IV. Wall cracks by the burglary proof areas: In Nigeria security screens on windows are now compulsory in every building to make them burglary proof as can be seen in figures 4.14 and 4.17. Since these buildings were built when security screens were not a necessity, none of the 20 buildings had the security screens originally. But these were introduced according to the occupants in the 1990s when house burglary became too rampant in Kaduna. Patches of cementious mortar could be noticed in the areas where these burglary proofs screens were fixed to the walls in almost all the buildings and severe cracks caused by their introduction in 32 rooms in 12 compounds.

Figure 4.17: Adobe building with security screen on the windows

V. Cracks by the mosquito's nettings: Being in the tropics mosquitoes are common in Kaduna and because the shops are linked with bedrooms, mosquito nettings were therefore fixed on the windows and inner doors in 7 buildings. The nettings are supported by timber framing and fixed between the window jambs by nailing into the adobe walls and patched up with cementious mix. The effects of this action are already explained above.

VI. Sagged and missing facial boards: 3 compounds have buildings with advertising boards nailed on the roof facia boards, which has resulted in the sagging of the facia in these 3 buildings. Part of the facia board was missing in building in 1 of the compounds.

VII. Cracks between existing and new walls: New buildings were constructed in between the adobe buildings and perimeter wall or between two blocks of buildings in 14 buildings. These extensions were carried out in order to accommodate shops and other services such as electricity generators and storage (see figures 4.17 and 4.19). Cracks were noted at the joints between the old adobe and the new concrete walls. In some instances timber or steel containers are used as in the case of figure 4.7. The roofs of these additions were independent of the roofs of the existing structures, and are mostly lean-to, that are attached to the adobe walls (see figure 4.10). The joints where the roof penetrates the adobe walls were rendered with cementious material without any water proofing material. The rendering is so porous that it allows rain to pass through these joints. This was noticed in all the 14 cases where the extension had a lean-to roof.

VIII. Cracks and leakages from the remodelled entrances: In order to accommodate more commercial activities in front of the newly converted shops canopies made from either steel or timber frame and covered with tarpaulin, transparent or translucent plastics, or zinc are usually introduced. This is also use for advertisements instead of signboards and for aesthetics purposes. 5 buildings have this extension.

4.2.3c. Defects associated with external sources

The defects identified that were caused by external sources during the condition survey are explained below.

I. Adjoining Properties: In 5 of the buildings the overhang of the roof of adjoining building was directly draining rainwater onto the adobe wall in another property (see figures 4.18 and 4.19). The rain water that drains on these buildings causes accelerated erosion of the adobe walls.

Figure 4.18: Roof of adjoining property affecting adobe wall in another property

Figure 4.19: This picture is of the same building above (figure 4.16) but taken from the opposite side. The effect of rain on the adjoining property is clearer from this view

II. Flooding and damp: 6 buildings were affected by flooded road and drains. This is caused by the introduction of drainage and resurfacing of existing roads. The roads along Lagos street, Katuru road, Bayajjidda street, Wushishi road etc. were recently rehabilitated. The consequence of this action is that all the buildings along these streets have their finished floors levels either lower than the newly refurbished road surface or on the same level. Since earth in general is vulnerable to moisture

(Hughes, 1987:59), most of the buildings on these streets are affected by storm water whenever it rained. This effect is aggravated by the shallow drains, which are always littered with objects from different sources. Thus storm water usually over flow these constantly blocked drains resulting in flooding of the adobe buildings. 6 adobe buildings were affected by flooding from the refurbished road (see figure 4.14, 4.15 and 4.16).

Table 4.3 is the summary of the condition survey. Detail condition survey reports of each of the 20 compounds are attached in appendix 1.2a.

	DEFECT	NO OF BUILDINGS THE SUCH DEFECT	POSSIBLE CAUSE(S) OF THE DEFECT
1.	**Defects associated with building component**		
	i. Roof leakages	4	• Ageing • Lack of maintenance
	ii. Roof sagging	4	• Ageing • Lack of maintenance • Inadequate sized roof structure
	iii. Deteriorated timber	7	• Material foreign to the area • Termites attack • Ageing • Lack of maintenance
2.	**Defects associated with previous works or intervention**		
	i. Basal erosion	17	• Cementious render
		14	• Lack of drains (roof and surface)
	ii. Floor cracks	20	• Sub standard materials and technique
	iii. Cracks on wall render	18	• Cementious render
	iv. Dampness on walls	18	• Cementious render • Oil paints
	v. Dampness associated with remodelling	4	• Rendering and painting on walls for adverts purposes
	ix. Dampness associated plumbing works	2	• Water and sanitary pipe leakages
	vi. Sagged timber lintels	2	• Introduction of larger windows
		1	• Introduction of larger doors in the cause of remodelling
	vii. Sagged facial boards	3	• Nailing of sign boards on facial boards
	viii. Cracks from electrical wiring	2	• Hacking off of existing walls and cementious patching
	x. Cracks associated with remodelling	18	• Use of cementious material for rendering and mortar
		12	• Introduction of burglary grills / screens
		7	• Introduction of mosquito's nets
		14	• Lack of bonding between existing adobe and new concrete blocks
		5	• Erection of entrance canopies
3.	**Defects associated with external sources**		
	i. Accelerated erosion of wall render	5	• Rain water from roofs of adjoining buildings
	ii. Damp	6	• Flooding as a result of roads and drainages construction causing the road level to be higher than the buildings' floor levels

Table 4.3: Summary of condition survey

4.3. Summary of Findings in Sabon Gari

From the field survey it was identified that the modern spatial planning, the strategic location and the heterogenic population combined to give the adobe buildings in Sabon Gari its distinct character, which is different from traditional settlement. Thus the material is traditional but the character is a combination of cultures in response to current needs (i.e. residential accommodation within commercial areas; rental accommodation; etc.).

The location of Sabon Gari was identified to be a major factor for the high demand of buildings in this area. Thus, the buildings are not only on high demand by tenants but are subjected to dual functions (residential and commercial), which results in pressure, change of use and misuse of the buildings. The lack of tenancy agreement meant that the buildings are left without repair, since neither the landlords nor the tenants are willing to take the responsibility.

The use of cementious material, the introduction of electrical, plumbing and other facilities meant that the remodelling was carried out by conventional (concrete) masons that have limited knowledge of earthen construction. Both the cementious render and remodelling has resulted in further deterioration of the adobe buildings. Furthermore, the standardisation of plot sizes meant that expansion and remodelling are confined to the 15 X 30m plot. In all instances these expansions and remodelling were often carried without government approval (e.g. figure 4.3). Some of these remodelling also affects adjoining properties (e.g. figure 4.18). As a consequence of these combined actions the adobe buildings are in dilapidated conditions. However, none of the stakeholders have idea of how to repair them. Thus, a new approach for the repair of these buildings needs to be developed.

Some suggestions were proffered by some of the respondents (e.g. use of traditional stabilisers) and the author identified some sustainable solutions (e.g. use of *azara* instead timber). However, most of the problems are social in nature and were generated in the pursuance of economic gains, which degenerated to technical problems. Thus, the problems identified from this field survey are divided into three categories, i.e. social, economic and technical issues and presented in table 4.4 below.

Finally, the findings from the survey are summarised using the structure proposed in section 3.3d in chapter three. Thus, the central phenomenon of the findings, the causal conditions that led to this phenomenon; the strategies employed by the occupants to cope with the situation, the conditions that shaped the strategies and the consequences of the strategies employed are identified, explained and illustrated in figure 4.18 below.

I. Central phenomenon of the findings in Sabon Gari: It was identified from the field survey that the adobe buildings in the 20 compounds surveyed in Sabon Gari, Kaduna are in dilapidated conditions.

II. Causal conditions of this phenomenon: The principal causes of the dilapidations of these adobe buildings were identified as lack of agreement between landlords and tenants; lack of maintenance; remodelling; pressure on the buildings; use of inappropriate material for remodelling; and lack of KASUPDA's technical expertise.

III. Strategies employed to cope with the condition: It was identified from the field survey that the occupants of these adobe buildings have developed nonchalant attitude to the care of their buildings.

IV. Conditions that shaped the strategies: Being located at the city centre these adobe buildings are in high demand for both commercial and residential purposes despite their deplorable conditions. Thus the landlords are assured of tenants.

V. The consequences of the strategies employed: As a consequence of the inappropriate actions and the nonchalant attitude of both the land lords and tenants the adobe buildings surveyed are in need of repair. Although the need for repair of these buildings was identified by the occupants, none of the stakeholders interviewed have idea on how to go about it.

	Social Issues	Economic Issues	Technical Issues
1.	Occupants' lack of adobe construction culture	Use of the adobe buildings for dual purposes	Defined plots sizes that limits expansion
2.	Lack social integration among the occupants	Pressure on the adobe buildings	Occupants' lack of adobe construction culture / knowledge
3.	Negative perception and stigmatisation of adobe	Lack of maintenance	Lack of information on appropriate repair
4.	Lack of skilled artisans in the area	Remodelling for commercial activities	Lack of maintenance
5.	Lack of maintenance and clarity about maintenance	Defects associated with previous works or intervention (see table 4.3)	Lack of skilled artisans in the area
6.	Lack of information on appropriate repair		Defects associated with building component (see table 4.3)
7.	Landlords and tenants' lack of commitment to building care		Defects associated with previous works or intervention (see table 4.3)
8.	Lack of tenancy agreement		Non availability of appropriate material in the area
9.	Non availability of appropriate material in the area		Defects associated with external sources (see table 4.3)
10.	Non enforcement of the building regulations		Defects caused by adjoining property
11.	Ignorance of the tenancy law and building regulation		Non availability of appropriate material in the area
12.	Defects caused by adjoining property		
13.	Defects associated with external sources (see table 4.3)		

Table 4.4: Categorisation of field survey findings

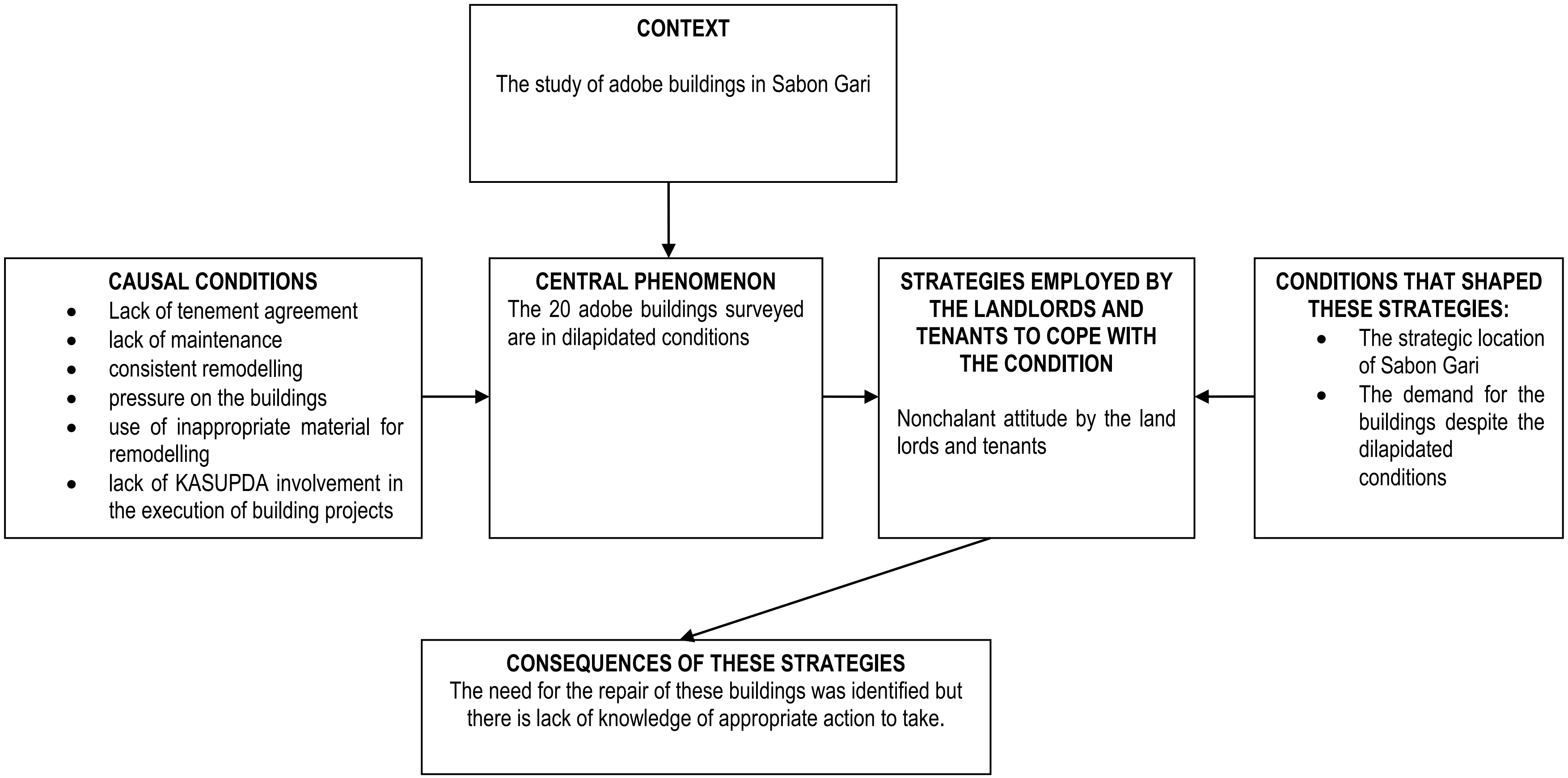


Figure 4.20: Summary of findings

4.4. Discussions

The field survey findings in Sabon Gari show that the problems are systemic. This is because all the parties involved in the care of the adobe buildings were identified to have shown laxity in their respective responsibilities. A critical analysis of the situation in section 4.3 above reveals that the problems are interrelated. The technical problems identified from the field survey findings are direct consequences of social and economic problems. Thus, by solving these social and economic issues, the technical problems will be minimised. For example, a tenancy agreement that specified the responsibilities of both tenants and landlords towards the care of buildings can help to ensure that the buildings are repaired whenever necessary. The critical issue identified is that basic information on what to do and how to do it is not available in Sabon Gari. As consequence an action plan need to be developed to address this situation.

The present adobe buildings in Sabon Gari are product of varying cultures, in a neutral modern environment, originally constructed with locally sourced materials, but currently being modified with factory processed materials. Just as in its conceptualisation, the continuous usages of the buildings are influenced by these factors, coupled with the stigmatisation of earthen buildings in general. Proffering solution to the problems identified in the field survey will therefore require a holistic approach that will consider these varying factors. The idea of the system theory (see chapter three) is therefore use in order to find solutions to the problems, since the problems are related and interwoven. As a consequence, the current situations in other urban areas in Nigerian cities need to be understood. Similarly, the place of the adobe building in the Nigerian building industry as well as in the Building Code must be understood. Furthermore, initiatives from around the world on the subject need to be critically examined in order to proffer holistic solution to the problems identified. Thus, in the subsequent three chapters these issues are critically examined and presented in order to propose a strategy for the repair of the adobe building in Sabon Gari.

CHAPTER FIVE

FIELD SURVEY 2

STUDY OF EARTH BUILDINGS REPAIR IN TRADITIONAL AREA IN THREE NIGERIAN URBAN SETTLEMENTS

What has changed the appearance of settlements (in Africa[11]) more than anything else was the introduction of new building materials from Europe.......

-Denyer, S. (1978:192)

5.0. Introduction

This chapter presents the findings from the field survey conducted in July 2006, which was aimed at identifying the current strategies in the repair of earth buildings in traditional areas within urban settlements in Nigeria. This second field survey also seeks to identify relevant strategies that can be used in the development of the proposed framework in Sabon Gari. Three traditional areas within urban settlements were identified in Zaria, Offa and Akamkpa (reasons for the choice of these towns were explained in section 3.3b.iv in chapter three). The condition of some selected earth buildings in these areas was critically examined. The occupants of the buildings and building professionals in these areas were also interviewed during the field survey.

Although this study preceded that of the study area (Sabon Gari) presented in chapter four, however, it is more logical and systematic to present the problems (i.e. the problems with the adobe building repair in Sabon Gari), before the search for possible solutions. Thus, the first field work carried out by the author is presented in this chapter, while the second was presented in chapter four.

The resources of the CECTech in Jos (being the only earthen architecture research centre in Nigeria), were explored from the inception of this thesis. Consequently, the author commenced the field survey in July 2006 from this research centre. Thus, key members of staff of CECTech were interviewed. The aim of the interview was to identify whether any research on the thesis' subject or related topic have ever been carried out by the centre, other related organisations or individuals. Furthermore CECTech

[11] Author's emphasis

was instrumental to the choice of the three urban settlements understudied in the later part of the survey. The chapter is therefore presented in the order the survey was conducted.

5.1. Field Survey Methodology

A semi structured interview was conducted by the author in CECTech involving key members of staff of the centre. The interview notes are attached in appendix 2. In Zaria City however, 20 earth buildings were first selected and 1 representative each from these buildings, 5 earth builders, 1 architect and 1 architecture student were interviewed, making a total of 27 persons. Similar methodology was adopted in Offa and Akamkpa. However, only 7 persons were interviewed in Offa and 13 in Akamkpa.

Although the author aimed at interviewing as many traditional earth builders (masons) as possible however in Zaria City, these skilled craftsmen are scarce. The decline of traditional builders in Zaria City has long been identified in earlier studies such as Schwerdtfeger (1982:23) and Marchand (1993:108). Apart from the envisaged scarcity of skilled craftsmen, the author also had difficulty in tracking down these few for interview. This is because the survey was conducted in the month of July, which is the peak of the rainy season when the earth builders were all busy on the farm, since they all combine the building trade with farming. Because farming is seasonal in Zaria City and the builders rely more on farming for income. Thus, it was only possible to conduct the interview in the evenings at the end of the day's work on the farm.

Although the survey was conducted under a tight schedule, with the earth builders having limited time, the choice of the rainy season was deliberate. This is because the rainy season is the critical period for the survival of earth buildings in Nigeria. Rainwater is the major natural factor that affects earth buildings in Nigeria (Guillaud, et al. 1995:12). Traditionally preventive measures and corrective interventions were usually carried out, before and after the rainy seasons respectively (Schwerdtfeger, 2008:50). Thus, it is the intention of this study to examine the earth buildings in Zaria City at this critical period and to see whether preventive and or corrective measures are still being carried out.

The 20 buildings examined are those that the author could gain access to, because of the restriction of male visitors to the *zaure* in Moslem communities such as Zaria City. Even these 20 buildings examined, the author could not take photographs of the building interiors so as not to abuse the privilege being accorded. Consequently pictures of the courtyards (*harem*), bedrooms, kitchen etc. are missing in this thesis.

Only 7 people agreed to be interviewed in Offa. There are no longer traditional earth builders in Offa. Thus, 6 out of the 7 persons interviewed are earth building owners, the other person is a Quantity Surveyor living in Offa (see appendix 2.3 for the profile of the interviewees). 4 out these 7 persons declined to give their names, because they do not want to be identified with earth building, because it is perceived to be for the poor. Consequently, these 4 persons are tagged 'interviewee 4, 5, 6 and 7' respectively (see appendix 2.3). Furthermore, none of the 7 interviewees have practical knowledge of cob construction or repair. As a consequence the field work in Offa was largely limited to the author's observations and theoretical knowledge of 1 of the interviewee who is a Quantity Surveyor at the Offa Polytechnic (see appendix 2.3).

The people of Akamkpa demonstrated similar attitude and perception of earth buildings just as the people in Offa. 24 buildings constructed of wattle and daub were examined, however, only 10 of the building owners agreed to be interviewed, but objected to their names being included in the thesis. Consequently, similar coding system used in Offa was used in Akamkpa. Thus the 10 interviewees were referred as: interviewee A, B, C, D, E, F, G, H, I and J respectively and only photographs of the 10 buildings were included in the thesis (see appendix 2.4). Just as in Offa, the field work in Akamkpa relied on theoretical knowledge and experience of 3 architects as well as interview responses and observation. 1 of the architects lived and practice in Calabar, the other lived in Abuja but has a branch office of his practice in Calabar since 1997, while the third has carried out research on earthen architecture in south east Nigeria.

The study in Zaria was more comprehensive because of its proximity to Kaduna, thus, it has similar climatic conditions, which means the soil conditions and technique of construction are the same. Furthermore, the adobe construction technique is currently use extensively in Zaria. The field survey therefore afforded the author the opportunities of observing the moulding of the adobe blocks in addition to the study of the existing buildings.

5.2. Analysis of CECTech Interviews Responses

The study at CECTech was conducted with an assumption that either the centre might have carried out research on the thesis' subject or the centre is aware of individuals and groups that have done so. Semi structured interviews were conducted in July 2006 at the CECTech's premises in Jos. The director, an architect and an engineer of the centre were interviewed (see appendix III for the names of the interviewees and interviews' notes). From these interviews the following were identified:

5.2.1. CECTech's research on non traditional adobe buildings in Nigeria: From the interviews it was identified that although CECTech in collaboration with MOTNA (also in Jos) have been involve in the repair of the replicas of earthen monuments in MOTNA, the centre have never carried out research on the repair of non traditional adobe building in Nigeria. According to the interviewees the buildings in MOTNA are always repaired using like material and original technique.

Furthermore, the centre conducted a research project on earth construction in Plateau State in 1993, which was published in Ogunsusi, et al. (1994:29). One of the findings from this study is that the adobe block was not only popular in both the rural and urban settlement in the state, but it has transformed the earth building forms from circular to rectangular. This study also postulates that the transformation of form might have been accelerated by the introduction of corrugated iron sheets to replace the traditional thatch that requires regular maintenance and is also vulnerable to fire. Ogunsusi, et al. (1994:29) based their argument on the fact that because the corrugated iron sheets are rectangular, it perfectly fit the rectangular plan, unlike the circular plan. However, the study did not identify any repair issue relating to this change.

CECTech was also involved in various demonstration projects using the combination of adobe block and CEB. The justification for combining the two techniques was that the former is no longer socially acceptable, thus the use of CEB is a strategy aimed at modernising earthen architecture in Nigeria, for greater acceptance. When asked whether this aim was achieved, the responses were no, but pessimistic that CEB is still the most appropriate alternative for the revival and promotion of earthen architecture in Nigeria.

The conclusion from the interviewees' responses on CECTech's research on adobe building in Nigeria is that although they recognised the popularity of this technique in Nigeria, however they are of the opinion that it needs to be modernised, hence the preference and promotion of CEB. Consequently, the repair of these adobe buildings is not a priority to the centre. Moreover, the centre is a government institution under the National Commission for Museums and Monuments (NCMM), there is therefore the tendency for the centre to concentrate on conservation of monuments instead of the repair of non traditional buildings, most especially those owned by individuals.

5.2.2. Identification of potential interviewees: CECTech have also been involve in training apart from research since 1990 (Ogunsusi, et. al., 1994:19). According to the interviewees 111 individuals from various organisations have attended the CECTech's courses from 1991 to 1994. Unfortunately however, the centre does not have an up to date record of these individuals and organisations that have attended their courses. The names of government or educational institutions and private companies were published in Ogunsusi, et al. (1994:20). Thus, the interviewees were only able to recall only 4 individuals they are of the opinion to have carried out research on adobe building in Nigeria at PhD level. 3 of these theses were briefly reviewed in chapter two (see table 2.1). The fourth thesis focused on the use of organic additives for stabilising soil for earth construction, which is not related to building repair (Solanke, 1984). Although these additives may be use in repair, however, this will be a new material in Sabon Gari, thus the issues of availability, affordability and skill have to be considered.

5.2.3. Identification of traditional areas within urban settlements with significant quantity of earth buildings: Another aim of the visit to CECTech was to identify urban settlements that still have significant quantity of earth buildings. 6 of the 10 settlements identified by CECTech's staff are in northern Nigeria (see appendix 2.1). In order to have a broader understanding of the problems associated with the repair of existing earth buildings in Nigeria, Akamkpa in the south east, Offa in the south west and Zaria in the northern region were selected for this study. *Tubali* was traditionally used in Zaria, cob was the traditional technique in Offa, while wattle and daub was used traditionally in Akamkpa. Thus the study cut across the three main geographical regions of Nigeria with varying earth construction techniques. The aim is to identify repair strategies used in these three settlements in the face of the inevitable changes associated with continuous urbanisation in developing countries such as Nigeria.

5.3. Analysis of Data Collected from the Field Survey in Zaria City

Zaria is the second largest city in Kaduna State and it is situated about 63 kilometres north of the State capital Kaduna (Ndubueze, 2009:22). The settlement that is presently known as Zaria consists of Zaria City (*Birnin Zaria*), Wusasa, Tudun Wada, Kongo, Samaru, Muchia and just as in Kaduna, Zaria also have Sabon Gari (see figure 5.1). This study is however limited to Zaria city, which is the traditional area where the indigenes of Zaria lives.

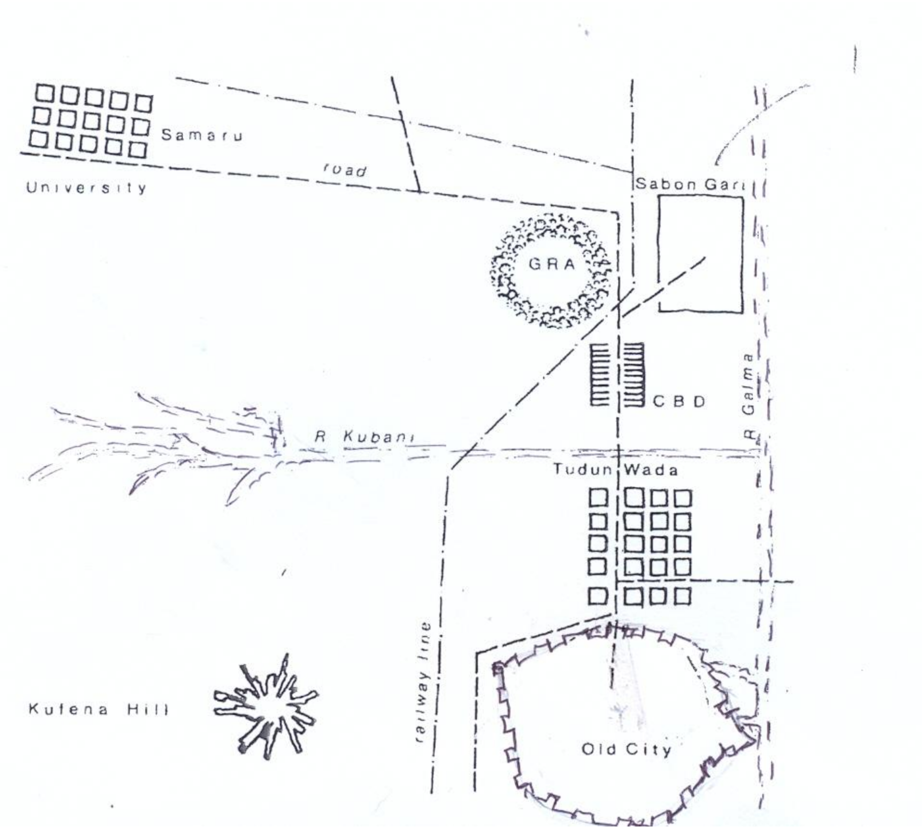
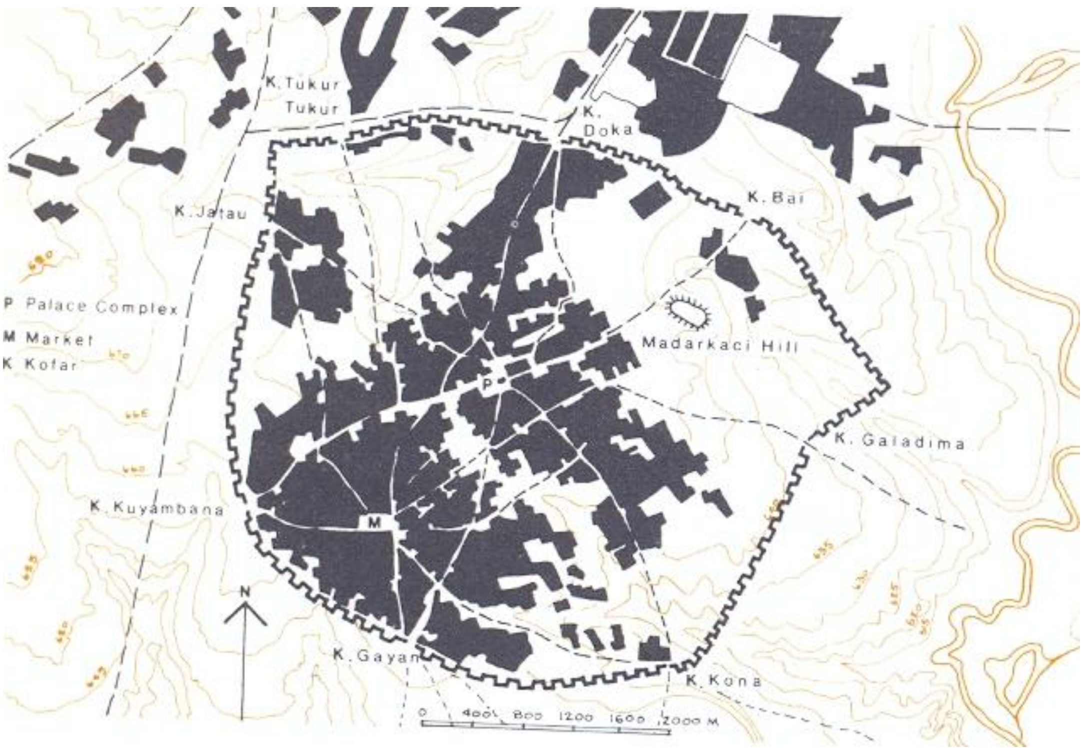


*Figure 5.1: Rough sketch of map of Zaria (**Source**: Moughtin, 1985:30)*



***NOTE**: P = Palace; M = Market; K = Kofa (gate), thus K Doka means 'Doka Gate'*

Figure 5.2: Map of Zaria city (Birnin Zaria)
***Source**: Moughtin (1985:33)*

Zaria City or *Birnin*[12] *Zaria* as it is traditionally called in Hausa is the area inhabited by indigenous Hausa tribes, while other part of Zaria mentioned above are all categorised as *Waje* and are inhabited by non indigenes that migrated from other part of the country (Schwerdtfeger, 1982:20). *Waje* in Hausa literarily mean 'outside', and in this context is use to refer to areas within present Zaria settlement that are outside the traditional city wall (Moughtin, 1985: 32). According to Schwerdtfeger (1982: xxxv) Zaria was founded in the fifteenth Century as a capital of a Hausa state and it still remain the seat of one of the most politically powerful contemporary emirate known as Zazzau Emirate. *Waje* areas such as Wusasa, Tudun Wada and Sabon Gari, came into existence in the late 19th and early 20th Century (Moughtin, 1985:29). The population of Zaria City in 1997 was estimated to be around 110,000 (Schwerdtfeger, 2008:15). The exact figure of the population in Zaria City in 2006 was not available as at the time of the field survey. However, it is certain the population has increased. This is based on the Federal Office of Statistics (FOS) annual urban settlements population growth in Nigerian, which was estimated to be between 5 and 9.3% (FOS, 2006:5).

5.3.1. The architecture and spatial planning of Zaria City: The traditional architecture of Zaria City was of earthen material (Moughtin, 1985: 51). Earth was used for both domestic and institutional buildings, including the city's defence wall, which was constructed as a protection against enemy attack (Moughtin, 1985:32). The entire Zaria City is still surrounded by the ruined earthen wall with circumference of about 14.9 Kilometres covering an area of approximately 1,600 hectares (Schwerdtfeger, 2008:15). The eight fortified gates still exist but have been remodelled using cementious material. Figure 5.3 is the picture of part of what remain of the defence wall called *ganuwa* in Hausa.

[12] *Birni* means city in Hausa, however when in use letter 'n' is usually added to facilitated pronunciation, e.g. Zaria city means *Birnin Zaria.*

Figure 5.3: Part of what remain of the Zaria City wall (ganuwa)

Earth is still in use for construction of buildings in Zaria City and many of the traditional buildings survived and are still in use. Thus, the current architecture of Zaria city is composed of traditional *tubali* and the adobe construction as well as concrete structures.

It was noted that the traditional residential spatial planning in Zaria City as explained by Schwerdtfeger (1982:10) Moughtin (1985:29) and Dmochowski (1990, vol.1:4.19) is still maintained. Thus, the extended family system is still preserved. Consequently, a household or compound consists of rooms for grandparents or even great grandparents, parents, children and widows; kitchen, toilet, horse stables and animals pens all enclosed with adobe walled fence (see figure 5.4). The compound is divided into various quarters for grandparents, parents, male and female children. The *zaure* is the reception room located at the entrance of the compound where male visitors are received. The open courtyard is limited to the members of the family, which serves as working space and recreational area for the women and children during the day. The rooms are only used for sleeping, thus, all other activities are carried out outside (in the courtyard).

Figure 5.4: A layout plan of a traditional Hausa compound in Zaria City as recorded by Moughtin (1985:62)

5.3.2. Analysis of interviews and author's observation of earth buildings repair issues in Zaria City: According to Chandler (1991:34) building repair starts with the understanding of the components and methods of the building construction. Consequently the study in Zaria City consisted of the data generated on the traditional and current earth construction in Zaria City. The analysis also included the study on the causes of deterioration of these buildings and how they are being repaired.

5.3.2a. Earth construction in Zaria City: From this field work it was observed and also confirmed by the 27 interviewees that the traditional *tubali* technique was no longer used in Zaria City. Instead the adobe block and concrete block are mostly used. However, some of the buildings constructed with *tubali* survive and habited in Zaria City. The field work was however limited to the *tubali* and adobe buildings. The traditional *tubali* is a pear shaped sun dried earth brick used not only in Zaria but by all over Hausa land in northern Nigeria (Dmochowski, 1990, vol.1:1.4), while the rectangular adobe block is commonly used these days among both the Hausa and other tribes in Nigeria (see figure 5.16).

According to the respondents the soil used for earth construction in Zaria City was sourced from burrowed pits within the walled City. However, it was observed that these burrowed pits are filled to the brink with rain water as can be seen in figures 5.5 and 5.6 (see also appendix 2.2.5). According to the interviewees the burrowed pits usually turns to pond every rainy season, thus building earth has to be sourced from the hillsides in the outskirt of the city. The earth is usually transported from the hillsides using donkeys as can be seen in figure 5.7.

Although earth construction and repair are economically viable in terms of availability of material, however, it constitutes both health and environmental hazards to the inhabitants of Zaria City. These flooded burrowed pits usually become breeding ground for mosquitoes during the rainy seasons. This is a serious issue that will require government's intervention because the burrowed pits will continue to get wider as earth is being dug for building purposes. Schwerdtfeger (1982:322) conducted a survey of the city between 1967 and 1978 and noted that burrowed pits takes about 1.9% (347,740 m^2) of total area of Zaria City. This total area of the burrowed pits must have increased by 2006 considering the erosion caused by the continuous sourcing of building earth during the dry season and the effect of rain. Some of the buildings in close proximity to these pits are already being threatened by erosion as shown in figure 5.8. More pictures of these burrowed pits are attached in appendix 2.2.5. The possible solution to this menace is to stop the inhabitants from sourcing building earth from these pits and then backfill all. However, this may further encourage the use of other materials most especially cement for repair and even construction of new buildings. Sadly, not everybody can afford cement, thus this may lead to further deterioration of the adobe buildings in Zaria City.

Figure 5.5: A burrow pit turned to pond during the rainy season in Zaria City and all are mosquitoes infested

Figure 5.6: Another burrow pit in Zaria City

Figure 5.7: Donkeys transportating building earth from the burrow pit outside the Zaria City to building site

Figure 5.8: An eroded burrow pit, which is already a threat to the adjoining adobe buildings

In order to further understand the similarities and differences between the traditional *tubali* and adobe techniques as well as the consequence of any differences between these two techniques on repair, the author undertook the study of both techniques in Zaria City. According to the 5 masons and 1 architect interviewed, the same materials are used for both techniques. Similarly, the method of preparing the soil is the same. However, the only difference is in the shape as a result of moulds use in the manufacturing of the adobe block, while the *tubali* is hand shaped. They briefly explained the process of laying the *tubali*, which is similar to that of adobe block. The only difference identified, is that in the *tubali* construction more mortar is required because of the shape and size of the brick. Figure 5.9 are freshly moulded traditional *tubali*. Figure 5.10 is a sketch of the *tubali* construction as observed in some old buildings and from the respondents' descriptions. Figure 5.11 is a demonstration wall using *tubali* constructed during the cob week at the University of Plymouth, while figure 5.12 is a ruined building constructed of *tubali* in Zaria City.

Figure 5.9: A freshly moulded tubali brick. The bricks were moulded by the author during the 'Cob Week' at the University of Plymouth in 2007

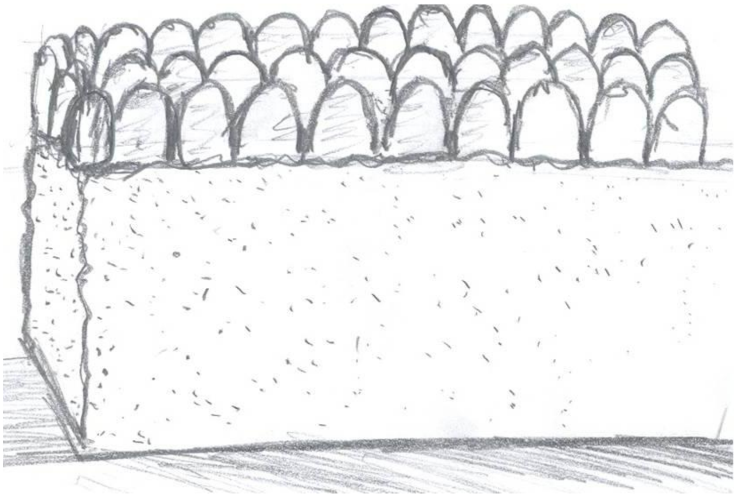


Figure 5.10: Sketch of tubali wall construction

Figure 5.11: Demonstration tubali wall under construction during the 'Cob Week' at the University of Plymouth

Figure 5.12: A ruined tubali wall in Zaria City

The respondents gave the following reasons for the preference of the rectangular adobe block as: first, the technique is faster to construct than the traditional type. Second, it consumes less mortar in comparison to the *tubali* technique. Third, the shape of the block and ease of construction ensures that the walls are straight and walls are at right angle to one another, which cannot be achieved with *tubali*. Fourth, it is cheaper to render the rectangular adobe wall using cementious material since it consumes less material than *tubali*. Five, it has the same shape as concrete blocks, thus modern architectural designs can be imitated using the adobe blocks. Lastly, it is difficult and expensive to find mason that can build using the *tubali*, unlike the rectangular adobe block. Although the fourth reason could be true, however, this is not appropriate and this was pointed out by the author to the respondents.

During one of the visits the author was able to observe how the adobe blocks are being moulded in Zaria and the observation is described below:

5.3.2b. Moulding of the adobe blocks in Zaria City: The author was able to observed two persons from the same extended family moulding the non traditional adobe blocks in Zaria City in July 2006 (see appendix 2.2.3a for details of the moulders and the moulding process). The soil that was to be used was already sourced the previous day from the nearby borrowed pit using donkeys as the means of transportation (see figures 5.7). According to the two persons, the soil was free and since they owned the donkeys they did not have to pay for transportation. Donkey is a major means of transporting building materials and farm produce in this community.

According to the two adobe block moulders, straw is used for stabilising the building earth and is sourced from fields within and around Zaria City at no cost. The straw was prepared days ahead by spreading it on foot paths and walk ways to softened it by humans and animals impact as they trample on the straw while walking on the footpaths. They noted that traditionally major footpaths were preferred, because of heavier traffic. However, this is presently not allowed on major roads in the city, thus the practice is limited to inner access roads, walkways and foot paths. They further pointed out that due to time limitation some people prefer to chop the straw by hand the same day it is to be used. When asked of the implication of this change, they pointed out that using longer straw can affect the quality of the blocks. Thus, the best practice is the later, i.e. softening of the straw by trampling upon by feet.

The ground where the adobe block was to be moulded was first of all cleared and levelled. The area set aside for demoulding and curing of the blocks was sprinkled with water to reduce rapid dehydration of the blocks during curing. According to the respondents this process of sprinkling water on moulded blocks may have to continue for at least the first 2 to 3 days of curing if the intensity of the sun is too much. This is to reduce rapid dehydration that will results in intolerable cracks on the blocks.

The earth pasty mixture is prepared by first of all breaking the earth lumps into almost granular state using hoes (see figure 5.13). Water was then added to the soil and consistently mixed using both feet until the mixture turns to a pasty like dough. This mixture was then spread using hoe and straw was added to this mix (see figure 5.14). Finally, water was added to this mixture and another round of rigorous mixing with legs completed the mixing process. Figure 5.15 shows the mixing process. According to the block moulders the consistent kneading and addition of water at every remixing accelerates the process of straw decomposition and bonding. They concluded that the more the number of remixing and the longer the interval between one mixing and the next, the better, the quality of the adobe (see also Dmochowski, 1990, vol.1:1.4). Unfortunately, both acknowledged that in the production of this adobe block the mix is repeated only once and in many instance a day after the first mixing. This could possibly affect the quality of the blocks.

To produce the adobe block the rectangular wooden mould was first of all lubricated with water, by dipping into water reservoir, to ensure easy demoulding of the earth mixture. The mould was then filled with a sufficient quantity of semi-solid[13] lump, flattened and compacted by hand to make sure that all

[13] Semi-solid: Pasty mixture for easy moulding and demoulding.

the voids are being filled with the pasty mixture, before demoulding. Figure 5.16 shows the demoulding process. According to the block moulders sand or oil can also be used for lubrication of the mould where water is scarce. The moulded adobe block is sun-dried for minimum of one week before use. Figure 5.17 shows the curing process.

Figure 5.13: Crushed building earth ready for mixing

Figure 5.14: Straw is being added to wet soil mix

Figure 5.15: Final stage of soil mixing and moulding of adobe blocks

Figure 5.16: Demoulding of adobe block

Figure 5.17: Curing of adobe blocks

There is no standard measurement for the quantities of water and straw that were added to the earth. The whole process requires experience to get it right. The block moulders explained that they acquired the skill from their parents. They began assisting their parents in soil preparation as young as they could remember. They could not remember their exact age then. They however, noted with regret that their children's generation are missing out from acquiring this experience because they have to go school. When reminded that the children can still participate in earth construction during holidays and over the weekends (Saturdays and Sundays), they pointed out that earth construction is seasonal and the season does not fall into the school holidays. Furthermore, the weekends are mostly used by the children to assist in cleaning and in doing other domestic chores.

The quantity of blocks produce per day depends on the skill of moulders. The two block moulders differ in their responses. The first respondent said he can produce between 800 and 1000 blocks per day, while the second said he can produce 600 to 800 in a day with the help of one experienced assistant. The other three masons interviewed in Zaria City in the course of this study also gave ranges of between 600 and 1000 blocks per day (see appendix 2.2.2b). Thus, it assumed that two person can produced between 600 to 700 blocks per day, working 8 hours per day (i.e. 75 and 87 blocks an hour).

Although the size of adobe block varies, however, the use of rectangular mould ensures that the blocks within a particular site are of the same size. The sizes noted are 500 x 450 x 150 mm; 450 x 300 x 100 mm and 400 x 300 x 100 mm (L x B x H). The ones being moulded are 450 x 300 x 100 mm.

5.3.2c. Effect of change from *tubali* to adobe block technique on architectural forms in Zaria City: It was observed that although the traditional Hausa compound type of spatial planning was still maintained in Zaria city however, significant numbers of buildings (including the 20 selected) have undergone various alterations using non traditional material. Furthermore, the change from *tubali* to the rectangular adobe block meant that buildings are now rectangular or square in plan. Thus, the circular plan is no longer in use, however a few buildings constructed with *tubali* still exists (see figure 5.18). The 27 interviewed attributed the reason for the change in plan form to the difficulty in construction of circular plan using the rectangular adobe block. Unlike in Plateau state where another reason for adoption of rectangular plan was given as the introduction of corrugated iron sheets as roofing material (see section 5.1.1 above), in Zaria City the respondents did not give this as one of the reasons for the change.

Figure 5.18: One of the few surviving traditional adobe buildings with circular plan

Figure 5.19: Circular plan adobe building with conical roof made from corrugated iron sheets

It was observed that some circular *tubali* buildings have corrugated iron sheets roofs (see figure 5.19). However, the conical shaped roof made of corrugated iron sheets corrodes faster than the roofs of buildings with rectangular plan constructed at the same time, as can be seen in figure 5.19 above. A critical examination of this circular building shows that in order to achieve this conical shape, the rectangular iron sheets were cut and trimmed into various pieces before nailing. These numerous nailed joints are observed to have aided the corrosion of the roof, possibly due to retardation of flow of rainwater at these joints. Leakages were observed from some of these corroded areas.

Another effect of change observed is the room sizes. The rooms of the buildings with rectangular plan constructed with the adobe blocks are bigger in size than those with circular plan. According to Moughtin's (1985:58) the circular buildings in Zaria City is between 2.5 to 3 metres in diameter in comparison with the width of some of the rectangular buildings surveyed that are more than 4 metres (see the rectangular plan adobe buildings in the background in figures 5.4 and 5.5). The implication of bigger structures to repair is that more resources are required in terms of material and labour. Consequently, the change in architectural form and the increased floor area could be another factor that has increased the difficulty in the repair of earth buildings in Zaria City.

5.3.2d. The physical conditions of the adobe buildings in Zaria: Most of the adobe buildings in Zaria have cementious render. According to the 5 earth builders and the architect the traditional earth based materials were used as sacrificial render on the *tubali* wall, which was periodically replaced during maintenance work. It was observed that this practice of periodic maintenance no longer exist in Zaria City. Unfortunately the lack of maintenance has resulted in the deterioration of both the *tubali* and adobe buildings. The effect of this neglect is even more visible in adobe buildings with cementious render as can be seen in figure 5.20.

Figure 5.20: A dilapidated adobe building with cementious render

The entire representatives from the 20 earth buildings explained that the use of cement based material to render earth buildings is to eliminate the periodic maintenance associated with earth based materials. However, the 5 builders, 1 architect and 1 student are of the opinion that the use of cementious material on earth buildings in Zaria City is mainly a symbol of affluence. These 6 persons are aware that cementious render is not compatible earth wall. The 20 interviewees that are in favour of the use of cementious render agreed that this result in an unpleasant appearance of the buildings after a few years (see figure 5.20). However, because they want to disassociate themselves from earthen material, which is being considered as material for the poor, they have resorted to the use of cementious material on their buildings, not minding the consequences. On the contrary, the 20 building owners are confident that the render increases the buildings' strength and durability, hence eliminating the maintenance associated with earth based material. This shows the ignorance of the consequence of cementious render among the 20 building owners in an attempt to avoid periodic maintenance. Thus, this attitude has led to abandonment of the traditional periodic maintenance that was associated with the traditional earth building in Zaria City. The long term effect of this action is the lack of patronage of the earth builders and this has led to many of these builders to abandon the trade.

6 interviewees stated that natural colour of earth render is too monotonous, and it is not possible to paint and change colour of paints on earth renders. On the other hand they identified that cementious rendering provides varying options for change of building's outlook. Thus, an argument in favour of earth based render based on failure of cementious based rendered walls did not go well with these 6. Furthermore, these 6 persons are ignorant of the fact that traditionally natural pigments of varying colours were used to decorate earth buildings even in Zaria City. This shows the level of decline in knowledge in earthen architecture even in traditional area such as Zaria City.

Furthermore, visible cracks were observed on adobe walls that have been either repaired or remodelled using cementious mortar or concrete blocks, figure 5.21 is a good example. Further examination of these cracks reveals that it all occurred at the joints between the earth and cementious materials. Various layers of cementious patching up were observed where the cracks occurred on these buildings. From the visual colours of these cementious patches it suggested that several attempts were made at various times to mend these cracks, without success. This assumption was later confirmed to be true by the building owners. However, the building owners explained that the cracks took about a year or two to reappear after the application of the cementious material. It was not possible to ascertain this claim within the duration of the field work. However, it may be that the cracks resurface much earlier but the building owners only took notice with increased expansion of the cracks.


Figure 5.21: A cracked cementious render on adobe wall

It was observed that these cracks creates cavity which allows rainwater penetration into the walls in addition to moisture due to capillary action, which are then trapped in the inner core of the walls as a result of low permeability of the cementious render. If the cracks remain untreated it can lead to the building collapse. Keefe (2005:165) compared mending earth walls with cementious material to mending an old, worn garment with strong leather patch.

The cementious materials are not only inappropriate but expensive in the context of Zaria City. A bag of cement was sold in 2006 for ₦1, 800[14] in Zaria City. The national minimum wage in Nigeria in 2006 was ₦7, 500 per month (FOS, 2005:12) and less than 10% of the nation's population received this amount or above the minimum wage (FOS, 2005:13). The respondents agreed that due to the high cost of cement and labour not everyone has the resources to carryout reapplication of the cementious patching even when there is a visible signs of defect in the building as the case in figures 5.20 and 5.21.

It was also observed that the traditional *tubali* residential buildings have wall thickness that ranges from 450 to 800mm depending on the height of the buildings (see also Dmochowski, 1990, vol. 1:1.20). This massive thickness prevents structural defects that could occur as a result of erosion even when the sacrificial earth based rendered has eroded (see also Dmochowski, 1990, vol. 1:1.21). A critical

[14] ₦ = Naira, which is the currency of Nigeria. £1 = ₦250 naira, which is equivalent to £72 per month in 2006.

examination of *tubali* building with earth based render shows that the erosion is minimal and even (see figure 5.22). Although the owner of this building cannot remember the exact year that the earth render was last reapplied, however he was confident that it was more than 15 years ago. A further examination of a ruined *tubali* wall (figure 5.9) shows that because of the conical shape of the *tubali*, wider mortar joints are created at the top of the bricks than at the bottom. These irregular vertical mortar joints when filled up ensure that both the earth mortar and later the render are keyed together, thus, creating a strong and structurally stable wall (see figure 5.22; see also Dmochowski, 1990, vol. 1:1.20). Consequently, the earth render are not usually easily eroded and when it does the effect is minimal.

Figure 5.22: A traditional adobe building with earth based render showing minimal and even surface erosion despite the lack of roof overhang

On the contrary the thickness of the adobe block walls in Zaria City is between 300 and 450mm, which is thin when compare with the traditional ones. This led to the assumptions that the adobe buildings may not be as structurally stable as the traditional types and do not possess the same thermal comfort as the traditional types. These assumptions are based on the fact that earth structures are weak in tension but strong in compression and the thermal properties of earth depends on it mass, thus the thicker the better (Keefe, 2005:165). This weakness in tension was compensated in the traditional buildings with thicker walls. Furthermore, the even surface and regular mortar joints of the adobe block walls does not provide the kind of bonding that the uneven surface of *tubali* provided. Consequently the bonding between the adobe blocks and the render is not as strong as that of *tubali* wall, even when earth based material is used. Thus, the rendering on the adobe walls erodes faster, which makes the effect of eroded wall render on the adobe block wall more severe. This can also be attributed to the walls thinness.

Another implication of thinner walls in the case of the adobe is that erosion could have a fatal consequence if not treated immediately, unlike the traditional types that can still be structurally stable for long period of time. Untreated eroded earth wall can lead to collapse of the wall and this may cause injury or even death. It was observed that the building owners have devised a means of countering this effect by constructing an external plinths with concrete blocks, which is usually between 450 and 600mm above the ground level (see figures 5.23 and 5.24). This concrete plinth called *dakali* in Hausa also serves as sitting area in addition to its primary structural purpose. However, the use of *dakali* as sitting area has another negative effect on the adobe buildings. It was observed that the paints on walls of adobe buildings with *dakali* have flaked and some of the wall render have cracked. The cause of these actions was observed to be as a result of the constant friction by both humans and animals that sit and stand on the *dakali*.

The study therefore conclude that majority of people (20 out of 27) interviewed are in favour of the use of cementious material for repair of earth buildings in Zaria City. This could be a reflection of the general opinion in this settlement, since majority of the buildings including those not surveyed have cementious render (see examples in appendix 2.2.4).

Figures 5.23 and 5.24: Adobe buildings with dakali

5.3.2e. The repair of adobe buildings in Zaria City: It was identified from the field survey that repair is seldom carried out on the earth buildings in Zaria City, neither is maintenance being carried out. 12 buildings out of the 20 surveyed are with cementious render and are in various stages of dilapidation as a result of the disintegration of the renders. 12 of the occupants (1 person each from the 12 buildings) interviewed stated that the buildings were never repaired since the cementious rendering was applied. The earliest application of the cementious rendering was in the year 2000 (which was 6 years as at 2006 when the survey was conducted). Despite the visible evidence of the earth buildings deterioration the owners are not making any effort to repair them. Ironically, 9 of the respondents are of the opinion that application of another cementious render is the only solution. Only 1 out of the 12 building owners with cementious render was later convinced that earth render is more appropriate than that of cementious material. However, he is also discouraged by the demand for periodic maintenance if he has to revert to earth based render.

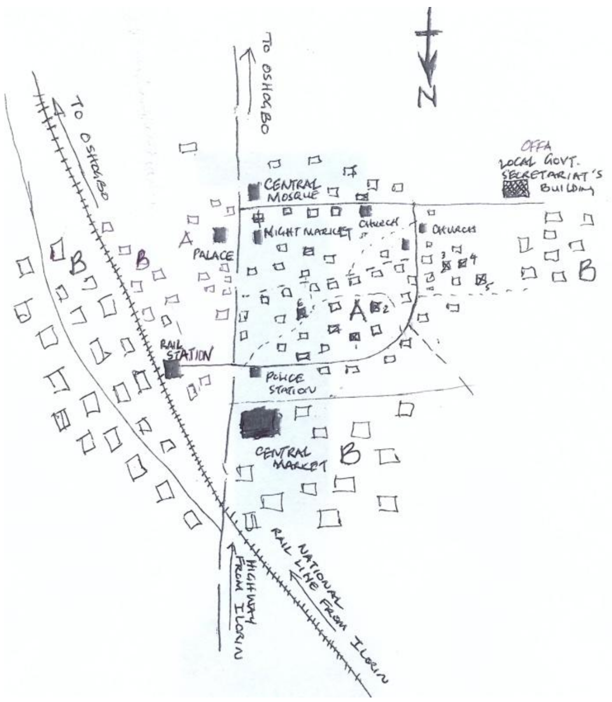
The 27 respondents were of the opinion that the adobe buildings in various state of disrepair can be mended but the process can be expensive. 7 respondents (5 masons, 1 architect and 1 student) recommended improvement on the earth buildings as part of the repair strategy. This includes the replacement of earth and thatch roof with corrugated iron sheets with overhangs wide enough to protect the earth walls. Another suggestion is that of elongation of existing roofs' eaves where this deficiency is observed. However, 18 respondents (all house owners) questioned the rational for spending much on earth repair. They noted that the cost of repair of earth building to satisfactory condition can almost equal the cost of erecting a smaller building made of concrete. When asked if any of the 18 respondents have what it cost to construct a small concrete building, they all agreed they do not have, but they are hopeful that one day either they or their children or relation will be able to effect this desired change.

5.3.2f. Skilled labour for the repair of adobe buildings in Zaria City: 20 of the respondents pointed out that it is difficult and expensive to find traditional masons that can carry out repair using earthen material and technique. Thus, the only alternative is to resort to the use of artisans that can only use cementious material, since they are more readily available. On the contrary, the five traditional masons interviewed complained of lack of jobs and as a consequence they rely more on farming and trading to survive than in earth construction. This shows the lack of communication even within closely knit community like Zaria city.

5.3.2g. The discontinuity of traditional method of dissemination in Zaria City: From reasons given by the two adobe block moulders (in section 5.3.2b above) it is apparent that the traditional method of parental training is no longer possible in contemporary Zaria City. It was identified in the course of this field survey in Zaria City that the traditional builders' guild that was associated with this settlement note in literature such as Dmochowski (1990, vol.1:1.20) and Marchand (1993:108) is no longer functioning. Furthermore, there is no institution or organisation in Zaria that offers training in earth construction. Similarly, the few remaining earth builders were complaining of lack of patronage and at the same time the building owners are complaining of scarcity of the builders (as noted in section 5.2.3d). Furthermore, the respondents acknowledged that some of this older generation have abandoned the trade and the few remaining artisan are not as skilful as the previous generation because of lack of consistent patronage in earth construction. The skill in earthen architecture in this traditional settlement may be eventually lost, unless drastic action is taken. There is therefore the need for a new approach to skill acquisition that is in line with the current situation.

5.4. Study of Cob Buildings Repair in the in Offa

Offa is the second largest city in Kwara State and is situated south of the State Capital Ilorin (see figure 1.1 in chapter one). Although Kwara State is politically classified as northern Nigeria, Offa is closer to the south west region than any part of the north. In addition, the people of Offa are Yoruba just as those from the south west Nigeria. Furthermore, the climatic condition is similar and consequently the earthen architecture is also the same as that of south west Nigeria. Thus culturally and in terms of architecture the people of Offa are considered as south west Nigeria (Basom, 1969:12 and Dmochowski, 1990, vol. 2:x).



KEY: **A**=Traditional area of the town. **B**=New layouts

☒ Cob buildings surveyed

⊞ Site of Moremi shrine once a National monument built with cob, but demolished by Moslem's extremist, being a Yoruba goddess shrine

Figure 5.25: Layout sketch of Offa

The cob technique was used traditionally in Offa and some of these buildings still exist (see figure 5.26). However, unlike in Zaria City (see section 4.2), the number of cob buildings in Offa are few, with many of them being abandoned. Figure 5.27 is a typical example. These cob buildings are scattered around the city with exception of recently developed areas that have buildings constructed solely of concrete. This study is therefore limited to the cob buildings still in use.

Figure 5.26: One of the cob building surveyed in Offa

Figure 5.27: An abandoned cob building in Offa

5.4.1. The physical conditions of cob buildings in Offa: The cob buildings in Offa including those abandoned have corrugated iron roofs. Some of the cob buildings have cementious render (figure 5.27), while some do not (e.g. figure 5.25). However, the buildings still in use are all dilapidated. Some of the defects noted in these cob buildings are horizontal cracks in-between lifts (figure 5.28), vertical cracks close to the roof's tie beams and at the corners (figure 5.29), basal erosion (figure 5.30), and cracking of cementious render (figures 5.28 and 5.30). Only 3 of the buildings were originally roofed with thatch but according to the two owners were replaced with corrugated iron sheets more than 60 years ago. The remaining buildings were all roofed with corrugated iron sheets from inception. According to the 7 interviewees the ages of their cob buildings ranges from 70 to 100 years. However, none of the owners have any documented evidence to back up the ages of these buildings. Although these claims may be doubtful, most especially the 2 of the buildings that were said to be constructed with corrugated iron sheets roofs about 100 years ago. However, the history of the use of corrugated iron sheets in Nigeria is more than 100 years old (see Colonial Reports – Annuals, 1904:34), which means that these claims could be true.

Figure 5.28: A cob building with cementious render in Offa

The hipped corrugated iron roofs with the overhangs are observed to be the key to the survival of these cob buildings. The roofs provided the cob walls with enough protection against rain from all the four sides. Thus, even the basal erosions noted in some of the buildings are as a result of lack of proper drainage around the buildings not as a result of rain. Evidence to this claim is that most of the buildings that have partially or completely collapsed were noted to have eroded from the base with most part of the upper walls and roof almost intact (e.g. figure 5.30).

Figure 5.29 Cob buildings with cracks between lifts

Figure 5.30: A cob building with vertical crack

Figure 5.31: Basal erosion on a cob building in Offa

Some of the buildings have been reinforced at their base with stone or concrete blocks in cementious mortar about 300 and 450mm above ground level (see figure 5.31). Just as in Zaria City, these plinths were constructed to reinforce the cob walls. However, this also has similar negative consequence. The cementious based plinth might have also accelerated the basal erosion in some of these buildings.

It was also noted that the width and height of openings are generally very small compare to those in concrete buildings. This could probably be due to the fact that the traditional builders are aware of the fact that the effect of shear forces is mostly critical around openings, thus the smaller the openings the better (see Houben & Guillaud, 1997:266). Smaller openings were preferred so as to minimise the length of wooden lintels that have the tendency to buckle if the openings are wider. This have also minimise cracks at the tops of the lintels which was common with the doorways of some shops in Sabon Gari (see example in figure 4.11 in chapter four).

Figure 5.32: Cob building with cementious render and stone plinth bonded with cementious mortar

5.4.2. Repair of cob buildings in Offa: The existing cob buildings in Offa are neither maintain nor repaired. The 6 cob building owners could not remember the year their buildings were last repaired. Consequently, none of the 6 has knowledge of the traditional repair methods. Thus the data generated in Offa was based on theoretical knowledge of a Quantity Survey (QS) who is a native of this city (see appendix 2.3). The QS stated that his paternal grandfather was a traditional builder, thus some of the knowledge was transmitted to him through oral communication in the course of his research for his terminal essay in the University (FUT Minna).

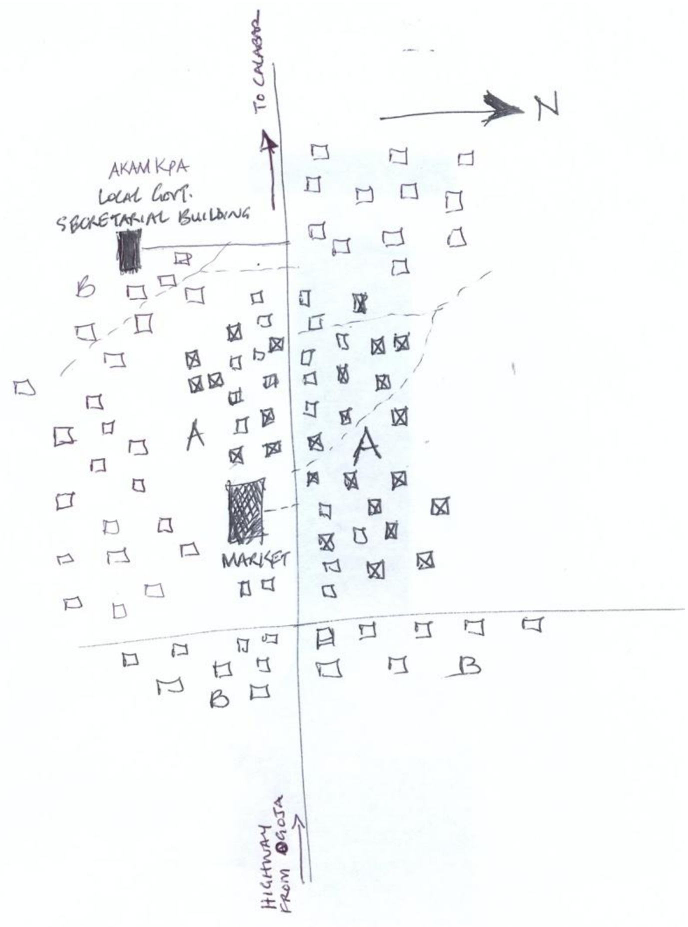
According to the interviewee (the QS) the traditional repair of cob buildings included the replacement of thatch roofs, cleaning of drainage around the buildings and reconstruction of eroded rammed earth floor. According to the QS the cob walls hardly need repair since the roofs and the base are adequately protected. He assumed that cob walls were only reconstructed not repaired whenever there was defects or failure. This assumption could be true, because it was noticed in some of the buildings that the colour and texture of the building earth differs from one side of the wall to another. This could be as a result of reconstruction at different times. Thus, the soil was from different sources, consequently different material composition and dates of construction are the factors for different colours of the walls.

The QS explained that the eroded cob base was reconstructed by mixing the cob with palm oil and cow dung. The palm oil and cow dung not only stabilised the soil but also provided the based with a smooth surface that was not easily eroded by rain, human and animal contacts. He however, noted that he is doubtful if people will today be able to afford stabilising cob with palm oil, if the buildings are to be repaired in traditional way. He argued that this product is now very expensive because its consumption is no longer limited to the Yoruba people that produce it, but to all Nigerians. According to the QS the demand of the product for human consumption is so high that it is so expensive to be use on mud building. Although the nation wide demand for palm oil is high, however, it was identified during the field work that it was still affordable by every family. A litre cost about ₦10 in 2006 in Offa, which is affordable, however, this may be very expensive to be used as additive on cob buildings because the owners attached no value to them.

The negative perception and attitude towards the repair of earthen buildings in Offa is worst than what was observed in Zaria City. This is because none of the people approached in Zaria City decline to be interviewed unlike in Offa where people do not even want to be associated with earth building. Sadly, most of the people that declined the interview in Offa are educated and influential members of this community.

5.5. Study of Wattle and Daub Buildings Repair in Akamkpa

Akamkpa is situated in the outskirt of Calabar the capital of Cross River State in southern Nigeria (see figure 1.1). The wattle and daub technique was the traditional earth construction technique in Akamkpa and most part of south east region in Nigeria. In Akamkpa, most of the low income people (mostly farmers) still construct their buildings using this technique. Furthermore, the middle and high income groups also use wattle and daub technique for construction of external kitchens and sit outs located at the back and front of the main buildings made from concrete respectively. The wattle and daub technique is use in this town as a necessity by the poor as well as on buildings that are consider of less importance (e.g. sit out and kitchen).



KEY: **A**=Traditional area of the town; **B**=Modern part of the town

☒ Wattle and daub buildings surveyed

Figure 5.33: Layout sketch of Akamkpa

5.5.1. The physical condition of some of the wattle and daub buildings in Akamkpa: A compound in Akamkpa consists of detached rooms meant for sleeping only, kitchen, toilet and a sit out all arranged to form a rectangular plan with central open space (courtyard). However, compounds are not fenced in Akamkpa unlike in Zaria City where the perimeter fence is an important and compulsory element of a residential building. The entrance to a compound in Akamkpa is usually defined by the orientation of the buildings and the location of the sit outs. The sit outs are always located in the front of the house and it serves various social and economic functions. Apart from relaxation and entertaining guests, it was observed that in some compounds the sit outs are use for domestic chores, trading stall, workshops (carving and blacksmithing), and a children's study area.

All the 24 wattle and daub buildings examined in Akamkpa have gable ended pitched roofs made of either thatch or corrugated iron sheets. Although the quality of the wattle and daub walls are generally very poor, the system of roof construction, wide overhangs and deep verandas in some cases, provide enough protection against excessive rainy and humid climate of the south east Nigeria. Only 1 of the buildings has cementious render both internally and externally. 3 of the buildings have internal cementious render, with the external wattle daub wall exposed. The remaining 20 buildings have no render both internally and externally. Thus, in some of these buildings without render the daub has eroded and exposes the wattle reinforcements, most especially at the gable end of the walls (see figure 5.32). Although the building with internal and external cementious render is relatively dry, however this could be as a result of the recent application of cementious render. The building is use as a sit out and kitchen, thus the windows and doors remain constantly open at any time of the day. The openings and the heat generated from the firewood use for cooking might have also contributed to the dryness of this building.

Figure 5.34: An eroded wattle and daub

According to the 3 architects (see appendix 2.4), the construction of wattle and daub building start with the erection of the wattle frames made from bamboo and the roof made from raffia leaves or thatch. However, because thatch is prone to fire, the material is seldom used these days for roofing rooms in the sleeping areas in Akamkpa. The corrugated iron sheets are now preferred except for those that cannot afford it. Thus, thatch is only used for communal areas such as kitchen, sit outs, market stalls, etc. The daub is usually applied after the roofs have been constructed, because of the consistent rainfall in this part of the country. Calabar area and other part of the Niger Delta in Nigeria experiences rainfall all the year (see figure 1.1). Thus, the roof is constructed before applying the daub to provide protection against the tropical rainfall (see figure 5.33).

Figure 5.35: A wattle and daub building under construction

Although most of the wattle and daub walls have cracks, however Akpan (one of the 3 the architects) noted that the cracks are due to the sandy nature of the soil, the lack of stabilisers, poor craftsmanship and lack of maintenance (Dmochowski, 1990, vol.3:11). Furthermore, the daub is not stabilised, except in few instances when special clays sourced from a location more than 60km from Akamkpa was used. However, according to the 10 interviewees this clay is rarely used these days because it is not locally available.

There is general biased against the use of earth for buildings in Akamkpa (just as in Offa). This is demonstrated in the haphazard nature in which the buildings were constructed and maintained. Only 1 building was rendered both internally and externally with cementious material. Although this could be seen as a positive development, it was however discovered the remaining buildings were not rendered with cementious material because their owners are of the opinion that these earth buildings are not worthy of repair with an expensive material such as cement.

5.5.2. The repair of wattle and daub buildings in Akamkpa: The only repairs that have been carried out in any of the 24 buildings are on the roof. None have ever carried out repair on the wattle and daub walls. 10 interviewees indicated that they would rather demolish and rebuild the wattle and daub building using the same material or replace it with concrete, than to carry out repair. They are of the opinion that the repair takes almost equal effort as construction of new wall. This claim is not exactly true. Demolition and rebuilding is more costly than repair. However, because both the cost of labour, which is through self help and material that are sourced locally at no cost are unquantifiable in terms of monetary value, the people assumed that it is free.

The 3 architects noted that traditionally wattle and daub buildings were maintained annually by reapplication of daub stabilised with cow dung. They also noted that the thatch roofs were usually mended whenever the need arose. The 3 architects also stated that unlike the walls that require annual maintenance, the thatch roofs could last up to between five to ten years before any maintenance was carried out, depending on the pitch of the roof, quality of the thatch and workmanship.

Although there is a general stigma attached to earth construction in Akamkpa, however, significant numbers of new buildings are in wattle and daub. The 10 building owners agreed that if they are to construct buildings as at the time of the interview they will only opt for the wattle and daub because of the high cost of the preferred concrete buildings. Critical findings from this study is that although the wattle and daub buildings are rarely repaired except for the roofs, the construction knowledge that still exist is of immense value to repair. Thus, what is required is to educate the people of the advantages of repair over demolition and rebuilding.

5.6. Summary of Findings

The summary of the findings from the field work in CECTech Jos, Zaria City, Offa and Akamkpa is presented using the methodology proposed in section 3.5 in chapter three. Consequently the findings are summarised as follows:

i. the central phenomenon of findings in the four locations that the field survey was conducted

ii. the strategies employed to deal with the phenomenon identified

iii. the conditions that shaped conditions

iv. the conditions that shaped the strategies employed, and

v. the consequences of the strategies employed

i. Central phenomenon of the findings: One of the implications of the CECTech's emphasis on CEB technique is the lack of literature on the repair of adobe buildings. Furthermore, the lack good example of repair of earth building in Nigeria by CECTech also manifested has in the 3 cities studied.

In Zaria City, Offa and Akamkpa it was identified that the earth buildings are neglected, abandoned, or inappropriately repaired.

ii. Causal condition of the phenomenon: It was identified from the study at CECTech Jos that the emphasis on CEB technique was informed by the situation in the construction industry and housing needs in Nigeria when the centre was established (see also Ogunsusi, et al., 1994:15 and Guillaud, et al., 1995:111). In Zaria City, Offa and Akamkpa it was identified that stigmatisation, preference and availability of factory processed materials most especially cement has influenced the lack of care or the unsympathetic repair practices in these cities.

iii. Strategies employed to cope with the current situations in the study locations: In order to achieve the CECTech's goal, manuals for production and construction using the CEB technique were published. In addition demonstration projects using CEB were executed as well as series of national training courses on the technique. In Zaria City, Offa and Akamkpa it was identified that the traditional strategy of planned preventive maintenance using locally sourced materials has been abandoned in favour of repair with cementious material.

iv. Conditions that shaped the strategies employed in the study locations: According to the CECTech's staff the combination of the negative attitude towards the use of the traditional earth techniques, the economic decline and the housing needs were factors that influenced the centre's preference for CEB technique. The preference of cementious material, scarcity of artisans and the disintegration of the traditional builders' guild were identified as the factors that influence the current conditions of earth buildings in Zaria City and Offa. On the other hand it was identified that stigmatisation and nonchalant attitude are the factors that influenced the current conditions of the wattle and daub buildings in Akamkpa.

v. Consequences of the strategies adopted by CECTech, in Zaria City, Offa and Akamkpa: The consequence of the CECTech's action to this thesis is the lack of research on the repair of the adobe buildings. Similarly, it was identified that the current deplorable states of many earth buildings in Zaria City, Offa and Akamkpa were as a consequence of neglect, lack maintenance and unsympathetic repair practices adopted by their owners.

Figure 5.34 below is the summary of findings from the interviews in Zaria City, Offa and Akamkpa.

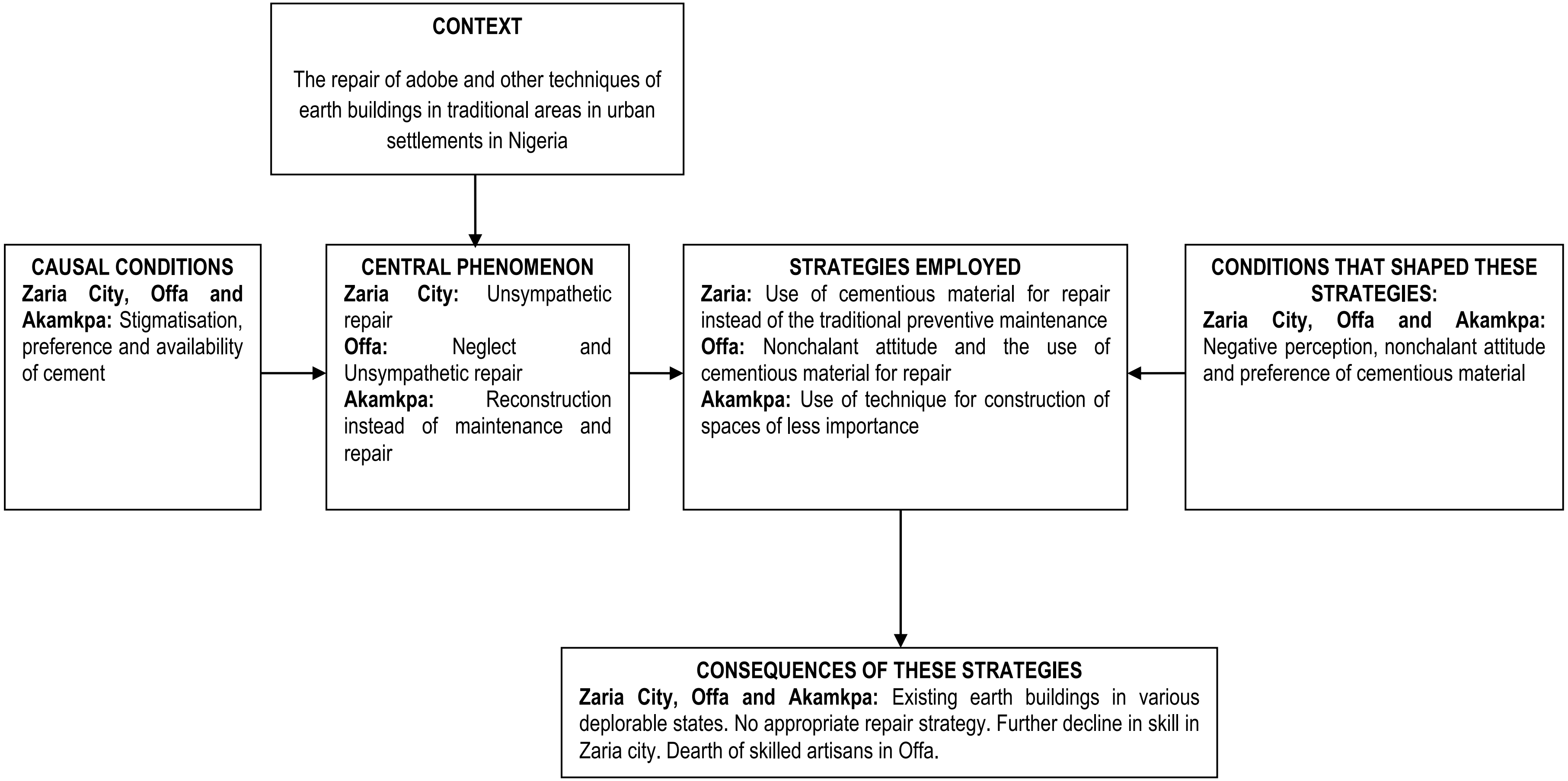


Figure 5.36: Summary of findings

5.7. Discussion

The traditional method of repair of buildings has been abandoned in these traditional areas. Unfortunately the current strategy adopted in these areas is inappropriate to the existing situation. A new repair strategy therefore needs to be developed even in these traditional areas. Consequently, none of the current repair strategy can be adopted in this thesis. As explained in chapter three, the strategy employed is to further explore the concept of the system theory by considering other sub systems that are correlated to the repair of the adobe building in Nigeria and from around the World. Consequently, in chapter six the structure of the current Nigerian building industry is critically examined, with the aim of identifying how the current practice affects the repair of adobe building. In chapter seven the building and maintenance strategies, sustainability discourse relating to building and earth building repair strategy from around the world are also examined with aim of identifying strategies appropriate to the adobe buildings in Sabon Gari.

CHAPTER SIX

THE REPAIR OF ADOBE BUILDING AND THE NIGERIAN BUILDING INDUSTRY

.... the National Council on Housing and Urban Development deemed it necessary and initiated the process of evolving a National Building Code to put a stop to the ugly trends in the Building Industry.

- **Olusegun Mimiko**
(Former Nigerian Minister of Housing and Urban Development, from the year 2003 to 2007)
Quotation from the preface to the National Building Code (FRN, 2006:iv).

6.0. Introduction

Before the publication of the Nigerian Building Code (NBC) in 2006, each of the 36 States and the Federal Capital Territory (FCT) Abuja had their building regulations, which differed from one another. As explained in chapter four, in Kaduna State (location of the study area), KASUPDA is responsible for supervision of building projects and other matters related to the built environment. NBC was designed with aim the aim of setting minimum standards for building construction and related matters (e.g. alteration, demolition, repair, etc.) from conception to implementation (FRN, 2006, section 1.2.2:5). This Code however is a general framework that is subject to adoption by all the states in Nigeria (FRN, 2006, section 1.2.3:5). However, Kaduna State is yet to adopt this proposed Code as at August 2011 (see attached emails in appendix 1.4.6). In this chapter the NBC is briefly analysed with the aim of identifying relevant sections that can be adapted to the adobe building repair in Sabon Gari.

6.1. Overview of the Nigerian Building Code (NBC) and its Relevance to Adobe Building Repair

The NBC contains four parts. Part one is titled administration and it contains brief introduction, as well as definition of key terms and abbreviations (FRN, 2006:5). Part two contains building design and construction classification as well as technical specifications for pre-design, design, construction and post construction stages. Part three contains guidelines for enforcing this Code, while part four contains samples of compliance forms (i.e. forms to be used by various building professionals during building inspection). Relevant sections in each of the four parts of the Code are critically analysed below.

6.1a. NBC part one: The section one, part one of the NBC contains the definition and aim of the Code. The following are the factors that led to the development of the Code:

- Indiscriminate construction of buildings in towns and cities without regard for the master plans
- persistent collapse of buildings (see also the quotation above)
- dearth of referenced design standards
- use of unqualified professionals
- use of untested materials, and
- lack appropriate building regulations and sanction for violators

The persistent collapse of buildings in Nigeria was emphasised in this Code (see the quotation at the beginning of this chapter), however publication of a Code alone cannot stop this unfortunate incident in Nigeria. Figures 6.1 and 6.2 are example of two buildings that recently collapsed in Lagos and Abuja while under construction. There is therefore the need for education and enlightening of the people on the consequences of the aforementioned problems, for the Building Code to succeed if eventually adopted by various States in Nigeria as proposed.

Figure 6.1: Rescue operation on a collapsed building site in Lagos with many trapped inside the building

Source: *http://news.bbc.co.uk/1/shared/spl/hi/pop_ups/06/africa_enl_1153318336/html/1.stm, accessed: 21st April, 2010*

Figure 6.2: Using bare hands for rescue operation on a collapsed building site in Abuja
Source: *http://www.topix.com/album/detail/ng/lagos/8775GCIOG5R2DMTQ, accessed on 21st April, 2010*

Two definitions in the section one of the part one of NBC relevant to this thesis are those for building condition survey report and building maintenance manual. Building condition survey report was described as a comprehensive report of the actual conditions of all the elements, components and installations in a building prepared by consortium of registered architects, builders and engineers (FRN, 2006, section 2.21:12). The recommendation that condition survey report must be prepared by consortium of architects, builders and engineers cannot be applicable for adobe building condition survey report in Kaduna. This is because it will increase the cost of the adobe building repair. Similarly, it is doubtful if KASUPDA will enforce this recommendation on adobe building even if Kaduna State's Government eventually adopts the Code. This is because the excuse given by KASUPDA for the general laxity in the supervision of adobe building construction and repair in Kaduna was that the people using the adobe technique are generally poor (see appendix 1.4.3a). It is therefore unlikely that KASUPDA will take any further action that will involve additional expenses. Moreover not many of the aforementioned professionals have knowledge of adobe building in Kaduna.

It was also recommended in section 2.24 that the preparation of building maintenance manual should be prepared by the same consortium of building professionals just as the condition survey report (FRN, 2006, section 2.24:12). This is also an unjustified additional cost in terms of adobe building repair due to the same reasons as those for the condition survey report. The importance of these two documents is acknowledged in this thesis as well as the cost implications. Consequently, a general guideline for preparing condition survey and maintenance manual are proposed in the repair framework in chapter eight. The proposed guideline is therefore designed such that any of the stakeholders that are literate can prepare the reports in collaboration with the artisans that are to be in charge of the repair.

The Building Code Advisory Committee (BCAC) recommended in the section three in the part one of the NBC include apart from representatives of related Federal ministries the following professions: architecture, building, engineering, town planning, estate surveying and valuation, quantity surveying and land surveying (FRN, 2006, section 3:23). The role of these professions in the Nigerian building industry in general and their relevance to adobe building repair in particular are explained in section 6.2.

6.1b. NBC part two: In section 4, part two of the NBC, buildings in Nigeria are classified according to usage into the following 12 groups, (FRN, 2006, section 4:27):

Group A: assembly uses

Group B: Business uses and professional uses

Group C: Educational uses

Group D: factory and industrial uses

Group E: High hazard

Group F: Institutional uses

Group G: Mercantile uses

Group H: Residential uses

Group I: Storage uses

Group J: Mixed use and occupancy

Group K: Doubtful use classification

Group L: Utility and miscellaneous

The adobe building in Sabon Gari falls into the group J, which is the mixed use and occupancy (FRN, 2006, section 4:27). The mixed use and occupancy is defined as building occupied for two or more uses (FRN, 2006, section 4:39). This is further divided into non-separate and separated uses. The former (non-separate) which the adobe building in Sabon Gari belong, is mixed building that varying activities takes place within a single block, while in the latter the activities are separated in different blocks (FRN, 2006, section 4:39). It was further specified that for the non-separate uses, the provisions in the Code for all the activities within the buildings should be applied (FRN, 2006, section 4:39). However, if there is conflicting provisions it was specified in the Code that occupants and public safety should be the primary consideration. For example, the business and professional uses i.e. group b (see FRN, 2006, section 4.4:30) and the residential uses i.e. group h (see FRN, 2006, section 4.10:37) requirements shall be applied for the adobe building in Sabon Gari, should the Code be adopted in Kaduna State. But if either the business or residential requirement in the course of repair of the adobe building in Sabon Gari poses any problem, the safety of humans and the building shall be the priority.

In section 12.1.3.1 part two of the NBC it was specified that repair, alteration, addition, and or change of use of a building may be carried out without complying to the Code of practice for building construction as specified in the NBC as long as it does not endanger public's safety, health and general welfare of the buildings (FRN, 2006, section 12.1.7.:212; 362). This implies that the adobe building repair may not require approval of KASUPDA based on this Code as long as the repair can be assessed and supervised by a competent person. This section is therefore used to justify the proposal in the repair framework. It shall therefore be proposed in the repair framework that only competent person with knowledge of adobe technique should supervise the repair of adobe building in Sabon Gari. Thus, this person can be a mason, landlord, tenant, etc. not necessarily an architect or engineer.

Similarly, it is specified in section 7.47.2 that all existing and adjoining public and private property must be protected from damage during building repair (FRN, 2006, section 7.48.1.1:215). This section is important in the repair of adobe building in Sabon Gari. This is because it was identified during the field survey in Sabon Gari that remodelling often affects adjoining properties as in the case of figure 4.18 in chapter four. This requirement is therefore included in the proposed repair framework.

6.1c. NBC part three: This part of the Code contains methods of enforcement of this Code and various sanctions for violation of the Code (FRN, 2006, section 13:429-443). On the contrary, the proposed framework in this thesis is not aim at enforcing any regulation or specification on anybody, consequently, a participatory approach was used in developing the framework (see section 3.2 in chapter three). The expectation of this thesis is that the proposed framework will be used to guide and educate the people of Sabon Gari on appropriate repair practice for adobe building. Although the thesis did not include the methodology of disseminating this framework, it however included this in the recommendations in chapter ten.

6.1d. NBC part four: This part contains list of references consulted in the preparation of the Code. However, no reference to any of the State's building regulations in Nigeria or any other publication relating to building construction in Nigeria. The list contains standards from the US (e.g. ANSI) and UK (BS) (see FRN, 2006:449-457). Thus, some of the specifications in the Code are not relevant to Nigeria, e.g.: specifications for rammed earth was included in the Code (FRN, 2006, section 10.24:350), despite the fact that the technique does not exist in Nigeria.

6.2. Building Professionals in the Nigerian Building Industry and their Roles in the Repair of Adobe buildings

As earlier stated in section 6.1a above seven building professions in Nigeria are recognised in this Code and they are recommended to be part of a committee that is referred as the Building Code Advisory Committee (BCAC) (FRN, 2006:23). The roles of these building professionals are specified in appropriate sections of the Code and are explained below.

Architect: Section 7 in the new Building Code contains the architectural design requirements (FRN, 2006:85). However, the person responsible for the architectural design was not stated. Similarly, the duty and responsibility of an architect in building project in Nigeria was not specified in this section or anywhere in the Building Code. On the other hand, an architect is described in the Federal Capital Territory's (FCT), Development Control Manual as a person licensed to practice the profession of architecture by the Architects' Registration Council of Nigeria (ARCON).

ARCON is the statutory body responsible for the registration and practice of architecture in the country (ADC, 2007:191). The Nigerian Institute of Architects' (NIA) code of practice of architecture in Nigeria also stated that architects are responsible for design and supervision of building projects (NIA, 2002:1).

It was further elaborated that the process of transforming the architectural drawings into buildings most often involves the collaboration of other professionals such as engineers (e.g. structural designs, electrical and mechanical designs, etc.) and other allied professionals (NIA, 2002:2).

Architects are required to produce drawings that will include the site plan, floor plan(s), roof plan, sections, elevations, doors and windows schedule, and other technical details that will enhance the understanding of the architect's design during construction (NIA, 2000:5). The architectural drawings are required for development approval for building projects together with the engineering drawings (section 4.2.2.viii in chapter four for the list of drawings required for planning approval by KASUPDA in Kaduna State).

All architectural drawings for buildings more than one storey high must be designed and stamped by ARCON registered Architect in Kaduna State (see section 4.2.2.viii in chapter four). The same is applicable in the FCT (see CDC, 2007:58). Thus, Architects not registered with ARCON are not permitted by law in Kaduna State and FCT to design and supervise buildings that are more than a storey high (see appendix 1.4.3a). This requirement could also apply to other States in Nigeria. This requirement do not however applies to the adobe buildings in Sabon Gari since they are single storey.

The role of architects in the repair of buildings was not stated in the Building Code. It was only specified that building repair, maintenance and rehabilitation should be carry out by a competent persons, without explicitly stated the person's profession, qualification (level of competence) or duties and responsibilities (FRN, 2006, section 7.43.3.4:213 and section 13.17:441). However, it is clear that from the specifications in the NBC that it is not mandatory for architects to be involved in building repair or any other related work in Nigeria.

Architects are not involved in the repair of the adobe buildings survey in Sabon Gari (see section 4.2.2.viii in chapter four). The official of KASUPDA confirmed that adobe building repair, remodelling, etc. do not require the services of an architect as long as it will not alter the size of the building (see appendix 1.4.3a). On the other hand, building repair in FCT is classified as minor and major repair works (CDC, 2007:58). Minor repair does not require supervision, but the Physical Planning department, FCT have to be notified of the intention. However, major repair will require supervision in addition to written notification of the FCT's Planning Department, but the status of the person qualify to carry out the supervision is not stated. Thus, it is not certain if it is mandatory to involve an architect in the building repair in FCT.

Builder (Building Technologist): The profession of building technology is not well defined in the Code just as that of architecture. However, the Nigerian Institute of Building (NIOB) define a builder as person with a Polytechnic or University diploma or degree in Building (Building Technology) (www.niob.org). A graduate builder can be registered with the Council for Accreditation and Registration of Builders of Nigeria (CARBON) after passing the institute's mandatory graduates' examination (www.niob.org). A person is then referred as a Chartered Builder upon successful registration with CARBON. Thus, masons (both conventional and earth building) are not considered as builders by NIOB.

It is specified in the Code that registered builder shall in conjunction with registered architect and structural engineer supervise, attest and sign compliance forms for the following tasks:

- setting out (FRN, 2006, section 15:461)
- construction of building foundations / basement (FRN, 2006, section 15:464)
- roofing and closing (FRN, 2006, section 15:468)
- superstructure construction (FRN, 2006, section 15:46471)

Furthermore, a registered builder shall in collaboration with a registered mechanical engineer and architect supervise, attest and sign compliance form for all mechanical installation in a building (FRN, 2006, section 15:473). Similar task is expected to be performed by a registered builder in conjunction with a registered electrical engineer and architect for all electrical installation in building (FRN, 2006, section 13:475).

What is not clearly stated in the Code is whether the registered builder is the building contractor or a consultant just as the architect, structural engineer, etc. This is because the roles given to a registered builder in the Code are accorded to an architect in the standard form of building contract in Nigeria prepared by the NIA (NIA, 1996:12; ARCON, 1996:23). This seems to be a duplication of responsibilities that will amount to additional cost of building project with no positive impact.

None of the documents required for planning permission in Kaduna State is prepared by a registered builder (see section 4.2.2.viii in chapter four). Similarly, it was not mentioned that it is mandatory to involve a registered builder in the implementation of building projects (see section 4.2.2.viii in chapter four). Planners, architects and engineers (Civil / Structural, Electrical and Mechanical) are the professionals specified by the FCT that should be involved in design and implementation of building project (ADC, 2007:174-175). Thus, it is not clear whether the introduction of the builders as recommended in the Building Code will take effect in Kaduna State, FCT and other states in Nigeria even for construction of new builders.

In the proposed framework therefore a mason or any other person with knowledge of adobe technology shall therefore be referred as a builder.

Engineers: Civil, Structural, Mechanical, Electrical and Geotechnical Engineering are the five engineering specialities that were acknowledged in the building code (FRN, 2006:11). Some of the requirements for civil, structural and geotechnical engineering in building construction includes: soil testing, foundation investigation, foundation design, etc. (FRN, 2006:227). The engineering procedures in the building code are just descriptive, without detail explanations of when or why are the procedures needed. Thus, the critical questions are: does every building require the services of all these engineers? If yes, why? and if no, why? These questions are very critical for the effectiveness of the building code. In the case of the adobe building repair in Sabon Gari the answer is no, engineers are not required. This is because it is ascertained that the causes of the buildings deterioration are not technical but caused by humans. It is also ascertained that these human causes can be corrected if the building occupants are aware of the consequence of the inappropriate repair practices that currently prevail in Sabon Gari. Consequently, a repair guideline is proposed in this thesis, which can be use by all the stakeholders, not only an architect or engineer.

Estate surveyor and Valuers: Estate Surveying and Valuation was mentioned in the introductory section of the Nigerian building code as one of the building professions in Nigeria that were consulted in the preparation of the document (FRN, 2006:V). However, estate surveying was not mentioned anywhere else in the Code. This could possibly be as a result of the fact that the Code is designed for construction of new buildings and the repair of existing ones. Thus there is no rationale for consulting the estate surveyors in the first place, if that was the case.

Some of duties of Estate Surveyors elaborated in the Nigerian Institute of Estate Surveyors and Valuers' website includes: (i) management and maintenance of rented buildings on behalf of land lords, in return for an agreed percentage of the rents; (ii) evaluation of buildings for prospective buyers and or owners (land lords) for various purposes other than buying and selling.[15]

Although, this thesis is involve with existing buildings that may require the services of an estate surveyor just as any rental building, however, for economic factor they are not required. A position of a caretaker, who shall be an occupant of the adobe building, is therefore proposed instead of an estate surveyor. The main duty of the caretaker shall be liaising with the landlord on behalf of other occupants of the building on matters relating to tenancy of the adobe building in Sabon Gari.

Quantity surveyors: Just as Estate surveying, the practice of Quantity Surveying profession is not defined in the National Building Code, despite being acknowledge as a profession in the Nigerian building industry. The Quantity Surveyor in Nigeria deals with the measurement of constructions

[15] http://niesv.org/home.php Accessed on the 21st April, 2010
http://www.niesv.org/constitution.html. Accessed on the 21st April, 2010

projects (both civil and building), calculation of construction cost, and the management of construction projects (NIQS, 2007:2). A Quantity Surveyor prepares the Bill of Quantities (BOQ), which is a document that contains materials specifications, quantities of materials and components required, the cost of each material and labour and the final cost of the construction project.[16] However, quantity surveyors are required for big projects, thus their services are not required for the repair of adobe building in Sabon Gari. Instead of a BoQ, a methodology for calculating the cost of adobe building repair was proposed in the repair framework.

Land surveyors: Land surveying is the technique and science of accurately determining the terrestrial or three-dimensional position of points and the distances and angles between them on the surface of the earth. These established points are used to set out land marks and boundaries for ownership or governmental purposes (Wilson, 1983:2). In building industry in Nigeria the services of land surveyors are employed in mapping out layouts, setting out and in taking and transferring levels from one point to another during building construction process[17].

Although the duties of land surveyors were not stated in the National Building Code, however, supervision of setting outs which is land surveyors' responsibility was allotted to registered builders (FRN, 2006:461). This contravenes the existing practice in the Nigerian building industry. The land surveyors are not required in the repair of adobe building in Sabon Gari and as a consequence are not included in the proposed framework.

Town Planners: Town Planners are also refers as Urban and Regional Planners. They are responsible for design of urban and country sides through the integration of land use planning and transport planning[18]. In Kaduna State, the town planners prepares the Site Analysis (SA) report, which is a requirement for all building projects and the Environmental Impact Assessment (EIA) report for

[16] http://www.niqs.net/1/default.asp. Accessed on the 21st April, 2010

[17] http://surconnews.blogspot.com/. Accessed on the 22 April, 2010

[18] http://www.nitpng.com/about.html. Accessed on the 22nd April, 2010

industrial projects (see section 5.12.viii in chapter five). The issue of SA and EIA reports being solely prepare by Town Planners in Kaduna State has been issue of contention by other building professional bodies most especially the Nigerian Institute of Architects (NIA) for a very long time. NIA based their argument on the fact that every architect do carry out a site analysis and environmental assessment before embarking on the actual design. Thus, the architects are in better position to prepare both SA and EIA reports (see appendix 1.4.3a). Since adobe building repair can be carried out in Kaduna without the approval of KASUPDA the SA and EIA are not included in the proposed framework.

6.3. The Place of Adobe Building Construction and Repair in the Current Nigeria Building Industry

As stated in section 2.3 in chapter two, the information on earthen architecture in the Nigerian Building Code is not only limited but mostly incorrect and some are not relevant to Nigeria. It is certain that the adobe building repair is yet to be given any priority in Nigerian building industry in general and in Kaduna State in particular. However, resources exist, which if pull together can be of immense benefits to the adobe building in general. It was identified in this chapter that although Kaduna State is yet to adopt this Code there are relevant sections that can be adopted in the proposed framework for the repair of adobe building in Sabon Gari. The relevant section identified includes the requirements for mix use of building in section 4.4 of the Code; repair requirements in section 12.17; and the adjoining property's requirement in section 7.47. 2.

Building artisans such masons, carpenters, electrician, and plumbers were not recognised in the National Building Code. However, these artisans are included in the proposed repair framework as major stakeholders.

This lack recognition of adobe building in National Code and the lack of institutions for training of artisans in earthen architecture are major hindrance not only for adobe building repair but earthen architecture in general. However, there are institutions in Nigeria apart from CECTech that can also involve in earthen architecture. For example, the Obafemi Awolowo University, Ife, offers post graduate course in Architectural Conservation with a module on traditional earthen architecture (www.oau.edu.ng). [19] Furthermore, the Abubakar Tafawa Balewa University Bauchi has recently incorporated earthen architecture into mainstream of its architecture undergraduate programme (www.atbu.edu.ng).[20] Although these two institutions are not in Kaduna State they can still be involve in dissemination of good practices in adobe technology not only in Sabon Gari but in Nigeria.

Despite the fact that the adobe building was not accorded any recognition in the Nigerian construction industry the existing institutions mentioned above together with CECTech can assist in the establishment of a community based organisation (CBO) that shall coordinate earthen architecture at regional and communities level just as DEBA in south west England (Keefe, 2005:188) and C: SoC in New Mexico, US (Taylor, 1990).

6.4. Summary of Findings

There is lack of recognition of the adobe building in the current Nigerian building industry. However, this lack of recognition cannot be a hindrance to the repair of adobe building in Sabon Gari. This is because there are existing knowledge base and resources that just need to be harmonised with proper coordination. In this chapter therefore these knowledge base and resources were identified and subsequently adopted in chapter eight to design the proposed repair framework. The coordination of these resources therefore starts with this thesis' proposal, which can be continue by adopting the recommendations that were proposed in chapter ten.

The summary of findings on the adobe building and the current situation in the Nigerian building industry is presented using the structure specified in section 3.3d in chapter three.

[19] www.oau.edu.ng accessed on 21 march 2007
[20] www.atbu.edu.ng, accessed on 21 march, 2007

i. Central phenomenon of the findings: The central phenomenon of the findings in this chapter is that although the adobe technique is not given prominence in the current Nigeria building industry, knowledge and resources exists but are scattered and hidden from those in need..

ii. **Causal condition of the phenomenon:** The lack of recognition of adobe as a technique of building construction that requires equal attention as any other building technique is the causal condition for the above phenomenon.

iii. Strategies employed to cope with the current situations: The strategy to cope with the current situation is that people just perceived that the adobe is not a technique that should be accorded any official recognition.

iv. Conditions that shaped the strategies employed: The non recognition of adobe building at both national and state levels is responsible for the inappropriate repair of these types of buildings.

v. Consequences of the strategies adopted: The lack of knowledge resource's base can be attributed to the huge gap in communication between artisans and prospective clients as identified in Sabon Gari (see chapter four) and in Zaria City (see chapter five).

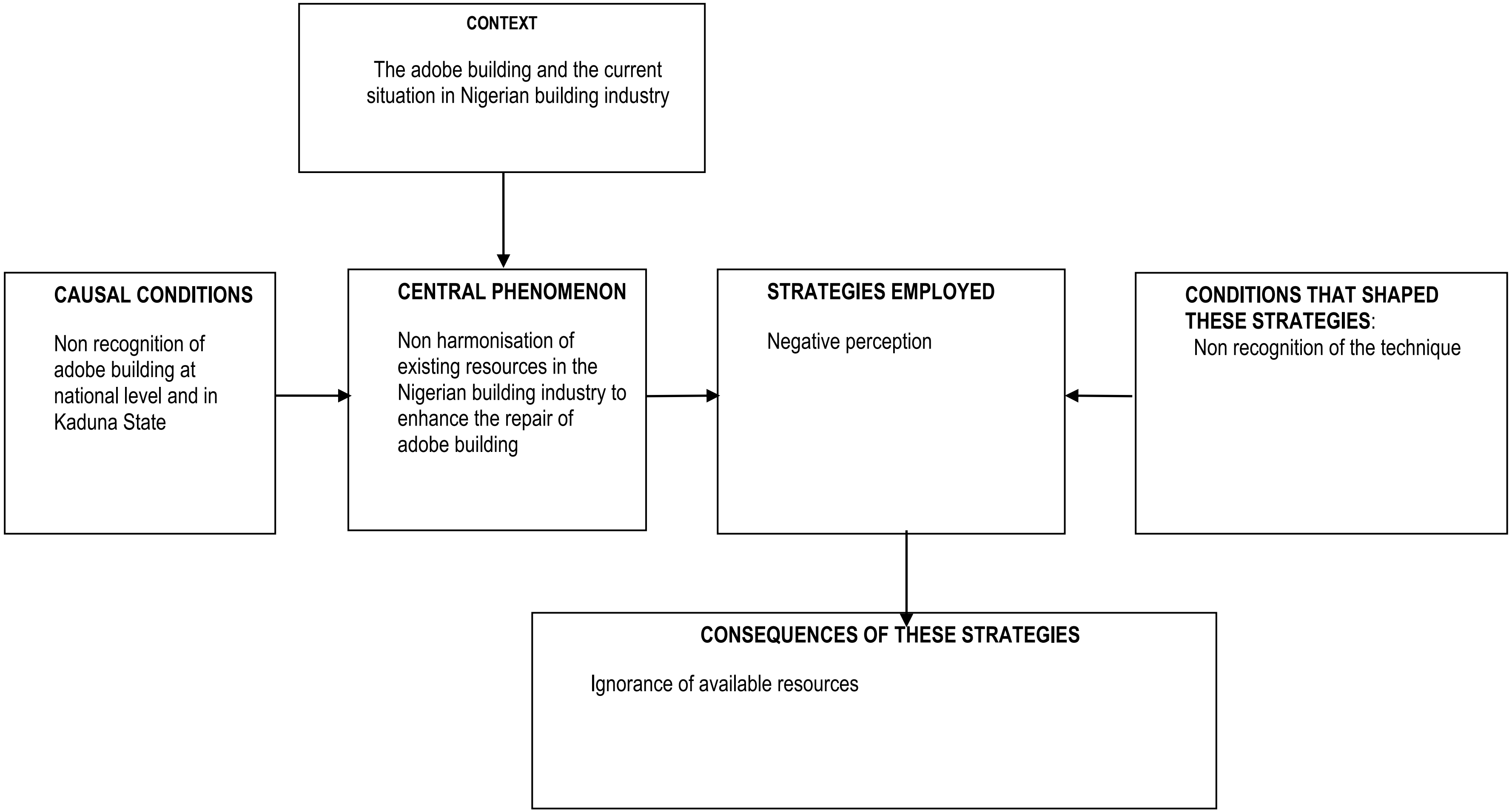


Figure 6.3: Summary of Findings

CHAPTER SEVEN

CRITICAL APPRAISAL OF BUILDING REPAIR STRATEGIES APPROPRIATE FOR THE ADOBE BUILDING IN SABON GARI

Think global, act local
- Sustainability development catchphrase

7.0. Introduction

The aim of this chapter is to critically reflect on the findings of this study as enumerated in chapters two, four, five and six and to formulate a structure for the proposed framework s using tried and tested ideas from relevant cases from around the World. The decision to review cases of earth building projects from around the World despite the fact that the thesis' study area is in Nigeria is informed by the sustainability catchphrase above. The UN's five lessons for sustainable urban development (see Girardet, 1999:62) also influenced this decision and are used as guidelines in this chapter.

The chapter is therefore divided in three parts. The first part is the analysis of sustainability approach to building repair. The second part contains the analysis of earth building repair and maintenance strategies, while the third part is the critical reflection and structure of the proposed repair strategy.

7.1. Sustainable Approach to Adobe Building Repair

The concern for the preservation of the ecology and a healthy environment are some of the major goals of sustainable development (Du Plessis, 2005:5). Consequently, the built environment (being one of the major sources of ecological degradation and environmental pollution) has received the attention of international policy makers such as the UN since the Brundtland Report of 1987. The sustainable construction was included in the overall framework for the United Nation's sustainable development agenda (Agenda 21), at the World Summit of the Sustainable Development in Johannesburg in September 2002 (Odhiambo & Wekesa, 2010:65). This document includes policy framework for the building industry, in line with the UN's initial goals for the sustainable development. As identified in chapter two, literature on sustainable building repair (the subject of this thesis) is almost nonexistent despite these various efforts by the UN and other related organisations. However, the five lessons for development of sustainable urban development policy and programmes emerged from an earlier UN summit on Sustainable City in Istanbul in 1996. These lessons according to Girardet (1999:62) are:

I. Power of good examples (Case studies)

II. Complexities of issues

III. Large repercussions of local actions

IV. Networking and knowledge exchange

V. Institutional change

Sabon Gari is an urban area and the adobe buildings are integral part of the urban system. Thus, any action taken in the repair of these buildings will have either negative or positive consequences on the on the City of Kaduna and beyond. These five lessons (listed above) are therefore considered in the developments of the framework for repair of adobe building in Sabon Gari as explained below.

7.1.1. Case studies: The power of good examples was recognised during the UN Habitat's 1996 Summit in Istanbul as an important tool for urban development. Thus, the various documents and films on sustainable urban development, produced by the UN Habitat, for many cities in several countries were recognised as important tools for urban sustainability. It was therefore recommended during this Istanbul Summit that despite varying cities' problems, these documents and films could be source of inspiration for all and guide on best practices. This recommendation is used in this thesis, thus case studies of earth building repair from Terra conference papers are analysed with the aim of identifying good practice relevant to the thesis. As stated in chapter three the Terra conference papers are considered because it is an internationally recognised conference on earthen architecture that has been consistently organised since 1972 (Ford, 2002: 21). 148 scholarly papers were identified and analysed from the last 6 conferences (occurring in 1987, 1990, 1993, 2000, 2003 and 2008). Relevant strategies employed in the repair and conservation of earth buildings presented in these papers were identified and used in the formulation of the structure for the proposed framework in section 7.2.

7.1.2. **Complexity of issues:** UN Habitat recognised that issues relating to the urban environment are complex, and obstacles to successful implementation of policies must be analysed and processes for implementation identified (Girardet, 1999:62). In the context of this thesis, the process and obstacles to the successful implementation of the proposed framework are proposed as part of the recommendations in chapter ten.

7.1.3. Local level action has large scale repercussions: The Istanbul's UN City Summit (Habitat II) in 1996 identified that every development action or policy has a large effect on the local community where the policy or action is being implemented. These effects also have tendency to go beyond the local community, as a consequence care must be taken in planning, implementation and monitoring (Girardet, 1999:63). In order to prevent negative consequences Girardet (1999:63) proposed that the following critical questions should be asked: how applicable are these actions outside the local environment? Under what circumstances can these actions succeed? and, who shall be the local partners for the success of these actions?

This thesis is therefore designed with the understanding that the repair of the adobe buildings in Sabon Gari can have a positive or negative influence in the city of Kaduna in particular, and in other urban and rural areas in northern Nigeria. This is because of the strategic location of Sabon Gari where these adobe buildings are located, as well as the social and political influence of Kaduna as the former capital of the old northern region. Thus, all the specifications in the proposed framework are closely tailored to local situations in Sabon Gari in particular and in line with current building regulations in Nigeria. The SWOT analysis and the TOWS matrix (see chapter three) are also used for the analysis of the sustainability of the proposed framework in Sabon Gari based on the stakeholders' validation (see chapter nine).

7.1.4. Networking and knowledge exchange: The UN Summit in 1996 also recognises that sharing of best practice between cities is an invaluable tool for sustainable development. The policy stated that learning from example can lead to local transformation, which will in turn lead to global change.

In the context of this thesis, networking and exchange of knowledge are encouraged among the stakeholders in the proposed framework. This is achieved by recognising that the relationship between landlords and tenants as well as artisans is paramount to the success of the proposed framework. Thus, mutual respect, dialogue in respect to decision making and constant communication among these stakeholders are encouraged in the proposed repair framework. Similarly, CECTech being the only institution for earthen architecture in Nigeria is identifies as an important player in the dissemination of this proposed repair framework. KASUPDA is another major stakeholder in this proposed framework. It is therefore recognised that KASUPDA can play a major role in dissemination and successful implementation of this framework.

7.1.5. Institutional change: The UN City Summit in 1996 recognises the power of allowing people direct access to best practice's examples through recognised regional, national and local institutions. Thus, all the UN publications are disseminated through institutions at various levels for public uses. Although it is not possible to provide copies of this thesis to CECTech, KASUPDA and other relevant institutions in Nigeria, an electronic copy of the relevant part of thesis shall be made accessible in the author's personal website. However, it was identified from the field surveys that the literacy level of the stakeholders is very low, thus the majority will not be able to read this thesis. Consequently, part of the thesis' recommendations in chapter ten is the development of dissemination methods for this category of stakeholders that cannot read.

7.2. Identification of Earth Building Repair Strategies in Terra Conferences Papers

Apart from the justifications for the review of Terra conferences papers explained in chapter three and section 7.1.1 above, building conservation also involves repair (see Feilden, 1994:34). Thus, although the 148 papers review delved into conservation of significant historic earthen buildings (mostly protected buildings), some of the strategies employed in the conservation of these earthen buildings are relevant to this thesis. In addition, some of the problems identified in the study area (see chapter four) and in Nigeria (see chapters five and six) were considered in these conservation projects. For example, the lack of records of the buildings' history was identified as one of the hindrance to sympathetic repair of some of earth buildings (e.g. Alaamandour, 2003:10), just as in this thesis' study area (Sabon Gari).

The common trend identified in the reviewed projects is that conservation is generally governed by principle or philosophy and this determines the strategy, type of material and method of repair. Thus principles and practices employed in the projects reviewed are from the International conservation Charters, mostly Venice and Nara (see Rojas & Crocker, 2000:419). These principles and philosophical approaches include among others: minimal intervention (Baca, 1993:256; Michon, 1990:99; etc.); use of like materials (Garrison, 1990:53; Nardi, 1987:71; etc.); traditional knowledge as indispensable asset (Bedaux, et. al., 2000:201; Rua, 1993:205; etc); periodic maintenance of earth building to minimise the need for repair (Kamamba, 1990:77, Nandadeva, 1990:105); etc. These principles are considered in the development of the proposed framework. Table 7.1 is the summary of conservation principles derived from the projects reviewed in the Terra conference papers relevant to the study area.

	Principles / Philosophies Governing the Interventions	**Author(s)**
1.	Conservation governed by principles and practices in the Venice and Nara Charters	Rojas & Crocker (2000:419)

2.	Interventions as learning process	Jerome (2003); Kanan (2003); Baca (1993:256); Jayhani & Omrani (2003: 542), Pandit (2003); Bedaux, et. al. (2000:201); Rua (1993:205); Baradan (1993:429); Michon (1990:99); Smail (1990:122); Emrick & Meinhardt (1990:153)
3.	Traditional knowledge as indispensable asset	Jayhani & Omrani (2003: 542); Pandit (2003); Bedaux, et. al. (2000:201); Rua (1993:205); Baradan (1993:429); Michon (1990:99); Smail (1990:122); Emrick & Meinhardt (1990:153)
4.	Intervention as means of preservation of history and traditions	Baca (1993:256)
5.	Holistic approach to intervention	Ndoro (1990:377); Hughes (1987:59)
6.	Minimal intervention	Azghandi (2003); Emrick & Meinhardt (1990:153); Nardi (1987:71)
7.	Intervention must be reversible	Garrison (1990:53); Agnew, et. al. (1987:3)
8.	Use of locally sourced material	Ebrahimi (2003); Smail (1990:122); Brown, Sandoval & Orea (1990:204); Nardi (1987:71)
9.	Use of like material	Rojas & Crocker (2000:419); Ebrahimi (2003); Garrison (1990:53); Nardi (1987:71);
10.	Sympathetic use of materials and methods	McHenry (1990:159)
11.	Local craftsmen are valuable asset to interventions	Jerome (2003); Kanan (2003); Baca (1993:256)
12.	Surviving traditional buildings are tangible medium for understanding and determination of appropriate intervention	Jerome (2003)
13.	Traditional earthen architecture is dynamic, so is its repair	Marchand (1993:108)
14.	Reuse of original material, except if identified to be the cause of deterioration	Rua (1993:205); Pujal (1993:244); Emrick & Meinhardt (1990:153)
15.	Use of only tried and tested materials and methods	Chiari (1990:267); Van Balen (1990:182); Emrick & Meinhardt (1990:153)
16.	Material sourcing within close proximity to the site	Bouwens (1990:14)
17.	Periodic preventive (cyclical) maintenance	Kamamba (1990:77); Nandadeva (1990:105); Chiari (1990:267); Taylor (1990:383); Taylor (1990:383)

Table 7.1: Principles / philosophies that influenced decisions during the conservation of earth buildings presented in the proceedings of 6 Terra conferences

It was also identified from the review that strategy for conservation of earthen buildings is usually in three phases. For example, Van Balen's (1990:182) three phases of earth building conservation should includes: (i) analysis phase, (ii) diagnosis phase and (iii) therapy and control phases. On the other hand, Guillaud, et. al. (2003:201) three phases of earthen architecture conservation are: (i) identification and characterisation; (ii) pathology and deterioration; and (iii) diagnosis and conservation. For the purpose of this study the conservation strategies derived from the projects review are divided into three phases, namely: (i) pre implementation, (ii) implementation and (iii) post implementation phases. Thus, the pre implementation strategy includes investigation and analysis, the implementation strategy involves therapy, while the post implementation strategy is the monitoring and continous care process (see figure 7.1).

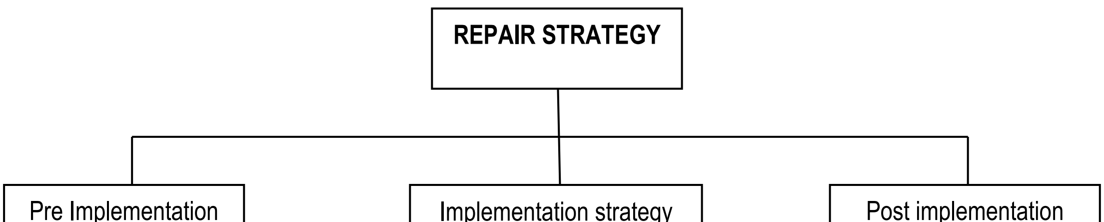


Figure 7.1: Earth building repair strategy

a. Pre implementation: The pre implementation strategy usually involves among others, strategy for investigation of building history, literature review, condition survey, etc. Tables 7.2 and 7.2a contain the pre implementation strategy derived from the projects reviewed. Some of the processes for investigation of building history applied in these projects includes: archaeological investigation (Boyer, 1990:193); literature review (Bohnett, 1990:261); study of the architecture history of the locality and region (Alaamandour, 2003:10); etc. Another process of investigation of building history is the use of old photographs and post cards to compare the past and the existing building's condition, as well as to understand its process of transformation (Oliver & Hartzler, 2000:78).

As earlier mentioned above, not all of the strategies for investigation of building history identified are relevant to this thesis. In this proposed framework, the historical investigation will be limited to oral accounts of present and past occupants of the building. Similarly, the KASUPDA is recommended as the resource base for relevant document relating to planning and development in Sabon Gari, e.g. Max Lock's Report (see section 3.3a, sub section iii in chapter three and Theis, et. al., 2002).

Furthermore, Warren (2000:361) and Garrison (1990:53) suggested that identification of the period when a building was constructed can provide better understanding of the building's style, original material and technique used in construction of the building. In the case of the adobe buildings in Sabon Gari, it has already been established that the buildings were constructed before 1965 based on the Max Lock report (see Theis, et. al., 2003:12 and chapter four). The reality is that these adobe buildings are not traditional and at the same time cannot be classified as recently built. They could be classified as pre 1965 buildings however, such classification could suggest the buildings are traditional, while they are not. Consequently this thesis suggests that for the purpose of clarity the adobe buildings in Sabon Gari should classified as pre oil boom buildings (i.e. buildings constructed before the era of crude oil exportation in Nigeria).

Various methodologies for condition survey of buildings were employed in the projects reviewed. However, not all of these methodologies are appropriate for the adobe buildings in Sabon Gari due to their complexities and cost. Examples of such complex condition survey method for analysis of building material includes the use of Scanning Electron Microscopy (SEM) for determining shrinkage in earth mortar or brick (Guillaud, et. al., 2003:201); X – Ray Diffraction (XRD) for analysis of earth bricks and mortar (Bell, 2003:61); etc. However, simple methodology such as physical inspection of the buildings by an experience person as proposed by Jensen (2003:309); and other methodologies such as in: Fiero, et. al. (2000:31); Goodarzi, 2003:197; etc. are adopted in the proposed repair framework. Similarly, the condition survey proposed in the repair framework shall also rely on information from the past and present occupants of the buildings.

It was identified that the condition survey outcome determines the aim and scope of repair. Consequently, Jensen (2003:309); Fiero, et. al. (2000:31); Rua & Rajer (1993:205) stated that the aim of a project is defined by the degree of deterioration and guiding conservation principles and philosophies. For example, a ruined historic building may require restoration, while a dilapidated building may require only repair. At institutional level, Dassler, et. al. (1993:597) designed and administered questionnaires to the stakeholders in order to identify and defined the conservation needs. However, Ahmed (1993:52) proposed that reappraisal of intrinsic values of the buildings, is paramount, in order to identify the sustainability of the building after intervention. He therefore, proposed that the viability of the material, technique and the building after repair must be critically evaluated before any intervention. Thus, Ahmed (1993:52) is in favour of inventive approach to conservation and adaptive reuse of buildings after conservation if the original use is no longer relevant to the community or client.

In order to decide on the repair methodology, Taylor (2000:189) proposed the evaluation of traditional techniques, while de Sousa Lima & Puccioni (1990:302); Caperton (1987:13) proposed studies of recent interventions (case studies). On the contrary, Achenza (2003:1), Alaamandour (2003:10); Botros & Abdel-Mageed (2000:276); Baca (1993:256); Arnon & Baca (1990:176); etc. ensured that the community were involved in every decision made from inception to completion of their respective projects. For effective communication with the local community, Alaamandour (2003:10) developed architectural models of the proposed repair, upon realisation that the illiterate community will not be able to understand architectural drawings of the new proposal. Furthermore, Bedaux, et. al. (2000:201) used the local language of the people of Djenne as medium of communication instead of French the official language of the Federal Republic of Mali. The adobe buildings in Sabon Gari are individually owned and participation of the landlords, tenants and other stakeholders in the decision making in the course of planning and implementation of repair is important, this will therefore be considered in the proposed framework.

	Pre Implementation Strategy	Author(s)
A.	**Strategies for preliminary data collection: Research and documentation**	
1.	Investigation into the building history	Rua (1993:205); Chaudhry (2003), Van Balen (1990:182); Balderrama, et. al. (1990:461); Van Balen (1990:182); Alvarenga, 1990:357); Andrade (1990:457); Hughes (1987:59)
2.	Literature review	Azad (2003); Guillaud & Avrami (2003:201); Bohnett (1990:261); Ndoro (1990:377)
3.	Research into the architecture history of the surviving traditional and those of the entire region	Alaamandour (2003:10); Jerome (2003)
4.	Categorisation of buildings according to period of construction (i.e.: antiquity, current and modern and foreseeable	Warren (2000:361); Garrison (1990:53)
5.	Knowledge of material and method of construction before condition survey	Emrick & Meinhardt (1990:153); Van Balen (1990:182)
	Detailed investigation	
	Inventory	Bedaux, et. al. (2000:201-207); Garrison (1990:53); Michon (1990:99)
7.	Condition survey	Alaamandour (2003:10); Azad (2003); Azghandi (2003:); Bell & Boke (2003:61); Jansen (2003: 309); Kanan (2003); Siyar (2003); Fiero, et. al. (2000: 31); Politis (1993:387); Rua & Rajer (1993:205); Pujal (1993:244); Garrison (1990:53); Bohnett (1990:261); Michon (1990:99); Caperton (1990:209); de Sousa Lima & Puccioni (1990:302); Ndoro (1990:377); Andrade (1990:457); Crosby (1987:33); Hughes (1987:59)
8.	Evaluation of traditional techniques and materials	Taylor (2000:189)
9.	Reappraisal of intrinsic values towards evolution of sustainable earthen architecture	Ahmed (1993:52)
10.	Case studies	de Sousa Lima & Puccioni (1990:302); Caperton (1987:13)
11.	Interdisciplinary collaboration in decision making	Taylor (1993:590)
12.	The use of questionnaire to identify global needs on earthen architecture – GAIA project	Dassler, et. al. (1993:597)
	Critical assessment of the project and its viability	
13.	Feasibility Study (Project viability, Environmental Impact Analysis (EIA), etc.)	Igbesias (2003:75), Jerome (2003)
14.	Determination of project's aim	Jansen (2003: 309); Fiero, et. al. (2000: 31); Rua & Rajer (1993:205); Pujal (1993:244); de Sousa Lima & Puccioni (1990:302); Caperton (1987:13); Taylor

		(1993:590)

Table 7.2: Relevant pre implementation strategies derived from papers in 6 Terra conferences proceedings

	Pre Implementation Strategy	Author(s)
B.	**Community involvement in the pre implementation**	
1.	Community partnership and participation	Achenza (2003:1); Alaamandour (2003:10); Contreras (2003:599); Herdoiza (2003:); Mascarenhas (2003); Botros & Abdel-Mageed (2000:276); Rojas & Crocker (2000:419); Baca (1993:256); Arnon & Baca (1990:143); Rua & Rajer (1990:176); McHenry (1990:159)
2.	Improvisation of medium of communication	Alaamandour (2003:10); Oliver & Hartzler (2000:78); Bedaux, et. al. (2000:201); Caperton (1990:209)
3.	Identification and use of the community symbol as a focal point for intervention projects (e.g. C: SoC)	Baca (1993:256); Smail (1990:122); Arnon & Baca (1990:143)
4.	Integration of culture and beliefs	Baca (1993:256); Schijns (1993:373); Nandadeva (1990:105)
C.	**Human resources and community development**	
1.	Incorporation of training	Fernandez (2003:128); Kukina, Blyankinshtein & Burovsk (2003); Azari (2003); Kanan (2003); Achenza (2000:379); Correia & Merten (2000:226); Lippe (2000:158); Baca (1993:256); Alva (639); Bohnett (1990:261); Balderrama, et. al. (1990:461); Stevens (1987:81)
2.	Publication of training materials	Taylor (1993:590); Alva (1993:639)
3.	Introduction of certified courses and development of courses' curriculums	Lippe (2000:158); Taylor (1993:590)
4.	Intervention aimed at job creation and tourism	McHenry (1990:159)
5.	Use of already trained local labour force	Baca (1993:256)
6.	Preparation of compendium of skilled artisans and professionals in the locality	Kanan (2003)
D.	**External support and collaboration**	
1.	External financial assistance	Kanan (2003); Rua & Rajer (1993:205); Michon (1990:99); Rua & Rajer (1990:176); McHenry (1990:159)
2.	Technical collaboration	Kanan (2003); Achenza (2003:1); Alva (1993:639); Dassler, et. al. (1993:597); Trappeniers (1993:605); Michon (1990:99); Balderrama, et. al. (1990:461)
3.	Institutional collaboration (e.g. PWD)	Usman (2008:108); Kamamba (1990:77); Michon (1990:99); Arnon & Baca (1990:143); Rua & Rajer (1990:176); Agnew (1990:243); de Sousa Lima & Puccioni (1990:302); Balderrama, et. al. (1990:461); Stevens (1987:81)
4.	Institutional capacity building	Mascarenhas (2003); Joffroy, et. al. (1993)
5.	Networking	Achenza (2003:1); Alva (1993:639); Dassler, et. al. (1993:597); Trappeniers

		(1993:605); Michon (1990:99); Balderrama, et. al. (1990:461)
E.	**Programme schedule**	
1.	Phasing and prioritisation of stages of project	Rua & Rajer (1993:205); Pujal (1993:244); Nardi (1987:71)

Table 7.2a: Continuation of the pre implementation strategies derived from papers in 6 Terra conferences proceedings

b. Implementation strategy: The implementation strategy is derived from the projects reviewed, these includes strategies for ensuring safety on site, choice of material; methods of repair; financing projects, programming; human resources and community development; external support and collaboration. These implementation strategies are explained below and also summarised in table 7.3.

Dubus (1990:401) and Odul (1990:404) suggested that the first safety precaution for an earth building rehabilitation site is that excess moisture in earth buildings must be removed before commencement of any work. Cooke (2003); Pujal (1993:244); Caperton (198:71) etc. ensured that the buildings were safeguarded by propping up of structural members that are deemed to be unstable before commencement of work. Similarly, Nardi (1987:71) first of all treated the symptoms before actual building repair as a safety precaution.

The strategies adopted for the choice of material were aimed at preserving the integrity of the buildings and at the same time ensuring that the existing and new materials are compatible with one another. Thus, the reuse of original material was favour as against introduction of new ones in some of the projects reviewed (e.g. Rua & Rajer, 1993:205; Bohnett, 1990:261, etc.). However, in cases were new materials were used, locally sourced materials were preferred, e.g. Ebrahimi (2003); Bouwens (1990:14); etc. In other projects, only tried and tested material were used e.g. Bell & Boke, 2003:61; Fiero, et. al., 2000:31; Jerome, 1993:381; etc. Furthermore, trial earth walls were constructed in the course of rehabilitation of the Fort Selden, New Mexico, US (Agnew, et. al., 1987:3). Several organic and inorganic materials were used to stabilise earth mortars that was used to rendering these trial earth walls in Fort Selden. Upon weather simulation of curing, the rendered walls were tested in the laboratory in order to study the performance of these materials before being used on earth buildings. The results of these tests were published in: Guerrero de Luna, 1993:410; Coffman, et. al., 1990:424; Agnew, et. al., 1990:243; Agnew, et. al., 1987:3; etc. Most comprehensive publication of these tests is that of Guerrero de Luna, 1993:410 and it is therefore summarised and presented in table 7.3 below.

TESTS CONCLUSION						
Plaster type		**Adhesion**	**Vapour transmission**	**Water resistance**	**Abrasion resistance**	**Capillarity**
Clay	WR-N	A	A+	D	D	A+
	WR-T	A	A+	C	D	A
	WR-A	A	B	B	B	C
	WR-E	A+	C	A	A	B
Lime	WR-N	B	B	A	D	A
	WR-T	C	B	A	D	A
	WR-A	A	C	A	A	D
	WR-E	A	C	A	A	B
Gypsum	WR-N	D	A	C	D	A
	WR-T	D	A	C	C	A
	WR-A	C	B	A+	A	D
	WR-E	B	B	A+	A	C
Clay lime	WR-N	C	B	A	D	B
	WR-T	B	B	A	C	C
	WR-A	B	C	A	B	E
	WR-E	A	D	A+	A	C
Gypsum lime	WR-N	C	B	B	D	A
	WR-T	D	B	C	D	A
	WR-A	C	B	A	B	D
	WR-E	B	C	A	B	A

KEY
WR-N = Plaster with no consolidants. **WR-T**=Plaster with tuna cactus. **WR-A**=Plaster with acrylic solution (Acryloide B-67). **WR-E**=Conservare OH (ethyl silicate).
A=Excellent. **B**=Good. **C**=Fair. **D**=Poor. **E**= No absorption

*Table 7.3: Summary of results of the test on various stabilisers for rendering of earth walls (**source**: Guerrero de Luna, 1993:410)*

The result of the tests presented in table 7.3 above shows that the performance of unstabilised clay (earth) render (which is also is the original render on the adobe buildings in Sabon Gari) is as effective as that of stabilised clay (earth) render. In fact the unstabilised clay (earth) render performed better in terms of adhesion to the adobe masonry than unstabilised lime, gypsum, clay lime and gypsum lime renders. Although the unstabilised clay (earth) render's resistance to water was poor, however, this can be minimised to the permissible level through proper drainage and adequate roof overhangs (see Keefe, 2005:194). Similarly, the clay (earth) render's poor resistance to capillary action can be minimised with proper drainage system that will preventing excess moisture from penetrating through foundation (see Houben & Guillaud, 1997:255). Furthermore, the resistance of the unstabilised clay (earth) render to abrasion was poor. Same results were recorded for the four other render. This implies that the best approach is to minimise causes of abrasion in the earth building. Common causes of abrasion include: human and animal contacts, rodent attack, etc. (Norton, 1997:23). However, these can be minimised if it cannot be avoided all together. The only organic stabiliser (tuna cactus) used in stabilising clay (earth) render shows almost the same result as the unstabilised render with the exemption of the fact that it shows fair resistance to abrasion. However this material is not available in Sabon Gari, moreover abrasion on earth wall can be minimised to barest minimum with adequate care by the residents.

Chiari (1987:25) and (1990:267) presented results of long term field test of the use of ethyl silicate and other inorganic consolidants discussed above to stabilised adobe walls in many site. Some of the sites were monitored for more than 20 years. However, the results are similar to those presented in table 7.3 above. Chiari (1987:28) also stated that the effects of all these inorganic stabilisers are irreversible. He therefore recommended that the principle of minimal intervention should be applied when using these stabilisers.

The use of unstabilised earth for rendering of the adobe building in Sabon Gari is therefore specified in the proposed repair framework. This decision is informed by the result of the above experiment as well as the philosophy of the use of like material (see table 7.1).

For the same reason as in the use of material, local know-how was preferred in terms of repair techniques in the projects reviewed. For example, Odiaua (2011:120); Contreras & Baca (2003:599); Jerome (2000:144); Marchand (1993:108); Michon (1990:99); etc. all suggested the use of traditional techniques and local artisans for conservation and rehabilitation of earth buildings. They argued that this strategy will ensure that original technique is preserved for future generations, thus ensures continous conservation of the buildings by the community. Marchand (1993:108) noted that the earth buildings in Zaria City rendered using the traditional technique performed better than those rendered with cementious material. Furthermore, Botros & Abdel-Mageed (2000:276); Ahmed (1993:52) suggested the use of community oriented and environmentally friendly technology, to ensure that buildings are not only conserved but easy to maintain by the community. Various incentives were therefore used to encourage the local community to fully engage in the implementation of the projects. Such incentives includes: provision of stipends to local participants (Baca, 1993:256), provision of food, drinks, and musical entertainment during repair (Odiaua, 2008:43) and provision of food for voluntary participants (Michon, 1990:99). Provision of these types of incentives, although appropriate in the projects reviewed, could be difficult to implement in Sabon Gari. This is because there is a no sense of community in Sabon Gari in the first place (see Theis, 2002:12). Moreover this is an additional expense that will escalate the overall cost of repair. There is already leverage for repair of adobe building by KASUPDA not enforcing the State's building regulation (see section 4.2.2 sub section viii in chapter four).

As a strategy, Rua & Rajer (1993:205) proposed that schedules for building conservation should be according to priorities. This is to ensure that areas in dire need of repair are given preference over areas that are not under much threat of deterioration. Furthermore, Pujal (1993:244) and Nardi (1987:71) divided the conservation and rehabilitation projects into phases. This strategy ensured steady but speedy execution of the projects, cost planning and control, thorough supervision to ensure quality, as well as working in accordance with available fund. These strategies are included in the proposed repair framework in chapter eight as part of the programme schedule for the adobe building repair.

The artisans used in all the projects reviewed were from local communities. In cases where the know-how no longer exists or new ideas were introduced, the locals were trained in the course of the repair. This strategy is post implementation strategy, thus explained in greater details in section on post implementation strategy.

Apart from benefitting from external funding for conservation and rehabilitation of projects, the diffusion of repair techniques was enhanced through collaboration between local and national or international institution. This was established in communities such as those in Sardinia, Italy (Achenza, 2003:1). In other instances conservation was through institutional collaborative research e.g. CRATerre and ICCROM (Dassler, et. al., 1993:597; Trappeniers, 1993:605; Alva & Houben, 1993:639; etc.). This type of international collaboration promotes networking and knowledge dissemination not only between the institutions concern but among other professionals from around the World. On the other hand, some institutional collaboration was geared towards improving or building capacity of institutions. For example, CRATerre, France collaborated with NCMM, Nigeria for capacity building in earthen architecture and conservation (Guillaud, et. al., 1993). One of the results of this collaboration is the establishment of CECTech in 1992, which remained under the management of CRATerre, until after the training of the NCMM staff in France (Guillaud, et. al. 1995:23). Similarly, collaboration between communities and institutions towards training of artisans was reported in some of the projects reviewed. For example, the Church as Symbol of the Community (C: SoC), a community organisation in New Mexico, USA dedicated to the conservation of local adobe buildings collaborated with the New Mexico Community Foundation (NMCF) for technical advice on preservation of adobe structures (see Arnon & Baca, 1990:143). This type of collaboration ensures that community based organisations (CBO) are encouraged and constantly updated on improved ways of achieving successful results. Other, advantages of this collaboration includes: networking within and outside the community, capacity building, youth empowerment, etc. However, this can only be possible where community organisations exist. As a consequence these strategies can only form part of recommendations for long term strategies for repair of adobe buildings in Nigeria.

	Implementation Strategy	**Author(s)**
A	**Safety precautions**	
1.	Consolidation and safeguarding of structure before commencement of work	Cooke (2003); Pujal (1993:244); Caperton (1987:13); Nardi (1987:71)

2.	Drying out of the building if moisture is observed	Dubus (1990:401); Odul (1990:404)
3.	Treatment of symptoms before actual repair	Nardi (1987:71)
B.	**Materials**	
1.	Use of locally sourced materials	Nwankwor (2008:69); Ebrahimi (2003:); Bouwens (1990:14); Smail (1990:122); Brown, Sandoval & Orea (1990:204); Nardi (1987:71)
2.	Reuse of original materials and components where possible	Rua & Rajer (1993:205); Bohnett (1990:261); Pujal (1993:244); Emrick & Meinhardt (1990:153)
3.	Use of tried and tested material	
	i. Laboratory testing of existing materials	Bell & Boke (2003:61); Jayhani & Omrani (2003: 542); Sikka (2003); Fiero, et. al. (2000: 31); Jerome (1993:381); Politis (1993:387); Guerrero de Luna, (1993:410); Baradan (1993:429); Coffman, et. al. (1990:250); Bohnett (1990:261); Helmi (1990: 277); Koob, et. al. (1990:289); Ndoro (1990:377); Coffman, et. al. (1990:424); Dassler (1990:430); Sramek & Losos (1990:449); Agnew (1990:243); Austin (1990:417); Agnew, et. al. (1987:3)
	ii. Laboratory testing of new materials	Langroudi (2003); Stazi (2003:); Rua, et. al. (2003); (1993:205); Schijns (1993:373); Guerrero de Luna (1993:410); Agnew (1990:243); Coffman, et. al. (1990:250); Selwitz, et. al. (1990:255); Koob, et. al. (1990:289); Zuixiong (1990: 295); Agnew, et. al. (1987:3); Taylor (1987:91); Neumann & Mehta (1987:103); Chiari (1987: 25)
C.	**Methods**	
1.	Drying up moisture using electro-osmosis	Dubus (1990:401)
2.	Community oriented and environmentally friendly technology	Botros & Abdel-Mageed (2000:276); Ahmed (1993:52)
3.	Use of traditional knowledge and artisans	Odiaua (2008:43); Contreras & Baca (2003: 599); Jayhani & Omrani (2003: 542), Pandit (2003); Jerome (2003); Kanan (2003); Jerome (2000:144); Marchand (1993:108); Bedaux, et. al. (2000:201); Rua (1993:205); Baradan (1993:429); Baca (1993:256); Michon (1990:99); Smail (1990:122); Emrick & Meinhardt (1990:153); McHenry (1990:159)
4.	Trial test walls	Bell & Boke (2003:61); Jayhani & Omrani (2003: 542); Guerrero de Luna (1993: 410); Agnew (1990:243); Ndoro (1990:377); Caperton (1990:209); Ferm (1990:274); Taylor (1987:91); Neumann & Mehta (1987:103); Agnew, et. al. (1987:3); Taylor (1987:91)
5.	Long term field test	Chiari (1990:267) and (1987:25)
D.	Training	Fernandez (2003:128); Achenza (2000:379); Baca (1993:256); Bohnett (1990:261); Stevens (1987:81), etc.
E.	**Wages and incentives**	
1.	Provision of stipends for trainees	Baca (1993:256)
2.	Provision of food, drinks, musical entertainment, etc.	Odiaua (2008:43); Michon (1990:99)

Table 7.4: Relevant implementation strategies derived from papers in 6 Terra conferences

c. Post Implementation strategy: From the reports of the projects reviewed it was identified that conservation and rehabilitation of earth buildings does not end after the actual intervention. Several strategies were designed to ensure that the buildings were continuously in good conditions. As stated earlier in the analysis of the implementation strategy, training of the local community is one of the common strategies employed in all the projects reviewed. For example, Fernandez (2003:128); Achenza (2000:379); Baca (1993:256); Bohnett (1990:261); Stevens (1987:81), etc. incorporated training of the local youths and artisans in the conservation projects. Their aims were to ensure continuity, local self reliance, creation of employment opportunities, preservation of local knowledge, continous survival of the buildings and promotion of sustainable living.

On the other hand, Lippe (2000:158) and Taylor (1993:590) commenced certified courses on earthen architecture conservation in their respective regions. This strategy ensured continous professional development not only within the locality but for everyone that wishes to learn more about the trade. Furthermore, Taylor (1993:590) and Alva (1993:639) designed and published training materials as part of their conservation strategy, thus, those that may not be able to attend the courses can still benefit from these publications. Similarly, Kanan (2003) compiled a compendium of skilled professionals in Putaendo town in Chile as part of the conservation strategy in the area. This strategy was aimed at promoting network among the practitioners, as well as to ensure that earth buildings owners can easily find these skilled professionals whenever their services are required. Although all the above strategies were successful and in many of the instances very essential for the survival of the buildings, however, these are long term strategies, which can only be included in this thesis as part of recommendations in chapter ten.

In order to ensure that the desire objectives were attained Mirjani (2003) and Bohnett (1990:261) designed assessment, evaluation and rating strategies after building repair. Furthermore, Jansen (2003:309); Fiero, et. al. (2000:31); Rua & Rajer (1993:205); Bohnett (1990:261); etc. ensured that the buildings were documented after repair. Thus, detail records of materials, techniques, etc. were kept for future purposes.

Adaptive reuse of buildings after intervention is another strategy employed in ensuring that the projects reviewed are continuously maintained. For example, the Kashan Ameriha complex in Iran was converted to hotel after restoration (Azghandi, 2003). Other example can be found in: Azari (2003) and Jerome (2003). However, instead of adaptive reuse, the C: SoC modelled its conservation strategy on community ownership (Baca, 1993:256). Thus, the community are involved in planning and implementation of conservation projects and the buildings are eventually handed over to the community for its continuous care. The adaptive reuse of the adobe buildings in Sabon Gari is already in existence in form of remodelling, thus this shall be further encouraged in the proposed framework. Furthermore, approach to conversion of these buildings to other uses such that the integrity and structural stability of the buildings are not compromised will be incorporated in the proposed repair framework.

Fiero, et. al. (2000:31); Bohnett (1993:261); etc. designed monitoring and management strategies that ensured that the sites are safeguarded after interventions. Furthermore, Chaudhry (2003); Bohnett (1990:261); Balderrama, et. al. (1990:461) argued that intervention and monitoring alone are not adequate for continuous conservation of buildings. They therefore advocated for continuous research into materials and best methods of building conservation. As part of this research strategy, Bohnett (1990:261) published the result of the conservation of the adobe buildings in Mesa Verde National Park, in the US. The post implementation strategies in this report included plan of action for periodic inspection of the adobe buildings. This strategy is therefore considered in the proposed framework. Table 7.5 is the summary of the post implementation strategies identified from the projects review.

	Post Implementation Strategy	**Author(s)**

1.	Training	Fernandez (2003:128); Achenza (2000:379); Baca (1993:256); Bohnett (1990:261); Stevens (1987:81), etc.
2.	Recording and documentation after intervention	Mirjani (2003); Bohnett (1990:261)
3.	Assessment, evaluation and rating after repair	Jansen (2003: 309); Fiero, et. al. (2000: 31); Rua & Rajer (1993:205); Pujal (1993:244); Garrison (1990:53); Bohnett (1990:261)
4.	Development of long-term preservation action plan	Azari (2003); Jerome (2003); Azghandi (2003)
5.	Adaptation and use of building after intervention	Jansen (2003: 309)
6.	Handing over the ownership to the community	Baca (1993:256); Stevens (1987:81)
7.	Site monitoring and management after intervention	Fiero, et. al. (2000: 31); Taylor (2000:189); Bohnett (1990:261)
8.	Preparation of compendium of skilled professionals in the locality	Kanan (2003)
9.	Continuous research after intervention	Chaudhry (2003); Bohnett (1990:261); Balderrama, et. al. (1990:461)
10.	Publication of result	Bohnett (1990:261)

Table 7.5: Relevant post implement strategies derived from papers in 6 Terra conferences' proceedings

7.2.1. Sustainability strategies derived from the Terra conferences papers review: Various strategies were employed to ensure the sustainability of the projects reviewed above. Some of these strategies were already discussed. Examples of those already discussed are the use of locally sourced material (Ebrahimi, 2003:133; Smail, 1990:12; etc.). Other example includes the use of waste products stabilised to earth walls (Igbesias, 2003:75 and Chiari, et. al., 2003:87). Earth was stabilised with by-product from the acetylene industry in both projects. This by-product was already degrading the local environment in the two areas. Thus the project was able to achieve dual advantages, i.e. stabilisation of the earth wall at no cost and at the same time helped in protected the local environment from further degradation. As far as the author is aware there are no industrial by-products in Sabon Gari, however, agricultural by-products such as rice and corn husks were used to stabilise earth render in many part of Nigeria (Nwankwor, 2011:239). These agricultural by-products can only be available in agrarian settlements, unfortunately Sabon Gari is not, thus, the product may not be economically sustainable. Furthermore the adobe walls' renders were originally stabilised with only straw and it is more appropriate to continue this tradition since it has proved to be successful.

7.2.2. Critical reflection on the strategies derived from the Terra conferences papers review: As earlier stated above several strategies applied in the conservation and rehabilitation of earth buildings projects presented in the Terra conferences are relevant to the adobe building repair in Sabon Gari. However, the issue of landlords and tenants' relationship (see table 4.4 in chapter four), which was identified in the course of this study as a major hindrance to the adobe building repair in Sabon Gari was not addressed. However, this omission is understandable because many of the buildings which are the focus of these conferences' papers are either listed or public owned. Thus, the tasks of the execution of the projects were generally the responsibilities of government, national and or international organisations. Furthermore, the Terra projects lack procedural acts of running a repair of earth buildings such as those in Sabon Gari because of their uniqueness. As a consequence of the limitation of these strategies, other building intervention strategies that consider types of ownership in building maintenance are critically reviewed. Apart from consideration of ownership in maintenance, routine and emergency maintenance is carried out with aim of replacing or mending defects in buildings just as repair (CIOB, 1982:8). There is therefore repair in these types of maintenance strategies and are adaptable to the repair of adobe building in Sabon Gari. These strategies are therefore review below.

7.2.2. Analysis of building maintenance strategies: 9 types of building clients (building owner) were identified in the British's Chartered Institute of Building's (CIOB) maintenance strategies, they are: government, public utility, municipal authority, industrial concern, commercial organisation, storage or warehousing company, domestic user, office user, property company (CIOB, 1982:9). This study is interested in the domestic user. However, irrespective of the type of client, three factors were identified in the CIOB's maintenance strategies to determine maintenance requirement of a building or an estate, these are: legal responsibilities, technical requirements, and social needs (CIOB, 1982:10).

It was identified in the CIOB's maintenance strategies that legal responsibilities in building or infrastructure maintenance affects the building, humans and the building's immediate environment (CIOB, 1982:12). Consequently, the legal responsibility of the person carrying out repair includes not only the protection of the fabric of the property and its equipment but also the owner, the occupier, occasional users and the general public. It was stated that appropriate Acts of Parliament in the UK are designed to safeguard people that are about to make use of a property or already using it. Examples of such legislations were given as: The UK Landlord and Tenant Act and Town and Country Planning Act. These Acts were designed to preserve the property as an asset, an amenity or at least to stop it becoming a nuisance to others. It was identified in the course of this study that these Acts also exist in Nigeria. However, they were never applied in the adobe buildings in Sabon Gari. As a consequence, these Acts shall be critically examined and relevant parts will be included in appropriate sections in the proposed repair framework.

It is was further specified in the CIOB's strategies that maintenance managers should be responsible for ensuring that these legal requirements are met and appropriate action taken and documented (CIOB, 1982:12). It was also recognised that this task may require further advice from solicitors, technical and scientific experts in collaboration with the maintenance manager. Employing maintenance manager for every of the adobe buildings in Sabon Gari is not only unrealistic but inappropriate. Thus, in the proposed repair framework, a caretaker is recommended instead of an estate agent or estate surveyor. Each adobe building in Sabon Gari shall therefore have a caretaker, who must be one of the tenants. The position is voluntary and will attract no fee unlike the estate agent or estate surveyor. The caretaker shall liaise with the landlord on behalf of other tenants on matters relating to tenancy, repair and continous care of the building. The use of caretaker is not only more economical for both parties (landlords and tenants) but more efficient and convenient. It was also stressed in the CIOB's maintenance strategies, that failure to meet the legal responsibilities can be costly and time consuming. Since one of the main objectives of this thesis is the development of a framework that is economically sustainable, this legal aspect is therefore critical. Thus, part three of the proposed framework is dedicated to this issue.

Direct labour and the use of contractors were considered in the CIOB's maintenance strategy (see CIOB, 1982:15). Both options are considered for the repair of adobe buildings in Sabon Gari. The direct labour is possible where the occupants have the skill to carry out the repair. The use of a contractor in the repair of the adobe building is also another realistic option where the occupants have no skills or decided to give out the repair on contract. Thus both options are considered in the proposed framework.

The second option is more realistic for adobe buildings with tenants. This is because most of the occupants of the buildings surveyed do not have the repair skilled (see chapter four), thus self help method is not possible. However, the choice of contractor shall be through mutual agreement between the landlords and tenants, unlike in the CIOB maintenance strategy where formal contract selection procedures were also recommended (see CIOB, 1982:17). Furthermore, 5 different types of contracts for building maintenance were specified (CIOB, 1982:16). These are: lump sum or fixed price, day work, term contracts, service contracts, and negotiated contracts. Only lump sum and day work contracts are appropriate to this thesis, thus are included in the proposed repair framework. The lump sum or fixed price contract is the type of contract where contractor will agree to carryout work for a fixed sum based on specifications, schedule of works, drawings and or site visit. In the day work contract, the builder (or mason) will carry out work and be paid for labour, materials and plant at cost, with a percentage for overheads and profits (CIOB, 1982:16). In the proposed repair framework, the lump sum contract shall be use for extensive repair, while day work contract shall be use for smaller repair works.

Two sources for funding of building maintenance project were identified from externally or internally generated funds (CIOB, 1982:12). Internally generated fund can be through fund from sales and services; savings and investment; proceeds from sale or lease of properties; reserves; and rents. The externally generated fund can be from the shareholders; banks and other financial institutions; credit; leasing arrangements; tax allowances; local authority loans; and government funds. In the case of the adobe buildings, only internally generated fund are feasible. This is because these buildings are owned by individuals and use for private purposes. Thus, it cannot have shareholders, neither can it be funded by government, nor can the building owners benefit from tax allowances or be able to secure bank loans or over drafts in Nigeria. Consequently, the internally generated fund and or fund from the landlords are considered in the proposed framework for repair of fair wear and tear (Chudley, 1982:34) in the adobe buildings. On the other hand, where it is ascertained that the defect is caused by the tenants through deliberate action, remodelling or any other avoidable means, the tenants shall be responsible for funding of the repair. This terms and condition will therefore be included in the new tenancy agreement proposed in this repair framework.

An annual budget for building maintenance is proposed (CIOB, 1982:20). This annual budget is based upon a forecast of possible areas of maintenance needs, which usually includes maintenance of the building fabric, fixtures, furniture, electrical and mechanical services. Annual estimates (budgeting) for the repair can be achieved in the repair of adobe buildings in Sabon Gari, by ensuring that every repair is documented with cost to create the data for these estimates. Thus, continous documentation over period of time (e.g. 5 to 10 years) can reveal a pattern of the repair needs and cost. Using those records, annual estimate can be prepared by forecasting the intensity and cost of the repair.

The social needs in maintenance strategy are the environmental and working conditions expected by the user (CIOB: 1982:10). In the context of the adobe buildings in Sabon Gari, the social requirements also includes several other factors elaborated in chapter four (see table 4.4 in chapter four). Some of the major social requirements that need to be addressed in Sabon Gari are stigmatisation of earth building and the nonchalant attitude among landlords and tenants. These problems are addressed in this thesis by ensuring that part one of the proposed framework is dedicated to specifications on the roles and obligations of landlords and tenants in accordance with the Nigerian tenancy Act and other related regulations.

Furthermore, the concept and role of stakeholders in Community Asset Management (CAM) is also use in the pre and post implementation strategies of the proposed framework. CAM according to Theis, et. al. (2005:2) is a strategy use in maintenance management of public buildings and infrastructure, by ensuring that the stakeholders are involved in planning, implementation and maintenance of building or infrastructure upon completion (Theis et al., 2005:6). In CAM, the community where the building or infrastructure is situated, the national or state government, the local authority and the international donor agencies are identified as the stakeholders (Theis, et. al., 2005:6). Thus, the international organisation in collaboration with the national or state government and the local authority provides the fund for the execution of the project, while the community are responsible for the running and continous maintenance of the building or infrastructure.

According to Lewa (2003:4), the key to success of CAM is that there must be sense of belonging to the project by the community. Thus, the whole concept of CAM relies on the presence and cooperation of the community. Consequently, Theis, et al. (2003:39) proposed that enablers and disablers should be first and foremost identified within the community. The enablers are those that can contribute to the success of CAM while disablers are those that will hinder success. Both enablers and disablers can be individuals and organisations (public and private) within the community, as well as legal and political structures. According Theis, et al. (2005:38) beliefs expectations and needs motivates individuals and organisation to be either enabler or disabler. The enablers can be use to encourage the disablers in order for CAM to succeed (Theis, et al. (2005:38). Thus in identifying stakeholders for CAM these 3 factors must be thoroughly understood. Theis, et al. (2005:39) suggested the use of community leaders, women leaders, youth leaders, religious leaders etc. and this group of people are refers as local champions. According to Theis, et al. (2005:42) these local champions play key roles in advocacy, consultation with the community, fundraising, contributes personal knowledge or skills that can be transfer to CAM, as well as vital in organisation and continuous management of the asset.

In the context of this thesis however, the vital ingredient of CAM, which is 'community' does not literarily exist in the study area as a result of past conflicts that ended up in segregation of people along religious beliefs in other part of the Kaduna with exception of Sabon Gari (Theis, 2003:34). Since the 2002 religious crisis Sabon Gari has become the beehive of traders, small scale manufacturers, printers and other similar business in respective of ethnicity or religion in addition to administrative activities

(Sony, 2002 in: Theis, 2003:65). Because of the heterogeneous nature of Sabon Gari in terms of ethnic backgrounds, culture and religion there is still this mistrust among the Christians and Moslems due to previous conflicts (Theis, et. al. 2008:12). However, despite the absence of community and the fact that the adobe buildings are privately owned, the CAM concept is still adaptable to the proposed repair framework. A compound with buildings constructed of adobe blocks shall be the community microcosm in the case of this proposed framework. Thus, the enablers and the disablers are the residence of these compounds (i.e. landlords and tenants). The compound head shall be the local champion and major enabler for owner occupier compounds, while the caretaker (tenants' representative) shall be the major local champion for rented compounds. The disablers among the occupants shall also be identified in every compound in order to further educate them on how to maintain the adobe buildings so as to minimise frequency and scale of repair.

7.3. The Sustainability of the Adobe Building Repair in Sabon Gari

Some sustainable approach to the conservation and rehabilitation of earth buildings were identified in the Terra projects reviewed above. The sustainable approaches that are relevant to adobe building were identified in the discussions above (see section 7.1 and 7.2). However, most of these sustainable strategies are aimed at ensuring the repeatability of the process employed, maintenance and future uses of the buildings, as well as the protection of the environment. Although these are important issues in attaining sustainability (which this proposed framework also wishes to achieve) however, more of the sustainability issues related to the adobe building repair in Sabon are social (see section 4.3 in chapter four). Consequently, the problems identified and presented in table 4.4 in chapter four is presented together with the plan of action in the proposed framework in table 7.6 below.

PROBLEMS IDENTIFIED IN THE ADOBE BUILDINGS SURVEYED IN SABON GARI AND THE PROPOSED PLAN OF ACTIONS FOR REPAIR							
SUSTAINABILITY FACTORS:		**Social**		**Economic**		**Environment**	
		PROBLEMS	**PLAN OF ACTION**	**PROBLEMS**	**PLAN OF ACTION**	**PROBLEMS**	**PLAN OF ACTION**
	Part One: Technical Requirements	Use of incompatible materials	Improved public awareness	Rising cost of soil due to non availability locally	Recommended recycling of material and provision of designated burrowed pits	Possible environmental degradation as a result of uncontrolled sourcing of building earth[21]	1. Improved public awareness 2. Recommended recycling of material and provision of designated burrowed pits.
		Continuous remodelling[22]	Improved public awareness			Basal erosion caused by rainfall	Recommended appropriate protection technique
		Dearth of skilled labour[21]	Improved public awareness and recommendation for informal training of artisans				
	Part Two: Humans' Requirements (Landlords and Tenants)	Stigmatisation	Improved public awareness	Continuous remodelling[23]	Improved public awareness and recommendation for informal training of artisans	Basal erosion caused by human and animal activities	Recommended appropriate approach for protection of foundation and wall against erosion
		Negligence	Improved public awareness	Varying social needs	Improved public awareness	Localised flooding as a result of road rehabilitation	Improved public awareness
		Dearth of skilled labour [23]	Improved public awareness and recommendation for informal training of artisans	Use of the building external fabrics for adverts	Improved public awareness		
		Non commitment to repair by both landlords and tenants	Use of relevant Laws and Acts, as well as CAM concept to enforce commitment by both parties				
	Part three: Sustainability and Statutory Requirements (Legal)	Type of Occupancy (tenancy)	Introduction of tenancy agreement and care takers.				
		Non availability of material locally	Recommended recycling of material and provision of designated burrowed pits.				

Table 7.6: Outline of the major problems identified in the course of this study and plan of action for repair of adobe buildings in Sabon Gari

21 This is environmental problem that requires both technical and legal responses
22 This is both social and economic issues that requires technical and human responses
23 This requires both human and technical responses

7.3.1. Problems and Plan of Actions towards Sustainable Adobe Building Repair in Sabon Gari

The problems associated with the repair of the adobe buildings in Sabon Gari as identified during the field survey (see chapter four) are divided into three themes, i.e. social, economic and the environmental problems (see table 7.6 above). In the proposed repair framework, improved public awareness is proposed as the means of resolving 6 of the 9 social problems. CAM concept, the existing building laws and Acts are also adopted in the proposed framework. The use of the CAM concept and Tenancy Act are aimed at involving all the stakeholders in the repair of the adobe building, so as to minimise the nonchalant attitude to repair as identified during the field survey discussed in chapter four. Similarly, the position of caretaker is also introduced. The duties of the caretaker are explained in greater details in the proposed framework in chapter eight.

It was observed in the course of the fieldwork that the environmental problems were mostly caused by the social problems (see chapter four). For example, the continous remodelling of the buildings using cementious material was responsible for basal erosion on some of the buildings, which have also affected the immediate surroundings of these buildings. As a consequence the same solutions are proposed, i.e. improved public awareness, CAM concepts, Tenancy Acts, etc. (see table 7.6 below).

Although improved public awareness, use of earthen material and recycling of existing ones could have long term positive effective on the overall cost of repair (i.e. reduction in cost), DIY approach to repair is also considered as an alternative in the proposed framework in order to further reduce the cost of repair. Thus, two repair frameworks are proposed in chapter eight. As earlier explained in section 3.3b.vii in chapter three, the first option is proposed for repair of adobe building with tenants or when the occupants (both landlords and tenants) have no repair skills. The second option, on the other hand is designed for building owners with knowledge of adobe technology that wishes to carry out repair through self-help. The building owner is therefore responsible for all decision making and implementation of the repair.

There is however the need for calculating the cost of adobe building repair before work commences just as any other building project. The British Standard Method of Measurement (SMM) (see Seeley & Winfield, 1999:6) is used in calculating the estimated cost of building project (Seeley & Winfield, 1999:377). Aluko-Olokun (2012) a Quantity Surveyor practicing in Kaduna, Nigeria also confirmed that this same method is used in calculation of estimated cost of building project in Nigeria[24]. This estimate is called the Bill of Quantities (BoQ) and is usually prepared by a Quantity Surveyor (Ostwald, 2001:77). The BoQ consists of description of each task in a project, quantity of work to be carried out, unit of measurement, rate per unit and the total amount of each task (see appendix 4 for sample of BoQ prepared by Proman Associate a Quantity Surveying Firm in Kaduna). However, the BoQ is too technical for the stakeholder to understand. Thus, a simplified cost model that is also user friendly is developed in section 7.3.2 below specifically for calculation of adobe buildings repair in Sabon Gari.

7.3.2. Adobe Building Repair Cost Modelling

Cost modelling according to Skitmore & Marston (1999:i) comprises all the techniques used in construction cost calculations and price forecasting. These techniques according to Skitmore & Marston (1999:9) are aimed at supporting any of the following tasks:

I. forecasting the total price that the client will have to pay for the building, at any stage in the design progression
II. comparing range of actual design alternatives, at any stage in the design conception
III. comparing a range of possible design alternatives, at any stage in the design development, and
IV. forecasting the economic effects upon society of changes in design codes and regulations.

24 Mrs B. Aluko-Olokun who is a Quantity Surveyor working with Proman Associate, Kaduna, Nigeria was interviewed by phone

In the case of this thesis, cost modelling for repair of adobe building in Sabon Gari is aimed at achieving all the above four tasks as explained below:

7.3.2.i. Total price forecasting for repair of adobe building: The calculation of total cost of repair of the adobe building in Sabon Gari involves the separation of the calculation of the cost of material, labour and that of equipment unlike the standard BoQ where all the three are added up together in a particular tasks (see sample of BoQ in appendix 4). Furthermore, unit of quantities of material as used in BoQ is eliminated. The exact quantity of material required shall therefore be specified. For example, since building earth (lateritic soil) is usually purchase and deliver on site in truck in Kaduna the usual unit of M^3 used in BoQ shall not be used, instead the exact truck load of lateritic soil required which is usually refer as 'trip' shall be used. Thus, the total cost of repair shall be calculated as shown in table 7.7 below.

This method of calculating cost of repair of adobe building is simpler and at the same time more elaborate, which makes it easier to use by local builders, traditional adobe masons, landlords, other occupants of the buildings and the rest of the stakeholders. The preparation of the estimate still requires the services of a literate person, for the writing up if the person in charge of the project is not literate. Any of the occupants of the building that is literate can be engaged. Thus the person in charge will dictate the quantities, prices, etc. while a literate person record these in writing, which is similar to the methodology the author employed in the administering validation questionnaires (see section 3.4.3d in chapter three).

COST ESTIMATE FOR REPAIR OF ADOBE BUILDING NUMBER 18 IN SABON GARI, KADUNA[25]

Cost of Condition Survey

S/No	Task	No. of days	No. of unskilled labour required	Rate per day for unskilled labour[26] (₦)	No. of skilled labour required	Rate per day for skilled labour (₦)[27]	Amount (₦)
1.				1,000		3,000	
2.							
						Subtotal (condition survey)	**A**

Material Cost

	Material Required	Quantity	Unit (trip, bundles, etc.)	Rate (₦)	Amount (₦)
1.					
2.					
				Subtotal (material cost)	**B**

Labour Cost(Repair Implementation)

	Task	No. of days	No. of unskilled labour required	Rate per day for unskilled labour (₦)	No. of skilled labour required	Rate per day for skilled labour (₦)	Amount (₦)
1.				1,000		3,000	
2.							
						Subtotal (labour cost)	**C**

Documentation Cost

	Type of document[28]	Cost of preparation of document(₦)	Cost of printing of document per page (₦)	Copies required	Amount (₦)
1.	Documentation of existing building as proposed in section 8.1.8a and presented in table 8.4 in chapter eight	Included in the condition survey cost			
2.	Preparation of estimated cost of repair (2 pages)				
3.	Documentation of building after repair as proposed in section 8.1.8a and presented in table 8.4 in chapter eight	Included in the condition survey cost			
4.	Preparation of maintenance manual as proposed in section 8.1.8a and presented in table 8.5 in chapter eight				
				Subtotal (cost of documentation)	**D**

Cost of Equipment Hire

	Type of Equipment	No. of days	Rate per day (₦)	Amount (₦)
1.	Hiring of scaffolds		1,500	
2.	Hiring of truck to cart away debris from site		7,000	
			Subtotal (cost of equipment hire)	**E**
			Subtotal cost of repair	A + B + C + D + E
	Overheads and profit (10% maximum[29]) = $\frac{A + B + C + D + E}{100} \times 10$			**X**
			Total cost of repair	(A + B + C + D + E) + **X**

Table 7.7: Methodology for preparing cost estimate for repair of adobe building in Sabon Gari

[25] See appendix 1.2a for the condition survey report of the adobe building number 18.
[26] The daily rates are for Kaduna, Nigeria as at December 2011
[27] ₦ is the symbol of Nigerian currency 'Naira'
[28] There are commercially operated centres called 'Business Centres' in Nigeria that provide typing and other documentation services for a fee for those that do not have personal computers.
[29] 10% is the maximum amount that can be charged for overheads and profits in Nigeria (Aluko-Olokun, per. com 2012).

7.3.2.ii. Use of the proposed cost estimate to determine mode of execution of the repair of the adobe building: The estimated cost of the repair when calculated using the above method can be used to determine how the repair is to be executed. For example, DIY approach will not attract neither condition survey cost, labour cost nor overheads and profit thus, could be cheaper than the day work and lump sum contracts. Similarly, day work contract will not attract overhead and profits if mason is commission to carry out the repair, since they only charge for daily wages (Hammai, 2006 and also see appendix 1.4.2a).

7.3.2.iii. Use of the proposed cost estimate for comparison of range of possible adobe building repair alternatives: Cost of different repair options can be calculated, compared with one another and the best option selected. However, from technical point of view the cheapest option may not be the best, thus cost should be secondary when it comes to the choice of material and technique of repair.

Furthermore, cost estimate can be use to determine how the repair project is to be carried out. For example, repair can be phased to reduce the number of days scaffold will be hired. This could be achieved by first of all starting with the activities that will not require scaffolding before those that will require one. Similarly, the cost estimate can be use to plan ahead, such that material and money to pay labour can be gradually saved for a period of time.

7.3.2.iv. Use of the proposed cost estimate for forecasting future repair cost and the economic effects of adobe building repair: The total estimated cost of repair will determine whether the project is worth carrying out or not. The cost of repair can be compared with the cost of demolition, rehousing of the occupants and rebuilding to determine the most viable option. Furthermore, the impact of the cost of repair on the landlord as well as other occupants can be determine based on the estimated cost of repair. Similarly, the knowledge of cost of repair can be used to determine cost of repair cause by the impact of remodelling (which is one of the major cause of repair), thus reducing unnecessary remodelling of the adobe building

Finally, cost estimate can also be used for the development of short and long term plans for the repair of the adobe building as well as the impact of these plans on the occupants, sourcing of funding, etc.

7.4. The Structure of the Proposed Repair Framework

The consequence of the above reviews to this thesis is that the proposed repair framework shall be in three parts for the two types of frameworks proposed. As a system the three parts are related to one another as illustrated in figure 7.2. The interlinked circles represents correlation of the three parts, thus must be used together simultaneously in order to attain sustainability in the repair of the adobe building in Sabon Gari. The first part is the social (human) requirements; the second part is the technical requirements, while the third part is the sustainability and statutory requirements. The three parts is developed in response to the problems identifying during the field work as enumerated in chapters four, five and six and embodied with the sustainability issues illustrated in table 7.6.

The structure of the proposed framework is therefore briefly explained below:

I. **Part one**: This part of the framework considers the technical requirement for the repair of adobe building in Sabon Gari and the responsibilities of the professionals that are will carry out the repair.

II. **Part two**: This part contains landlords and tenants' obligations at every stage in the repair of adobe building in Sabon Gari. These requirements are in accordance with the Kaduna State building regulations, the Nigerian tenement law (FRN, Law of Property Act, 1925 and FRN Land Use Act, Chapter 202, Part III, 1990 as specified in the CIOB, 1982:12), relevant sections in the Nigerian Building Code and the other relevant code of practice in Nigeria.

III. **Part three**: This part of the proposed framework contains the sustainability and legal requirement that shall govern the repair of the adobe buildings. These requirements are based on sustainability issues discussed in section 7.3 and the existing building regulations in Kaduna

State as well as other statutory regulations relating to buildings in Nigeria. This part shall be structured as illustrated in table 7.6.

7.4.1. The content of the proposed repair framework: Each of the three parts of the proposed framework is divided into three sections. Section one is the pre implementation strategy, section two is the implementation strategy, while section three contains post implementation strategy.

The pre implementation strategy (section one) include data generation strategy for the building to be repaired. Various strategies were used for generation of data in the Terra projects earlier reviewed. Some of these strategies include literature review (Azad, 2003:31); inventory (Bedaux, et. al., 2003:201); condition survey (Jansen, 2003:309); etc. As earlier noted not all of these strategies are required or appropriate for the adobe building repair in Sabon Gari. For example inventory is not required. The adobe buildings are already recorded in Max Lock report. Consequently, the appropriate pre implementation strategy for the three parts of the framework is presented in table 7.7 below.

The implementation strategy includes the specifications for appropriate repair techniques of the adobe building in Sabon Gari. The post implementation strategy includes the plan of actions towards the care of the buildings after repair. This third section contains landlords and tenants obligations after repair; plan of actions towards the care and maintenance of the building; and sustainability requirements relating to the use of the building. Table 7.7 below summarises the structure and content of the proposed adobe building repair framework in Sabon Gari.

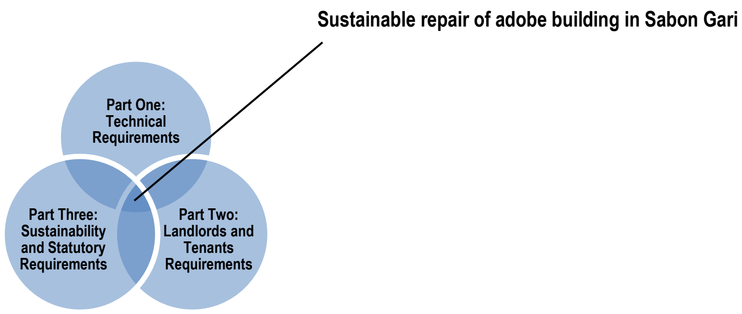


Figure 7.2: The interrelationship of the three parts of the proposed repair framework

STRUCTURE OF THE PROPOSED FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN SABON GARI				
	OPTION ONE			OPTION TWO
	Part One Technical Requirements	Part Two Landlords and Tenants' Obligations	Part Three Sustainability and Statutory Requirements	
Pre Implementation Strategy	1. Strategy for mobilisation for repair (either through self-help or appointment of contractor)	1. Role of landlords and tenants in the choice of mode of repair delivery (i.e. self-help or contract)	1. Use of existing building regulation in Kaduna State; use of CAM concept	1. Prognosis and diagnosis plan of actions
	2. Strategy for generation of data relating to previous interventions	2. Role of landlords and tenants in the generation of data relating to previous interventions	2. Use of document such as Max Lock Report and other related document with KASUPDA	2. Methodology for calculation of repair estimate
	3. Strategy for reconnaissance survey and physical measurement	3. Role of Landlords and tenants during reconnaissance survey and physical measurement	3. Use of past and present occupants to generate data apart from physical inspection and measurement	
	4. Strategy for condition survey and analysis	4. Role of landlords and tenants during condition survey and analysis	4. Involvement of past and presents landlords and tenants, as well as past and present neighbours in the condition survey	
	5. Strategy for the determination of materials, technique, cost, etc.	5. Role of landlords and tenants towards the determination of materials, technique, cost, etc.	5. Use of original material and technique, except where it is ascertained to be inappropriate. There must be consideration for social, economic, and environmental factor in determination of material and technique	
	6. Strategy for preparation of work plan	6. Role of landlords and tenants in the preparation of work plan	6. Prioritisation of work according to importance and fund	
Implementation Strategy	7. Strategy for repair implementation	7. Role of landlords and tenants in the for repair implementation	7. Involvement of building occupants as much as possible as well as local artisans. Strict compliance with the local building laws, regulations and practices	3. Therapy (repair) plan of action
Post Implementation Strategy	8. Strategy towards continous care of the adobe building after repair	8. Role of landlords and tenants in the continous care of the adobe building after repair	8. Documentation of the whole process and preparation of maintenance manual using the CAM concept.	4. Monitoring and continous care plan of action

Table 7.8: Structure of the proposed framework for sustainable repair of adobe building in Sabon Gari

7.5. Summary

The outline for the proposed framework for sustainable repair was developed in this chapter. This outline was designed bearing in mind that the adobe buildings in Sabon Gari are in an urban area, thus it is subjected to various urban challenges. Consequently, the five lessons of urban sustainability policies identified by the UN during the World submit on urban sustainability in Istanbul, Turkey in 1996 was critically analysed. Critical to this thesis from these five lessons is the use of case studies. The Terra conference papers were therefore considered and projects on conservation and rehabilitation of adobe buildings were analysed. From these projects review, several repair strategies appropriate to the adobe building in Sabon Gari were identified. However, not all the repair problems in Sabon Gari were addressed in these Terra projects. As a consequence other building intervention strategies were considered. Thus, the CIOB's maintenance strategies and CAM strategy were reviewed. From these second review the issue of ownership in building maintenance was critically examined and some of the strategy were adopted in the proposed repair framework

Having identified in chapter four that the problem associated with the repair of adobe building in Sabon Gari are more of social and economical than technical issues, the outline of the proposed framework was therefore designed to critically examined these social issues in learn with other sustainability requirements. The problems considered in this outline were enumerated in terms of social, economic and the environment. Consequently, a three part framework is proposed.

CHAPTER EIGHT

THE PROPOSED FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN SABON GARI, KADUNA, NIGERIA

'Just as not all landlords are devils, not all tenants are angels'
- Shill, 2003:505, in: UNHabitat (2011:20)

8.0. Introduction

This proposed framework is designed using the outline proposed in chapter seven. As illustrated in table 7.7 in chapter seven, this framework contains three parts. Two types of framework containing three parts each are proposed. The first option is designed for adobe buildings with tenants, as well as for landlords that do not have the repair skills, thus will require the services of skilled professional to carry out the repair. The second option proposed is aimed at occupants with the repair skills who may like to carry out the repair through self-help rather than employing someone else.

The content of the first option of this proposed framework is in three parts. Part one contains the technical requirements in the repair of adobe building in Sabon Gari. The part two contains landlords and tenants' obligations in the implementation these technical requirements. Part three contains the sustainability and legal considerations for the implementation of these technical requirements in the repair of adobe building in Sabon Gari.

The second option is also divided into three sections. The first section contains pre repair implementation strategy. The second section contains implementation strategy, while the third contains the post repair implementation strategy.

The first option of the proposed framework is aimed at protecting the adobe building by specifying sustainable repair practices and at same time protecting the interest of all parties concern in the repair of adobe building in Sabon Gari. The expectation is that this repair framework will bring to lights role of all stakeholders in the repair of adobe building so as to avoid the current lack of commitment by all the parties involve. Similarly, the second option is aimed at encouraging DIY approach to repair by those that have the repair skills.

The outline of the proposed framework is further illustrated in figure 8.1, this is then followed by presentation of the three parts of the proposal.

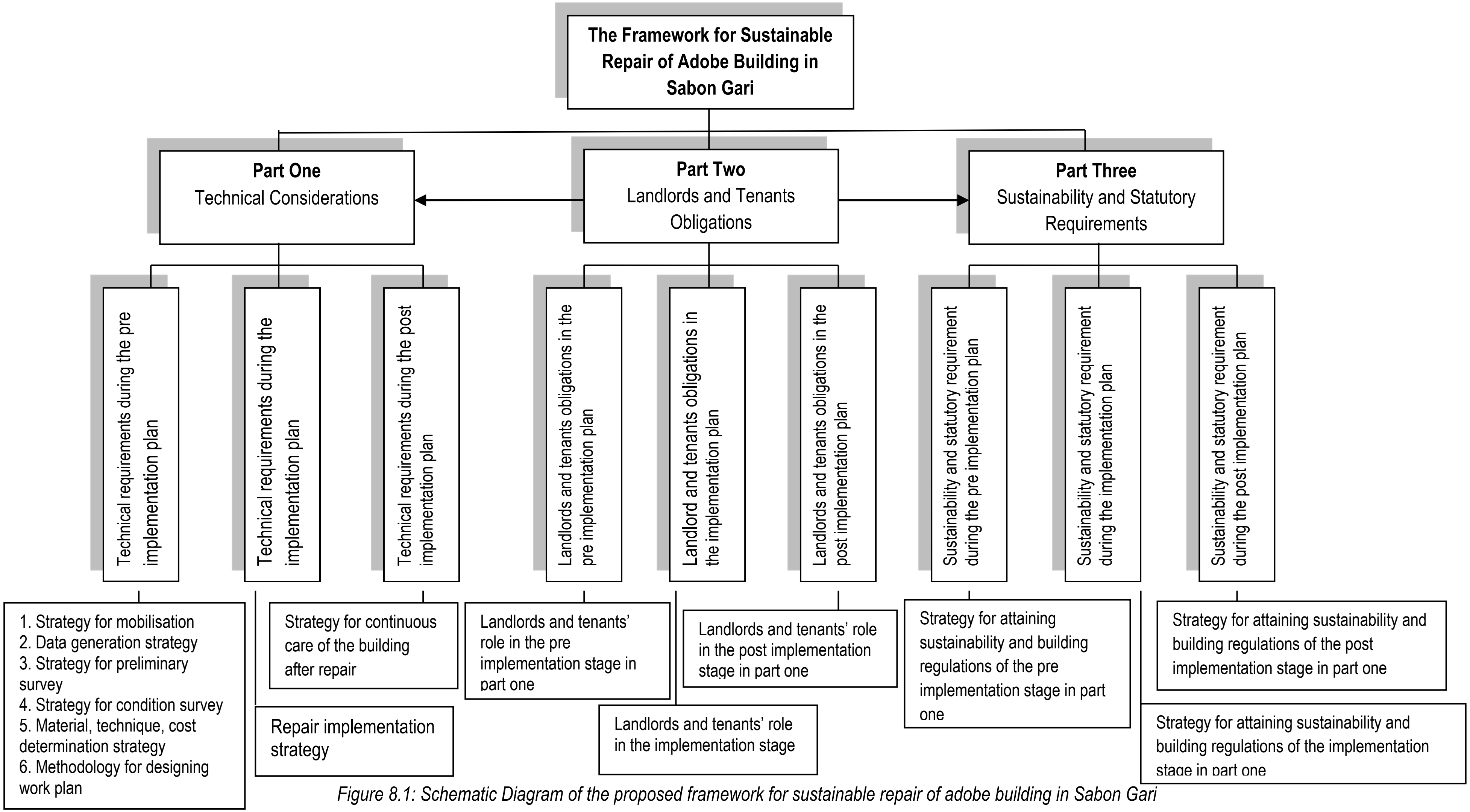


Figure 8.1: Schematic Diagram of the proposed framework for sustainable repair of adobe building in Sabon Gari

OPTION ONE

FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN SABON GARI

PART ONE

Technical Considerations in the Repair of the Adobe Building in Sabon Gari

Preambles

This first part of the repair framework contains detailed description of the technical procedure in the preparation for repair of the adobe building in Sabon Gari. The structure presented in section 7.4.1 in chapter seven is use as outline of this part of the repair framework. The technical requirements are therefore presented as follows:

PRE IMPLEMENTATION STRATEGY

8.1.1. Section One: Strategy for Mobilisation for Execution of Adobe Building Repair

The adobe building repair in Sabon Gari shall be executed through direct labour (self-help), day work or contract.

8.1.1a Day work: The repair of adobe building in Sabon Gari can be executed by an experienced mason who must also have knowledge of adobe technology and shall be paid for labour, materials, cost of hiring plant (if required), and percentage for overheads and profits[30].

The person commissioned to carry out the adobe building repair on day work basis shall upon presentation of estimated cost of repair; sign an agreement

[30] The methodology for calculating cost is presented in section 8.1.5, sub section g

to carry out the repair on the agreed sum and within a duration that shall also be agreed upon.

8.1.1b. Lump sum or fixed price contract: The adobe building repair in Sabon Gari can be executed by commission an experienced contractor to carry out the repair. A fixed sum shall be agreed between a contractor and landlord. In case of rented building tenants' representative may be included in the negotiation and signing of contract's agreement.

This type of contract shall involve preparation of contract documents. These contract documents may include any or all of the following: architectural drawings, cost estimate as proposed in section 7.3.2i in chapter seven, condition for engagement, and or mechanical and electrical drawings (NIA, 2002:15).

The contractor shall therefore be obliged to execute the repair as agreed upon; execute the repair within the time frame agreed upon; and on an agreed sum in the contract document.

The advantage with this type of contract is that it provides the opportunity for proper documentation of the adobe building, since the production of architectural drawings and other relevant documents are required. However, this type of contract is expensive and inappropriate for such a small project like the adobe building repair in Sabon Gari. It is therefore not recommended.

8.1.1c. Recommendation on choice of type of contract: The second form of contract (day work) is more likely in Sabon Gari at present. This is because the first option (self-help) will require that the occupants must have the required skill for adobe building repair. None of the 36 persons interviewed have adequate skill to carry out repair through self-help (see appendix 1.4.5a). On the other hand the third option is usually used for bigger projects and it will require the services of architects, quantity surveyor, etc. to prepare the contract documents. This additional expenses on repair is unjustified, therefore not encouraged.

8.1.1d. The person in charge of the adobe building repair: An experience professional with knowledge of adobe technology shall be commission by the land lord to carry out repair if the mode of execution is either through day work or lump sum contract. This experience professional shall be referred as the person in charge in this framework.

The person in charge shall upon commissioning be responsible for the planning and execution of repair. The person in charge shall also be responsible for appointment of sub contractors, i.e. carpenters, electrician and plumbers whenever necessary.

8.1.2. Section Two: Data Collection Strategy

The person in charge of the repair of the adobe building (if the repair is not through self-help) shall require collect data on of previous interventions.

The only available document on these adobe buildings is the Max Lock Report (Theis, 2002) and this as already discussed in chapter three is generic with no detailed data on individual buildings. Furthermore, KASUPDA can provide generic data on Sabon Gari but none on individual adobe building (see appendix 1.4.3a). Consequently, past and present landlords and tenants as well as neighbours shall be involved in the generation data.

Data to be generated shall include:

- Type and sources of original material and methods used in construction of the adobe building (KASUPDA can provide generic information on source(s) of the building earth used for the adobe buildings in Sabon Gari)
- date of construction
- dates of previous repairs, remodelling, renovation, etc.
- further details on these previous interventions
- Names and addresses of the artisans involved in the past interventions, etc.

8.1.3. Preliminary Survey and Physical Measurement

The person in charge of the adobe building repair shall conduct a reconnaissance survey of the building in order to get acquainted with the building. The person in charge shall also take physical measurement of building to be repaired. Both the exterior and interior spaces including floor area, walls, window, doors, etc. shall be measured and documented. These measurements shall be subsequently used to produce the contract documents using the methodology presented in section 8.1.8a.

8.1.4. Section Four: Condition Survey Strategy

A condition survey is the process of examination of the state of a building through detailed inspection, diagnosis and prognosis of possible defects in the building (Watt, 2007:149). The diagnosis and prognosis are subsequently presented in form of a report.

The condition survey of the adobe building shall be carried out by the person in charge of the repair project. No assumption should be made of any possible cause of deterioration. Consequently, the person in charge shall be in constant consultation with current occupants of the building (and possibly previous occupants) in order to ascertain issues related to the building's condition. The occupants and even neighbours may provide clues that can lead to better understanding of the possible causes of deterioration.

The condition survey report shall contain record of observations of every of part of the building, the defects and deteriorations noted and the possible causes of the defects. In some instances tests results of materials are included (Keefe, 2005:159).

8.1.4a. Type of data to be recorded: The following six items shall be recorded during the condition survey of adobe building (see also Keefe, 2005:159):

- External environmental factors (orientation, topography, exposure, land and domestic drainage, soil geology, climatic conditions, the impact of the adjoining building, etc.)
- Description of the building (roof structure, roof covering, floor structure, openings, masonry plinth, wall finishes, etc.).
- Description of any differences in colour and texture of surfaces and features caused by previous interventions.

- Existing condition of building and description of observed failures and defects in roof, walls (internal and external) and floors. Defects such as cracks, fissures, structural movements, dampness, etc. shall be described in detail, photographed and or sketched.

- Dampness survey (measurement of moisture levels in affected areas).

- Detail description of previous types of activities within the building. This shall include details of conversions from residential to commercial and vice versa (see Watt, 2007:165).

8.1.4b. Methods of Investigating Building Conditions: Apart from oral accounts on the building's history and condition, the four human's sense can be used to identify causes of deterioration in adobe the building. These are sense of vision, smell, feeling and hearing and the processes are explained below (see also Watt, 2007:164 and Houben & Guillaud, 1997:346):

- **visual (stains, cracks)**: a damp adobe wall will have a stained darker appearance that will distinguished it from dry wall.

- **physical (structural failure)**: cracks, bulging, basal erosion, crumbling, crazing, blistering, blowing, efflorescence, etc. are all visible defects that can be noticed in adobe walls. Consequently, the person in charge must take note of all these signs (see Houben & Guillaud, 1997:341).

- **olfactory (odours)**: defects may occur in areas that are concealed in the interior and not easily accessible from the exterior. E.g. roof leakage may cause the timber trusses and ceiling to rot and smells. Such defects can be detected by the smell of the interior of the building

- **aural (sound)**: a defective render will give a different sound when tapped by hand because of the void space between the render and the wall as a result of detachment of the two surfaces. This is common with the adobe buildings in Sabon Gari rendered with cementious material (see appendix 1.2a).

- **tactile (uneven surfaces)**: a defective render caused by inappropriate material and or technique or other defects can result into an uneven wall surfaces.

However, one of the major defects of the adobe buildings surveyed in Sabon Gari is crack in the adobe walls (see chapter four). The major causes of this cracks was noted to be as a result of use of inappropriate material (cementious material) during remodelling and previous interventions. Consequently, the cause of any crack noticed must be investigated. However, not all cracks in adobe building are as a result structural deficiency (Houben & Guillaud, 1997:341). There are negligible, very slight, slight and moderate cracks that are not as a result of failure (Holland, et. al., 1992:42). Table 8.1 below is description of different types of cracks and their effects on a building.

Thorough investigation of the cause of the crack is mandatory irrespective of the degree of the crack. It should also be investigated if an attempt was made previously to mend the crack, if it is not possible to ascertain through physical inspection.

8.1.4c. Data analysis and condition survey report: All the defects identified as well as their possible causes shall be critically examined and recorded. A comprehensive report of the adobe building condition shall be prepared based on the survey conducted. Condition survey report will require the services of a literate person. However, significant numbers of both the occupants and skilled artisans are not literate, as a consequence the landlord shall be responsible for documentation. The landlord shall therefore carry out the documentation if s/he is literate or appoint literate person that will assist in the documentation. Other alternatives for documentation are discussed in section 8.1.8a.

Condition survey reports for the 20 compounds surveyed are attached in appendix 1.2a. Similar pattern can therefore be use for subsequent condition survey report.

GUIDELINE FOR CLASSIFICATION AND RECORDING OF DAMAGE TO WALLS DURING CONDITION SURVEY				
Address of the Building:	e.g.: *AZ 12 Lagos Street, Sabon Gari, Kaduna*			
Part of the Building:	*Walls*			
	Category of Damage	**Degree of Damage**	**Description of Damage**	**Approximate Crack Width (mm)**
	0	Negligible	Cracks of less than 0.1mm width are classified as negligible	Up to 0.1
	1	Very slight	Cracks that can be treated during decoration works e.g. isolated slight fracturing in building. These cracks	Up to 1

			are rarely visible externally.	
	2	slight	Cracks that can be easily filled. By applying soil slurry.	Up to 5
	3	Moderate	Cracks require retrofitting or rendering probably requires after the existing rendering have been hacked off.	5 to 15 (or a number of cracks up to 3)
	4	Severe	Cracks requires extensive repair work, which could involve hacking off and replacing sections of walls, most especially over doors and windows. Window and door frames distorted. Service pipes disrupted, etc.	15 to 25, this also depends on number of cracks
	5	Very severe	Cracks repairs major repair, which could involve partial or complete rebuilding. Deteriorations also includes loss of beams bearing, deflection of wall, distortion of doors and windows, etc.	Usually greater than 25, this also depends on number of cracks.

*Table 8.1: Guideline for classification and recording damage to walls when carrying out condition survey (**Source**: Holland, R., Montgomery, B.E. and Moore, J.F.A, 1992:42*

8.1.5. Section Five: Determination of Repair Options and Calculation of Cost Estimate

Using the condition survey report the material and technique of repair shall be determined and cost of repair shall be calculated by the person in charge.

8.1.5a. Guiding philosophy for the choice of material and technique of repair: In order to achieve sustainability in the repair of adobe building in Sabon Gari the following philosophy shall guide the choice of material and technique that shall be used for repair:

- Use of like materials (Bell & Boke, 2003:61; Correia & Morten, 2000:226).
- Changes from the original material, method or component in the course of adobe building repair if it is the only sustainable option (Mohammadi, 2003:427).
- Respect for habits that have become culture or tradition (e.g. mixed used of buildings and consistent remodelling) in the course of adobe building repair (Odiaua, 2008:43; Alaamandour, 2003:10; Smail, 1990:122).
- Use of traditions that are of intrinsic values (Majeed, 2000:283).
- Adobe building repair must be economically sustainable (Koumas & Koumas, 1993:231).
- The quality of the repair should influence positive change (McHenry, 1990:159).

- Adobe building repair process as an opportunity to document the building (Fiero, et al., 2000:31).

- Planned preventive maintenance measures should be included as part of the post repair strategy, based on the traditional practice in Nigeria (Odiaua, 2008:43; Marchand, 1993:108)

8.1.5b. Guide for the choice of material: In line with the above repair philosophies adopted for the repair of the adobe building in Sabon Gari, the following recommendations shall guide the person in charge, landlords and tenants when taking decision on the choice of materials.

Foundation: Stone, adobe and concrete blocks where originally used in the buildings surveyed (see section 4.2.1 in chapter four). Thus, these same materials are recommended for repair of foundations. Thus, stone shall be replaced with stone, concrete block with concrete block, and adobe with adobe.

Floor: 25 mm cementious screeding were used in the buildings surveyed (see section 4.2.3b in chapter four). This should be replaced with a more durable flooring, preferably 150mm thick concrete flooring. The 25mm cementious screed should be applied as the smooth finishing to the concrete flooring.

Wall: Adobe blocks of the same material and size as the original are recommended for repair of walls. Earth based render and mortar is recommended where new render and mortar are required as part of the repair. The composition of the rendering and mortar material should be the same as that of the original adobe blocks. The use of cementious render and mortar are strictly prohibited.

Similarly, doors, windows, burglar screens, and mosquito nets shall be repaired or replaced with the same size as the original.

Should wider window or door replace small ones, the old lintels shall be replaced with a new one to cover the span of the opening. The traditional *azara* is therefore preferred in this case. This is because *azara* has a better tensile strength than timber, thus more effective in covering wider spans (see Dmochowski, 1990, vol. 1:1.20).

Roof: The original roofing system (i.e. hipped roof with corrugated iron sheets) is recommended. However, lean-to roof were used in some of the extensions (see section 4.2.3c). This should therefore be replaced with hip roof. This is because this roofing system provides adequate protection to all the four sides of the walls unlike lean-to roof that protects only a side.

Furthermore, leaking roofing sheets should be replaced with the original type only after the timber roof structure has been inspected and any defect rectified.

Repair of roof shall be carried out by an experienced carpenter who shall be appointed by the person in charge of the repair.

8.1.5c. Technique: Just as in the use of material, original techniques should be maintained during repair and remodelling. In case where it is ascertained that the original technique is deficient, tried and test technique that is compatible with the entire structure should be adopted.

8.1.5d. Cost estimate: An estimate for the cost of repair shall be prepared by the person in charge and shall submit this costing to the landlord for approval before commencement of the project, if the mode of execution is through contract.

The methodology for calculating cost of adobe building repair developed in section 7.3.2.i and presented in table 7.7 in chapter seven shall be used for calculation of cost of repair of the adobe building in Sabon Gari.

An example of how to calculate the cost of repair of adobe building is presented in table 8.2 below using one of the buildings surveyed (building number 18) in Sabon Gari. The condition survey report of this building is attached in appendix 1.2a.

COST ESTIMATE FOR REPAIR OF ADOBE BUILDING NUMBER 18
SABON GARI, KADUNA

Cost of Condition Survey

S/No	Task	No. of days	No. of unskilled labour required	Rate per day for unskilled labour (₦)	No. of skilled labour required	Rate per day for skilled labour (₦)	Amount (₦)
1.	Site visit, reconnaissance survey and physical measurement	0.5	1	1,000	1	3,000	2,000
2.	Building inspection	0	0	0	1.5	3,000	4,500
	Subtotal (condition survey)						**6,500**

Material Cost

	Material Required	Quantity	Unit (trip, bundles, etc.)	Rate (₦)	Amount (₦)
1.	Lateritic soil from burrowed pit in Rigasa[31]	4	Trips	7,000	28,000
2.	Straw	10	bundles	200	2,000
3.	Gravel	2	Trips	15,000	30,000
4.	Sand	1	Trips	15,000	30,000
5.	Cement	16	bags	2,000	32,000
	Subtotal (material cost)				**122,000**

Labour Cost(Repair Implementation)

	Task	No. of days	No. of unskilled labour required	Rate per day for unskilled labour (₦)	No. of skilled labour required	Rate per day for skilled labour (₦)	Amount (₦)
1.	Hacking off of existing render	1	1	1,000	1	3,000	4,000
2.	Hacking off of existing cementious floor screed	2	2	1,000	1	3,000	10,000
3.	Removal and replacement of cracked adobe blocks	1	1	1,000	1	3,000	4,000
4.	Retrofitting of cracked mortar joints	2	1	1,000	1	3,000	4,000
5.	Replacement of eroded stone based foundation footing	1	0	0	1	3,000	3,000
6.	Application of earth based render	1	3	1,000	3	3,000	12,000
7.	Casting of mass concrete flooring	2	5	1,000	2	3,000	22,000
8.	General cleaning and carting away of debris from site	1	3	1,000	0	0	3,000
	Subtotal (labour cost)						**62,000**

Documentation Cost

	Type of document	Cost of reparation of document(₦)	Cost of printing a copy of each document(₦)	Copies required	Amount (₦)
1.	Documentation of existing building as proposed in section 8.1.8a and presented in table 8.4 in chapter eight	Included in the condition survey cost	150	3	450
2.	Preparation of estimated cost of repair (2 pages)	3,000	80	3	480 (each set consist of 2 pages maximum

Documentation Cost (continuation)

	Type of document	Cost of	Cost of	Copies	Amount (₦)

[31] Rigasa is one of the settlement in the outskirt of Kaduna where burrowed pit for building earth can be found

		reparation of document(₦)	**printing a copy of each document(₦)**	**required**	
3.	Documentation of building after repair as proposed in section 8.1.8a and presented in table 8.4 in chapter eight	Included in the condition survey cost	150	3	450
4.	Preparation of maintenance manual as proposed in section 8.1.8a and presented in table 8.5 in chapter eight	3,000	150	3	450
	Subtotal (cost of documentation)				**1,830**
Cost of Equipment Hire					
	Type of Equipment	**No. of days**	**Rate per day (₦)**	**Amount (₦)**	
1.	Hiring of scaffolds	5	1,500	7,500	
2.	Hiring of truck to cart away debris from site	1	7,000	7,000	
	Subtotal (cost of equipment hire)			**14,500**	
	Subtotal cost of repair			6,500 + 122,000 + 62,000 + 1,830 + 14,500 = **206,830**	
	Overheads and profit (10% maximum) = $\frac{206,830}{100}$ X 10			**20,683**	
	Total cost of repair			206,830 + 20,683 = **227,513**	
	The estimated total cost of repair of adobe building number 18 is: Two Hundred and Twenty-seven thousand, Five Hundred and Thirteen Naira[32]				

Table 8.2: Estimate for repair of adobe building (building 18 in appendix 1.2a) in Sabon Gari

Note: it should be noted that sections 8.1.1 to 8.1.2 in part one of this repair framework will not incur any cost, as these are explanatory notes for the stakeholders. The repair of the building number 18 will not require KASUPDA's approval thus section 8.1.6a (KASUPDA's approval) is not applicable. Similarly, section 8.1.6e (issuance of notices) will not incur any cost because it is expected that the house owner shall notify all the occupants before the commencement of work.

Furthermore, parts two and three of the proposed framework are also requirements for the stakeholders, which will not incur any cost.

[32] £1 = ₦250 as at August 2011, thus, ₦227,513 = 910.05

8.1.6. Section Six: Notification to Commence Work and Production of Work Plan

Building repair projects does not required planning approval in Kaduna State as long as the original size of the building is maintained and it does not require additional services such as access road, drainage, etc. (see appendix 1.4.3a and DCD, 2007:12). However, it is recommended that the person in charge should first of all verbally notify KASUPDA, so as to ascertained whether approval has to be granted or not. Architectural drawings and other documents listed in section 4.2.2, sub section viii in chapter four are therefore required should the project requires approval from KASUPDA.

Repair of buildings that produces waste products that need discharging through the central sewers also requires KEPA approval (KEPA, 1998:2). This should also be verified by the person in charge.

8.1.6a. Repair requiring public utilities: The authorities concern must be informed if the repair will involve connection and reconnection of water and electricity from the public mains. The Kaduna State Water Board is the authority in charge water, while the Power Holdings Company of Nigeria (PHCN) is responsible for electricity.

This is a specialist area for a plumber and electrician however, the person in charge shall coordinate this activity and shall therefore appoint these specialist as sub contractors as specified section 8.1.1e.

Prior to commencement of work, the person in charge shall inform both organisations in writing of his or her intention and the date their services shall be required.

It should be noted that engaging both organisations will attract charges, which varies depending on scope of work. These charges therefore have to be confirmed and included in the estimated cost of repair (see section 8.1.5d).

8.1.6b. Preparation of programme schedule: This document is not compulsory. However, it is useful to the person carrying out the repair. This document can also be use to negotiate day work contract (see section 8.1.1b).The person in charge therefore have a choice whether to prepare or not to prepare the repair's programme schedule.

A programme schedule is a specifically designed programme showing set of activities that are to be done, the order in which the tasks are to be carried out, date of implementation of each task and the amounts of time allocated to each task (Ellis, et. al., 1975:351).

Urgent tasks shall be giving optimum priorities when preparing the work plan (McHenry, 1984:193). The consolidation of the building shall be the first task (Pujal, 1993:244). This may involve drying up of wet areas (Dubus, 1990:401), propping up of openings, beams and roof members (Nardi, 1987:71), etc. A programme schedule for repair of one of the adobe buildings surveyed i.e. building number 18 in appendix 1.2a is presented in table 8.3 below. The repair is estimated to last 3 weeks (5 working days in a week) and is illustrate in table 8.3 below. Same building is used in the calculation of the estimated cost of repair in section 8.1.5d above using the same programme schedule.

Furthermore, material schedule, details of craftsmen, cost planning, transportation, insurance and other logistics may be produced as explained below. Although these documents are optional but may be considered if it is a lump sum contract. Thus, the documents are contractor's personal documents. Thus, s/he shall pay for the production of these documents not the client.

PROGRAMME SCHEDULE FOR ADOBE BUILDING REPAIR																	
	Description of Activity		**Week 1**					**Week 2**					**Week 3**				
		Days	**Mon 1st Mar.**	**Tue 2nd Mar.**	**Wed 3rd Mar.**	**Thurs 4th Mar.**	**Fri 5th Mar.**	**Mon 8th Mar.**	**Tue 9th Mar.**	**Wed 10th Mar.**	**Thurs 11th Mar.**	**Fri 12th Mar.**	**Mon 15th Mar.**	**Tue 16th Mar.**	**Wed 17th Mar.**	**Thurs 18th Mar.**	**Fri 19th Mar.**
1.	Condition Survey:																
	i. Reconnaissance survey and physical measurement																
	ii. Building inspection																
2.	Procurement of materials required for the building repair (earth, straw, etc.).																
3.	Storing of all the tools require for the repair, e.g. shovels, diggers, wheel barrow, head pans, spades, etc.																
4.	Erection scaffoldings.																
5.	Hack off existing internal and external wall render and cart away the debris from the building.																
6.	Hack off existing cementious screed floor rendering and cart away the debris from the building.																
7.	Removal and replacement of eroded stone based foundation footing.																
8.	Retrofitting of crack walls.																
9.	Rendering of walls using earthen material.																
10.	Casting of mass concrete flooring																
11.	Curing of concrete floor																
12.	Removal of debris and general cleaning of the building and its surrounding.																
13.	Dismantling of scaffoldings.																
14.	Demobilisation from the building.																
15.	Documentation (photographs, notes, sketches, etc.)																
16.	Handing over.																

Table 8.3: Sample of programme schedule for the repair of adobe building

8.1.6c. Material Schedule: Using the drawings and other documents described in section 8.2.5 above a material schedule shall be prepared. The material schedule is a list containing the materials and the quantity required for each particular task (BEC, 1986:34).

8.1.6d. Cost Planning: The aim of cost planning is to ensure continuous cash flow throughout the duration of the repair (Wood, 2003:67). However, this is also not compulsory, but useful for effective implementation of adobe building repair.

A cost plan is a breakdown of the costs of material required, labour, equipment, transport and logistics and or plant calculated separately from the estimated total cost for every task that is to be carried out (BEC, 1986: 13). Similarly, the mode for disbursement of fund shall be planned.

8.1.6e. Issuance of notices: The person in charge shall send written notices to occupants, neighbours and all other parties that shall be temporarily affected by the repair at least 2 weeks prior to mobilisation to the site (NIA, 2000:13).

The same parties shall also be notified of any temporary closure of public road or temporary interruption of water and electricity. The day(s) and time must be specified and the person in charge shall strictly adhere to this plan (DCD, 2007:58).

IMPLEMENTATION STRATEGY

8.1.7. Section Seven: Repair Implementation Strategy

Repair of adobe building shall be carried out as proposed in sections 8.1.5 and 8.1.6.

Written approval must be received from KASUPDA and if necessary from KEPA for building repair that requires approval (see section 8.1.6; FRN, 2006:442 and KEPA, 1998:2).

For effectiveness of implementation of the repair proposal the following steps shall be taken:

8.1.7a. Timing of the repair: The traditional practice of carrying out repair at the beginning of rainy season in order to make use of rainwater instead of fetching from the wells (see section 5.2.3a in chapter five) is recommended for the repair of the adobe buildings. Although there is pipe borne water in Sabon Gari Kaduna, however the supply is not regular, beside it is more economically and environmentally sustainable to use rainwater than relying on pipe borne water.

8.1.7b. Special consideration of religious and cultural beliefs: In case of buildings occupied by the Moslems, special consideration shall be given to women in purdah by ensuring that any repair to be carry out in the harem[33] shall be executed as quick as possible so as not to deprived the women of the use of such an important part of the building for a long duration.

[33] Harem: An enclosed compound or courtyard in an Islamic domestic building where women and children carry out domestic activities without interference or any visual contact with the non members of the family.

8.1.7c. Insurance: it is required by law that all buildings and contractors should be insured (FRN, 1990:34). However, none of the compound surveyed in Sabon Gari is insured. Thus the person carrying out the repair should either do personal insurance or be prepared to bear any liability in case of accident.

8.1.7d. Safety precautions during adobe building repair: The site should be well organised so as to avoid injuries to personnel working on site and damage to materials and the building as well. Artisans not engaged should not be allowed on site, so as to decongest the site.

Adequate safety precautions shall be taken to ensure that the building occupants are well protected (Chandler, 1991:127). Warning signs at strategic locations within the area to be repaired shall be placed to warn people of the repair and possible hazards that could occur if safety precautions are not adhered to.

Furthermore, the repair may be done in phases to avoid interference between the workforce and the building occupants. Thus the phasing can be done such that the occupant will move to one part of the building while repair is being carried out on the other part.

8.1.7e. Erection of scaffoldings: Scaffolding should be erected only when needed and should be dismantled as soon as possible. Similarly, scaffoldings should not obstruct occupants (if still living inside the building), neighbours and general public’s movement.

The building should always be kept neat and tidy during the repair process so as to avoid accident.

8.1.7f. Curing of Wet Areas: Freshly applied earthen material (e.g. earth render or mortar) must be allowed to dry naturally, since earth construction involves wet mixes. Similarly wet walls and foundation should be protected from animals and humans.

Post Implementation Strategy

8.1.8. Section Eight: Post Repair Implementation Strategy

The aims of the post implementation plan are:

- to ensure the repeatability of the repair process in future,
- to ensure that the need for repair is kept to the barest minimum through planned preventive maintenance, and
- to determine when the building shall be due for another repair (see also Wood, 2003:35).

The above aims shall be achieved as follows:

8.1.8a. Documentation: The entire process specified above must be documented in order to ensure the repeatability of the repair in future. Consequently, the following documents shall be produced:

i. final report

ii maintenance manual

or alternatively the following document can be produced

iii. repair log and

iv. maintenance log

i. Final Report: A final report shall be prepared by the person in charge. The copy of the report shall be given to the landlord. The report shall contain detail description of the repair, sources of material and artisans used in the execution of the repair; problems encountered and how these problems were resolved. The report shall also contain copies of architectural drawings, and other relevant documents of the building before and after repair (Chandler, 1991:104). Alternatively the following documents can be provided.

Photographs and Sketches: Photographs and sketches can be used supplement architectural drawings (Cooke, 2010 in: Rainer, et. al., 2010:155). These shall be produced by the person commissioned to carry out the repair or he / she can commission another person upon consultation with the landlord for the photographs and or sketches.

ii. Maintenance manual: In order to minimise the need for repair a preventive maintenance schedule shall be prepared by the person in charge. This plan preventive maintenance shall be prepared in form of a manual with instruction on how the building occupants shall take care of the building to minimise the need for repair.

It shall includes periodic activities such as cleaning of drainages; trimming of tree branches close to an adobe building; applying sacrificial earth rendering on adobe walls; etc. (Odiaua, 2008:43; Marchand, 1993:108).

iii. Repair log: It is acknowledged in this framework that majority of the masons with knowledge of adobe building are not illiterate. Similar situation was also observed with occupants of the adobe buildings surveyed in Sabon Gari. And commissioning an architect or engineer to prepare these documents will be expensive and unjustified. As a consequence a user friendly method documentation that can be used by illiterate artisans and building occupants is proposed in tables 8.4 and 8.5 in part three of this framework.

Maintenance log: A user friendly maintenance log can be prepared just like the repair log.

Documents' production: These documents (i.e. condition survey report, repair report, and maintenance manuals) will require the use of digital camera, computer and printer. However, camera from mobile can be used as all the persons interviewed during the field survey had one. The documents can then be produced in a Business Centre. Just as explained in table 7.7 in chapter seven there are commercially operated centres that provides computing service for a fee for those that do not have a computer and or a printer. Typing and printing of an A4 size document cost ₦80 for a black and white print in Kaduna, while coloured printing cost ₦150 as at August 2011.

SAMPLE OF USER FRIENDLY REPAIR REPORT MANUAL			
Address of building surveyed:			**Survey No:**
Name of landlord:			**Name of care taker:**
Name and address of the person in charge:			**Repair commencement Date:** **Repair Completion date:**
Building features before repair	**Tick 'YES' (√) if this feature was repaired**	**Tick 'NO' (x) if this feature was not repaired**	**Building feature after repair**
 **Roof**			*Space for picture of roof after repair*
 **Wall**			*Space for picture of wall after repair*
 **Doors and windows**			*Space for picture of windows and doors after repair*

Table 8.4: Repair report manual

<table>
<tr><th colspan="3">SAMPLE OF MAINTENANCE MANUAL</th></tr>
<tr><td colspan="2">Address of building surveyed:</td><td>Survey No:</td></tr>
<tr><td colspan="2">Name of landlord:</td><td>Name of care taker:</td></tr>
<tr><td colspan="2">Name and address of the person in charge:</td><td>Repair commencement Date:
Repair Completion date:</td></tr>
<tr><td>Building features</td><td>Maintenance date</td><td>Date due for repair</td></tr>
<tr><td>
Roof</td><td>annually, biannual, etc.</td><td>10years , 20 years, etc.</td></tr>
<tr><td>
Wall</td><td></td><td></td></tr>
<tr><td>
Doors and windows</td><td></td><td></td></tr>
</table>

Table 8.5: Maintenance manual

8.1.9. Summary: The table below is the summary of part one of the repair framework for adobe building in Nigeria.

Outline of the Technical Requirements in Planning for Sustainable Repair of Adobe Building in Sabon Gari	
Sections	**Description**
Section One	**Strategy for Mobilisation for Execution of Adobe Building Repair** The preliminary plan of action towards commissioning of the person that shall carry out the adobe building repair and the preliminary data collection process.
Section Two	**Data Collection Strategy** Methodology for data collection
Section Three	**Preliminary Survey and Physical Measurement** This section contains strategies for preliminary building inspection and methodology for taking physical measurements.
Section Four	**Condition Survey Strategy** Strategy for prognosis and diagnosis of building defects
Section Five	**Determination of Repair Options and Calculation of Cost Estimate** Strategy for identification of sustainable repair options, calculation of cost, etc.
Section Six	**Notification to Commence Work and Production of Work Plan** Strategy for planning approval process and development of work programme schedule
Section Seven	**Repair Implementation Strategy** Strategy for successful implementation of repair in accordance with the initial plan.
Section Eight	**Post Repair Implementation** Strategy for continous maintenance of the building after repair and long term plan for future repair.

Table 8.6: Outline of the Action Plan for the Repair of Adobe building in Nigeria

FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN SABON GARI

PART TWO

Landlords and Tenants' Obligations towards the Sustainable Repair of Adobe Building

8.2. Preambles

This part of the framework is in response to the problems associated with the landlords and tenants' relationship in respect to adobe building repair as identified in the course of the fieldwork in Sabon Gari (see chapter four). Thus, it contains specifications of the responsibilities and duties of landlords and tenants in the repair of adobe building in Sabon Gari. This part of the framework is therefore developed with the aim of ensuring participatory approach in decision making towards sustainable repair of the adobe building in Sabon Gari. This is to ensure that these major stakeholders (i.e. landlords, tenants and the artisan commissioned for the repair) are part of the decision making from inception to completion. Thus, all the parties concern shall be responsible for the success or the failure of the repair. This strategy will also ensure that mistakes are not repeated in the future.

The existing Nigerian tenement laws, which were never applied during lettings or to resolve disputes in the repair of adobe buildings in Sabon Gari, are used in developing this part of the framework. The Nigerian Property Act of 1925 and the Tenancy Act of 1990, which contains legal requirements for landlords and tenants in respect to the buildings they own and occupy respectively, are therefore applied in this part of the framework.

The outline derived in section 7.3 in chapter seven is use as the outline of this part of the repair framework.

8.2.1. Section One: The Role of Landlords and Tenants in the Development of Pre Implementation Strategy for Adobe Building Repair

The landlords and the tenants shall play a prominent role during the development of pre implementation strategy for repair of adobe building in Sabon Gari. The role of both parties at this stage of repair is explained below.

8.2.1a. Mobilisation for Execution of Adobe Building Repair

It is the duty of the tenants to report to the landlords any defect or sign of building deterioration that will require immediate repair (FRN, 1990:12 and FRN, 1925:12). Both parties shall agree on the next plan of action, which shall include discussion and agreement on who to contact (i.e. artisans, architects, engineers, etc.), how to finance the repair, type of contracts to choose (see section 8.1.1) and when to carry out the repair.

8.2.1b. Financing adobe building repair: It is stated in the Nigerian Tenancy Act that it is the duty of the landlords to finance building repair except if it is ascertain that the defect or deterioration that call for repair was caused by the tenants either due to negligence, accident or through other avoidable means (FRN, 1990:16). This law shall therefore be enforced in the adobe building repair in Sabon Gari. However, the tenant could finance urgent repair such as replacement of blown off roof, leakages etc. on agreement with landlord for refund of the money spent, if the landlord is not in position to finance this urgent repair. The agreement shall be in writing and signed by both parties together with witnesses (preferably the representative of the landlord and that of the tenant and a solicitor). The agreement shall contain the landlord's consent and the agreed date for the refund of the money.

Alternatively, this agreement shall be included in the tenancy agreement, which is discussed in section 8.3.1a in part three of this framework. This option is more economical for both parties and is therefore recommended.

8.2.1c. Engagement of skilled professional: The landlord in consultation with the tenants shall agree on competent persons who have the adobe construction skills to be hired for the repair of the adobe building.

8.2.2. Section Two: Role of Landlord and Tenants during Data Collection

As noted in section 8.2.1 data on the adobe building in Sabon Gari is limited as a consequence current and previous landlords and tenants, as well as neighbour shall provide the person in charge with data relating to the previous interventions and uses.

The landlord shall also assist the person in charge in sourcing documents such as old electricity and water bills, which could provide some clue to causes of some defects or dates relating to interventions.

8.2.3. Section Three: Role of Landlords and Tenants during Preliminary Survey and Physical Measurement

The landlord and the tenants shall agree on the date and time that the person in charge shall come and conduct preliminary investigation of the building. The tenants (or tenants' representative) and land lord (if residing in the building) shall also on request assist the person in charge during the reconnaissance survey and in taking the physical measurement. However this is voluntary. Thus, the person in charge must give prior notice to the person that will be involved.

The occupants (tenants and or landlords) of the adobe building to be repaired shall ensure that both the exterior and interior are clean and free from any obstacle that will obstruct movement and work flow.

8.2.4. Section Four: Role of Landlords and Tenants during the Condition Survey

The landlord (if residing in the building) and tenants shall furnish the person in charge with information that will enhance better understanding of the causes of defects or deterioration during the condition survey. Tenants shall provide details of defects observed, e.g. when it was first noticed, the pattern of deterioration, as well as past intervention (if any), etc. Furthermore, the tenants and landlord shall furnish the person in charge with details on how the building has been used over a period of time (e.g. residential, commercial, mix use, etc.).

8.2.5. Section Five: Role of Landlords and Tenants in the Determination of Repair Options and Calculation of Cost Estimate

The material and method of repair of adobe building shall be decided in collaboration with the landlords and the tenants in consultation with the person in charge of the building repair.

The person in charge shall submit to the landlord the estimated cost of repair. Upon the receipt of the estimate, the landlords and tenants (or tenant's representative) shall negotiate with the person in charge and agree on the cost of the repair. The person in charge shall prepare the final cost estimate for the repair and submit a copy to the landlords for approval.

8.2.6. Section Six: Role of Landlords and Tenants in Development Approval and Production of Work Plan

The landlords and tenants in consultation with the person in charge shall assess the condition survey report and the repair proposal before determining the immediate priority. The landlords shall discuss and agree with the tenants on the date and time each task shall be carried out so as to ensure that the building is accessible to those that will carry out the repair. If necessary the person in charge shall through the landlords notify the occupants (tenants) of the building in writing when each of the tasks shall be carried out.

8.2.7. Section Seven: Role of Landlords and Tenants during Repair Implementation

The landlords shall ensure steady cash and material flow as agreed before the commencement and during repair. Similarly, both the landlords and tenants shall ensure that the repair is carried out as planned by constantly monitoring the repair process. The tenants and landlords shall ensure that the building is either evacuated during repair or the activities or persons within the building do not interfere with the repair and vice versa.

8.2.8. Section Eight: The role of the land lords and tenants in the development of the post repair strategy

The person in charge shall upon completion of repair brief the landlords and tenants on best approach for continous care and maintenance of the building. Alternatively, a planned preventive strategy in form of maintenance manual can be designed by the person commissioned to carry out the repair in consultation with landlords and tenants. The maintenance manual can be prepared using the same format as the repair log in table 8.4 in part one of the proposed framework.

FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN SABON GARI

PART THREE

The Sustainability and Statutory Requirements in the Repair of the Adobe Building in Sabon Gari

Preambles

This part of the proposed framework contains the sustainability and legal requirements for occupants (landlords and tenants) and the persons that shall be involve in the repair of adobe building in Sabon Gari. This part of the framework is prepared in accordance with the Nigerian National Building Code, the Kaduna State's Building Regulations, Codes of Building Professional Practices in Nigeria, relevant traditional practices and sustainable building practices appropriate for the repair of adobe building in Sabon Gari. Thus, it is a blend of contemporary and traditional practices in response to the issues identified from the research on the adobe building repair in Sabon Gari Kaduna.

Having realised that the practice of adobe building repair is not recognised in the current Nigerian building industry (see chapter six), the author have proposed a sustainable approach to repair of these adobe buildings in line with current building regulations. Thus, the factors identified as hindrance to the repair of the buildings surveyed were addressed. Of all these factors the landlords and tenants relationship was identified to be more critical (see chapter four). As a consequence, the use of the caretaker was proposed as a means of resolving this problem. The structure derived in section 7.3 in chapter seven shall be use as outline of the part three of this repair framework.

8.3.1. Section One: Landlords Tenants Relationship

The interest of both the landlords and tenants was taken into consideration in the development of this framework. The following was therefore proposed in order to avert dispute when making decision to carry out repair.

8.3.1a. Introduction of tenancy agreement: A tenancy agreement between the landlords and tenants of the adobe buildings in Sabon Gari is proposed. This agreement shall be sign at the commencement of the tenants' tenure in the rented adobe building (FRN, 1990:10).

The tenancy agreement shall include rental cost, mode of payment (e.g. monthly or annual), the role of the landlord and the tenants in the repair of adobe building.

Furthermore, this tenancy agreement shall include what is constitute as acceptable wear and tear of which tenant shall not be liable for the cost of repair. As well as those that the tenants shall be liable for.

The tenancy agreement could also contain option for the tenants to finance adobe building repair in case of emergency, but the landlord shall on agreed date refund the tenants as discussed in section 8.2.1b in part two of the repair framework.

8.3.1b. Introduction of a caretaker: A caretaker shall be appointed among the tenants for all rented adobe buildings in Sabon Gari instead of an estate agent or estate surveyor. The caretaker who is also a tenant shall liaise with the landlord on behalf of other co-tenants on tenancy related issues. This is common in rented buildings in the outskirt of the city such as Romi, Gonin

Gora, etc. This traditional practice has multiple advantages, which includes facilitation of communication between landlords and tenants, economically cheaper than estate agent, fair representation of both parties, etc.

8.3.2. Section Two: Sustainability and Statutory Requirements for Development of Adobe Building Repair Pre Implementation Plan

The pre implementation plan for the repair of the adobe building in Sabon Gari shall be designed such that the proposal shall be socially acceptable among the landlords and tenants, economically viable for both parties and with minimal or no negative impact on the building, neighbours and the entire environment. In addition, the repair must be in line with current building regulations in Kaduna.

As a consequence the person in charge of the building repair must be acquainted with the Kaduna State's building regulation in addition to the knowledge of adobe technology. S/he shall also be conscious of the three sustainability criteria from the inception to completion of the repair.

Some of the social, economic and environmental factors that shall be considered during pre implementation stage of the adobe building repair are explained as follows:

8.3.3. Sustainable data collection

As specified in sections 8.1.3 and 8.2.3 data relating to the previous interventions is vital to the repair of adobe building and can best be generated from both the best and present occupants of the buildings. However oral accounts can be conflicting and sometimes incorrect. As a consequence the person in charge must confirm the validating of any orally generated data.

The person in charge must therefore interview at least three persons from each compound separately in order to confirm the authenticity of the individual accounts. Furthermore the person in charge shall carry out independent investigation on oral data that relates to material. Such investigation could include laboratory test of samples, observations, second expert opinion etc.

For rented accommodation the landlord can be interviewed separately if s/he does not reside in the compound before interviewing tenants. Therefore must be correlation between these various sources of data before such information can be accepted as being valid and authentic.

8.3.4. Sustainable building inspection strategy

As already explained in section 8.1.7b in part two of the repair framework, privacy, culture and religion of the building occupants must be respected during building inspection.

The building occupants shall therefore be notified and briefed on the activities that shall be carried out in the building. It is common for Moslems and other followers of traditional religion to devote a space for prayer within residential space. It is forbidden for any person to enter such spaces with shoes on (Schwerdtfeger, 1982:12). There may be other religious and cultural practices, among the adobe building occupants, which need to be respected during repair. Consequently, the person in charge must ascertain every occupant’s culture and religious belief before carrying out building inspection.

8.3.5. Sustainable condition survey report documentation

The condition survey shall also be carried out with the same caution as the first building inspection. Similarly, non destructive methods shall be used in the prognosis and diagnosis of defects in the adobe building. Some of these non destructive approach were discussed in section 8.1.4b in part one of the repair framework (see also Garrison, ND:3).

8.3.6. Repair options

The repair options specified in section 8.1.6 are informed by the philosophical approach to repair which promotes sustainability in terms of social, economic and environment. Consequently, options that do not meet these three criteria were not specified. For example, cow dung was used traditionally to stabilise earth render and this was proved to be one the best organic stabilisers in Nigeria (Denyer, 1978:23). However, unstabilised earth based render was recommended because the former is no longer socially accepted most especially by the Moslems on religious ground.

The person in charge must therefore consult and advise the landlords and tenants when making decision on the type of material to be used for repair of the adobe building.

8.3.7. Sustainable implementation strategy

The implementation of adobe building repair must also be sustainable just as in the pre implementation strategy. The data generated and the steps followed during data collection, preliminary inspection and condition survey must guide the repair process.

8.3.8. Sustainable post implementation strategy

The adobe building repair can be more sustainable if the post implementation strategy is appropriately implemented. For example implementing planned preventive maintenance as proposed in section 8.1.8 can ensure that frequency of repair is drastically reduced. Consequently a user friendly maintenance manual is proposed using the same concept as the condition survey report log. Sample of this manual is presented in table 8.4.

OPTION TWO

FRAMEWORK FOR SUSTAINABLE REPAIR OF ADOBE BUILDING IN SABON GARI

DIY (SELF-HELP) APPROACH

Introduction: The repair of adobe building in Sabon Gari can be executed by the occupants of these buildings on the condition that they have the knowledge of adobe technology. This alternative option is recommended for owner occupier buildings or in buildings where the owner lives with other tenants and willing to carry out repair through self-help.

Figure 8.2 below is the diagrammatic representation of this second option of the proposed framework. This concept is adopted from the projects reviewed in the Terra conferences papers in section 7.2 in chapter seven. The diagram below is also an adaptation of figure 7.1 in chapter seven.

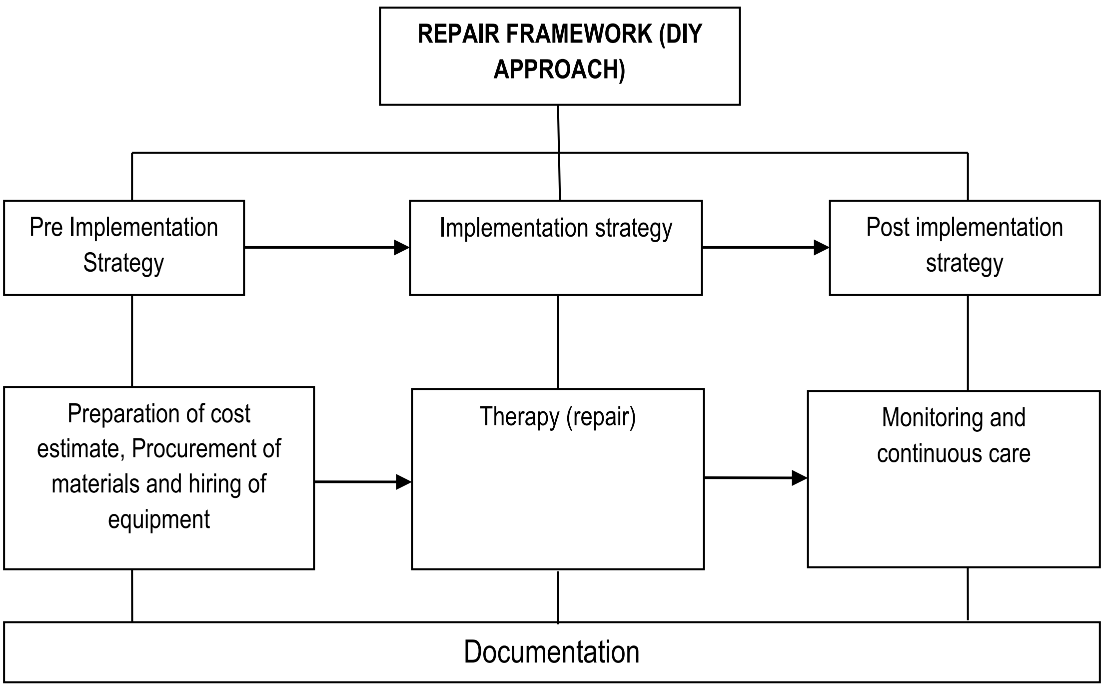


Figure 8.2: Framework for Self-help (DIY) Repair of Adobe Building in Sabon Gari

8.4. Section One: Pre Implementation Strategy

It is assumed that the owner of the building lives in this building and has knowledge of adobe building repair. Thus, will carry out the repair and as a consequence do not require any condition survey because as an occupant of the building and with the repair know-how, it is assumed that s/he is aware of the building condition.

8.4.1. Cost Estimate: The owner of the building may prepare cost estimate of the adobe building to be repaired using the same methodology as in option one (see section 8.1.6).

The cost of repair of the same building number 18 (see condition survey report in appendix 1.2a) if it is to be repaired through self-help (DIY) is therefore presented in table 8.7 below.

Only the cost of material, documentation and hiring of equipment shall therefore be incurred using this second option. As can be discerned from tables 8.2 and 8.7 the option two is cheaper by ₦89,183 (£356.73). However, this second option though cheaper can only be used by the house owner who has knowledge of adobe technology and willing to carry out the repair.

COST ESTIMATE FOR REPAIR OF ADOBE BUILDING NUMBER 18 IN SABON GARI, KADUNA USING DIY APPROACH					
Material Cost					
	Material Required	**Quantity**	**Unit (trip, bundles, etc.)**	**Rate (₦)**	**Amount (₦)**
1.	Lateritic soil from burrowed pit in Rigasa	4	Trips	7,000	28,000
2.	Straw	10	bundles	200	2,000
3.	Gravel	2	Trips	15,000	30,000
4.	Sand	1	Trips	15,000	30,000
5.	Cement	16	bags	2,000	32,000
				Subtotal (material cost)	**122,000**
Documentation Cost					
	Type of document	**Cost of Preparation of document if the building owner literate(₦)**	**Cost of printing a copy of each document(₦)**	**Copies required**	**Amount (₦)**
1.	Documentation of existing building as proposed in section 8.1.8a and presented in table 8.4 in chapter eight	Free (any of the occupants that is literate shall voluntary to prepare this document	150	3	450
2.	Preparation of estimated cost of	Free (any of the occupants that is literate shall voluntary to prepare this document	80	3	240
3.	Documentation of building after repair as proposed in section 8.1.8a and presented in table 8.4 in chapter eight	Free (any of the occupants that is literate shall voluntary to prepare this document	150	3	450
4.	Preparation of maintenance manual as proposed in section 8.1.8a and presented in table 8.5 in chapter eight	Free (any of the occupants that is literate shall voluntary to prepare this document	150	3	450
				Subtotal (cost of documentation)	**1,830**
Cost of Equipment Hire					
	Type of Equipment	**No. of days**	**Rate per day (₦)**	**Amount (₦)**	
1.	Hiring of scaffolds	5	1,500	7,500	
2.	Hiring of truck to cart away debris from site	1	7,000	7,000	
			Subtotal (cost of equipment hire)	**14,500**	
			Total cost of repair	122,000 + 1,830 + 14,500 = **138,330**	
	The estimated total cost of repair of adobe building number 18 is: One Hundred and Thirty-eight thousand, Three Hundred and Thirty Naira[34]				

Table 8.7: Estimate for repair of adobe building (building Number 18 in appendix 1.2a) in Sabon Gari

[34] £1 = ₦250 as at August 2011, thus, ₦138,330 = £553.32

8.4.1a. Material Procurement: The owner of the building shall determine and arrange for delivery of all material required to the site.

8.4.1b. Hiring of Equipment: The owner of the building shall ensure that equipments such as concrete mixers, shovels, pans, wheel barrow, etc. are brought to the site at least a day before the commencement of work. Similarly, scaffolding must be hired and mounted on site ready for work a day before work commences. Scaffolding should be dismantled and moved away from the site as soon as it is no longer required.

8.4.2. Section Two: Implementation Strategy

The repair of adobe building using DIY approach shall be carried out using the guidelines explained in section 8.1.6 as well as meeting the requirements in sections 8.2.6 and 8.3.6.

8.4.3. Section Three: Post Implementation Strategy

The post implementation repair strategy shall involve documentation of the whole repair process as illustrated in table 8.4. Maintenance manual shall also be designed as illustrated in table 8.5.

The owner of the building shall take pictures of the building before commencement, during and after the repair using digital camera or camera from the mobile phone (all the people interviewed during the field work had mobile phones with camera). As earlier explained in table 7.7 in chapter seven and in section 8.1.8a (i.e. document production), the document can then be produced in a Business Centre at the cost of ₦80 for a copy of a black and white document in A4 size.

8.5. Discussion

This framework is a cumulative result of the previous six chapters (i.e. chapter two to seven), consequently it is grounded in theories, concepts and analyses from these preceding chapters.

A participatory concept through team work was conceived in part one of this framework, which focuses on the plan of action for adobe building repair. The author bridge the gap in the repair of the adobe building in Sabon Gari through the blending of the Nigerian Building Code, the Kaduna State building regulation, Nigerian Town Planning Acts and some traditional concepts to attain sustainability in the repair of these buildings. The argument in this part of the framework is that irrespective of the material, all building repair projects must be subjected to the building and town planning laws and regulations. Thus, a flexible and most sustainable approach to repair was proposed.

Part two of this framework was designed to address the relationship between the landlord and tenants in respect to the repair of adobe building as identified during the field work in Sabon Gari (see chapter four). Thus, the responsibilities of both the landlords and tenants in the repair of adobe building were specified in accordance with the Nigerian tenancy law. A participatory approach was conceived, which shall encourage consultation and dialogue between landlords and tenants such that both parties are responsible for the overall wellbeing of the building and for the repair. This part of the framework also ensures that the interests of both parties are protected, thus there are only winners and no loser.

In response to the problems identified during the fieldwork a sustainable approach in line with the existing building regulation and traditional practice was developed in part three of this repair framework. The role of estate surveyor or agent was substituted with the caretaker as the liaison officer between the landlords and the tenants during the post repair stage. This approach is not only economically viable but more convenient and efficient for communication and dialogue between the landlords and tenants.

A user friendly maintenance manual was also proposed in order to encourage continous care and maintenance of the adobe building in order to minimise deterioration and the need for repair.

CHAPTER NINE

CRITICAL ANALYSIS OF THE VALIDATION QUESTIONNAIRES' RESPONSES

'Ijo tutun, ilu tutun'.

- A Yoruba[35] proverb

9.0. Introduction

The above Yoruba proverb literarily means a new or unique challenge requires a new or unique solution. Unique challenges to the repair of adobe building in Sabon Gari were identified in the course of this research and a unique solution was proposed by developing a repair framework in chapter eight. Since this proposed framework was designed with the input of the stakeholders identified at the inception of this research, they were also involved in testing of the validity of the draft repair framework. Summary of the framework and a validation questionnaire was sent to the stakeholders. Copies of the summary of the framework and the questionnaire are attached in appendix 4.

The questionnaire responses are analysed in this chapter. The suggestions from the stakeholders through the validation questionnaire were also critically analysed in this chapter.

9.1. Brief Overview of the Validation Questionnaire

The summary of the repair framework presented in chapter eight and validation questionnaire were sent to the 47 of the 48 persons previously interviewed in Sabon Gari and CECTech Jos in July and August 2006 respectively. Out of 45 questionnaires sent to Kaduna 18 were completed and returned. Although 3 staff of CECTech were interviewed in 2006, however one of them past away about 2 years ago, as a consequence only 2 validation questionnaires were sent (see table 9.1 below).

The validation questionnaire consists of five sections (see appendix 4). Section A contains respondent's personal data, which includes respondent's occupation or status (for landlords and

[35] Yoruba is one of the three major languages in Nigeria and is spoken in south west region.

tenants) and three other optional questions, i.e. respondent's name, email address and telephone number.

Section B of the questionnaire contains questions relating to the sustainability of part one of the proposed repair framework in terms of economic viability and social acceptability in Sabon Gari.

Section C of the questionnaire contains questions relating to the economic viability, social acceptability and the environmental impact of the part two of the proposed repair framework in Sabon Gari.

Section D of the validation questionnaire contains questions relating to the sustainability in terms of economic viability, social acceptance and the environmental impact of the part three of the proposed framework.

Section E of the validation questionnaire contains questions aimed at assessing the validity in terms of strengths weaknesses, opportunities and threats to the proposed adobe building repair framework.

The last part of the questionnaire contains space for respondents to add any suggestions, comments or explanation relating to their responses.

9.2. Analysis of the Validation Questionnaire's Responses

The questionnaires responses are critically analysed below starting with section A.

9.2a. Section A: Out of the 18 respondents that completed and returned the questionnaire 3 are architects, 1 is a town planner, 1 is a mason (concrete block), while another 1 is a retired mason, 2 are landlords and 9 are tenants in some of the 20 compounds surveyed by the author (see chapter four). Table 9.1 below is the summary of the questionnaire's distribution and those returned.

Occupation or status of respondent	Number of questionnaires sent	Number of questionnaires completed and returned
Staff of CECTech (1 architects and 1 engineer)	2	0
Architects	2	2
Town planner	1	1
Masons	2	2
Self builder	1	0
Kaduna State Rents Tribunals' Judge	1	0
Landlords	10	2
Tenants	26	9
Total	**47**	**18**
Percentage of returned questionnaires	**38.30%**	

Table 9.1: Distribution of validation questionnaire

9.2b. Section B: All the 18 respondents indicated that involvement of both landlord and tenants in the repair of adobe building will be economically viable and socially acceptable by the adobe building occupants in Sabon Gari. Similarly, all the 18 respondents indicated that the introduction of tenancy agreement; use of the Nigerian tenancy act; introduction of caretaker as against estate surveyor in the repair framework will be economically viable and socially acceptable (see table 9.2 for summary of responses).

Proposed strategy	Sustainability of the proposed strategy								
	Economically viable			Socially acceptable			Environmentally friendly		
	Yes	No	I don't know	Yes	No	I don't know	Yes	No	I don't know
a. Involvement of both land lords and tenants	18 respondents	0	0	18 respondents	0	0	Not applicable here		
b. Introduction of tenancy agreement	18 respondents	0	0	18 respondents	0	0	Not applicable here		
c. The use of tenancy act	18 respondents	0	0	18 respondents	0	0	Not applicable here		
d. The introduction of caretaker as an alternative to the use of Estate Surveyor	18 respondents	0	0	18 respondents	0	0	Not applicable here		

Table 9.2: Responses to validation of part one of the repair framework

9.2b. Section C: All the 18 respondents indicated that the involvement of landlords and tenants in decision making from conception to implementation of adobe building repair will be economically viable and socially acceptable. Similarly, the 18 respondents indicated that the use of some of the specifications in the National Building Code in the proposed repair framework will be economically viable and socially acceptable by the adobe building occupants in Sabon Gari.

12 (66.67%) out of the 18 the respondents indicated that the recommendation for the use of like materials in the proposed framework will be economically viable and socially acceptable. However, the remaining 6 indicated that they do not know of both the economic and social implications of using like material. The author had telephone conversations with 2 of these 8 respondents (both tenants) and they express the fear that because building earth is not available in Sabon Gari, they are not sure that using the like material (earth) will be economically viable and socially acceptable. However, the two later agreed that the benefits of using like material will outweigh the cost after explaining to them the implication of using different material most especially cement.

12 (66.67%) respondents indicated that using tried and tested materials for the repair of adobe building will be economically viable, socially acceptable and environmentally friendly in Sabon Gari, while 6 indicated that they do not know. 1 of these 6 respondents noted in the column for further suggestions and comments that the use of tried and tested material may not be economically viable in Sabon Gari because such tests will be very costly, of which the occupants of these adobe buildings may not be able to afford such expenses. Although any extra expenses will affect the acceptability of the framework however, the author is not proposing that the people should carry out the tests but to use the already tried and tested ones, e.g. the use of traditional additives (see Dmochowski, 1990, vol.1:1.7).

15 (83.33%) of the 18 respondents indicated that the option of not to involve building professionals such as architects, civil engineer, etc. will be economically viable and socially acceptable, while 3 (2 architects, 1 town planner) indicated it will not be economically viable, socially acceptable and will have negative impact on the environment. It is interesting to note that the town planner is the KASUPDA official interviewed in August 2006 and supported the non interference of his office in the construction and repair of adobe building in Kaduna (see section 4.2.2.viii in chapter four and appendix 1.4.3). The town planner and the two architects noted in the suggestion column that if architects or engineers are not involved in the repair of adobe buildings the unsustainable practice of using cementious material will continue. However, this observation can only be right if the architect or engineer involved have

knowledge of adobe construction. Unfortunately many do not have (see section 4.12 in chapter four). Thus, once the occupants and masons are aware of good repair practices they can carry out repair without of neither architect nor engineer.

All the 18 respondents indicated that the proposal for the use of original technique in the repair framework will be economically viable, socially acceptable and environmentally friendly. 12 (66.67%) respondents indicated that the introduction of maintenance manual in the repair framework will be economically viable, socially acceptable and will enhance the environment; while 6 indicated that this will not be economically viable and sociable acceptable. See table 9.3 below for the summary of the validation questionnaire responses.

Proposed strategy	**Sustainability of the proposed strategy**								
	Economically viable			**Socially acceptable**			**Environmentally friendly**		
	Yes	No	I don't know	Yes	No	I don't know	Yes	No	I don't know
a. Involvement of landlords and tenants in decision making from inception to completion of repair	18	0	0	18	0	0	18	0	0
b. Use of some relevant sections in the National Building Code for adobe building repair framework	18	0	0	18	0	0	18	0	0
c. Use of like material	12	0	6	12	0	6	12	0	6
d. Use of tried and tested new materials	12	0	6	12	0	6	12	0	6
e. Option not to involve building professionals such as Architects, Civil Engineers, etc. in adobe building repair	15	0	3	15	0	3	15	0	3
f. Use of original technique except if ascertained to be inappropriate	18	0	0	18	0	0	18	0	0
g. Introduction of maintenance manual and documentation of entire process	12	6	0	12	6	0	12	6	0

Table 9.3: Respondents' validation of part two of the repair framework

9.2b. Section D: 11 respondents indicated that the consideration of some relevant Codes of professional practices in Nigeria in the design of the statutory framework will be economically viable, socially acceptable and will enhance the environment. However, 7 (38.89%) indicated that they do not know how the use of the Code will enhance the adobe building repair in Sabon Gari economically, socially and in terms of the environmental impact.

All the 18 respondents indicated that the adoption of relevant traditional practices in the statutory repair framework will be economically viable, socially acceptable and will enhance the environment.

12 (66.67%) respondents indicated that the formulation of statutory framework using relevant sections in the Kaduna building regulations will be economically viable, socially acceptable and will have positive impact on the environment. 10 respondents indicated that the use of relevant sections in the National Building Code; Town and Country Planning Act and the Nigerian Tenancy Act will be economically viable, socially acceptable and will have positive impact on the environment. However, 6 indicated that they do not know if these will have any of the three sustainability impacts.

Table 9.5 is the summary of the responses to section D of the validation questionnaire.

Proposed strategy	**Sustainability of the proposed strategy**								
	Economically viable			**Socially acceptable**			**Environmentally friendly**		
	Yes	No	I don't know	Yes	No	I don't know	Yes	No	I don't know
a. Consideration of some Codes of professional practices in Nigeria in the design statutory framework for the repair of adobe building in Sabon Gari	11		7	11		7	11		7
b. The adoption of relevant traditional practice	18		0	18		0	18		0
c. The formulation of statutory framework in accordance with the following:									
i. The Kaduna State building regulations	12		6	12		6	12		6
ii. The Nigerian Building Code	10		8	10		8	10		8
iii. The Nigerian Town and Country Planning Act	10		8	10		8	10		8
iv. The Nigerian Tenancy Act	10		8	10		8	10		8

Table 9.4: Responses of the validation of part three of the repair framework

9.2e. Section E: Table 9.6 below shows the respondents choices of what are the strengths, weaknesses and threats to the proposed repair framework. Each of these factors (i.e. strengths, weaknesses and threats) are analysed below.

The Proposed Strategy	**SWOT Analysis**			
	Strength	**Weakness**	**Opportunity**	**Threat**
a. Involvement of both landlords and tenants	18	0	0	0
b. Introduction of tenancy agreement	18	0	0	0

c. The use of tenement act	18	0	0	0
d. The introduction of caretaker	18	0	0	0
e. Use of some relevant sections in the following documents in the design of the statutory framework for the repair of adobe building in Sabon Gari : • Nigerian Building Code • Kaduna State's building regulation • Codes of practice of building professional bodies in Nigeria	12	6	0	0
f. Use of like material	12	6	0	0
g. Use of tried and tested new materials	10	8	0	0
h. Option not to involve building professionals such as Architects, Civil Engineers, etc. in adobe building repair	14	4	0	0
i. Use of original technique except if ascertained to be inappropriate	8	10	0	0
j. Introduction of maintenance manual and documentation of entire process	10	8	0	0
k. The conceptualisation of the strategy in line with the Nigerian code of practice for conventional building material and relevant traditional practice	9	9	0	0
l. **Other issues relating to the successful implementation of the framework:**				
i. Low literacy level of the occupants and land lords of the adobe building	0	0	4	14
ii. CECTech Jos as the only earthen architecture training institution	0	0	6	12
iii. Training of building artisan in Nigeria through informal apprenticeship	0	0	8	10
m. **Please suggest and also assess other issue(s) that is (are) of relevant to repair of adobe building not mentioned above if any**:				
i.				
ii.				
iii.				
iv.				
v.				
vi.				
viii.				

Table 9.5: Summary of section E of the validation questionnaire's responses

i. **Strengths of the repair framework chosen by the respondents**: All the 18 respondents indicated that the following are strengths to the adobe building repair framework:

- involvement of landlords and tenants in the proposal
- introduction of the tenancy agreement
- the use of relevant sections in the Tenancy Act of Nigeria
- the introduction of a caretaker

Further 12 (66.67%) respondents indicated that the use of relevant sections in the National Building Code is a strength to the proposed framework. 10 respondents indicated that the specification for the use of like material as well as the use of tried and tested material are strengths to the proposal. However only 8 (44.44%) indicated that the specification for the use of original technique is a strength to the proposal.

15 (83.33%) respondents indicated that the option of not to use building professionals such as architects and or engineers for the repair of adobe building in Sabon Gari is a strength to the proposal. Similarly, 10 respondents indicated that the introduction of a maintenance manual as part of the post implementation strategy is a strength to the proposal. 50% (9) respondents indicated that the development of the repair framework in line with relevant Code of practices of some building profession in Nigeria is additional strength to the proposal.

ii. **Weaknesses of the repair framework as indicated by the respondents**: 6 (33.33%) of the respondents indicated that the specification in the repair framework for the use of like material is a weakness to the proposal. Reason for indicating that the use of like material is a weakness was given by 2 of the 6 respondents and it was explained in section 9.2b above. The reason given was the non availability of building earth in Sabon Gari. However, cost of building earth in Kaduna is still cheaper than that of cement. Similarly, the same 6 respondents indicated that the specification for the use of tried and tested material is a weakness to the repair framework. 2 of the 6 respondents cited cost as the reason for the weakness of the use of tried and tested material in the repair of adobe building. However, as noted in section 9.2b the occupants of the adobe building are not required to carry out the test but to use the already tested material.

Just as any guideline, legislation, etc. this proposed framework can be subject to several interpretation a good examples is the one explained above. Consequently, part of the recommendation in chapter ten is how to disseminate the proposal in language that all the stakeholders will understand.

Furthermore, 10 (55.56%) respondents indicated that the specification for the use of original technique for the repair of adobe building is a weakness to the proposal. 3 respondents explained in the comment's column at the bottom of the questionnaire that because of the lack of skilled traditional artisans the original technique cannot be used for repair. However, it was identified during the field survey in August 2006 that there are few people in Sabon Gari with knowledge of the original technique used in the construction of the adobe buildings in this area. Similarly, the technique is still in use in other part of the city (see chapter four). Thus, the issue is the lack of awareness by the occupants of these buildings of the existence of the skilled labour. It was therefore proposed in chapter six that a regional organisation such as DEBA in south west England or a community based organisation such as C: SoC in New Mexico, US is needed in Sabon Gari to coordinate activities and human resources in adobe technology.

3 respondents (2 architects, 1 town planner) indicated that the option of not to use building professionals such as architects and engineers in the repair of adobe building in Sabon Gari is a weakness to the proposal. They later explained at the bottom of the questionnaire that there is a limited knowledge of adobe technology among the occupants and mason in Sabon Gari and as a consequence they cannot repair adobe building appropriately. However, as explained

in section 9.2b there is also limited knowledge of adobe technology also among the architects and engineers just as with the building occupants and masons. In fact it was identified in the course of the research that there are masons that have the knowledge of adobe technology in Kaduna (see chapter four).

8 (44.44%) respondents indicated that the introduction of a maintenance manual in the proposed repair framework is a weakness to the proposal. 2 of the 10 respondents later explained at the bottom of the questionnaire that the cost of preparing such a manual will make this part of the proposal a weakness to the framework. However, it was proposed in the repair framework that the maintenance manual should be prepared by those that carry out the repair in collaboration with both the landlord and tenants thus, this will be affordable. Furthermore, any additional expenses inquired in the cost of the preparation of a maintenance manual is justify, when compared to the cost of repair as a result of lack of maintenance.

9 (50%) of the respondents indicated that the conceptualisation of statutory framework (part three) of the proposal using relevant sections of the Code of professional practice, National Building Code, the Kaduna State's building regulations and some traditional practices is a weakness to the proposal.

iii. **Opportunities of the repair framework as indicated by the respondents**: 4 (22.22%) of the respondents indicated that the low literacy level of the adobe building occupants is an opportunity that the framework can explored. 6 (33.33%) respondents indicated that the presence of CECTech in Jos is an opportunity, while 10 (55.56%) respondents indicated that introducing informal apprenticeship of building artisans is an opportunity to the success of the repair framework.

iv. **Threats to the repair framework as indicated by the respondents**: 14 (77.78%) respondents indicated that the low literacy level of the occupants of the adobe buildings will be a threat to the success of the repair framework. 12 (66.67%) respondents indicated that the presence of CECTech in Jos is a threat. 2 of the 12 respondents explained that there should be CECTech in Kaduna and other cities in Nigeria not only in Jos. 10 (55.56%) respondents indicated that informal apprenticeship for building artisans could be a threat to the success of the proposal.

9.2.1. Analysis of suggestions from the validation questionnaires: The following suggestions were noted by the 3 (including 2 architects) of the respondents apart from those already discussed above.

i. There is the need for one page summary of the repair framework

ii. There is the need for diagrammatical illustration of the repair framework

iii. There is the need for translation of the repair framework into Hausa language

The first two suggestions are implemented in section 9.4 below. However, the third will require the services of a specialist in Hausa language which is beyond the scope of this thesis, as a consequence it is included as part of recommendations in chapter ten.

9.2.2. Systematic analyses using the SWOT (Strengths, Weaknesses, Opportunities and Threats) Analysis: Factors indicated by the respondents as strengths, weaknesses, opportunities and threats in section 'E' of the questionnaire are critically appraisal in this section using the SWOT analysis as proposed in section 3.5.2 in chapter three.

As can be discerned from table 9.6 above some factors were indicated to be the strength of the repair framework by some respondents, while same factors were indicated as weaknesses by others. Similarly, the same factors that were indicated as opportunities by some respondents were also recorded as threats by others. This indicates that either the respondents have different understanding and interpretation of the framework or their responses are the reality for the implementation of the framework. Consequently, these factors are critically examined using the ideas from system theory discussed in section 3.5.1 in chapter three. Each factor is therefore considered to be a sub system within a system, which will only function effectively if other factors are equally effective (see section 3.5.1 in chapter three and Ackoff, 1960:10). The threats are first of all examined to identify if they are really threats as indicated or opportunities. Similarly, the weaknesses are also examined to determine if they are actually weaknesses or strengths. Using the TOWS (Threats, Opportunities, Weaknesses and Threats) Matrix the factors identified as real threats are re-examined and solution proffered from either the opportunities indicated by the respondents or other factors within the system not included in the questionnaire. This same procedure is carried out for the factors identified as weaknesses in relation to the strengths indicated by the respondents and those that exist within the system (see figure 9.1).

9.2.2a. Threats and Opportunities: The low literacy level of the occupants of the adobe buildings in Sabon that was identified as a threat to the implementation of the repair framework can be dealt with if the traditional method of dissemination through learning by doing is introduced in Sabon Gari (see Dmochowski, 1990, vol. 1:1.4 and Crouch & Johnson, 2001:20). This dissemination approach shall therefore be included in the recommendations in chapter ten. Thus, each repair project can be used to train artisans. Furthermore, onsite training can be introduced by CECTech and through local organisation such as DEBA in south west England as proposed in section 6.3 in chapter six.

Another threat identified by the respondents is the fact that CECTech is the only institution that specialises on earthen architecture in Nigeria and for the fact that the centre is in Jos which is around 300 Km from Kaduna. The effect of this threat can be countered by forming an association as discussed earlier in section 6.3 in chapter six and mentioned above. This association will become resource base and dissemination centre on all matters that relates to adobe technology in Sabon Gari and its environs. The association will include literate and non literate members of the community that can speak the local language and transmit the know-how to adobe building owners that cannot read.

Informal training of artisans is identified as a threat by 10 (55.56%) respondents. However, this should be seen as one of the strengths of the proposed framework because of the low literacy level of the artisans which makes it impossible for them to undergo formal training. However, CECTech could organise formal training for those that are interested. The centre had organised series of this training programme in the 1990s (Ogunsusi, et. al., 1994:23). It is still possible for the centre to organise formal training on request and as long as those interested are able to pay the training fee. The training fee as at 1992 was ₦2, 000 excluding cost of feeding and accommodation. The duration of the training programme was 2 weeks (see appendix 1.2). Cost of transportation, feeding and accommodation for 2 weeks as at 1992 would have cost about ₦1, 500 making a total of ₦3, 500. This was a huge expense that only very few could afford. The minimum wage in Nigeria in 1992 was ₦750 per month (FOS, 2005:12). Considering the fact that the training fee will be higher than what it was in 1992, only very few can still afford it today. It is therefore more cost effective and feasible to carry out onsite training in Sabon Gari or to disseminate through informal apprenticeship as with other trades (e.g. concrete masonry, carpentry, plumbing, etc., see Schwerdtfeger, 2008:99).

9.2.2b. Weaknesses and Strengths: The use of some relevant sections in the Nigerian Building Code and building professional ethics and the consideration of the Kaduna State building regulation were considered a weakness by 6 respondents, while 12 respondents considered it as strength. Both verdicts are worthy of further examination. In considering the Codes and regulations, local conditions in terms of economic, social and environment in Sabon Gari, in Kaduna and in Nigeria in general were put into consideration. Thus, only factors that will positively enhance the condition of the adobe building in Sabon Gari were considered. For example, the section 4 in part two of the National Building Code, which specified that mixed use buildings should be treated based on the activities the building is being used for, was adopted in the proposed repair framework (see section 6.1b in chapter six and FRN, 2006:39).

The specification in the repair framework for the use of like material was identified as weakness by 8 respondents and as strength by 12 respondents. The reason for indicating that this factor is a weakness was given by 2 respondents and is explained in section 9.2b below. The 2 respondents expressed that because building earth is longer available in Sabon Gari it will be difficult to use like material for repair. However, this is a strength because the alternative to the use of earth is cementious material and cement and sand being the main components are more expensive than building earth. A bag of cement cost ₦1, 700 and 8m^3 of sand cost ₦16, 000, on the contrary, 8m^3 of building earth cost ₦5, 000 in Kaduna as at July 2011 (Guardian Newspaper, online, 2011)[36]. As a consequence, the use of earth is more cost effective but more importantly more appropriate for repair of adobe building. The proposition for the use of like material is therefore one of the strengths of the proposal not a weakness.

The specification in the repair framework for the use of tried and tested material was also considered as a weakness by 8 respondents, while 10 considered this as a strength. 2 of the 8 respondents gave their reasons as the high cost of testing the material (see section 9.2b above). However, as earlier noted, the intention of this proposal is not for individuals to carry out the tests but to use material that have already been used elsewhere and proved to be effective. This is a misinterpretation of the specification in the framework and it shows how important it is to consider the best approach of disseminating this framework. However, this is beyond the scope of this thesis, hence considered as part of recommendation to further this study.

The specification for the use of original technique was indicated as weakness by 10 respondents, while 8 respondents indicated that, this is a strength. The same 2 respondents that gave reasons for considering the use of like material as a weakness, also explained that because there are no skilled artisans in Sabon Gari to carry out the repair using the original technique. However, just as in the use of material this is a strength. This is because it was identified in the course of this study that there are

[36] www.guradin.nigeriannewspaperonline.com accessed on the 21st July, 2011

skilled artisans in other areas within the City of Kaduna that could carry out repair of adobe building using original technique (see section 4.2.2.vii in chapter four and appendix 1.4.2e).

The option in the repair framework of not to use building professionals such as architects and engineers for repair of adobe building in Sabon Gari was considered a weakness by 3 respondents (see section 9.2b). However, this option is contained in the National Building Code (see FRN, 2006, section 12.1.7:212). Similarly, in Kaduna State buildings less than two storeys high does not require the services of a registered architect or an engineer, and all the adobe buildings surveyed in Sabon Gari are single storey. What is really important is that the person in charge must be knowledgeable in adobe technology and must consider the safety of the building and humans during repair. However, most of the architects and engineers do not have knowledge of adobe technology (see section 6.1a in chapter six), thus not qualify to carry out repair. This informed the decision to specify in the proposed framework that only competent person with knowledge of adobe technology shall carry out the repair of the buildings in Sabon Gari. Consequently, this factor is a strength not a weakness.

The specification for a maintenance manual in the repair framework is considered a weakness by 8 respondents, while 10 indicated that this is a strength. 2 of the respondents that considered this as a weakness cited cost of producing this manual as their reason (see section 9.2b above). However, the manual proposed is not a document that has to be prepared by an architect, engineer or any other building professional that will inquired another cost. This manual can be prepared by a mason in collaboration with the tenants and or the landlord and the documentation can be carried out by any person that is literate among this group of persons.

The overall concept of this repair framework using ideas from the National Building Code, Kaduna State building regulations and some relevant traditional practices was considered a weakness by 9 respondents, while the remaining 9 indicated that it is a strength. The consideration for this document was informed by the fact that for this framework to succeed it must conform to the existing statutory requirement in Kaduna State and Nigeria, as well as socially acceptable within the society (i.e. Sabon Gari). Similarly, the sections considered from these documents are those that are feasible within the context of Sabon Gari. Thus, cheaper but most effective alternatives were considered, since economy and efficiency as well as socio-cultural factors are the major issues with the adobe buildings in Sabon Gari (see table 4.4 in chapter four).

Table 9.7 below is the TOWS Matrix explaining how the factors that were identified as threats are being transformed to opportunities, and the weaknesses to strengths.

Threats		**O**pportunities
1. Low literacy level		1. Dissemination and implementation will be cheaper
2. CECTech Jos as the only institution of its kind in Nigeria	TO	2. Opportunity to establish local organisation with the assistance of CECTech
3. Informal apprenticeship	WO TS	3. Those in need of training cannot afford CECTech's training. The informal apprenticeship which is cheaper and more effective afford this group the opportunity to train
Weaknesses		**S**trengths
1. Involvement of land lords and tenants	WS	1. Encourages participatory approach and equal responsibilities
2.Introduction of tenancy agreement		2. Protection of both parties' interests
3. Introduction of caretaker		3. Facilitates communication between the 2 parties
4. Use of Codes and regulations		4. It legitimises the framework as a document that can function with the existing law
5. Use like materials		5. Like material are not only effective but cheaper
6. Use of tried and tested materials		6. These are more effective, cheaper and feasible
7. Use of original techniques		7. These are more effective, cheaper and feasible
8. The option to use other artisans or self built instead of architects, engineers, etc.		8. It is cheaper, effective and encourages the use of only competent persons
9. Introduction of maintenance manual		9. This could minimise or prevents the need for repair
10. Overall concept of the framework		10. It is in line with the problems identified

***Note**: **TO** = Threats-Opportunities; **TS** = Threats-Strengths; **WS** = Weaknesses-Strengths; **WO** = Weaknesses-Opportunities*

Table 9.6: Analysis of the strengths, weaknesses, opportunities and threats identified by the respondents using the TOWS Matrix

9.3. Conclusion of the Validity of the Proposed Repair Framework

Only 18 (38.30%) of the total 47 validation questionnaires sent were completed and returned. This percentage is fair considering the fact that the questionnaires were sent by email to one person who first of all helped in distributing it to the respondents before the telephone conversation between the author and the respondents (see appendix 4). The author is therefore of the opinion that the percentage responses may have been higher if similar method used in administering the first questionnaire was used (see appendix 1). However, the representation of those that returned the questionnaire cut across all the stakeholders in Sabon Gari with the exception of the Rent Tribunal's Judge (see table 9.1 above). Consequently, it can be concluded that this is a true verdict of the repair framework based on the full representation of all the stakeholders.

The questionnaire's responses further show the need for consideration for dissemination methodology of this framework if it is to be used in Sabon Gari. However, as earlier noted this is beyond the scope of this study but considered for further research.

9.4. Further Action Based on the Validation Questionnaire Responses

Three suggestions were made by the respondents in the validation questionnaire and these suggestions were analysed in section 9.2.1. In response to these suggestions a summarised version of the proposed framework is presented together with diagrammatical illustration of the interrelationship of the different parts of the proposal in table 9.7 below. Furthermore, a comparative cost analysis is also presented in section 9.4.2 in order to validate the economic viability of the framework.

9.4.1. Summary and diagrammatical illustration of the proposed framework: Based on the respondents' suggestions a schematic diagram of the repair framework is presented in figure 9.8 below. This schematic diagram is a summary of the repair framework, which can be called the black box of the system (the repair framework). The black box concept in a system is explained in section 3.5.1 in chapter three.

Table 9.8 is the condensed version of the proposed repair framework. This representation can also serve as a content page as well as a summary of the proposal presented in chapter eight. This version is also meant for those who just want to have general idea about the entire framework but do not have the time to go through the detailed proposal in chapter eight.

Each part of the proposed framework is presented in a column in table 9.8, with part two (landlords and tenants' obligations) in the middle. The two middle arrows indicates that the both the landlords and tenants are the principal actors in the implementation of part one (technical requirement) and part three (legal and sustainability requirement).

This version of the proposed framework (table 9.8) also shows at a glance the concepts, building regulations and Acts adopted in the formulation of this framework. Thus, users of this framework can easily refer to these documents for further clarification not only on adobe building repair but on other matters relating to built environment.

The upward and downward arrows indicate that although the framework is in three parts all the three are one entity. Each part is mutually interrelated to the others, after the same time none has an independent monopoly on the others but the three parts complement one another. Thus, the three parts must be used simultaneously in order to attain sustainability in repair of adobe buildings in Sabon Gari. This concept is in line with the systems theory adopted in the analysis of this study in section 3.5.1 in chapter three.

Content of the Proposed Framework for Sustainable Repair of Adobe Building in Sabon Gari			
	Content of Part One	**Content of Part Two**	**Content of Part Three**
Pre implementation strategy	1. Strategy for mobilisation	1. Role of landlords and tenants in the mobilisation for repair	1. Self-help, day work and standard contract procedures
	2. Data generation strategy	2. Role of landlords and tenants in the data generation	2. Possible sources of data: a. How to identify past and present landlords and tenants b. KASUPDA c. Max Lock Report (website address)
	3. Strategy for preliminary survey	3. Role of landlords and tenants in the preliminary survey	3. Sustainable methodologies for preliminary survey data collection
	4. Strategy for condition survey and analysis	4. Role of landlords and tenants During condition survey	4. Sustainable methodologies for data collection and analysis of condition survey
	5. Material, technique, cost determination strategy	5. Role of landlords and tenants In the determination of material, technique, costing, etc.	5. Material scheduling, description of appropriate technique, and cost planning method
	6. Methodology for designing work plan	6. Role of landlords and tenants in the designing of work plan	6. Hierarchal ordering of repair process
Implementation strategy	7. Repair implementation strategy:	7. Role of landlords and tenants in the repair implementation	7. Description of sustainable repair methods in terms of social, economic and environment, as well as in line with existing building regulation:
			a. Qualification of the artisan to carry out the repair
			b. Appropriate repair material
			c. Appropriate repair technique
			d. Site organisation
			e. Safety precautions on site
			f. Testing and handing over
Post implementation strategy	8. Strategy towards continous care of the building after repair	8. Role of landlords and tenants in the continous care of the building after repair	8. Use of existing laws, regulations, Acts, CIOB's strategies, CAM concept and traditional practice to develop:
			a. Process of appointment of a Caretaker
			b. Methodology for documentation of the entire
			c. Maintenance manual
	Description of documentation process at every stage of adobe building repair		
Sustainable adobe building repair in Sabon Gari			

Table 9.7: Summary of the proposed repair framework based on the stakeholders suggestions in the validation questionnaire

9.4.2. The economic viability of the proposed framework based on the questionnaire's responses: The responses of the validation questionnaire on the economic viability of the proposed framework show that 11 (61.11%) out of the 18 respondents indicated that the proposal is economical viable in terms of the consideration of some of the existing building codes in Nigeria (see section 9.2b and table 9.4). The remaining 7 do not know whether this consideration can be economically sustainable. Similarly, 12 (66.67%) indicated that the use of existing Kaduna State building regulations in the proposed framework is economical valuable, while the remaining 6 do not know. Furthermore 10 respondents each indicated that the use of the Nigerian building code, Town and Country Planning Acts and the Tenancy Act in the proposed framework can make the proposal economically viable. Similar responses were recorded for the social and environmental sustainability (see section 9.2b and table 9.4). However, all these indicators from the questionnaire responses are qualitative, thus, a quantitative indicator of the economic sustainability of this framework is required. As a consequence a cost comparative analysis of the proposed repair framework is presented in section 9.4.2a below.

9.4.2a. Comparative cost analysis of adobe building repair using the proposed repair framework: Cost of repair of one of the adobe buildings surveyed in Sabon Gari was calculated in section 8.1.5d in chapter eight using the repair framework developed in the same chapter. Using the option one of the repair framework the total cost of the repair of building number 18 including 10% overheads and profit is ₦227,513. This option already attracts additional 10% contractor's charges for overheads and profit cost which amount to ₦20,683 apart from labour cost. As shown in figure 9.1 below, 59.95% (₦124,000) of the total expenditure on the repair, excluding the overheads and profit is on mass concrete floor, which is entirely a new construction not repair. This huge expenditure on a single item is however justified. This is because the existing cementious floor screed is not durable, thus requires almost annual maintenance according to the owner of the building (Nuhu, 2006 in appendix 1.4.2b). The mass concrete proposed is the only durable alternative that can be used. Furthermore, the mass concrete could last up to 80 years or longer without any need for repair

(Chandler, 1991:78), thus the choice is justified. As explained in section 7.3.2.iv in chapter seven, the cost of future repair can be forecast using the cost model developed in this thesis. In the case of building 18 the cost of future repair can therefore be forecast to be less than 60% of what it cost at present, since the floor will no longer be repaired.

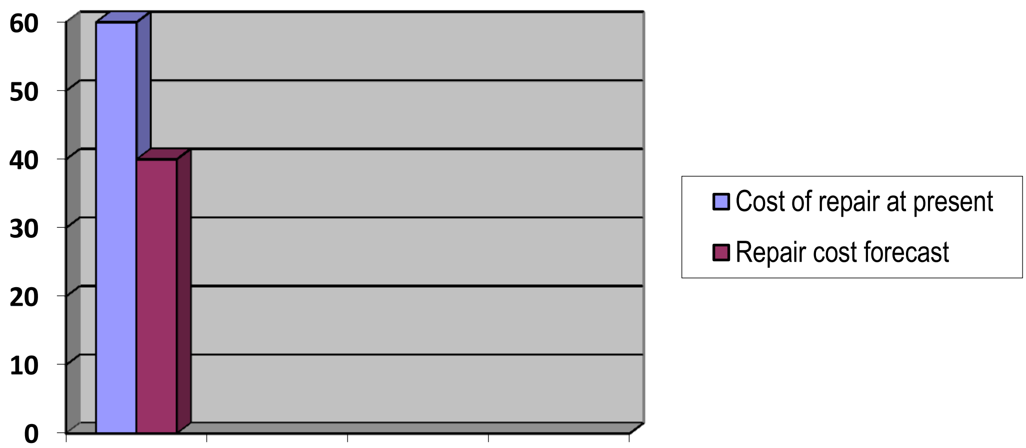


Figure 9.1: Comparative cost analysis of current cost of repair and repair cost forecast

Other on the other hand the same building will cost the sum of ₦138,330 to repair if the option two of the proposed framework which is designed for DIY approach is used. There will therefore be a savings of ₦89,183, which is the cost of condition survey, labour, overheads and profit that will not be incurred if the owner of the building is carrying out the repair through self-help. There will be further savings of ₦92,000 if the cost of gravel, sand and cement for the mass concrete flooring is deducted from the estimated cost (see table 8.3 in chapter eight). Thus, the repair of the same building could have cost ₦46,330 only. It can therefore be forecast that the cost of repair of the same building using the option two of this framework in future will be at least 67% cheaper since the mass concrete floor will not be required. Figure 9.2 is a diagrammatical illustration of differences in cost using the two options, while 9.3 is that of the cost of DIY approach with and without the mass concrete flooring.

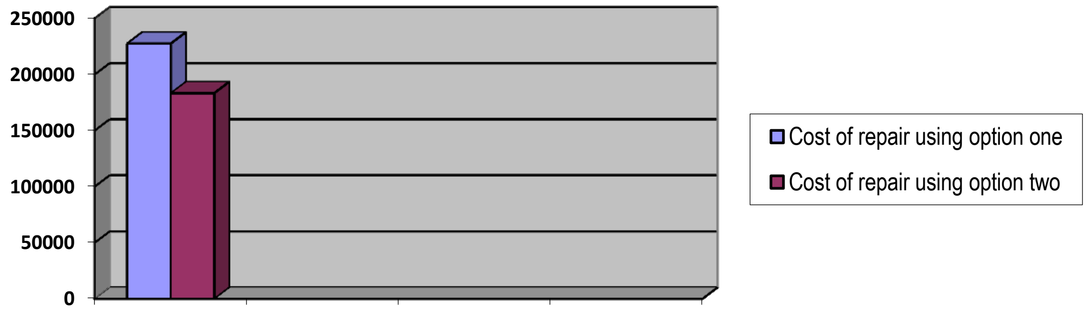


Figure 9.2: Comparative cost analysis using the two options of the repair framework

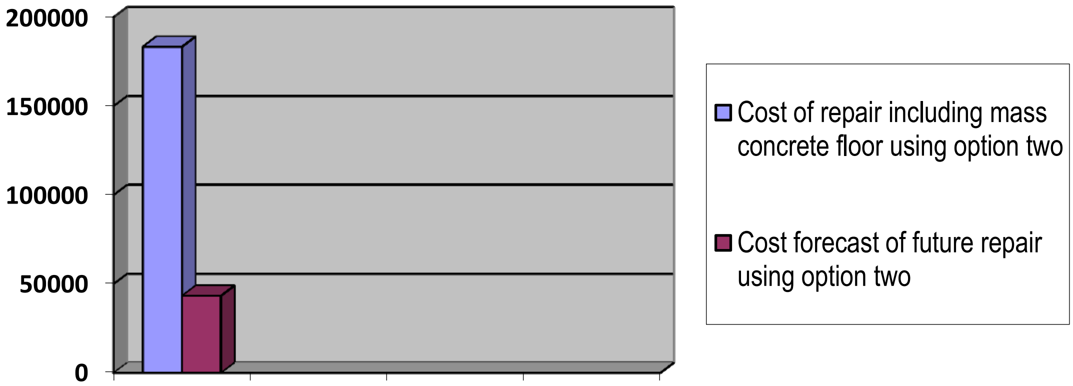


Figure 9.3: Comparative cost of repair at present and in the future

Although there is significant difference between option one and two of the repair framework in terms of cost, however, the option one which incidentally is more expensive is more feasible in Sabon Gari. This is because only 1 person out of 42 interviewed has knowledge of adobe technology in Sabon Gari (see section 4.2 in chapter four). Thus, DIY approach can only be possible in future if the stakeholders are able to acquire the necessary skills for repair.

The standard form of calculation of estimated cost of building project in Nigeria, which is the BoQ prepared by the Quantity Surveyor is not used in this project, a new methodology was designed instead (see sections 7.3.2.i in chapter seven). This new method of calculation of estimated cost of repair is necessary because the conventional BoQ is not only too technical for the stakeholders as earlier explained in section 7.3.2.i in chapter seven but more expensive to produce. This is because unlike in the UK and other developed country where there is standard fees of hiring building professionals (e.g.

Architects, quantity surveyors, etc.) on hourly or daily basis (see Langdon, 2010:777), fees for hiring building professionals in Nigeria are on monthly basis irrespective of whether the person is engaged for only an hour or a day. Thus, if a Quantity Surveyor is to be employed to prepare a BoQ for the repair of the building number 18 s/he will be paid at least a month wages. Table 4.i in appendix 4 contains man month (monthly) consultation fees for Architects, Civil Engineers and Quantity Surveyors. It can be discerned from this table that the minimum cost of hiring a Quantity Surveyor (i.e. someone with less than 4 years experience) is ₦33,000 per month. There may be likelihood that a Quantity Surveyor that has knowledge of adobe building has more years of experience, which will cost more. For example, a Quantity Surveyor with over 15 years working experience will cost ₦92,400 per month (see table 4.i in appendix 4). However, an experience mason with knowledge of adobe building will prepare the estimated cost of repair using the methodology proposed in this framework in a day, which will cost only ₦3,000[37]. The significant rise in cost of repair when using even a less experience Quantity Surveyor as against an experienced mason as shown in figure 9.4 lead to the conclusion that the use of masons to prepare estimate is by far more economical (i.e. ₦33,000 as against just ₦3,000). After all the formal training of Architects, Quantity Surveyor, Engineers, etc. in Nigeria does not including earthen architecture (Ogunsusi, 2006). Thus, few of this group of building professionals in Nigeria that are knowledgeable in this field acquired the knowledge outside the formal learning environment and are very scarce. On the other hand there are still skilled masons that can effectively handle adobe building repair. Figure 9.5 also shows the rise in cost of repair a more experienced Quantity Surveyor with over 15 years working experience is engage.

[37] The daily wages for masons in Kaduna as at December 2011 is ₦3,000

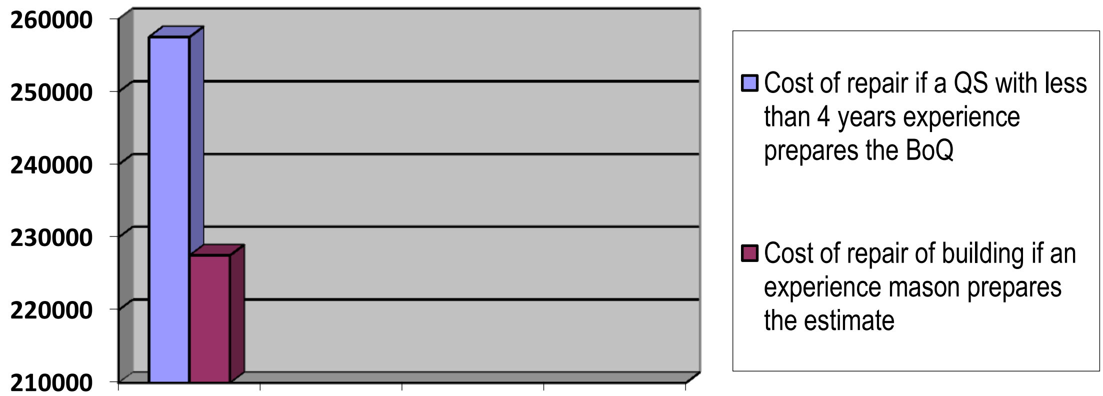


Figure 9.4: Comparative cost analysis of repair if a less experience Quantity Surveyor prepares the BoQ and an experience mason prepares the estimate

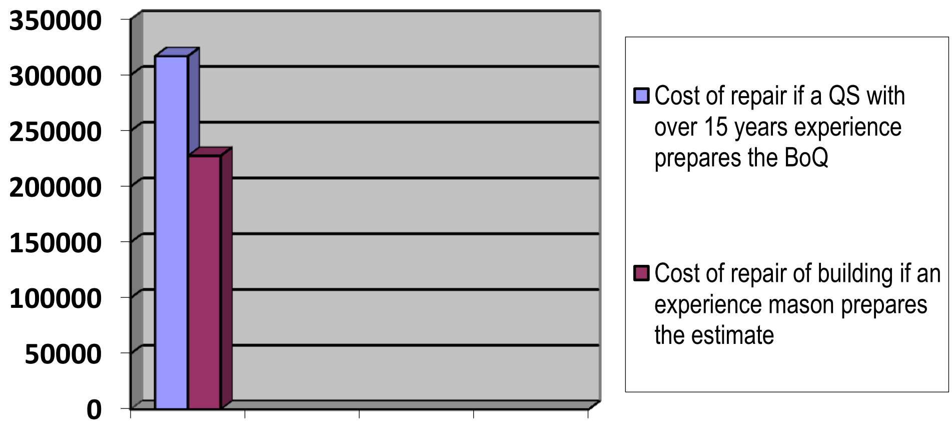


Figure 9.5: Comparative cost analysis of repair if an experience Quantity Surveyor prepares the BoQ and an experience mason prepares the estimate

The situation is the same just as with the Quantity Surveyor if an Architect or Engineer is engage to carry out either the condition survey and or the actual repair. The monthly consultation fee of an Architect with less than 4 years working experience is ₦46,200, while that of a Civil Engineer with the same years of experience is ₦33,000 (see appendix 4). Just as with Quantity Surveyor it may be likely that the Architect or the Engineer that has knowledge of adobe technology may have longer years of experience, thus will cost more. An architect with over 15 years working experience will cost ₦122,300 per month, while a Civil Engineer with the same years of experience will cost ₦92,400. There is therefore a minimum savings of ₦43,200 (i.e. ₦46,200 – 3,000) if a mason is used instead of an Architect for the condition survey and ₦30,000 (₦33,000 – 3,000) in case of a Civil Engineer. In addition, the minimum sum of between ₦46,200 and 33,000 is saved by engaging a masons instead of an Architect or Engineer to carry out the repair. This is because the Architect or Engineer will only carry out supervision, whilst the mason carries out the actual repair. However, an experienced mason will not require supervision for such a project.

These additional expenses on labour as expressed in figure 9.6 below are however not justified for a small project like the repair of the adobe building in Sabon Gari. Moreover, there is likelihood that some of the occupants may like to repair the buildings themselves in the future. Thus, the option two of the proposed framework is ideal for such group of people that may like to carry out the repair on their own.

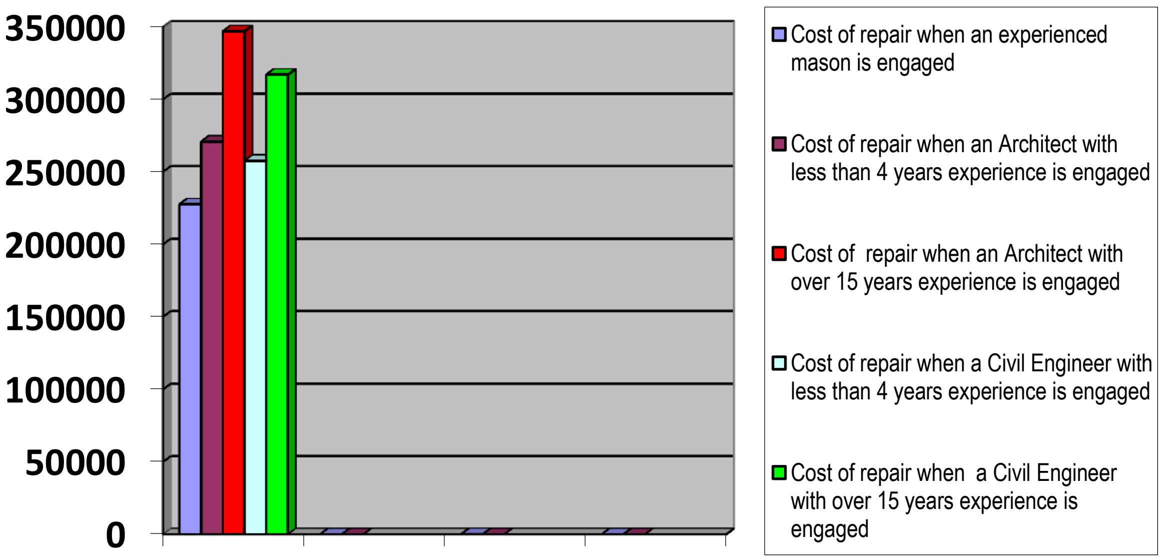


Figure 9.6: Comparative cost analysis of adobe building repair involving experience mason, Architect and Engineer with different years of experience

The difference in current cost of repair with that of future repair in building 18 arose from the need for introduction of mass concrete floor, which was not originally in the building. This new element in the building will not only provide comfort to the occupant but it will also prevent damp, thus improving the durability of the building and invariably reducing the need for repair as well as cost. Further, reduction in cost of future repair could also be achieved from experience accrue from previous repair. Each repair provides an experience that will be useful in terms of quality and cost of future repair. These gains shall be enhanced by documentation of every stage of repair, thus its importance cannot be undermined. Furthermore, it should be not that no two buildings are the same, every building is unique (Watt, 2005:3). It is therefore apparent that the cause of decay or deterioration as well as remedy will vary from one building to another. As a consequence, there may be other repair needs in the other adobe buildings that were surveyed that are not in building number 18, which could incur additional cost. Similarly, there may still be significant savings between current cost of repair and future cost just as in building number 18.

9.5. Ownership of the Proposed Framework

The sustainability of the proposed framework depends largely on the stakeholders. However, the stakeholders comprises of individuals and government without any umbrella that unites these varying groups. As a consequence the implementation and sustainability of this proposal requires an organised structure (organisation) under which these groups can operate as one entity.

An integrated Community Based Organisation (CBO) such as Devon Earth Building Association (DEBA) in the UK (Watson, 2000:23; Keefe, 2005:188), Church: Symbol of the Community (C:SoC) in the US (Taylor, 1993:590; Arnon & Baca, 1990:143), etc. is therefore proposed in Kaduna. Just as DEBA this proposed CBO shall include the adobe building owners, CECTech and KASUPDA as representative of the Kaduna State Government. The CBO shall be responsible for publication of this framework in revised version appropriate for public use. The author is willing to be part of this organisation and this shall form part of his immediate future plan of action towards the enhancement of earthen architecture in Nigeria.

Similar method of dissemination employed by DEBA (Watson, 2000:23; Keefe, 2005:188) and C:SoC (Taylor, 1993:590; Arnon & Baca, 1990:143), i.e. website, short courses and public lectures shall also be employed by this CBO. However, this mode of dissemination is not enough in Kaduna because of the literacy level of many of the stakeholders, as a consequence other means of dissemination such as radio and television could be explore.

The above proposal will however requires funding for it to take off. Financial support from National, States government and international organisations can therefore be explored. This can be facilitated by CECTech having benefitted from such supports in the past (Ogunsusi, et. al., 1994:22). However, of most importance is the enthusiasm of the stakeholders most especially the individuals living in these buildings and this can be stimulated through improved public awareness. Thus the first step towards achieving this objective could be an awareness workshop in Sabon Gari, which will involve both teaching and practical demonstration using one of the buildings.

9.6. Summary

The validation questionnaire was analysed in this chapter. The responses show the level of understanding of the repair framework. The questionnaire responses show that the repair framework can be sustainable in Sabon Gari. It also identified areas in the proposed repair framework that need further explanation and these explanations and corrections implemented were presented in this chapter, while the remainder were included as part of the recommendations.

CHAPTER TEN

RECOMMENDATIONS, SUMMARY AND CONCLUSION

The formulation of development policies, particularly those concerned with the built environment, appropriate to a given situation clearly requires an understanding of the cultural history of the community for whom such policies are designed.
- Moughtin (1985:158)

10.0. Introduction

This chapter presents recommendations based on the research findings, summary of the entire thesis and the author's conclusions of this study.

10.1. Recommendations

This thesis has made significant contribution to the body of knowledge in earthen architecture, but at the same time it further reveals some areas within the field of study that requires further research. Thus based on this fact the following are recommended:

I. The proposed framework needs to be presented using medium that can be understood by illiterate landlords, tenants, masons and other stakeholders. Sample of a user friendly repair report and maintenance manuals were developed and presented in chapter eight. The effectiveness of these manuals therefore needs to be tested. In addition, further research on other appropriate dissemination method is required.

II. There is need for further research and documentation of non-historic adobe buildings in Nigeria, as against the practice of concentrating on monuments and CEB technique.

III. There is the need for establishment of community based organisation (CBO) in Sabon Gari to compliment CECTech and to attend to local issues related to the repair of adobe building including the implementation of this framework.

IV. There is the need for networking and dissemination of knowledge at local, national and international levels, which this CBO will facilitate. The CBO can publish repair manual which should be made available electronically in the organisation website, as with the case of DEBA in south west England (Keefe, 2005:188).

V. The Federal and Kaduna State Governments should encourage the use of earth as a building material and the repair of existing ones, through public awareness programmes and training.

VI. There is also the need for financial assistance from the three tiers of governments (i.e. local, state and national) for the proposed CBO to take off as well as for the recommended awareness and training programmes.

VII. There is the need for KASUPDA to develop a more positive attitude towards adobe buildings in Sabon Gari in general.

10.2. Summary

Development of plan of action relating to the built environment such as the adobe building repair in Sabon Gari requires an understanding of the cultural history of the community for whom the action plan is designed for (above quote; see also Moughtin, 1985:158). Although the thesis' study area is not a traditional settlement like Zaria City, Kano, Katsina, etc., the adobe building in Sabon Gari has its unique architectural character and problems. These problems evolved out of varying socio-cultural factors some of which were earlier identified in Max Locks Report (Theis, et. al. 2003:68). In the course of this study other socio-cultural, economic and environmental problems were also identified.

The decision to develop a repair framework for adobe building was reached having identified from the literature reviewed in chapter two a lack of scholarly literature in adobe building repair in Nigeria. Similarly, it was identified from the literature review that scholarly literature on sustainable repair of adobe building does not exist. This thesis therefore drew from existing literature on sustainable architecture, earth building repair, conservation and rehabilitation, as well as case studies of earth building conservation and rehabilitation from Terra conferences paper to develop a framework for sustainable repair of adobe building.

For the purpose of this thesis Sabon Gari, Kaduna was chosen as the study area because of the uniqueness of Kaduna as the only city of its kind in Nigeria that was established by the imperial power in 1911. Thus, the city does not belong to any ethnic group and as such it is heterogeneously composed of almost all the Nigerian major ethnic groups. Sabon Gari in Kaduna is the commercial and the administrative area of the city and most of the buildings constructed before the oil boom era of the 1970s were of adobe blocks. 20 compounds with buildings constructed with adobe were selected and surveyed for the purpose of this thesis. It is based on these adobe buildings in Sabon Gari that the repair framework was developed.

As discussed above, literature pertinent to adobe building repair in particular, earth building repair in general and sustainable discourse relating to earth building repair were reviewed in chapter two. This review was outlined using the modern building repair guideline as an outline because the adobe building in Sabon Gari was identified to more recently built thus cannot be classified as traditional. As earlier stated above it was identified that despite significant literature on earthen architecture and sustainability there is no literature on the sustainability of adobe building repair. This gap in literature is one of the factors for the decision to consider sustainability issue in the proposed repair framework.

In chapter three, the strategy for moving from the research findings to the set objective was developed. The strategy developed enables the research to be systematically organised and logically presented using the systems theory. This was achievable by conceptualising the adobe building repair as a system, with sub systems and supra systems. Consequently, a participatory approach was considered in the data generation during the fieldwork. This approach involved identifying stakeholders in the repair of the adobe building in Sabon Gari. The stakeholders are the tenants, landlords, artisans, KASUPDA and CECTech in Jos. The same approach was later used in the validation of the repair framework.

The adobe building repair in Sabon Gari was studied during the fieldwork in August 2006 and the findings are presented in chapter four. Adobe buildings in 20 compounds were studied with aim of identifying the problems associated with the repair of these buildings. Questionnaire was also administered to occupants of these 20 compounds. The occupants of these adobe buildings in the 20 compounds were also interviewed. Similarly, masons, architects, representative of KASUPDA and rent tribunal Judge were interviewed. Summary of key findings from this study are presented below.

I. mixed use of the adobe buildings in Sabon Gari (residential and commercial)

II. the use of corrugated zinc and iron sheets for roofing as against the traditional thatch or earth roofs

III. elimination of traditional structural components such as arches in favour of linear (rectangular shape) lintels made with reinforced earth

IV. changes in occupancy pattern, i.e. adobe buildings were mostly occupied by tenants as against the traditional settlement where owner occupier is the practice

V. scarcity of skilled artisans for repair of the adobe building in Sabon Gari

VI. lack of repair skills among the occupants of the adobe buildings

VII. loss of traditional values such as easement that was used traditionally to protect adjoining buildings and those within the same neighbourhood

VIII. lack of building earth (soil) within the immediate vicinity due to urbanisation and this could increases the cost of repair

IX. the use of unsympathetic repair methods

X. lack of government control in repair and construction of adobe buildings

XI. lack of training institutions for earthen architecture

Based on CECTech's recommendations three different urban settlements, namely Zaria City, Offa and Akamkpa with earth buildings were studied during the fieldwork. The aim of this study was to identify how the earth building in this area are being repaired being in an urban area. It was however identified that these three urban areas have their unique problems as well as some that are similar to Sabon Gari. The analyses and findings from these studies were presented in chapter five. Below is the summary of the key findings.

I. CECTech's past programmes are on CEB and conservation of monument
II. foreign assistance were on conservation and modernisation of earth construction using the CEB
III. change from the use of tubali to adobe blocks in Zaria City
IV. change from circular to rectangular plans in the adobe buildings in Zaria City
V. lack of communication and networking between earth building owners and artisans in Zaria City
VI. neglect and unsympathetic repair of earth buildings in Zaria City
VII. dispassionate attitude towards earth buildings in Akamkpa and Offa
VIII. preference for demolition and rebuilding instead repair in Akamkpa
IX. lack of knowledge of earthen architecture in Offa
X. dearth of skilled artisan in Offa
XI. neglect of earth buildings in Offa

The adobe building in the current Nigerian building industry was critically analysed in chapter six. It was identified that the adobe technology has no place in the formal sector of the Nigerian building industry, despite the popularity of the technique in Nigeria. As a consequence, sections in the Nigerian Building Code and Kaduna State's building regulation relevant to the repair of adobe building in Sabon Gari were identified in this chapter. These relevant sections were later included in the proposed repair framework.

One of this thesis' aims is to attain sustainability in the repair of the repair of adobe building through the application of the framework developed in the course of this thesis. Consequently, the UN's five lessons towards achieving sustainability in any urban development policies (Girardet, 1999:62) was used in chapter seven as guide in developing a structure for the proposed repair framework. This five lessons includes the use of case studies, complexity of urban issues, networking, consequences of policies at local and national levels; and importance of decentralised co-operation (e.g. use of CBOs). Consequently, earth building conservation and rehabilitation projects presented in 148 papers in 6 Terra conferences (i.e. 1987, 1990, 1993, 2000, 2003 and 2008) were reviewed. Similarly, other building intervention strategies i.e. CIOB and CAM were reviewed. Issues relating to the repair of adobe building in Sabon Gari were identified from these reviews and used to formulate a structure for the proposed repair framework in line with relevant sustainable traditional practices and relevant sections identified in chapter six.

Chapter eight presents the major contribution this thesis is making to the body of knowledge in earthen architecture. The structure developed in chapter seven was used as an outline of the proposed repair framework in this chapter. The proposed framework was therefore developed using data generated through participatory approach. The proposed framework is also embedded in grounded tried and tested theories and concepts related building repair and sustainability of earth building in line with current legislation in the Nigerian building industry.

In line with the participatory concept adopted from the inception of this research, a validation questionnaire together with the summary of the proposed framework was sent to the stakeholders. This is aimed at permitting the stakeholders to ascertain the sustainability of the proposed framework. The stakeholders' responses are therefore analysed in chapter nine. Relevant issues raised in this validation questionnaire were addressed in chapter nine, while some were included as part of the recommendations in later part of this chapter.

10.3. Conclusion

This thesis arose from the understanding that adobe construction is still a living practice both in urban and rural centres in Nigeria, but currently in a cross road of history of adaption to contemporary needs. Consequently, the adobe building in urban areas such as Sabon Gari is in various state of dilapidation and requires a new approach to its repair. It was therefore assumed from inception of this research that the adobe building in Sabon Gari can be repaired if the knowledge and awareness exits. It was further argued that adobe building in Sabon Gari being part of the urban fabric deserves equal attention and respect as any other building. The decision to develop a repair framework was therefore reached based on this premise.

The conclusion from the study of the adobe building in Sabon Gari is that through improved public awareness sustainable repair of these buildings can be achieved. The framework is therefore the first and major step towards achieving this aim. The subsequent plans of actions towards realising this goal are already presented as recommendations in section 10.0 above.

10.4. Discussion and Reflection

This thesis identified the gap in research in the field of earthen architecture in Nigeria, of which the lack of research on repair of adobe buildings is one. A repair framework was therefore developed based on systematic analyses of data generated through participatory process between the author and the stakeholders. In response to the problems identified a framework that was grounded in theory was developed. This proposal therefore serves as a modest contribution to the body of knowledge.

The recommendations above are meant to further this research and to successfully achieve the long term goal of this study. The strategy employed in this thesis is that, by ensuring that the existing earth buildings are well maintained, it may also encourage the use of the technique for construction of new buildings. This is because by mere seeing existing adobe buildings in good condition can stimulate interest which could consequently erase the negative perception and bring positive attitudinal change. This strategy may lead to the revival of skilled artisans in earthen architecture, which may be transferrable to other sectors such as conservation of monuments. CECTech and other interested institutions in Nigeria can also explore this possibility.

The option not to involve building professionals such as architects, quantity surveyors, etc. in the adobe building repair and estate surveyors in the post repair process will reduce the cost of repair and maintenance of the adobe buildings in Sabon Gari.

The proposed framework if successfully used in the repair of the adobe building could have multiple advantages. First of these advantages, is that the building will no longer be in dilapidated condition. Second, the quality of a building can enhance the business that the building is use for, since most of the buildings are use for commercial purposes. Third, the use of locally sourced material has economic advantage to the people and the community where the building is located. Fourth, repair as against demolishing and rebuilding is cheaper and this is also an economic advantage. Fifth, the use of biodegradable material such as earth (which adobe is made from) has an environmental advantage. Sixth, the repair of mixed use buildings is economical advantageous to the occupants in particular and to Nigeria as a whole. Seventh, the adobe buildings studied are responses to the social need of the people, i.e. living within the close proximity of their businesses, of which the repair of such buildings can enhance their health and social well-being. Eight, the success of implementation of this repair framework could be transferred to other towns and cities in Nigeria. Nine, with proper dissemination there will more awareness of the adobe technology which could lead to more construction using the technique. Ten, this thesis demonstrated that building repair is a collective responsibility, thus teamwork is very crucial to the successful implementation.

Finally, this thesis is deviation from past research that focuses only on traditional earthen architecture, conservation of monuments and the promotion of the use of CEB in construction of new buildings.

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APPENDIX 1:

FIELD SURVEY 1 (STUDY OF ADOBE BUILDINGS IN SABON GARI, KADUNA, NIGERIA) DATA

Appendix 1.0. Sample of Questionnaire

Survey No:__________

SURVEY OF EARTH BUILDINGS IN SABON GARI, KADUNA

1. **Name of Building** (e.g. Gidan Bamaiyi, Gidan Niger, etc.):

2. **Name of House Owner:**

3. **Full Address of the Building Location:**

4. **Storey height:** (Tick appropriate box please)

i. Bungalow ☐ ii. Storey building ☐ iii. Mixed (bungalow and storey building) ☐

5. Building Type: (Tick appropriate box please)

i. Residential ☐ ii. Commercial ☐ iii. Mixed (Residential & commercial) ☐

6. Occupants' Status (Tick appropriate box please):

i. Land lord only ☐ ii. Tenants only ☐ ii. Mixed (land lord & tenants) ☐

7. Foundation Material (Tick appropriate box please):

i. Adobe blocks ii. Adobe brick (tub ☐ iii. Mixed (Adobe blocks & bricks) ☐

iv. Mixed (Adobe blocks & cement blocks) ☐ Mixed (Adobe bricks & cement blocks) ☐

vi. Mixed (Adobe blocks, adobe bricks & cement blocks ☐ Stone ☐

viii. Others (specify please):

8. Walling Material (Tick appropriate box please):

ii. Adobe blo ☐ ii. Adobe brick (tu ☐ Mixed (Adobe blocks & bricks) ☐

iv. Mixed (Adobe blocks & cement blocks) ☐ Mixed (Adobe bricks & cement blocks) ☐

vi. Mixed (Adobe blocks, adobe bricks & cement blocks ☐

9. Rendering (Plaster) Material (Tick appropriate box please):

i. Earth (mud) ☐ **ii.** ii. Cement ☐ iii. Mixed (earth & cement) ☐

10. Are the walls painted? (Tick appropriate box please):

i. Yes ☐ ii. No ☐ (please go to question 12 if the answer to question 10 is **No**)

11. Type of paint (Tick appropriate box please):

i. water base ☐ ii oil base ☐ iii. Traditional coating ☐

12. Roofing Material (Tick appropriate box please):

i. Zinc ☐ ii. Asbestos ☐ ii. Iron ☐ . Aluminium ☐ Thatch ☐ Earth ☐

13. Who usually carry out repairs? (Tick appropriate box please):

i. Land lord ☐ ii. Tenant(s) ☐ iii. Land lord and tenant(s) ☐

14. How often do you carryout repairs or maintenance? (Tick appropriate box please):

i. Yearly ☐ ii. Bi annual ☐ iii. Three to ten years ☐

iv. Cannot remember but very frequent ☐ v. Cannot remember but not very frequent ☐

15. Do you know how to repair earth buildings? (Tick appropriate box please):

i. Yes ☐ ii. No ☐

(Please go to question 17 if the answer to question 15 is No)

16. Do you carry out the repairs and maintenance work yourself? (Tick appropriate box please):

i. Yes ☐ ii. No ☐

(Please answer question 17 if the answer to question 16 is No)

17. What kind of professionals do you engage for the repairs? (Tick appropriate box please):

i. Traditional masons (earth) ☐ ii. Conventional masons (cement blocks) ☐. Architects ☐

iv. Engineers ☐ v. Traditional & conventional masons ☐

vi. Masons & architects ☐vii. Masons & engineers ☐

18. Is it easy to find professionals that knows how to mend earth buildings? (Tick appropriate box please):

i. Yes ☐ ii. No ☐

19. Is it easy to get building earth (soil) for mending your building? (Tick appropriate box please):

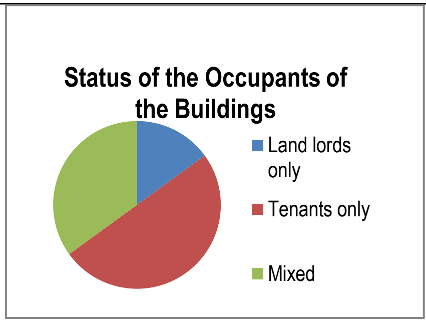
i. Yes ☐ ii. No ☐

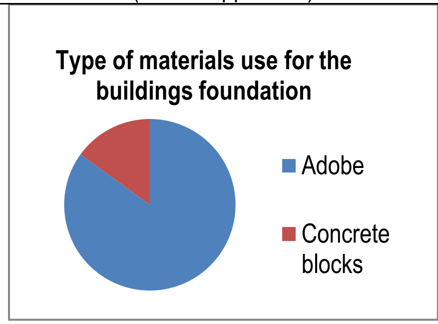
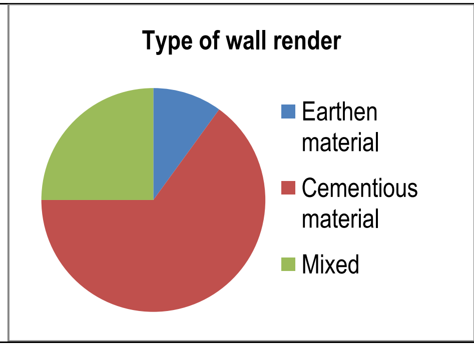
20. Where do you normal get your building earth (soil)? (Tick appropriate box please):

i. Burrowed pits ☐ ii. Within the neighbourhood ☐ iii. Buy ☐

iv. I do not know because I have never carried out any repairs ☐

Appendix 1.1. Questionnaire Analysis

QUESTION No.	QUESTION	OPTIONS	No. of RESPONSES	%	GRAPHICAL REPRESENTATION OF RESPONSES (Where applicable)
Question 1	Name of building	There are no options in this question	None of 20 buildings has a name	0%	
Question 2	Name of landlords	There are no options in this question	All responded and the names revealed that only 1 landlord is from the north.	100%	
Question 3	Address	There are no options in this question	All the 20 buildings are in Sabon Gari	100%	
Question 4	Type (storey height)	1. Bungalow	20	100%	
		2. More than a storey high	0		
		3. Mixed	0		
Question 5	Building Type	1. Residential	0		
		2. Commercial	0		
		3.Mixed	20	100%	
Question 6	Occupants status	1. Land Lord Only	3	15%	
		2. Tenants only	10	50%	
		3. Mixed	7	35%	

QUESTION No.	QUESTION	OPTIONS	No. of RESPONSES	%	GRAPHICAL REPRESENTATION OF RESPONSES (Where applicable)
Question 7	Foundation material	1. Adobe block	17	85%	
		2. Adobe bricks (tubali)	0		
		3. Adobe blocks & adobe bricks	0		
		4. Adobe blocks & concrete blocks	0		
		5. Adobe bricks & concrete blocks	0		
		6. Adobe blocks, adobe bricks & concrete bricks	0		
		7. Stone	0		
		8. Others (specify)	3 (concrete block)	15%	
Question 8	Walling Material	1. Adobe block	20	100%	
		2. Adobe bricks (*tubali*)	0		
		3. Adobe blocks & adobe bricks	0		
		4. Adobe blocks & concrete blocks	0		
		5. Adobe bricks & concrete blocks	0		
		6. Adobe blocks, adobe bricks & concrete blocks	0		
Question 9	Rendering (plaster) material	1. Earth (mud)	2		
		2. Cementious material	11		
		3. Mixed	5		

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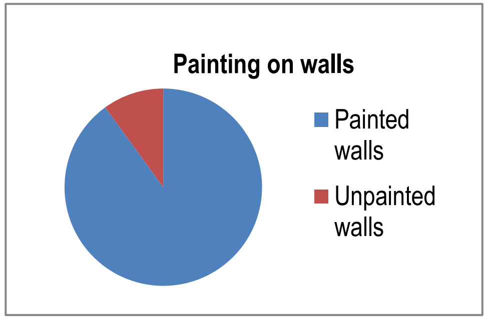
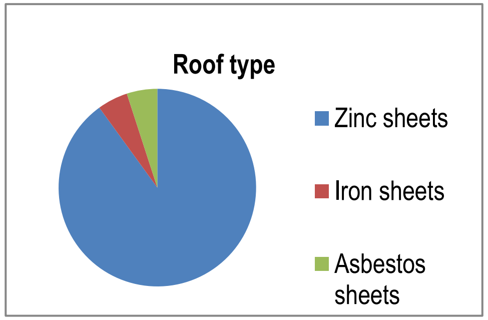
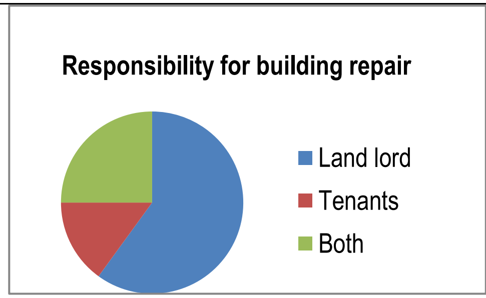
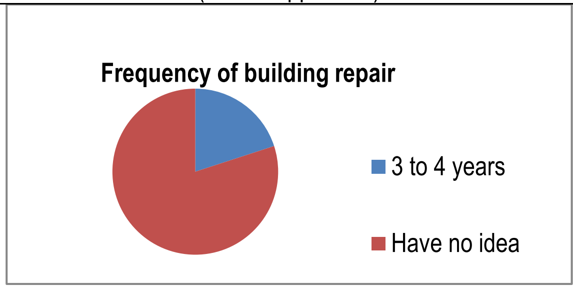
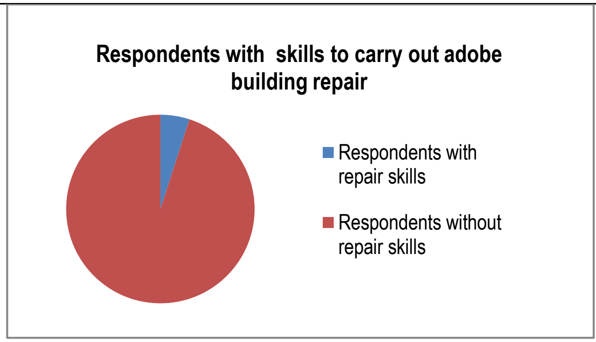
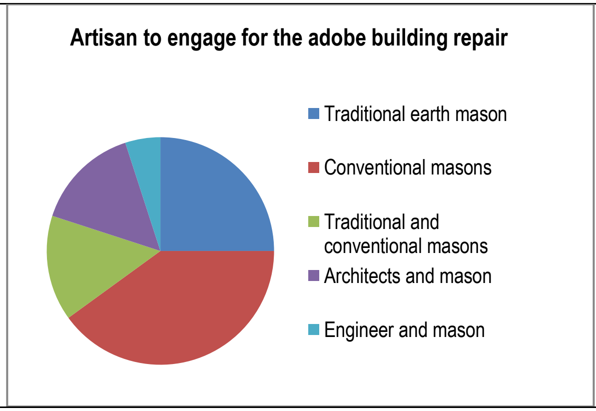
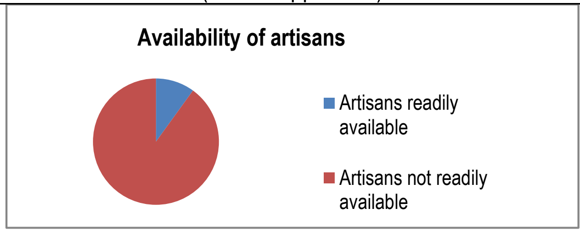
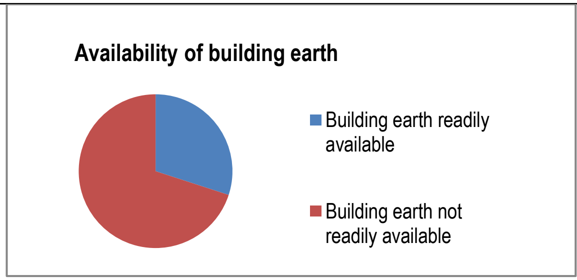
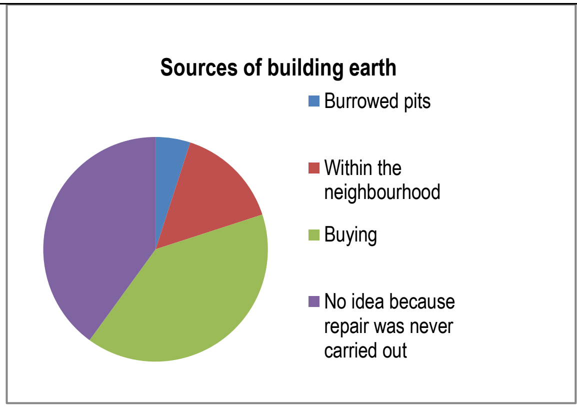
QUESTION No.	QUESTION	OPTIONS	No. of RESPONSES	%	GRAPHICAL REPRESENTATION OF RESPONSES (Where applicable)
Question 10	Are walls painted?	Yes	18		
		No	2		
Question 11	Type of paint (if painted)	1. Water base	18 (interior)		
		2. Oil base	18 (Exterior)		
		3. Traditional coating	0		
Question 12	Roofing material	1. Zinc	18	90%	
		2. Asbestos	1	5%	
		3. Iron	1	5%	
		4. Aluminium	0		
		5. Thatch	0		
		6. Earth and Zinc	1		
Question 13	Who usually carry out the repair?	1. Land Lord	12	60%	
		2. Tenants	3	15%	
		3. Both	5	25%	

QUESTION No.	QUESTION	OPTIONS	No. of RESPONSES	%	GRAPHICAL REPRESENTATION OF RESPONSES (Where applicable)
Question 14	Frequency of repair	1. Yearly			
		2. Bi annual			
		3. 3 to 4 years	4	25%	
		4. Can't remember but very frequent	16	75%	
		5. Can't remember but not very frequent			
Question 15	Do the occupants have repair skills?	1. Yes	1		
		2. No	19		
Question 16	Do the occupants carry out the repair through self-help?	1. Yes	1		
		2. No	19		
Question 17	Who do they engage in the repair if it is being done by someone else?	1. Traditional masons (earth)	5		
		2. Conventional masons (concrete blocks)	8		
		3. Architects	0		
		4. Engineers	0		
		5. Traditional & Conventional masons	3		
		6. Architects & masons	1		
		7. Engineers & masons	1		

QUESTION No.	QUESTION	OPTIONS	No. of RESPONSES	%	GRAPHICAL REPRESENTATION OF RESPONSES (Where applicable)
Question 18	Are skilled professionals readily available?	1. Yes	2	10%	
		2. No	18	90%	
Question 19	Is building earth (soil) readily available?	1. Yes	6	30%	
		2. No	14	70%	
Question 20	If not readily available, where is the source of the building earth?	1. Burrowed pits	1		
		2. Within the neighbourhood	3		
		3. Buy	8		
		4. Don't know since repair was never carried out by the occupant	8		

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Appendix 1.2. Addresses of the 20 Compounds Surveyed

1. JJ 1 Abubakar Kigo Road, Sabon Gari, Kaduna
2. JJ 2 Abubakar Kigo Road, Sabon Gari, Kaduna
3. 1 Gombe Road, Sabon Gari, Kaduna
4. AB 2 Kano Road, Sabon Gari, Kaduna
5. AB 7 Kano Road, Sabon Gari, Kaduna
6. Q6 Kano Road, Sabon Gari, Kaduna
7. AK 11 Wushishi Road, Sabon Gari, Kaduna
8. CC 20 Gombe Road, Sabon Gari, Kaduna
9. D 15 Damaturu Road, Sabon Gari, Kaduna
10. E 8 Katuru Road, Sabon Gari, Kaduna
11. AD 3 Kano Road, Sabon Gari, Kaduna
12. AD 16 Kano Road, Sabon Gari, Kaduna
13. V 3 Sardauna Crescent, Sabon Gari, Kaduna
14. V 17 Sardauna Crescent, Sabon Gari, Kaduna
15. AI 17 Sardauna Crescent, Sabon Gari, Kaduna
16. AJ 7 Benue Road, Sabon Gari, Kaduna
17. BZ 92 Sardauna Crescent, Sabon Gari, Kaduna
18. NH 18 Lokoja Road, Sabon Gari, Kaduna
19. NO 13 Ibibio Road, Sabon Gari, Kaduna
20. NF 11 Abeokuta Street, Sabon Gari, Kaduna

Appendix 1.2a. Condition Survey Report

Building No: 01

Occupants: Land lord and tenants

Uses: (Mix commercial and residential)

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Sagged roof	Ageing and lack of maintenance	Physical inspection and occupants account
Roof leakage	Rusting of roofing sheets and sagging of roof trusses. Due to ageing, lack of repair and maintenance.	Leakages noticed 2 years ago and reported to land lord but roof was never repaired. Sagging was noticed last year that was when some of the roofing sheets were replaced. 1 of the occupants confirmed that the roof was never repaired for more than 20 years that he has been living in the house until last year (2005) when some of the roofing sheets were replaced.
Sagged and rotten roof facial board	Sagging of roof trusses, due to ageing. Excessive moisture from leakages. Possible termite attack due to non treatment of the timber facial board.	Same as above
Cracks on adobe walls	i. Remodelling and use of inappropriate materials. ii. Unsympathetic repair. iii. Lack of ventilation in two of the rooms iv. Introduction of burglary proofs and mosquito's screens v. Lack bonding between old and newly added walls	Physical inspection and occupants accounts. Cracks severe in areas with new electrical wiring. There are no windows in two of the middle rooms.
Dampness on walls	i. Cementious rendering. Use of impermeable oil based paints ii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection and comparison with other adobe buildings not rendered with cementious material
Basal erosion	Cementious rendering, lack of roof guttering and site drainage as well flooding caused by road rehabilitation.	Observation.
Cracked cementious floor screed	The thick of the cementious screeding on rammed earth floor bed is only 35mm as against the standard 150mm thickness concrete floor slab	The crack is wide and deep in one of the rooms so it is possible to measure the depth of the cementious screed and to see the material used.

Building No: 02

Occupants: Tenants only

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 4 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Missing roof facial boards	Ageing and lack of maintenance	Physical inspection and tenants accounts
Crack cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets iv. lack of bonding between rubble stone dwarf fence in cementious mortar and the adobe building	Physical inspection
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets iv. lack of bonding between rubble stone dwarf fence in cementious mortar and the adobe building	Physical inspection
Damp walls	i. Cracked cementious render ii. Oil based paint on the rendered adobe walls iii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection
Cracked cementious floor screed	The thick of the cementious screeding on rammed earth floor bed is only 25mm as against the standard 150mm thickness concrete floor	The crack is wide and deep in one of the rooms so it possible to measure the depth of the cementious screed and to see the material used.
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection and tenants accounts

Building No: 03

Occupants: Tenants and land lord

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Sagged roof	Ageing and lack of maintenance	Physical inspection and occupants account
Sagged and partially rotten facial	Ageing and lack of maintenance	Physical inspection and occupants account
Roof leakage	Ageing and lack of maintenance	Physical inspection and occupants account
Crack cementious render	i. Incompatibility of cementious rendering and adobe. ii. Introduction of a canopy for signage at the entrance of one of the shops iii. Remodelling iv. Lack bonding between old and newly added walls v. Construction of an addition shop using concrete blocks	Physical inspection
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Introduction of a canopy for signage at the entrance of one of the shops iii. Remodelling iv. Construction of an addition shop using concrete blocks v. Failure of timber lintels due to the span of the doors and windows (spans too wide)	Physical inspection and occupants account
Damp walls	i. Cementious rendering ii Entrance canopy iii. Flooding caused by road rehabilitation iv. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection
Crack floor	The thick of the cementious screeding on rammed earth floor bed is only 25mm as against the standard 150mm thickness concrete floor.	The crack is wide and deep in one of the rooms so it possible to measure the depth of the cementious screed and to see the material used.
Basal erosion	Cementious rendering, lack of roof guttering and site drainage as well flooding caused by road rehabilitation.	Physical inspection

Buildings No: 04, 05 and 06

Occupants: Tenants and land lord

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Sagged roof	Ageing and lack of maintenance	Physical inspection and occupants account
Missing facial	Ageing and lack of maintenance	Physical inspection and occupants account
Crack cementious render	i. Incompatibility of cementious rendering and adobe. ii. Use of walls as signage in building number 05 iii. Remodelling iv. Construction of an additional shop using concrete blocks in building number 06	Physical inspection and occupants account
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Use of walls as signage in building number 05 iii. Remodelling iv. Construction of an additional shop using concrete blocks in building number 06 v. Lack bonding between old and newly added walls	Physical inspection and occupants account
Damp walls	i. Cementious rendering ii. Oil based paint on the rendered adobe walls iii. Flooding caused by road rehabilitation iv. Underground moisture (capillary action) due to cracking of cementious floor screed v. Use of walls as signage in building number 05	Physical inspection
Crack floor	Insufficient thickness (25mm thick in building number 05, 35mm thick in buildings number 04 and 06)	The crack is wide and deep in one of the rooms so it possible to measure the depth of the cementious screed and to see the material used.
Basal erosion	Cementious rendering, lack of roof guttering and site drainage as well flooding caused by road rehabilitation.	Physical inspection

Building No: 07

Occupants: Tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 3 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Missing facial	Ageing and lack of maintenance	Physical inspection and occupants account
Crack cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iv. New electrical installations	Physical Inspection and occupants account
Cracked adobe wall	i. Remodelling using inappropriate material and technique ii. New electrical installations iii. Rain water from the roof of adjoining property iv. Failure of timber lintels due to the span of the doors and windows (spans too wide) v. Lack bonding between old and newly added walls	Physical inspection and occupants account
Sagged timber lintel	i. Remodelling ii. Lintel span too wide to carry the load above	Physical inspection and occupants account
Cracked floor	Use of cementious screed only instead of mass concrete	Physical inspection

Buildings No: 08 and 09

Occupants: Land lords and tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Sagged roof (building no. 09 on the right)	Ageing and lack of maintenance	Physical inspection and occupants account
Leaking roof (building no. 09 on the right)	Ageing and lack of maintenance	Physical inspection and occupants account
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iv. New electrical installations	Physical inspection and occupants account
Cracked adobe wall	i. Remodelling using inappropriate material and technique ii. New electrical installations iii. Lack bonding between old and newly added walls	Physical inspection and occupants account
Damp walls	i. Incompatibility of cementious rendering and adobe. ii. Lack of ventilation no windows in all the front rooms (3 rooms in building number 08 and 2 rooms in building number 09) iii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection and occupants account
Partial collapse of adobe wall (building no 08 on the left)	i. Negligence and lack of maintenance ii. Consistent remodelling	Physical inspection and occupants account
Cracked floor	Use of cementious screed only instead of mass concrete	Physical inspection
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection

Building No: 10

Occupants: Tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Roof leakage	Ageing	Physical inspection and occupants account
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iv. New electrical installations	Physical inspection and occupants account
Cracked adobe wall	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. New electrical installation iv. Failure of timber lintels due to the span of the doors and windows (spans too wide) v. Introduction of burglary proofs and mosquito's screens vi. Lack bonding between old and newly added walls	Physical inspection and occupants account
Damp walls	i. Incompatibility of cementious rendering and adobe. ii. Lack of ventilation no window in 3 rooms used both as shops and bedrooms iii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection
Cracked floor	Use of cementious screed only instead of mass concrete	Physical inspection
Basal erosion	Cementious rendering, lack of roof guttering and flooding caused by recent road rehabilitation.	Physical inspection

Building No:11

Occupants: Land lord only

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 6 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Sagged ceiling and facial board	Warping of untreated timber facial board, noggins and joists	Physical inspection and occupants account
Damp walls	i. Incompatibility of cementious rendering and adobe. ii. Lack of ventilation no window in 2 rooms iii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection and occupants account
Cracked floor	Use of cementious screed only instead of mass concrete	Physical inspection

Building No: 12

Occupants: Tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 4 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets	Physical inspection and occupants account
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs iv. Adjoining property v. Failure of timber lintels due to the span of the doors and windows (spans too wide) vi. Lack of bonding between old and newly added walls	Physical inspection and occupants account
Cracked cementious screed floor	i. Use of cementious screed only instead of mass concrete.	Physical inspection
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection

Building No: 13

Occupants: Tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets	Physical inspection and occupants account
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets iv. Failure of timber lintels due to the span of the doors and windows (spans too wide) v. Lack of bonding between old and newly added walls	Physical inspection and occupants account
Cracked cementious screed floor	i. Use of cementious screed instead of mass concrete. ii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection

Building No: 14

Occupants: Tenants

Uses:

Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Sagged roof	Ageing and lack of maintenance	Physical inspection
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets iv. Use of walls for signage (products advertisement) v. Erection of entrance canopy	Physical inspection
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Introduction of burglar proofs and mosquito nets iv. Use of walls for signage (products advertisement) v. Erection of entrance canopy vi. Failure of timber lintels due to the span of the doors and windows (spans too wide) vii. Lack of bonding between old and newly added walls	Physical inspection and occupants account
Cracked cementious screed floor	Use of cementious screed instead of mass concrete.	Physical inspection and occupants account
Damp	i. Cementious render ii. Application of oil paint iii. Inappropriate remodelling v. Lack of ventilation vi. Underground moisture (capillary action) due to cracking of cementious floor screed. vii. Flooding caused by road rehabilitation	Physical inspection and occupants account
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection and occupants account

Building No: 15		
		
Occupants: Tenants		
Uses: Mix (commercial and residential)		
Key architectural features: Compound type comprising of 5 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows		
Defects	**Possible causes**	**Survey method / Evidence**
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Remodelling iii. Rain water from the roof of the adjoining a building in the adjoining compound	Physical inspection
Cracked adobe walls	i. Inappropriate remodelling ii. New electrical wiring iii. Introduction of burglary proofs and mosquito's screens iv. Lack of bonding between old and newly added walls	Physical inspection
Cracked cementious screed floor	Use of cementious screed instead of mass concrete.	Physical inspection and occupants account
Damp	i. Cementious render ii. Inappropriate remodelling iii. Lack of ventilation iv. Underground moisture (capillary action) due to cracking of cementious floor screed v. Rain water from the roof of the adjoining a building in the adjoining compound.	Physical inspection and occupants account
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection and occupants account

Building No: 16

Occupants: Land lord only

Uses:

Key architectural features: Compound type comprising of 4 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Eroded earth based render	i. Inadequate roof overhang ii. Neglect and lack of maintenance iii. Introduction burglary proof and mosquito's nets screens iv. Incompatibility of concrete block used for the construction of the adjoining building	Physical inspection
Cracked adobe walls	i. Inadequate roof overhang ii. Neglect and lack of maintenance iii. Introduction burglary proof and mosquito's nets screens iv. Lack of bond between the concrete blocks used for the construction of the adjoining building.	Physical inspection
Cracked cementious screed floor	i. Use of cementious screed instead of mass concrete. ii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection and occupants account

Building No: 17		
		
Occupants: Land lord		
Uses: Mix (commercial and residential)		
Key architectural features: Compound type comprising of 4 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows		
Defects	**Possible causes**	**Survey method / Evidence**
Eroded earth based render	i. Inadequate roof overhang ii. Neglect and lack of maintenance iii. Inappropriate remodelling iv. Incompatibility of concrete block used for the construction of the adjoining building v. Misuse	Physical inspection and occupants account
Cracked adobe walls	i. Inadequate roof overhang ii. Neglect and lack of maintenance iii. Inappropriate remodelling iv. Incompatibility of concrete block used for the construction of the adjoining building v. Misuse vi. Introduction of burglary proofs and mosquito's screens vii. Lack of bonding between old and newly added walls	Physical inspection and occupants account
Cracked cementious screed floor	i. Use of cementious screed instead of mass concrete.	Physical inspection and occupants account

Building No: 18

Occupants: Tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound type comprising of 6 blocks. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Inappropriate remodelling iii. Neglect and lack of maintenance iv. abrasion caused human and animal (goats) movements	Physical inspection and occupants account
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Inappropriate remodelling iii. Neglect and lack of maintenance iv. abrasion caused human and animal (goats) movements v. Introduction of burglary proofs and mosquito's screens vi. Lack of bonding between old and newly added walls	Physical inspection and occupants account
Cracked cementious screed floor	Use of cementious screed instead of mass concrete.	Physical inspection and occupants account
Damp	i. Inappropriate remodelling ii. Lack of ventilation iii. Underground moisture (capillary action) due to cracking of cementious floor screed	Physical inspection and occupants account

Buildings No: 19 and 20

Occupants: Tenants

Uses: Mix (commercial and residential)

Key architectural features: Compound types comprising of 5 blocks each. Adobe walls with cementious rendering, corrugated iron sheets roof, steel frame doors and windows

Defects	Possible causes	Survey method / Evidence
Cracked cementious render	i. Incompatibility of cementious rendering and adobe. ii. Inappropriate remodelling iii. Neglect and lack of maintenance iv. Introduction of entrance canopies v. Use of walls as signage for products and services advertisements	Physical inspection and occupants account
Cracked adobe walls	i. Incompatibility of cementious rendering and adobe. ii. Inappropriate remodelling iii. Neglect and lack of maintenance iv. Introduction of entrance canopies v. Use of walls as signage for products and services advertisements vi. Failure of timber lintels due to the span of the doors and windows (spans too wide) in building number 08 vii. Introduction of burglary proofs and mosquito's screens viii. Lack of bonding between old and newly added walls	Physical inspection and occupants account
Damp walls and floors	i. Incompatibility of cementious rendering and adobe. ii. Inappropriate remodelling iii. Neglect and lack of maintenance iv. Introduction of entrance canopies v. Use of walls as signage for products and services advertisements vi. Lack of ventilation vii. Underground moisture (capillary action) due to cracking of cementious floor screed viii. Moisture from water leaking from the plumbing pipes in buildings number 19 and 20	Physical inspection and occupants account
Cracked cementious screed floor	Use of cementious screed instead of mass concrete.	Physical inspection and occupants account
Basal erosion	Cementious rendering, lack of roof guttering and site drainage.	Physical inspection and occupants account

Appendix 1.3. Names and Profiles of the Building Professionals Interviewed in Sabon Gari

	Name	Profile
1.	Abdullahi Hammai	Hammai was an earth building mason but have to change to concrete block masonry due to lack of patronage.
2.	Abdullahi Nuhu	Nuhu is an Architect. He was born and bred in an adobe building in Sabon Gari. Although he no longer lives in an adobe building, he is still passionate of it. He has theoretical knowledge of earth construction and also acquired the practical experience living in Sabon Gari as a child.
3.	Adebisi Opadokun	Opadokun is a retire mason. He constructed buildings using both adobe and concrete blocks. He is from south west region but has lived in Sabon Gari for about 60 years.
4.	Ali Mohammed	Mohammed is an Architect, also born and bred in an adobe building in Sabon Gari. He has both theoretical and practical knowledge of adobe construction.
5.	Menson Dangana	Dangana place of work in Sabon Gari but live in a self built adobe building another part of the city. He also repairs his building whenever the need arises.
6.	Musa Abdulkarim	Abdulkarim is an employee of KASUPDA and a Town Planner by profession.
7.	Irmiya Samson	Samson is a Judge at the Kaduna State Rent Tribunal (a court established by the Kaduna State Judiciary to deal with rents related matters in the state).

Table I: Names and Profiles of the Persons Interviewed in Sabon Gari

1.4. Interviews Report

Appendix 1.4.1. Interview Guide for Building Professionals in Sabon Gari:

Session One: the adobe construction in Sabon Gari

1. Brief description of adobe construction in Sabon Gari

Session Two: the state of the adobe buildings in Sabon Gari

1. Description of the current states of the adobe buildings in Sabon Gari

1a. What is (are) the reason(s) for the current state of these adobe buildings?

1b. Reason(s) for the tenants, preference of the adobe buildings in Sabon Gari?

Session Three: Repair of earth buildings in Sabon Gari

1. Brief description of adobe building repair in Sabon Gari.
2. Suggestions (if any)
3. Repair or replace?

Appendix 1.4.2. Summary of Interviews Responses

1.4.2a. Summary of Abdullahi Hammai's Interviews Responses

Session One: According to Hammai the adobe buildings in Sabon Gari were constructed long before Nigerian independence[39] and as a consequence people of his own age cannot give account of how the buildings were constructed. However, Hammai have in the past constructed adobe buildings in other part of the city and had repaired some in Sabon Gari. He explained that the adobe blocks used for construction of these buildings are rectangular in shape. He explained that the system of adobe construction is the same as that of concrete, thus, the only difference is in material. He also explained that *azara* was used as lintels and roof trusses instead of timber. He further explained that some of the buildings originally have thatched roofs, while some have corrugated iron sheets, however, all the thatch have since been replaced with corrugated iron sheets.

Session Two: Hammai is not happy with the current state of adobe buildings in Sabon Gari, because according to him they are all in state of disrepair. He attributed the causes of the dilapidation of the adobe buildings in Sabon Gari to lack of maintenance culture and the inappropriate repair practices.

Hammai noted that these buildings are still in high demand despite their dilapidated conditions. He attributed this high demand to the strategic location of Sabon Gari and the convenience of using the buildings for both commercial and residential.

[39] Nigerian gained independence on the 1st October, 1960

Session Three: Hammai explained that the adobe buildings in Sabon Gari are being repaired by masons that do not have knowledge of earth construction. Consequently, inappropriate techniques and material are currently being used in the buildings repair.

Hammai is of the opinion that the adobe buildings should be repaired instead of demolishing and replacing.

Hammai suggested the traditional planned preventive maintenance instead of remedial intervention as the practice is nowadays.

1.4.2b. Summary of Abdullahi Nuhu's Interviews Responses

Session One: Nuhu explained that the rectangular adobe blocks were used in the construction of the adobe buildings in Sabon Gari using the same system as concrete block. He explained that the simple stretcher bond was used in laying the adobe block walls, azara was used for lintels and later plastered with earth mixture. He stated that thatch or corrugated iron sheets were the original roofing materials, however almost all the thatch have been replaced with corrugated sheets.

Nuhu noted that the popularity of adobe has transcended the northern Nigeria and it is now popular even in the south. Nuhu presented a picture he took a year earlier (2005) of an adobe building in Ogoja in Cross River State, south east Nigeria (see figure 4.6 in chapter four) where the traditional earth construction technique was wattle and daub to further justifies his argument. However, Nuhu is of the opinion that the popularity of adobe is due to poverty not out of choice. He argued that lower cost of construction and similarity to the preferred concrete block are the major reasons for this preference.

Session Two: Nuhu shares Hammai's view on the state of the adobe buildings in Sabon Gari. He however attributed this phenomenon to the dearth of repair skills, lack of materials within close proximity to Sabon Gari and the general nonchalant attitude to the care of earthen buildings in Nigeria. He also gave same reasons as Hammai for the preference of the adobe buildings, which are location and convenience for mix uses.

Session Three: Nuhu explained that the adobe buildings in Sabon Gari are repaired by masons with no knowledge of adobe construction using inappropriate technique and incompatible material (mostly cement). He is of the opinion that good repair practice could change people's negative perception of earth buildings in general. He however noted that the non availability of building earth in Sabon Gari could be a hindrance towards achieving appropriate repair, since the best practice is to use the original material for repair, which is the building earth.

Nuhu is also of the opinion that the adobe buildings should be repaired instead of demolishing and replacing them.

1.4.2c. Summary of Adebisi Opadokun's Interview Responses

Session One: Opadokun description of adobe construction is explicit and is explain as follows:

Material sourcing: The major material (building earth) used in the construction of the adobe buildings in Sabon Gari were mostly sourced according to Opadokun from two sites. The first is the present site were the stadium is presently situated (Ahmadu Bello Stadium) and the second is the present site of

ABU Teaching Hospital's staff quarters. He noted that donkeys, carts and motorised trucks were used, however the mode of transportation was later limited to the use of trunks. Similarly, the sourcing of material was later limited to the second site when the first was developed in the early 1960s. Sourcing of lateritic soil for other construction purposes continued on the second site till the late 1990s when the area was fully developed.

Straw and thatch were also sourced from adjoining areas that were yet to be developed. However, *azara* and corrugated iron were brought from local market. He explained that the *azara* was sourced from neighbouring villages, while the roofing sheets were imported. Opadokun further explained that timber was used for facial board and roof trusses in some buildings. The timbers were treated against termites using the insecticide with commercial name called 'Gamaline 20' according to Opadokun. He noted that this treatment do last up to 20 years before another treatment is required. He however noted that nowadays the insecticide is often diluted with kerosene which weakens its effects, thus no longer last up to 20 years.

Material preparation: Opadokun explained that building earth used to be prepared about a month or two ahead of time. Within this period the mixture are repeatedly mixed and covered with straw until it attained the desirable consistency for use.

Adobe construction method: Opadokun explained that both the traditional earth masons and the concrete block masons were used in the construction of the adobe buildings. He noted that the combination of expertise (i.e. traditional and modern) contributed to the distinctive style which is neither traditional nor modern. He however lamented that this fusion between the traditional and modern artisans is completely lost in Sabon Gari.

Opadokun recalled that the traditional masons were always happy to learn how to use new tools such as trowels, lines and spirit level from the concrete block masons. Similarly, the concrete block masons were also learning how to use earth from the traditional masons. He recalled that the traditional masons used to be thrilled with the function of the spirit level, which they called '*katako mai ruwa*', which literarily means '*a piece of wood with water*' in Hausa. The spirit inside the spirit level is referred as the water.

According to Opadokun roof construction starts 2 to 3 weeks after the adobe wall construction have been completed. This is to allow the masonry wall to dry and any defect amended before the roof construction.

Session Two: Opadokun is not happy with the current state of adobe buildings in Sabon Gari. He identified followings as the causes of the dilapidation of these buildings:

- neglect by both the tenants and landlords
- consistent remodelling
- use of incompatible material (i.e. cementious material) for repair and remodelling
- The practice of paying 1 or 2 years rent in advance, thus the tenants are always assured that they cannot be evicted once they paid no matter how the buildings are used.

Opadokun is of the opinion that the location and the advantage of mixed use of the adobe buildings are the reasons why people still prefer to rent these buildings.

Session Three: Opadokun noted that the adobe buildings in Sabon Gari are repaired and remodelled using incompatible material and unsympathetic techniques due to lack of knowledge and dearth of skilled artisans.

Opadokun is worried with the relationship between land lords and tenants on the issues of rents and responsibilities to the buildings repair. He therefore wants government (through the State's Rent Tribunal) to intervene by fixing maximum amount land lords can charge as rent and also stop the current practice of collecting 1 or 2 years rents at once. He also wants the government to be involved in training of masons for the repair adobe buildings using appropriate material and technique.

Opadokun stated that there is both immediate and long terms economic benefits of repairing these adobe buildings, thus he is of the opinion that they should be repaired instead replacing them.

1.4.2d. Summary of Ali Mohammed's Interview Responses

Session One: Mohammed explained that the rectangular adobe block was used in the construction of the adobe buildings in Sabon Gari. He noted that the difference between the adobe in Sabon Gari and the traditional *tubali* is in shape. He explained that adobe blocks in Sabon Gari were fabricated using the rectangular moulds made from timber, while *tubali* was hand moulded.

Mohammed however confessed that all the adobe buildings in Sabon Gari were constructed before he was born and he is 40 years old (in 2006). Thus, he is sure that none of the buildings are less than 40 years old, which attest to the durability of the material and technique used in the construction of the buildings.

Session Two: Mohammed is of the opinion that the current defects on the adobe buildings in Sabon Gari were as a result of uses of new material and technique during repair and remodelling. In his opinion, the original materials should always be maintained.

Mohammed noted that people (most especially the non indigenes from the southern states) preferred these adobe buildings despite their current states. He attributes this preference to location of Sabon Gari as the Central Business District, the relative peace and security in the area, as well as the conveniences for both business and as residential purposes.

Mohammed however noted that the popularity of adobe buildings in many part of Nigeria is due to poverty not out of choice. He is of the opinion that the current deplorable state of the adobe buildings such as in Sabon Gari is a factor for the negative perception that the technique is for the poor.

Session Three: Mohammed stated that the adobe buildings in Sabon Gari are rarely repaired. Remodelling is therefore common instead. He regretted that the remodelling are often carried out using cementious material, which is not compatible with earth. He noted that there is a limited knowledge of appropriate repair of adobe buildings in Sabon Gari because of the death of the traditional earth masons who in his opinion have the skills for repair of these buildings. As a consequence he is of the opinion that there is the need to train artisans because there is a big clientele already waiting.

Mohammed however noted that the non availability of building earth within close proximity to Sabon Gari could be a hindrance to appropriate repair. He however noted that with government intervention the material can be sourced at affordable cost. Furthermore, Mohammed suggested sensitisation and training as a means of changing people's negative perception.

Mohammed is of the opinion that repair is more advantageous than demolition and replacement, thus in support of repair.

1.4.2e. Summary of Menson Dangana's Interview Responses

Session One: Dangana's description of adobe construction in Sabon Gari did not differ much with that of Opadokun's. However, Dangana is of the opinion that adobe construction is very simple such that it does not require any specialised skill. He explained that he learned to build with adobe by watching others doing it as a child and he single-handedly built his house in Sabon Tasha (another area in southern part of Kaduna city).

Session Two: Dangana is not happy with the dilapidated states of the adobe buildings in Sabon Gari. He attributed the current state of disrepair to the nonchalant attitude of both the land lords and tenants. Dangana however predicted that the buildings will continue to be in high demand despite the conditions, because of the strategic nature of Sabon Gari, the low rental cost and the possibility of using the buildings for both commercial and residential purposes.

Session Three: Dangana stated that remodelling is common in Sabon Gari instead repair and maintenance of the adobe buildings. He noted that the buildings are often remodelled to accommodate new businesses or conversion from residential to commercial.

Dangana is of the opinion that repair of these buildings is more economically viable than the traditional maintenance. He argued that repair favours tenants than rebuilding, which will involve displacement of the occupants and the possibilities of rent increase or renting out to other tenants upon completion of the new building.

Appendix 1.4.3. Interview Guide on Building Repair Regulations in Kaduna State

1. What is the role of KASUPDA in the repair of adobe buildings in Sabon Gari?

2. What are the requirements for repair of adobe buildings in Kaduna State?

3. What is the role of KASUPDA on tenement issues in Kaduna State?

1.4.3a. Summary of Musa Abdulkarim's Interview Responses

Session One: According to Abdulkarim KASUPDA is a Kaduna State Government agency responsible for planning and development of the built environment in all the urban areas in the state. Thus, apart from the head office he in Kaduna (where this interview was conducted) KASUPDA have offices in all the major towns and cities in the state. Consequently, KASUPDA has a role to play in the repair of the adobe buildings in Sabon Gari just as any other building in the area. According to Abdulkarim all building repair irrespective of the material used in construction must be approved by KASUPDA, except for minor repair that will not affect the external fabric of the building and will not require additional utilities such as electricity, plumbing and telephone.

Session Two: Abdulkarim noted that there is no special requirement when seeking for approval for the repair of adobe building. He however noted that most of the applications are for new construction. Abdulkarim explained that because most of the people using adobe technique are generally very poor there is a general laxity by KASUPDA in enforcing the building regulations where the technique is being used and in its repair. Some of the justifications for KASUPDA's lack lustre attitude according to KASUPDA are: first, all adobe buildings are single storey thus not complicated to build and repair and this has minimal risk that even unskilled persons can manage effectively. Second, the adobe buildings are constructed without architectural and other related drawings, which are major requirements for planning application with the KASUPDA, and enforcing this on the people could becoming a hindrance to repair or owning a house.

Abdulkarim is of the opinion that adobe construction and repair should be left with the people, thus there should be no government interference just as the KASUPDA is currently doing. He stated that the leverage enjoyed by the people and the fact that soil are available within close proximity to the site at no cost encourages people to build with adobe in all the squatter settlement in Kaduna and other part of the State. The interviewer pointed out to Abdulkarim the negative consequences of unplanned settlements to an urban settlement, which included sub standard buildings, over congestion that could lead to spread of diseases, inadequate infrastructures due to overcrowding, etc. Abdulkarim noted that he is aware of these negative consequences. However, there is dare need by the people in urban settlements for accommodations (both residential and commercial), and in his own opinion it is only the through adobe construction and the waiver[40] accorded by KASUPDA that this requirement can be met in the state.

Abdulkarim however explained that KASUPDA ensures that all buildings are safe for human habitation through regular inspection by Zonal Inspectors of KASUPDA. Thus the city of Kaduna is divided into several zones, with each zone having designated inspectors that regularly inspects existing buildings and supervises those under construction. He stated that buildings that are considered not safe can be demolished on the order of KASUPDA. Furthermore, buildings that require approval before construction but were not approved are usually demolished by KASUPDA. Thus, he advises clients to always consult KASUPDA before embarking on projects, since not all services attract monetary charges.

Abdulkarim stated all building applications require the following:

- 3 copies of architectural drawings
- 3 copies each of structural, mechanical and electrical drawings (if required)
- application fee which is determined by the size of the project (e.g. a 2 bedroom house will attract less charges than 3 bedrooms)
- site analysis report

[40] Abdulkarim sees the KASUPDA's nonchalant attitude as a waiver that will allow the urban poor to own their own buildings.

- a written application stating the land lord’s intention

Session Three: Abdulkarim stated that although KASUPDA has the right to demolish or enforce repair of a building that is a threat to the lives of the occupants the agency have no right on any issues related to tenement even if it is obvious that the cause of the building deterioration is due to matter relating to tenement. He therefore referred the interviewer to the Kaduna State Rents’ Tribunal, which is the agency responsible for tenement related matters in the state.

Appendix 1.4.4. Interview Guide on Tenement Issues in Kaduna State

1. What is Rent Tribunal?

2. Do the Rent Tribunal’s activities include the adobe buildings in Sabon Gari?

3. What role can the Rent Tribunal play in the current impasse between the land lords and tenants of the adobe buildings in Sabon Gari?

1.4.4a. Summary of Irmiya Samson’s Interview Responses

Session One: According to Samson (the tribunal Judge) the Rent Tribunal is a judicial arm of the Kaduna State’s Ministry of Justice established to deal with cases relating to tenancy in the state. The tenancy issues that the tribunal deals with includes disputes between land lords and tenants, defaults in paying rents, unjustified or arbitrary increase of rents, forced eviction, use of buildings by tenants for purposes other than those in the tenancy agreement, etc.

Session Two: According to Samson the Rent Tribunal is for all occupants of rented buildings and their owners irrespective of the material or construction technique.

Session Three: Samson explained that the law exists which protects both land lords and tenants against any form of injustice relating to rented buildings including the adobe buildings. However, many people are not aware of the law or the tribunal, while some that are aware are often not keen in reporting matters even when faced with injustice. Thus the law can only take its course if reported to the tribunal.

Samson however noted that the literacy level of the majority of the adobe building occupants (both land lords and tenants) are hindrance to the understanding of the tenement laws and the use of the tribunal for resolving disputes. He therefore advocated for the translation of the law from English to the 3 major Nigerian languages (Hausa, Igbo and Yoruba) to facilitate dissemination.

Appendix 1.4.5. Adobe Building Occupants’ Interview Guide

1. What is (are) the major reason(s) living in an adobe building?

2. Do you have any tenement agreement?

3. Do you face any problem with the tenement agreement or lack of it?

4. What is (are) the problem(s) with the repair of these adobe buildings?

5. Are you contented living in an adobe building?

6. Do you want this building repaired?

7. Have this building been remodelled?

8. Was KASUPDA consulted before the remodelling?

9. Repair or replace?

1.4.5a. Summary of the 36 responses (10 land lords and 26 tenants)

Session one: The following as the major reasons were given by the tenants and land lords for living in an adobe building:

I. 21 of the 26 tenants (80.77%) interviewed gave the low cost of rent as the reason for living in these adobe buildings

II. Both the land lords (10) and tenants (26) gave the location of Sabon Gari as another reason for living in these adobe buildings.

III. The better thermal comfort of the adobe buildings is another reason given by the 21 tenants.

IV. Over congestion of buildings made of concrete such that more people shares utilities such as toilets and kitchen is another reason given by 1 of the tenants interviewed. The same tenant also explained that the room sizes in the adobe buildings are bigger than those made from concrete, which makes the adobe buildings more comfortable.

V. One of the occupants Hamza Magaji (the only person that consented for his name to be included in this interview report) living in his parent's house stated that the non indigenes (i.e. those that are not the native of Kaduna State) prefer the adobe buildings in Sabon Gari because they never planned to live permanently in Kaduna. Thus, they prefer to live and carry out their business in one building, which saves them money apart from the convenience.

Session two: All the 26 tenants and 10 land lords interviewed stated that no tenancy agreement was signed when they (tenants) move into the adobe buildings. Thus, the agreement on rental fee was verbal.

Session three: All the 26 tenants and 10 land lords interviewed stated that dispute between tenants and land lords. However, 18 tenants and the 10 land lords stated that the disputes are always resolved among the tenants and the land lords without the involvement of any third party. 8 tenants however stated that the land lords always explore the lack of tenement agreement and the desperation of the tenants by increasing the rents arbitrarily and not maintaining the building.

Session four: The 26 tenants stated that repairs are seldom carried out on the adobe buildings, while the 10 land lords stated that repair are usually carried out whenever necessary. 5 of the land lords complained of high cost of building material (cement and roofing sheets) and the low rents charges as the hindrance for the repair of the buildings. On the other hand the 26 tenants accused the land lords of greed and the fact that the land lords are aware of the people's desperation for accommodation in Sabon Gari irrespective of the building's condition.

Session five: All the 36 respondents are contented living in these adobe buildings. However, 17 are still of the opinion that adobe building is for the poor.

Session six: The 10 land lords stated that the adobe buildings can remain unrepaired as long as the tenants are not complaining, while the 26 tenants interviewed wants the buildings repaired. They all pointed out one of two places in need of repair, e.g. rendering of walls, mending of cracks, replacement of missing facial board, mending of leaking roof, etc. However, the 26 tenants are of the opinion that any repair will attracts increase in monthly rents by the land lords. They all complained that the land lords indirectly make them pay for repair using various means. One of the indirect strategies adopted by the land lords according to the tenants is that they can be asked to pay an additional 6 months or a year rent at once depending on the cost of repair, so that the land lord will use the money for repair. They however lamented that the land lords always increase the rents after the repair. And the tenants will be expected to pay the extra increase on monthly basis after paying 6 months or a year in advance. As a consequence the 26 tenants stated that they hardly report any defects or ask the land lords to carry out repair.

One of the tenants complained that after repeated complaints to his land lord to replace a broken window, he was forced to bear the cost when the land lord refused to act despite the obvious fact that his room was no longer secured. However, he has preserved the old window and promised to remove the new one and fix the old whenever he is moving out of the house. The structural effect of such action to the adobe walls was pointed out to this tenant. He confirmed that he is aware of the implication but that does not bother him.

All the 36 respondents are confident that the buildings will not collapse despite the lack of repair. They stated that the roofs of the adobe buildings in Sabon Gari provide adequate protection against rain which is the major cause of adobe building collapse. They are of the opinion that the roofing system is the reason why no adobe building has ever collapse in Sabon Gari despite the lack of repair.

Session seven: All the 36 respondents stated that their adobe buildings (20 in number) have all undergone remodelling at one point or the other.

Session eight: All the 36 respondents admitted that KASUPDA was not consulted before carrying out the remodelling.

Session nine: All the 36 respondents opposed the demolition and replacement of the adobe buildings. They are all of the opinion that repair is the only viable option. The 26 tenants are of the opinion that landlords should responsible for the adobe buildings repair, while the 10 land lords stated that the tenants should finance the cost of repair since they are responsible for the deterioration of the buildings.

APPENDIX 2:

FIELD SURVEY 2 (CECTech, ZARIA, OFFA AND AKAMKPA INTERVIEWS AND BUILDINGS CONDITION SURVEYS) DATA

Appendix 2.1. CECTech Interviewees' Profiles:

	Name	Profession / Position	Qualification and experience in Earthen Architecture
1.	Valentine Ogunsusi	Architect / Director of CECTech since 1992	Obtained a Masters' Degree (DPEA) in Earthen Architecture in 1991 from the Grenoble School of Architecture, France. He has been the Director of CECTech since the establishment of the Centre in 1992.
2.	Peter Kolawole	Architect (CECTech's staff since 1992)	Attended intensive courses on Earthen Architecture at the Grenoble School of Architecture, France. He is involved in all the CECTech's activities including co-authoring all the centre's publications.
3.	Linus Nnok	Civil Engineer (CECTech's staff since 1992)	Attended intensive courses on Earthen Architecture at the Grenoble School of Architecture, France. He is involved in all the CECTech's activities including co-authoring some of the centre's publications.

Table IIa: Profile of Interviewees at CECTech

Appendix 2.1.1. CECTech Interview Guide

Session One: CECTech's Main Activities

1. What are the Centre's main areas of activities?
2. What is (are) the driving force(s) for the choice main area of activities?

Session Two: CECTech's Research Activities on the Rectangular Adobe Blocks Technology

1. Have CECTech ever carry out research on buildings constructed with the rectangular adobe blocks in Nigeria?

1a. If yes what is (are) the title(s) of the research?

1b. Is the research published?

1c. If yes, kindly name where the research is published

2. Have CECTech ever carry out construction project using the rectangular adobe blocks in Nigeria?

2a. If yes, what is (are) the title(s) of the project(s)?

2b. Is (are) the project(s) published?

2c. If yes, kindly name where the project(s) is (are) published:

3. Have CECTech ever carry out research on the repair of buildings constructed with the rectangular adobe blocks in Nigeria?

3a. If yes, what is (are) the title(s) of the research?

3b. Is the research published?

3c. If yes, kindly name where the research is published:

4. Have CECTech ever carry out repair of buildings constructed with the rectangular adobe blocks in Nigeria?

4a. If yes, where (location(s))?

4b. Is (are) the project(s) published?

4c. If yes where?

Session Three: Inquiry on Individuals and Organisations

1. Do you know any organisation(s) that have carried out research on buildings constructed with the rectangular adobe blocks in Nigeria?
2. If yes, what is (are) the name(s) and address(es) of the organisation(s)?
3. Do you know any person(s) that have carried out research on buildings constructed with the rectangular adobe blocks in Nigeria?
4. If yes, what is (are) the name(s) and address(es) of the individual(s)?

Session Four: Inquiry on Traditional Areas in Urban Settlements with Buildings Constructed of Earthen Material

1. Kindly suggests towns or cities in Nigeria with significant quantities of buildings constructed of earthen material:

Appendix 2.1.1: Summary of the Interviews

2.1.1a. Summary of Valentine Ogunsusi's Interview Responses

Session One: According to Ogunsusi (Director of CECTech), the centre was established in 1992 with the financial assistance from the French Government through its Embassy in Nigeria and the technical support from another French organisation CRATerre based at the Grenoble School of Architecture, France. Ogunsusi stated that CECTech was established with aim of promoting the use of earth for construction of contemporary buildings in Nigeria, most especially residential buildings. According to Ogunsusi the centre was established at the time when Nigeria was facing acute shortage of residential buildings in its urban settlements due to dwelling economy. Thus, the initial CECTech's target was to encourage the Government and Housing Associations in Nigeria to use the CEB to construct houses for the low income group in Nigerian urban settlements at cheaper cost. The justification for the adoption of CEB technology instead of the traditional technique or the rectangular adobe block is that there was (and still is) stigmatisation of non stabilised earth technique in Nigeria. Furthermore, the conventional concrete block (sandcrete blocks) was becoming too expensive that even the rich were struggling to afford it. Thus CEB was conceived as an intermediate technique that posses the advantages of both unstabilised earth and the conventional concrete, but cheaper than the concrete construction. As a consequence the major area of activities of CECTech is the CEB technology.

Session Two: Ogunsusi stated that the Centre carried out a study of the earth construction in Plateau state and from the study it was identified that the rectangular adobe blocks have replaced the traditional *tubali*. The research was published in Ogunsusi, et al., 1994: 29 to 32 (see references list).

Furthermore, CECTech have constructed some buildings using the rectangular adobe building in Jos and Kaduna. Notable of these buildings are the exhibition pavilion at the trade fair complex in Kaduna and the demonstration building at MOTNA in Jos. Similarly, other buildings were constructed using the combination of CEB and the rectangular adobe blocks. However, the centre has neither carried out repair nor research on the repair of building constructed with the rectangular adobe blocks.

Session Three: Ogunsusi is not aware of any organisation in Nigeria that has carried out research on buildings constructed with the rectangular adobe blocks. However, he knows three individuals that have carried out doctorial (PhD) research on traditional Nigerian Architecture. Nsude (one of the researchers) later explained that none of the three delve into adobe blocks. (The three theses were briefly summarised in chapter two).

Session Four: Ogunsusi suggested 11 towns that have significant quantity of earth buildings. 7 of the 11 towns are in the north, 2 from the south west and 2 from south east. The names of the towns suggested are as follows:

- North: Zaria, Kano, Daura, Katsina, Funtua, Rano and Hadeja
- South west: Offa and Owo
- South east: Akamkpa and Bekwarra

2.1.1b. Summary of Peter Kolawole's Interview Responses

Session One: Kolawole's responses on the CECTech's history and main area of activities are in agreement with those of Ogunsusi's (above). He further emphasised that the traditional earth construction techniques are no longer feasible in urban settlements in Nigeria. He argued that the heterogeneous nature of urban settlement makes it impossible to replicate traditional techniques. He further pointed out that the rectangular adobe blocks although popular, are mainly used by those that could not afford the concrete blocks. He is therefore of the opinion that CECTech's strategy of promoting CEB as cheaper and viable alternative is appropriate.

Session Two: Kolawole's responses on the CECTech's research activities on the rectangular adobe blocks technology are the same with those of Ogunsusi's.

Session Three: Kolawole is not aware of any organisation that has carried out research on buildings constructed with the rectangular adobe blocks in Nigeria. He is also not aware of any individual that have carried out similar research, he however, refer me to the Director because he is not sure if there is any one.

Session Four: Kolawole suggested 10 towns that have significant quantity of earth buildings in Nigeria. 5 of these towns are from the northern region, 3 from the south west and 2 from the south east. The towns are:

- North: Zaria, Kano, Katsina, Daura and Sokoto

- South west: Offa, Owo and Akure
- South east: Akamkpa and Ogoja

2.1.1c. Summary of Linus Nnok's Interview Responses

Session One: Nnok's initially declined to respond to the question on the history and main activities of CECTech. His argument was that there is no point in interviewing him on this issue since the Director who is more knowledgeable than him has been interviewed. However, it was explained to him that the essence of interviewing him is to get more responses from the centre's staff and not to contradict any one. His response on this matter however turns out to be the same as those of Ogunsusi (Director) and Kolawole's. He also shares Kolawole's opinion that CEB is the only acceptable alternative of earth construction that CECTech can promote in Nigeria.

Session Two: Nnok's responses on CECTech's research activities on the rectangular adobe blocks are the same as Ogunsusi and Kolawole's.

Session Three: Nnok's responses on both organisations and individuals that have carried research on buildings constructed with the rectangular adobe blocks are the same as Kolawole's (above), but he did not refer to the Director for further investigation.

Session Four: Nnok suggested 10 towns that have significant number of earth buildings in Nigeria. 6 are from the northern Nigeria, 2 from south west and 2 from south east. The names towns suggested are as follows:

- North: Zaria, Panshin, Panyam, Kano, Daura and Katsina
- South west: Offa and Akure
- South east: Akamkpa and Enugu

Appendix 2.2: Zaria City Interviewees' Profile

	Name	Profession	Experience in Earthen Architecture
1.	Salisu Jibrin Aminu	Architect / University lecturer	He was born in Zaria City and currently resides there. He grew up helping his parent during the annual maintenance of their earth building. He has published few articles and research papers on earthen architecture of Zaria City and traditional Hausa architecture.
2.	Ibrahim Waziri	Architecture student	He is a native of Zaria city. He was born and bred in Zaria City. He was involved in maintenance of their earth building as a child. He was also involved in moulding of adobe blocks construction of an additional room to accommodate when his uncle was about to get married.
3.	Mallam[41] Balarabe	Earth building mason / Farmer	Balarabe is a native of Zaria City where he lives in the inherited earth building with his family since he was born about 70 years ago (he is not sure of his actual age). He started his traditional earth mason's apprenticeship with his late father at about the age of six (not sure of the exact age). He continued working with his late father even after qualifying as a mason until the father's death about 30 years ago. Balarabe and his late father had a working group, which comprised of qualified masons and apprentices and they were also part of the guild of earth masons in Zaria City. He took over the leadership of this working group after his father's death. But the number of the group began to dwindle in the late 1980's and as at the year 2006 the group have seize to exist. Although Balarabe still practice as earth mason, he however acknowledged that the patronage is low, thus he supplements his income with farming.

Table IIb: Profile of professionals interviewed in Zaria City

[41] Mallam means Gentle Man, Learned Person or Mister (Mr.) in Hausa

	Name	Profession	Experience in Earthen Architecture
4.	Mallam Ibrahim	Earth builder / Farmer	He was born in Zaria City and is also a native the City. He became an earth building apprentice to his late Dad at about the age of six. He is a farmer during the rainy season and an earth building mason during the dry season. He has about 50 years' earth building experience
5.	Danjuma Shehu	Earth builder / Farmer	He was born in Zaria City and is also a native the City. He became an earth building apprentice to his late Uncle at about the age of five (his Father died when he was about a year old). He is a farmer during the rainy season and an earth building mason during the dry season. He has about 60 years' earth building experience.
6.	Mallam Garba	Earth builder / Farmer	He was born in Zaria City and is also a native the City. He earth building masonry from his senior brothers, uncles and father at about the age of five. He is a farmer during the rainy season and an earth building mason during the dry season. He has about 55 years' earth building experience.
7.	Mallam Bashir	Earth builder / Farmer	He was born in Zaria City and is also a native of the City. He learned earth building masonry by doing under the supervision of his late Dad and other male members of his extended family at about the age of six. He is a farmer during the rainy season and an earth building mason during the dry season. He has about 65 year' earth building experience.

Table IIb (continued from page 5): Profile of professionals interviewed in Zaria City

	Name	Profession	Position in the Family	Experience in Earthen Architecture
1.	Respondent A	Trader	Oldest male member of the family	Have little knowledge.
2.	Respondent B	School Teacher	Oldest literate member of the family	Have little knowledge.
3.	Respondent C	Butcher	One of the male member of the family	Can build with earth.
4.	Respondent D	Civil servant /	One of the male member of the family	Have little knowledge.
5.	Respondent E	Trader and farmer	Oldest male member of the family	Can build with earth.
6.	Respondent F	School Teacher	One of the male member of the family available for interview	Have little knowledge.
7.	Respondent G	Civil servant	One of the male member of the family agreed to be interviewed	Can build with earth.
8.	Respondent H	Farmer / Carpenter	Oldest male member of the family	Can build with earth.
9.	Respondent I	Blacksmith	Oldest male member of the family	Have little knowledge.
10.	Respondent J	Woodcarver / farmer	Oldest male member of the family	Have little knowledge.
11.	Respondent K	Farmer / Trader	One of the male member of the family	He use to be an earth building mason but quit due to lack of patronage
12.	Respondent L	Retired Soldier	One of the male member of the family	Can build with earth.
13.	Respondent M	Motorcycle Mechanic	One of the male member of the family	Have little knowledge.
14.	Respondent N	Civil Servant	One of the male member of the family	Have little knowledge.
15.	Respondent O	Trader	One of the male member of the family	Have little knowledge.
16.	Respondent P	Farmer / Trader	One of the male member of the family available for interview	Can build with earth.
17.	Respondent Q	Farmer / Carpenter	Oldest male member of the family	Can build with earth.
18.	Respondent R	Farmer / Trader	One of the male member of the family available for interview	Have little knowledge.
19.	Respondent S	Blacksmith / farmer	One of the male member of the family available for interview	Have little knowledge.
20.	Respondent T	Trader	One of the male member of the family available for interview	Have little knowledge.

Table IIc: Profile of representative of earth building dwellers interviewed in Zaria City

Appendix 2.2.1. Zaria City Interview Guide

Session One: Earthen architecture of Zaria City

1. Brief description of earth construction in Zaria City

1a. Is there any difference between the old and the new earth buildings in Zaria City?

1b. If yes, what is (are) the difference(s)?

Session Two: Interviewees' knowledge of earth building repair

1. Do you know how to repair earth building?

1a. If yes, do you carry out the repair of your earth building?

1b. If the respond to question 1 is no, how do you carry out the repair of your building?

2. Is (are) there difference(s) in the traditional and current repair of earth buildings in Zaria City?

2a. If yes, what is (are) the difference(s)?

Session Three: Repair of earth buildings in Zaria City

1. Brief description of earth building repair in Zaria City.

2.2.2. Summary of Interviews Responses in Zaria City

2.2.2a. Summary of Salisu Jibrin Aminu's Interview Responses

Session One: Aminu explained that *tubali* was used traditionally in construction of earth buildings in Zaria City. However, the rectangular adobe building has since replaced *tubali*. According to Aminu, the material and method of preparing both *tubali* and adobe are the same. The only difference however, is the shape. *Tubali* is hand moulded and pear shape, while adobe is moulded in a rectangular mould which gives it the regular rectangular shape.

Aminu explained that the method of preparing the earth for moulding the blocks and construction of the adobe building are still the same as it was traditionally. His step by step description of earth building in Zaria City is noted as follows:

- sourcing of building earth from burrowed pit (*kududdufi*) within the City wall or outside and straw from the field
- transportation of building earth using donkeys

- Spread of the straw along footpaths and nowadays on roads. The vehicular and human movements help in kneading the straw to workable size and texture suitable for use as reinforcement in building earth mixture
- the preparation of material was done traditionally months and some times a year ahead, usually at the beginning of dry season
- mixing of the earth and straw with water (traditionally for several weeks or months but these days for only two days)
- moulding of *tubali* and nowadays adobe blocks
- commencement of construction after curing of adobe by sun drying for about 2 weeks

Aminu is of the opinion that the change from *tubali* to adobe is inevitable for the following reasons:

- Emergence of rectangular concrete blocks that are assumed to be more durable and sign of affluence. Thus, adobe became the preferred choice for those that could not afford concrete blocks
- Emergence of corrugated iron sheets that are also assumed to be more durable than earth roof or thatch and not vulnerable to fire like thatch. This roofing sheet was also seen as a sign of affluence
- The corrugated iron roof does not require frequent maintenance as thatch or earth roofs. Similarly the overhangs of the corrugated iron sheets provide additional protection to the adobe walls and this further minimise the need for frequent maintenance.
- The change in climate that has resulted in change in rainfall pattern in Zaria City makes thatch and earth roofs more difficult to maintain. Thus, corrugated iron sheet is gradually becoming a necessity in Zaria City and this fits the adobe more than *tubali*.

Aminu further stressed that although cementious materials are nowadays preferred in Zaria City earth buildings are more comfortable to live in.

Session Two: Aminu stated that he has the theoretical knowledge of earth building repair but have no practical experience. He explained that the repair of their family building is usually carried out by one Mallam Balarabe a traditional earth building mason. Balarabe was also interviewed (see summary of his response below). Aminu further explained that the repair of both traditional and the adobe buildings are similar. He however stated that the application of cementious render have brought about a new challenge to the repair of these buildings.

Session Three: Aminu explained that the adobe buildings in Zaria City are rarely repaired until the building has reached almost the state of disuse or partial collapse. He attributed this trend to the application of cementious render, which is believe to be durable, thus requires no maintenance or repair. He stated that rebuilding and reapplication of cementious render are more common in Zaria City.

2.2.2b. Summary of Mallam Balarabe's Interview Responses

Session One: Balarabe's description of earthen architecture in Zaria City did not differ from Aminu's. He also in accord with Aminu on the reasons for the change from *tubali* to adobe, thus he is of the opinion that it is impossible to revive the use of *tubali* in Zaria City. Balarabe equally sees this change from *tubali* to adobe block as a great advancement in the field of earthen architecture in Zaria City. He is however not optimistic that earthen architecture in Zaria City will survive if the Nigerian economy improves, such that the cost of cement becomes affordable to all the inhabitant of the city.

Balarabe stated that the existing earth buildings in Zaria City are mostly rendered with cementious material, while those that cannot afford the cementious rendered hardly replace the earth render when due. As a consequence several of the earth rendered walls that still have earth roofs are eroded. He however noted that those buildings with corrugated iron roofs are protected from rain, thus the erosion of the earth render are minimal. He is of the opinion that the introduction of corrugated iron sheet is a significant factor for the survival of the earth buildings in Zaria City despite the general neglect and the use of inappropriate materials for repair and remodelling. Balarabe lamented the current practice of replacing earth buildings with concrete. He stated that the collapse of earth building is currently seen as an opportunity to replace it with concrete.

Session Two: Balarabe is one of the few remaining practicing earth building masons in Zaria City. He however lamented that remodelling is more common in Zaria City nowadays than the annual maintenance and repair. Some of the reasons for this phenomenon according to Balarabe include among others the lack of maintenance culture, the quest for the use of cementious material, the need for more accommodation due to increase in family size and changing needs (e.g. commercial activity), etc. He stated that patronage is very low and the number keeps decreasing annually. Thus, most of the repairs he carries out his, his family compound and those of his close friends.

Session Three: Balarabe explained that traditionally planned preventive maintenance was common however, this is no longer the case. According to Balarabe the application of cementious render is seen as a remedy for this annual maintenance. He however stated that this assumption is not true and the unfortunate implication of this action is the decay of earth buildings and lack of patronage of earth builders like him.

Balarabe stated that in the past every earth building owner was involved in construction, repair and maintenance of their building. And materials were prepared months ahead at the convenience of the building owners. Donkeys and carts were used to transport the earth from the burrowed pits to the sites. He added that these means of transportation are still in use in addition to wheel barrow and on rare occasions motorised trucks are used.

2.2.2c. Summary of Mallam Ibrahim's Interview Responses

Session One: Ibrahim's description of earthen architecture in Zaria City did not differ from Aminu and Balarabe's. He also sees the change as inevitable and a key to continuity of earthen architecture in Zaria City. He is however of the opinion that cementious material is preferred over earth, thus the continuity of earth construction depends on the economic situation in the city. He stated that only the poor that cannot afford cement, uses the earth to build.

Session Two: Ibrahim combines earth building masonry and farming to earn a living. He however acknowledged that he relied more on farming than earth construction because of low patronage.

Session Three: Ibrahim stated that most of the earth buildings in Zaria City are repaired using cementious material. He admitted that he also uses cementious material for earth building repair on the request of some clients. Ibrahim stated that there is a huge difference in the care of earth buildings when he was younger and nowadays. He explained that traditionally earth buildings were maintained annually and materials were sourced months or a year ahead. However, nowadays earth buildings are only repair when there is defect.

2.2.2d. Summary of Danjuma Shehu's Interview Responses

Session One: Shehu shared the same view with the previous respondents above on the earthen architecture of Zaria City.

Session Two: Shehu combines the earth building masonry work with farming just like Ibrahim (above) and for the same reason. He admitted that the house where he lives with his immediate and extended family is partly rendered with cementious material. He however acknowledged that the cementious rendered does not adheres to earth walls but it does not erode like earth based render. Shehu later admitted that the earth based render is more advantageous than the one made from cementious material. Shehu and the rest of the family members have abandoned the traditional periodic maintenance of their house as a result of the cementious rendered applied about 20 years ago (not sure of the exact year). He noted that the exterior walls use to be very damp during the rainy seasons but they use to dry up the damp by ensuring that the windows are always open and occasionally heat the room (using fire wood).

Session Three: Shehu explained that most of the repair carried out these days is as result of neglect (lack of annual maintenance) and other human factors e.g. inappropriate remodelling, wear and tear due to day to day activities, etc. He acknowledged that although annual maintenance will ensure that the earth buildings did not deteriorate, he however explained that this practice is no longer acceptable in Zaria City. He argued that people's perception of a building is that it should be durable to extent that it will not require periodic maintenance, hence the preference for cementious material. He however acknowledged that even the buildings rendered with cementious material have shown the need for periodic maintenance.

2.2.2e. Summary of Mallam Garba's Interview Responses

Session One: Garba description of earthen architecture in Zaria City is similar with the others already explained above. He also identified the major difference between the *tubali* and the adobe block techniques as the shape of the later which is due to the rectangular mould used in its fabrication.

Session Two: Garba is one of the few surviving earth building masons in Zaria City. He also combines this trade with farming to supplement his income. Garba acknowledged that apart from his house and those of few friends and relations people hardly commissioned him to repair their earth buildings.

Session Three: Garba explained that earth building owners in Zaria City have abandoned the traditional periodic maintenance for interventions such as repair and rebuilding. He noted that repair are carried out on deteriorated buildings, while those that partly collapsed or in verge of collapse are rebuild and in most instances using mixture of earth and cementious material. Garba explained that traditionally, earth buildings care was a continous process. Thus, material that are to be used the following year were gather after harvesting farm produce, mixed and covered with straw until the beginning of another rainy season a year after. This rigorous practice according to Garba is no longer feasible due to the socio-cultural change (i.e. from predominantly agrarian life to educated civil servants, traders, etc). He explained that only very few now know how to build with earth unlike before when every inhabitant of Zaria City was a builder. Thus, the repair of earth buildings requires the hiring of masons. To minimise the need for hiring masons annually, cementious material were used to render the building with the false believe that this rendering can minimise maintenance.

2.2.2f. Summary of Mallam Bashir's Interview Responses

Session One: Bashir description of earthen architecture in Zaria City agrees with others already explained above. He however, expressed the fear that earthen architecture is in the verge of extinction because of the preference of concrete buildings.

Session Two: Bashir explained that with the exemption of friends and close relatives people hardly commissioned him to repair their earth buildings neither do people construct new buildings using earth. He has also diversified to farming to supplement his earnings. He further explained that the use of corrugated iron sheet have minimised the need for maintenance, and on the other hand cementious render have resulted in the need for repair. He noted however that repair is seldom carried out until the building is in verge of collapse.

Session Three: Bashir explained that most of the repairs are carried out as a result of defects associated with neglect and inappropriate use of material (i.e. use of cementious material). He stated that unfortunately majority of repairs are still carried out using cementious material. The implication of this action to earth building mason is lack of patronage, except for the ones that cannot afford to use the cementious material.

2.2.2g. Summary of the Interview Responses of the 20 Earth Building Owners

The responses of the representative of 20 earth buildings surveyed in Zaria City are summarised in the following tables below.

<table>
<tr><th></th><th>Question</th><th colspan="3">Responses / Respondents</th></tr>
<tr><td></td><td colspan="4">Session One:</td></tr>
<tr><td>1a.</td><td>Brief description of earth construction in Zaria City</td><td colspan="3">Description in agreement with previous responses (All the 20 respondents)</td></tr>
<tr><td>1b.</td><td>Is there any difference between the old and the new earth buildings in Zaria City?</td><td colspan="3">Yes (All the 20 respondents)</td></tr>
<tr><td>1c.</td><td>If yes, what is (are) the difference(s)?</td><td colspan="3">Tubali was used traditionally while the rectangular adobe block is used nowadays (All the 20 respondents)</td></tr>
<tr><td></td><td colspan="4">Session Two:</td></tr>
<tr><td>1a.</td><td>Do you know how to repair earth building?</td><td colspan="2">No.
They questioned the rationale spending money on the repair of earth building (Respondents A, B, D, E, F, G, H, I, J, K, L, M, N, O, P, R, S and T)</td><td>Yes
(Respondents C and Q)</td></tr>
<tr><td>1b.</td><td>Do you carry out the repair yourself?</td><td colspan="2">Did not respond
(Respondents A, B, D, E, F, I, J, K, M, N, O, R, S and T)</td><td>No
(Respondents C, E, G, H, L, P and Q)</td></tr>
<tr><td>1c</td><td>How do you carry out the repair of your building?</td><td colspan="2">Uses professional earth masons (Respondents D, O and T)</td><td>Uses the conventional (concrete) masons (Respondents A, B, C, E, F, G, H, I, J, K, L, M, N, P, Q, R and S)</td></tr>
<tr><td>2.</td><td>Is (are) there difference(s) in the traditional and current repair of earth buildings in Zaria City?</td><td colspan="2">Do not know
(Respondents A, B, D, E, F, I, J, K, M, N, O, R, S and T)</td><td>Yes
(Respondents C, E, G, H, L, P and Q)</td></tr>
<tr><td>2a.</td><td>If yes, what is (are) the difference(s)?</td><td colspan="2">Did not respond
(Respondents A, B, D, E, F, I, J, K, M, N, O, R, S and T)</td><td>Periodic maintenance was the traditional practice. Repair, remodelling and rebuilding are common nowadays. (Respondents C, E, G, H, L, P and Q)</td></tr>
<tr><td></td><td colspan="4">Session Three:</td></tr>
<tr><td>1.</td><td>Brief description of earth building repair in Zaria City</td><td>Have limited knowledge, thus cannot describe (Respondents M, N, O, R and S)</td><td>Planned preventive maintenance was the practice traditionally. Remedial action is the practice nowadays. (Respondents C, G, H, L, P and Q)</td><td>Reapplication of cementious render (Respondents A, B, D, E, F, I, J, K and T)</td></tr>
</table>

Table IId: Summary of key points from the interview responses of 20 earth building occupants in Zaria City

2.2.3. Brief Description of the Earth Buildings Surveyed in Zaria City

20 compounds with earth buildings were randomly selected and surveyed. 15 of these buildings were constructed with the tubali, while the remaining 5 are of rectangular adobe blocks. All the 20 compounds surveyed are inhabited by members of an extended family and as a consequence there is tendency that remodelling will continue as the family size increases mostly due to marriages. 12 of the buildings have cementious rendered. All the buildings with cementious render have visible sign of dampness, fungi growth and cracks.

All 20 compounds have buildings covered with corrugated iron sheets, earth and or thatch. The buildings with earth roofs showed more signs of deterioration on its walls. For example, the buildings with corrugated iron sheets and earth render did not erode as those with earth roof despite the fact that both types were hardly maintained.

Basal erosion was noted in 16 of the buildings. The possible causes of the erosion was identified as lack of drainage around the building, human and animal activities, inappropriate use of material and construction of plinth (*dakali*) that were used for sitting. The effect of *dakali* on earth walls was more noticeable were the *dakalis* were rendered with cementious material.

All the 20 compounds have undergone various remodelling, which were visible from the varying colours of layers of the material used at various times. The older buildings were constructed with *tubali*, while the newer ones were of the rectangular adobe blocks. The earlier mentioned corrugated iron sheets are another effect of remodelling. Defects were noted where cementious material was used in the remodelling. Similarly, defects were also noticed where the corrugated iron sheets projects on unprotected earth walls (most especially fences).

Although the effect of cementious render is obvious and visible however, it was noted that this has become a common phenomenon. This is because various layers of cementious render that were applied at various times were noted in 12 buildings. This is an indication that fresh cementious render were applied whenever the previous failed.

2.2.3a. Brief description of adobe blocks moulding in Zaria City

The author was able to observed Shehu and Garba (both are from the same extended family) moulding the adobe blocks and the following were noted:

Sourcing of material: According to Shehu and Garba the building earth was sourced from the nearby borrowed pit a day earlier and was transported to the site on the back of donkeys owned by the two (each owning one). According to the two persons, the soil was free and since they owned the donkeys they don’t have to pay for transportation. They acknowledged that donkey is a major means of transporting building materials and farm produce in this community. The straw was also sourced about 2 weeks earlier from the nearby fields and their farms and brought to the site using the same means of transportation.

Preparation of material: The straw was softened by spreading it on foot paths and walk ways adjoining the site. Humans and animals impact as the straw is being trampled upon soften it to the required texture for the block moulding. Shehu and Garba explained that traditionally major footpaths were preferred, because of heavier traffic. However, this is presently not allowed on major roads in the city, thus the practice is limited to inner access roads, walkways and foot paths. They further pointed out that due to time limitation some people prefer to use their bare hands to chop the straw the same day it is to be used. When asked of the implication of this change, they pointed out that using longer straw can affect the quality of the blocks.

Mixing of the building earth: The building earth was brought to the site in lumps, which was then broken down into almost granular state using hoes. Water was then added to the dried soil and consistently mixed using both legs until the mixture turns to a pasty like dough. This mixture was then spread using hoe and straw was added. Finally, additional water was added to this mixture and another round of rigorous mixing with legs complete the mixing process. According to Shehu and Garba the consistent kneading and addition of water at every remixing accelerates the process of straw decomposition and bonding. They concluded that the more the number of remixing and the longer the interval between one mixing and the next, the better, the quality of the adobe. Unfortunately, two acknowledged that nowadays mixing is down only twice and in many instances on the same day that the material is to be used.

Moulding of adobe: The ground where the adobe block was moulded was first of all cleared and levelled. The area set aside for demoulding and curing of the blocks was sprinkled with water and the wooden moulds as soaked in water. According to Shehu and Garba the wetting of the ground before moulding is to reduce rapid dehydration that can results in intolerable cracks on the blocks. To produce the adobe block the rectangular wooden mould was first of all lubricated with water, by dipping into water reservoir, to ensure easy demoulding of the earth mixture. The mould was then filled with a sufficient quantity of semi-solid[42] lump, flattened and compacted by hand to make sure that all the voids are being filled with the pasty mixture, before demoulding. Shehu and Garba explained that sand or oil can also be used for lubrication of the mould where water is scarce. The moulded adobe block is sun-dried for minimum of one week before use.

Mixing ratio: There is no standard measurement for the quantity of water and straw that were added to the earth. The whole process requires experience to get it right. The block moulders explained that they acquired the skill from their parents. They began assisting their parents in soil preparation as young as they could remember. They could not remember their exact age then. They however, noted with regret that their children's generation are missing out from acquiring this experience because they have to go school. When reminded that the children can still participate in earth construction during holidays and over the weekends (Saturdays and Sundays), they pointed out that earth construction is seasonal and the season does not fall in to the school holidays. Furthermore, the weekends are mostly used by the children to assist in cleaning and in doing other domestic chores.

Production rate: The quantity of blocks produce per day depends on the skill of moulders. The two block moulders differ in their responses. The first respondent said he can produce between 800 and 1000 blocks per day, while the second said he can produce 600 to 800 in a day with the help of one experienced assistant. The other three masons interviewed also gave ranges of between 600 and 1000 blocks per day. Thus, it assumed that two person can produced between 600 to 700 blocks per day by a team working 8 hours per day (i.e. 75 and 87 blocks an hour).

[42] Semi-solid: Pasty mixture for easy moulding and demoulding.

Block size: Although the size of adobe block varies, however, the use of rectangular mould ensures that the blocks within a particular site are of the same size. The size of the being moulded is 450 x 300 x 100 mm. Other sizes of adobe blocks noted in Zaria City are 500 x 450 x 150 mm; 450 x 300 x 100 mm and 400 x 300 x 100 mm (L x B x H).

Appendix 2.3: Profile of respondents in Offa

	Name	Status / Profession	Experience in Earthen Architecture
1.	Sunday Adeleke	Cob building owner / Teacher	None of the 6 respondents have knowledge of cob building.
2.	Yunusa Bamidele	Cob building owner / Trader	
3.	Respondent A	Cob building owner / Accountant	
4.	Respondent B	Cob building owner / Police Officer	
5.	Respondent C	Cob building owner / Mechanical Engineer	
6.	Respondent D	Cob building owner / Geologist	
7.	Niyi Shogo	Quantity Survey	Have theoretical knowledge of earthen architecture. Acquired the knowledge through oral dissemination from paternal grandfather when writing a degree dissertation.

Table IIb: Profile of respondents in Offa

2.3.1. Offa Interview Guide

Session One: Earthen architecture of Offa

1. Brief description of earth construction in Offa

1a. Is there any difference between the old and the new earth buildings in Offa?

1b. If yes, what is (are) the difference(s)?

Session Two: Interviewees' knowledge of earth building repair

1. Do you know how to repair earth building?

1a. If yes, do you carry out the repair of your earth building?

1b. If the respond to question 1 is no, how do you carry out the repair of your building?

2. Is (are) there difference(s) in the traditional and current repair of earth buildings in Offa?

2a. If yes, what is (are) the difference(s)?

Session Three: Repair of earth buildings in Offa

1. Brief description of earth building repair in Offa.

2.3.2. Summary of the Interview Responses in Offa

The responses of the interview in Offa are summarised in the following tables below.

	Question	Responses / Respondents		
	Session One:			
1a.	Brief description of earth construction in Offa	Cob technique was used traditionally in Offa. However, earth construction is no longer popular (All the respondents)	Use of palm oil as stabiliser. But no longer economically viable s due to high demand for human consumption. (**NS**)	Cob building is no longer relevant in Offa, thus only few people like us (Adeleke) that cannot afford concrete building that are still living in earth building (**SA**)
1b.	Is there any difference between the old and the new earth buildings in Offa?	No (All the respondents)		
1c.	If yes, what is (are) the difference(s)?	Response not required		
	Session Two:			
1a.	Do you know how to repair earth building?	No. (**SA**, **YB** and Respondents **A**, **B**, **C** and **D**)	Yes (**NS** have theoretical knowledge)	
1b.	Do you carry out the repair yourself?	No. (All the 7 respondents) None of the 6 cob building owners could remember when the buildings were last repaired		
1c	How do you carry out the repair of your building?	Will use conventional (concrete) masons whenever repair is to be carried out (All 6 cob building owners)		
2.	Is (are) there difference(s) in the traditional and current repair of earth buildings in Offa?	No. (All the 7 respondents)		
2a.	If yes, what is (are) the difference(s)?	Response not required		
	Session Three:			
1.	Brief description of earth building repair in Offa	Have limited knowledge, thus cannot describe (**SA**, **YB** and respondents **A**, **B**, **C** and **D**)	The cob buildings in Offa are hardly repaired. It has become common practice to either reconstruct a defect cob building using cementious material or to repair using cementious material. Reasons giving for this practice are: lack of knowledge, dearth of traditional masons and non availability of building earth within the city. **Suggestion:** The need for more awareness through public lectures and training (**NS**)	
KEY: SA = Sunday Adeleke, **YB** = Yunusa Bamidele, **NS** = Niyi Shogo and Respondents **A**, **B**, **C** and **D** = 4 of the cob building owners that want to remain anonymous				

Table IId: Summary of key points from the interview responses in Offa

2.3.3. Brief Description of the Cob Buildings Surveyed in Offa

Most of the cob buildings in Offa are in dilapidated condition or abandoned. Consequently only 10 buildings that are still in use were surveyed. All the cob buildings in Offa including those abandoned have saddled ended roof with corrugated iron sheets. 4 of the cob buildings have cementious render, while 6 do not have. 3 of the buildings were originally roof with thatch and 2 of the owners explained that the thatches on their buildings were replaced with corrugated iron sheets more than 60 years ago. The remaining 7 buildings were all roofed with corrugated iron sheets from inception. Although there were no written records of any of the buildings, however the age ranges of the cob buildings were between 70 and 100 years according to their owners. However, these claims may be doubtful, most especially the 2 of the buildings that were said to be constructed with corrugated iron sheets roofs about 100 years ago. Thus, these shall be further clarified from literature on architecture history of Nigeria, in order to verify when the corrugated iron sheets were first introduced in Nigeria.

The system of roof construction was observed to be the key factor for the survival of these buildings despite the lack of care. The roof overhangs provided adequate protection to the cob walls. As a consequence, most of the buildings that have partially or completely collapsed are as a result of basal erosion. In order to stop the basal erosion, some of the buildings were reinforced at base with stone or concrete blocks in cementious mortar about 300 and 450mm above ground level. However, this has negative consequence. The cementious based plinths were noted to have accelerated the basal erosion in some of these buildings. Other defects noted in these cob buildings are horizontal cracks in-between lifts, vertical cracks close to the roof's tie beams and at the corners, basal erosion, and cracking of cementious render. The widths and heights of openings in the cob buildings are generally very small compare to those in concrete buildings, probably due to the limited effective span of lintels in cob.

As earlier noted the existing cob buildings in Offa are neither maintain nor repaired. Thus, the 6 cob building owners could not remember the year their buildings were last repaired. Consequently, none of the 6 has knowledge of the traditional repair methods. Niyi Shogo a Quantity Survey (QS) who is also a native of Offa was interviewed having realised that he have the theoretical knowledge acquired through oral dissemination by his paternal grandfather who was a traditional builder. According to Shogo (the QS) the traditional repair of cob buildings included the replacement of thatch roofs, cleaning of drainage around the buildings and reconstruction of eroded rammed earth plinths. He further explained that the cob walls were hardly repaired since the roofs and the based are adequately protected. His assumption was that the cob walls were only reconstructed not repaired whenever there was defects or failure. It was however noticed in some of the buildings that the colour and texture of the building earth differs from one side of the wall to another. This could be as a result of reconstruction at different times, which makes the soil to be different since they might have been from different source. Consequently different material composition and dates of construction are the factors for different colours of the walls. Thus Shogo's assumption may not be true.

Shogo explained that the eroded cob base was reconstructed by mixing the cob with palm oil and cow dung. He however expressed his doubt whether people will be able to afford stabilising cob with palm oil nowadays because of high demand for human consumption. A litre of palm oil cost about ₦10 in 2006 in Offa, which is affordable, however, this may be very expensive to be used as additive on cob buildings because the owners attached no value on them.

2.3.4. Cob Buildings Surveyed in Offa

2.3.4. Cob Buildings Surveyed in Offa

2.3.4. Cob Buildings Surveyed in Offa

Appendix 2.4: Profile of respondents in Akamkpa

	Name	Status / Profession	Experience in Earthen Architecture
1.	Respondent A	Earth building owner / farmer	All the 10 respondents have knowledge of wattle and daub construction. They personally constructed (self built) their houses using the technique.
2.	Respondent B	Earth building owner / trader	
3.	Respondent C	Earth building owner / trader	
4.	Respondent D	Earth building owner / blacksmith	
5.	Respondent E	Earth building owner / farmer	
6.	Respondent F	Earth building owner / farmer	
7.	Respondent G	Earth building owner / farmer	
8.	Respondent H	Earth building owner / welder	
9.	Respondent I	Earth building owner / carpenter	
10.	Respondent J	Earth building owner / farmer	
11.	Godwin. Nsude	Architect	Have theoretical knowledge of earthen architecture. His PhD thesis was on Traditional Igbo [43] Architecture
12.	Moses Oladele	Architect	Have theoretical knowledge of earthen architecture. Have designed and constructed 3 buildings using CEB technique
13.	Gabriel Akpan	Architect	Have theoretical knowledge of earthen architecture.
KEY: Respondents **A**, **B**, **C, D, E, F, G, H, I** and **J** = The wattle and daub building owners that want to remain anonymous			

Table IIe: Profile of respondents in Akamkpa

2.4.1. Akamkpa Interview Guide

Session One: Earthen architecture of Akamkpa

1. Brief description of earth construction in Akamkpa

1a. Is there any difference between the old and the new earth buildings in Akamkpa?

1b. If yes, what is (are) the difference(s)?

Session Two: Interviewees' knowledge of earth building repair

1. Do you know how to repair earth building?

1a. If yes, do you carry out the repair of your earth building?

1b. If the respond to question 1 is no, how do you carry out the repair of your building?

2. Is (are) there difference(s) in the traditional and current repair of earth buildings in Akamkpa?

2a. If yes, what is (are) the difference(s)?

Session Three: Repair of earth buildings in Akamkpa

1. Brief description of earth building repair in Akamkpa.

2.4.2. Summary of the Interview Responses in Akamkpa

The responses of the interview in Akamkpa are summarised in the following tables below.

[43] Igbo is the major ethnic group in south east Nigeria and their traditional buildings are predominantly of wattle and daub.

	Question	Responses / Respondents	
	Session One:		
1a.	Brief description of earth construction in Akamkpa	The traditional wattle and daub technique is still in use in Akamkpa. However, cementious material is currently preferred. Thus only the low income group still build with earth. (All the respondents)	
1b.	Is there any difference between the old and the new earth buildings in Akamkpa?	No (All the respondents)	
1c.	If yes, what is (are) the difference(s)?	Response not required	
	Session Two:		
1a.	Do you know how to repair earth building?	Yes, but questioned the rationale for repair. (All the earth building owners interviewed)	
1b.	Do you carry out the repair yourself?	No. (All the respondents) None of the wattle and daub building owners could remember when the buildings were last repaired	
1c	How do you carry out the repair of your building?	Will use conventional (concrete) masons whenever repair is to be carried out (All the building owners)	
2.	Is (are) there difference(s) in the traditional and current repair of earth buildings in Akamkpa?	No. (All the respondents)	
2a.	If yes, what is (are) the difference(s)?	Response not required	
	Session Three:		
1.	Brief description of earth building repair in Akamkpa	Only roofs are repaired. The walls are demolished and reconstructed instead of repair (all the building owners)	Traditionally wattle and daub buildings were periodically maintained by application of stabilised daub mixture. Periodic maintenance has now been replaced by demolition and rebuilding. (**GN**, **MO** and **GA**)
KEY: **GN** = Godwin Nsude, **MO** = Moses Oladele, and **GA** = Gabriel Akpan			

Table IIf: Summary of key points from the interview responses in Akamkpa

2.4.3. Brief Description of the Wattle and Daub Buildings Surveyed in Akamkpa

24 compounds were surveyed in Akamkpa. Each of the compound surveyed consist of detached rooms (sleeping areas), kitchen, toilet and a sit out all arranged in a rectangular plan around a central open space (courtyard). Compounds do not have perimeter fences in Akamkpa unlike in Zaria City where fence is an important and compulsory element of a residential building. The sit out defines the entrance to a compound in Akamkpa, which is always located in the front of the house. The sit out serves various social and economic functions ranging from place for family relaxation, area for entertaining guest, area for doing domestic chores (washing of plates, drying of food stuff, plaiting etc.); , trading stall, workshops (carving and blacksmithing), children's study area, etc.

16 of the 24 compounds surveyed have the sleeping areas constructed of concrete and the remaining part of the compound are of wattle and daub, while the remaining 8 compounds have wattle and daub buildings only. The survey was therefore limited to the wattle and daub buildings. All the buildings constructed in wattle and daub have gable ended pitched roofs made of either thatch or corrugated iron sheets. The qualities of the wattle and daub walls are generally very poor. However, the thatch (and in some corrugated iron sheets) roofs with wide overhangs and deep verandas, provide enough protection against excessive rainy and humid climate of the south east Nigeria.

Nsude, Oladele and Akpan (the 3 architects interviewed) described the construction of wattle and daub building as follows:

The building construction usually starts with the erection of the wattle wall frames and the roof structure all made from bamboo. Because rain falls all the year round in this part of the country, the roofs are thatch before the application of the daub, in order to protect the wet soil mixture. The roof is thatched using elephant grass, but traditionally raffia leaves were used. They explained that nowadays sleeping areas are roofed with corrugated iron sheet instead of thatch that is prone to fire.

According to Nsude, Oladele and Akpan as well as the building owners the wattle and daub walls are rarely repaired, while the thatch last up to between 3 and 5 years before maintenance is carried out.

Only 1 of the buildings has cementious render both internally and externally. 3 of the buildings have internal cementious render, with the external wattle daub wall exposed. The remaining 20 buildings have no render both internally and externally. The author initially thought that the wattle and daub building owners knew about the negative consequence of cementious render and that was why majority of the buildings have earth based render. However, this initial perception was wrong. The reason according to the people interviewed was that they are of the opinion that wattle and daub building are not worthy of rendering with such an expensive material as cement. They argued that they will rather demolish the wattle and daub building and replace with concrete instead of rendering with cement.

The buildings without the cementious render have eroded and expose the wattle reinforcements, most especially at the gable end of the walls. It was difficult to ascertain the performance of the building with internal and external cementious render because the rendering was recently applied (about a month before the survey), thus it was relatively dry. Furthermore, the building is use as a sit out and kitchen, thus the windows and doors are always open in addition to the constant heat from the fire wood use for cooking. Thus the adequate ventilation from the window openings and the heat generated from the fire wood use for cooking might have also contributed to the dryness of this building.

The walls have visible cracks and I was informed that this is the natural appearance of all the wattle and daub buildings in south east region due to the sandy nature of the soil in that region. Although there is a general bias towards the wattle and daub buildings in Akamkpa however, 10 of the 13 respondents stated that if they have to construct another building as at the time of the interview they will still use the same technique because it is the only cheaper and affordable alternative.

All the buildings were constructed by their respective owners (self built) and the material were sourced within the close proximity of the building sites at no cost. The lack of ability to quantity the cost of labour (since the buildings are self built) and material (since material are free) are the major factors why the wattle and daub buildings are never appreciated in Akamkpa, since they are of the opinion it cost nothing.

2.4.4. Wattle and daub buildings surveyed in Akamkpa

2.4.4. Wattle and daub buildings surveyed in Akamkpa

2.4.4. Wattle and daub buildings surveyed in Akamkpa

APPENDIX 3:

Summary of the Reviewed Terra Conference Papers

TERRA 2008 The 10th International Conference of the Study and Conservation of Earthen Architectural Heritage (TERRA), Bamako, Mali. 1st to 5th February, 2008. Proceeding edited by Rainer, L., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
1. Odiaua, I. (2010:120-123)	i. Recognition of traditional practices ii. Consideration for varying incentives	i. Use of traditional practices ii. Incentives for motivation	
2. Avrami, E. (2010:328-331)	Consideration of social, economic and environmental issues (sustainability)		
3. Pereira, H. N. (2010:247-252)	Laboratory testing of material	Use of tried and tested local material	
4. Nwankwor, N. A. (2010:239-246)	Laboratory testing of material	Use of tried and tested local and factory processed materials	
TERRA 2003 9th International Conference of the Study and Conservation of Earthen Architecture (TERRA), Yazd, Iran. 29th November to 2nd December, 2003. Proceeding edited by Vatandaust, A., et. al.			
Author	**Pre implementation strategy**	**Implementation strategy**	**Post implementation strategy**
1. Achenza, M. (2003:1-7)	i. Local capacity building and partnership ii. Technical collaboration	i. Use of local artisans ii. Onsite training	Networking
2. Alaamandour, M. (2003:10-21)	i. Historical investigation & evaluation ii. Local capacity building and partnership iii. improvising medium of communication iv. Condition survey		
3. Bell, J. S. and Boke, H. (2003:61)	i. Laboratory testing of material ii. Condition survey		
4. Iglesias, F. T. C. (2003:75-80)	Consideration of social, economic and environmental issues (sustainability)	Use of waste material	
5. Chiari, G., et. al. (2003:87-92)	Consideration of social, economic and environmental issues (sustainability)	Use of industrial waste material	
6. Goodarzi, M. A. (2003:197-200)		External environment as the focal point	
7. Guillaud, H. and Avrami, E. (2003:201)	Literature review		
8. Jayhani, H. R. and Omrani, S. M. A. (2003:542-561)	i. Recognition of traditional practices ii. Laboratory testing of material	Use of traditional practices	

TERRA 2003 9th International Conference of the Study and Conservation of Earthen Architecture (TERRA), Yazd, Iran. 29th November to 2nd December, 2003. Proceeding edited by Vatandaust, A., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
9. Stazi, A. (2003:542-561)	Laboratory testing of material		
10. Contreras, F. U. and Baca, L. F. G. (2003:599-606)	i. Local capacity building and partnership ii. Recognition of traditional practices	Use of traditional practices	
12. Jansen, M. (2003:309-318)	i. Setting of achievable and realistic aim ii. Condition survey iii. Recording & documenting	Recording & documenting	i. Long term preservation plan ii. Recording & documenting
13. Herdoiza, J. (2003:262-270)	Local capacity building and partnership	Partnership	Partnership
14. Ebrahimi, A. (2003:133-140)	Consideration for locally sourced materials		
15. Siyar, S. H. H. (2003)	i. Scientific understanding of material ii. Condition survey		
16. Langroudi, A. E. (2003:357-362)	Scientific approach towards the understanding of material		
17. Azad, M. (2003:31-47)	i. Literature review ii. Condition survey		
18. Azghandi, A. A. (2003:48-60)	Condition survey		Adaptation and reuse
19. Jerome, P., et. al. (2003:319-328)	i. Viability and environmental impact analysis ii. Recognition of traditional practices	Use of traditional practices	Adaptation and reuse
20. Mirjani, H. (2003:419-426)			Assessment, evaluation and rating after repair
21. Sikka, S. (2003:531-538)	Scientific understanding of material		
23. Mascarenhas, A.F.(2003:388-394)	i. Local capacity building and partnership ii. Institutional capacity building		
24. Cooke, L. (2003:102-109)	Consolidation and safeguarding before intervention		

TERRA 2003

9th International Conference of the Study and Conservation of Earthen Architecture (TERRA), Yazd, Iran. 29th November to 2nd December, 2003. Proceeding edited by Vatandaust, A., et. al.

Author	Strategies relevant to this thesis		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
25. Kukina, I. V., et. al., (2003:344-356)	Local capacity building	Onsite training	
26. Chaudhry, C. (2003:81-86)	Continous research		
27. Pandit, M. (2003:475-484)	Recognition of traditional practices	Use of traditional practices	
28. Kanan, M. I. (2003:334-343)	i. Generation of fund through external source(s) ii. Recognition of traditional practices iii. Local capacity building iv. Technical collaboration v. Condition survey	i. Use of traditional practices ii. Technical collaboration	i. Production of compendium for local artisans ii. Technical collaboration

The following papers below were reviewed but are not related to the thesis' subject.

29. D'Aragon, J. (2003:120-127)	48. Izumida, H. (2003:303-308)
30. Flores, R. A. and D'Aragon, J. (2003:128-132)	49. Schijins, W. (2003:504-512)
31. Solaymani, F. and Ghamaria, N. (2003:539-541)	50. Kamaladdin, S. M.B. (2003:329-318)
32. Mandegari, K. (2003:371-376)	52. Helwing, B. (2003:255-261)
33. Maniatidis, V. and Walker, P. (2003:377-387)	53. Imankulov, J. and Tentieva, A. (2003:593-598)
34. Mohammadi, M. R. N. (2003:427-439)	54. Vladimir, K. (2003:612-615)
35. Munteanu, S. (2003:440-445)	55. Walls, A. and Quarme, G. (2003:630-655)
36. Talebian, M. H. (2003:562-574)	56. Fadaii, H. (2003:141-166)
37. Talebian, M. H. and Ebrahimi, A. (2003:575-582)	57. Gupta, D. (2003:170-183)
38. Hossein, S. and Seyed, H. (2003:271-292)	58. Orazi, R. and Colosi, F. (2003:465-474)
39. Clark, D. and Walker, P. (2003:93:101)	59. Fodde, E. (2003:170-183)
40. Crocker, E. (2003:110-119)	60. Hurd, J. (2003:293-295)
41. Walker, P. (2003:616-629)	61. Okada, Y. (2003:451-456)
42. Falamaki, M. (2003:167-169)	62. Rafaty, M. (2003:485-491)
43. Claudia, N., et. al. (2003:395-414)	63. Reddy, B. V. V. and Walker, P. (2003:492-503)
44. Watanabe, K., et. al. (2003:656-665)	64. Valibeig, N. (2003:607-611)
45. Barbosa, N. P. *et. al.* (2003)	65. Schroeder, H., et. al. (2003:513-530)
46. Munteanu, S., et. al., (2003)	
47. Isik, B. (2003)	

TERRA 2000 8th International Conference of the Study and Conservation of Earthen Architecture (TERRA), Torquay, Devon, United Kingdom. Proceeding edited by Fidler, J., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
1. Fiero, K., et. al. (2000:31-38)	i. Defining realistic and achievable aim ii. Scientific understanding of material iii. Condition survey iv. Recording & documenting	Recording & documenting	i. Recording & documenting ii. Monitoring and evaluation
2. Oliver, A. B. and Hartzler, R. (2000:78-85)	Improvising medium of communication	Improvising medium of communication	
3. Jerome, P. (2000:144-149)	Scientific understanding of material		
4. Kanan, M.I. (2000:150-157)	Scientific understanding of material		
5. Lippe, H. (2000:158:160)	i. Local capacity building ii. Curriculum development	Onsite training	Introduction of certified courses
6. Mold, P. (2000:161-163)	Scientific understanding of material		
7. Taylor, M. R. (2000:189-194)	Recognition of traditional practices	Use of traditional practices	
8. Bedaux, R., et. al. (2000:201-207)	i. Inventory of buildings with the same character in the locality ii. improvising medium of communication iii. Recognition and use of traditional practices	Use of traditional practices	
9. Correira, M. and Merten, J. D. (2000:226-230)	Local capacity building	Onsite training	
10. Keefe, L., et. al. (2000:254-260)	Condition survey		
11. Botros, A. K. and Abdel-Mageed, W. S. (2000:276-278)	i. Local capacity building and partnership ii. Community as focal point	Onsite training	
12. Harries, R., et. al. (2000:319-321)	Recognition of traditional practices		
13. Warren, J. (2000:361-365)	Identification of period of construction		
14. Achenza, M. (2000:379-382)	i. Local capacity building ii. Technical collaboration	Onsite training	Technical collaboration
15. Rojas, E. and Crocker, E. (2000:419-425)	Local capacity building and partnership	Onsite training	

TERRA 1993 The 7th International Conference on the Study and Conservation of Earthen Architecture (TERRA). Silves, Portugal. Proceeding edited by Alcada, M., et.al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
1. Ahmed, I. (1993:52-57)	i. Reappraisal of intrinsic values ii. Community as focal point		
2. Marchand, T. H. J. (1993:108-111)	Recognition of traditional practices		
3. Das, S. K. (1993:145-147)	i. Recognition of traditional practices ii. Scientific understanding of material		
4. Puga, C.M. (1993:177-180)	Recognition of traditional practices		
5. Rua, C. and Rajer (1993:205-209)	i. Defining realistic and achievable aim ii. Scientific understanding of material iii. Recognition and use of traditional practices iv. Condition survey v. Prioritising and phasing vi. Generation of fund through external source(s) vii. Recording & documenting	Recording & documenting	Recording & documenting
6. Koumas, A. and Koumas, C. (1993:231-236)	i. Recognition of traditional practices ii. Condition survey		
7. Pujal, A. J. (1993:244-249)	i. Defining realistic and achievable aim ii. Condition survey iii. Prioritising and phasing iv. Consolidation and safeguarding before intervention v. Material recycling vi. Recording & documenting	Recording & documenting	Recording & documenting
8. Baca, S. (1993:256-261)	i. Local capacity building ii. Recognition of traditional practices iii. Consideration for monetary incentives iv. Community partnership v. Recognition and use of traditional practices	i. Use of traditional practices ii. Use of local labour	
9. Schijns, W. (1993:373-378)	i. Scientific understanding of material ii. Recognition of traditional practices	Use of traditional practices	

TERRA 1993 The 7th International Conference on the Study and Conservation of Earthen Architecture (TERRA). Silves, Portugal. Proceeding edited by Alcada, M., et.al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
10. Jerome, P. (1993:381-386)	Scientific understanding of material		
11. Politis, K. D. (1993:387:392)	i. Scientific understanding of material ii. Condition survey		
12. Guerrero de Luna, M. I. B. (1993)	Scientific understanding of material		
13. Baradan, B. (1993: 429-438)	i. Scientific understanding of material ii. Recognition of traditional practices	Use of traditional practices	
14. Taylor, M. R. (1993:590-596)	i. Interdisciplinary collaboration ii. Production of manual		i. Monitoring and evaluation ii. Curriculum development iii. Introduction of certified courses
15. Dassler, L., et. al. (1993: 597-604)	i. Questionnaire as data collection tool ii. Technical collaboration		Networking
16. Trappeniers, M. (1993: 605-611)	i. Technical collaboration ii. Institutional capacity building		Networking
17. Alva, A. and Houben, H. (1993:639-644)	i. Local capacity building ii. Production of manual iii. Technical collaboration		Networking

ADOBE 1990 The 6th International Conference on the Study and Conservation of Earthen Architecture (Adobe 90). Las Cruces, New Mexico, USA. Proceeding edited by Agnew, N., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
1. Bouwens, D. (1990:14-19)	Consideration of local materials		
2. Garrison, J. W. (1990:53-56)	i. Case studies ii. Identification of period of construction iii. Condition survey iv. Recording & documenting	Recording & documenting	Recording & documenting
3. Jiyao, H. and Weitung, J. (1993:72-76)	Recognition of traditional practices		
4. Kamamba, D. M. K.(1990:77-80)	Institutional collaboration		
5. Michon, J. L. (1990:99-104)	i. Inventory of buildings with the same character in the locality ii. Condition survey iii. Recognition and use of traditional practices iv. Consideration for varying incentives v. Generation of fund through external source(s) vi. Technical collaboration vii. Institutional collaboration		Networking
6. Nandadeva, B. D. (1990:105-110)	Recognition of traditional practices	Use of traditional practices	
7. Smail, D. (1990:122-125)	i. Consideration of local materials ii. Recognition of traditional practices iii. Local capacity building and partnership	Use of traditional practices	
8. Sumanov, L. (1990:131-136)	Scientific understanding of material		
9. Arnon, N. and Baca, S. (1990:143-148)	i. Local capacity building and partnership ii. Institutional collaboration		
10. Baradan, B. (1990:149-152)	Scientific understanding of material		

ADOBE 1990 The 6th International Conference on the Study and Conservation of Earthen Architecture (Adobe 90). Las Cruces, New Mexico, USA. Proceeding edited by Agnew, N., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
11. Emrick, M. and Meinhardt, C. (1990:153:158)	i. Scientific understanding of material ii. Material recycling iii. Recognition and use of traditional practices		
12. McHenry (Jr.), P. G. (1990:159-165)	i. Local capacity building and partnership ii. Recognition and use of traditional practices iii. Job creation and tourism development iv. Generation of fund through external source(s)		
13. Rua, C and Rajer, A. (1990:176-181)	i. Historical investigation & evaluation ii. Local capacity building and partnership iii. Material recycling iv. Generation of fund through external source(s) v. Institutional collaboration		
14. Van Balen, K. (1990:182-187)	i. Historical investigation & evaluation ii. Knowledge of the building material and technique		
15. Boyer, J. L. (1990:197-203)	Scientific understanding of material		
16. Brown, R. B., et. al. (1990:204-208)	Consideration of local materials		
17. Caperton, T. J. (1990:209-211)	i. Condition survey ii. Consideration for varying incentives		
18. Agnew, N (1990:243-249)	i. Scientific understanding of material ii. Institutional collaboration		
19. Coffman, R., et. al. (1990:250-254)	Scientific understanding of material		

ADOBE 1990 The 6th International Conference on the Study and Conservation of Earthen Architecture (Adobe 90). Las Cruces, New Mexico, USA. Proceeding edited by Agnew, N., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
20. Selwitz, C., et. al. (1990:255-260)	Scientific understanding of material		
21. Bohnett, A. S. (1990:261-266)	i. Literature review ii. Condition survey iii. Material recycling iv. Scientific understanding of material v. Local capacity building vi. Assessment, evaluation and rating after repair vii. Recording & documenting		i. Monitoring and evaluation ii. Continous research iii. Publication of result
22. Chiari, G. (1990:267-273)	Long term field test		
23. Ferm, R. (1990:274-276)	Scientific understanding of material		
24. Helmi, F. M. (1990:277-282)	Scientific understanding of material		
25. Koob, S. P., et. al. (1990:289-294)	Scientific understanding of material		
26. Zuixiong, L. (1990:295-301)	Scientific understanding of material		
27. De Sousa Lima, S. J.F. and Puccioni, S. (1990:302-310)	i. Condition survey ii. Case studies iii. Defining realistic and achievable aim iv. Institutional collaboration		
28. Alvarenga, M.A. A. (1990:357:362)	Historical investigation & evaluation		
29. Ndoro, W. (1990:377-382)	i. Literature review ii. Condition survey iii. Scientific understanding of material		
30. Taylor, M. R. (1990:383-392)	Historical investigation & evaluation		
31. Dubus, M. (1990:401-403)	Consolidation and safeguarding before intervention		
32. Odul, P. (1990:404-416)	Consolidation and safeguarding before intervention		
33. Austin, G.S. (1990:417-423)	Scientific understanding of material		
34. Coffman, R., et. al. (1990:424-429)	Scientific understanding of material		
35. Dassler, L. (1990:430-437)	Scientific understanding of material		

ADOBE 1990 The 6th International Conference on the Study and Conservation of Earthen Architecture (Adobe 90). Las Cruces, New Mexico, USA. Proceeding edited by Agnew, N., et. al.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
36. Sramek, J. and Losos, L. (1990:449-456)	Scientific understanding of material		
37. Andrade, R. M. A. (1990:457-460)	i. Historical investigation & evaluation ii. Condition survey		
38. Balderrama, A. A., et. al. (1990:461-468)	i. Historical investigation & evaluation ii. Local capacity building iii. Technical collaboration iv. Institutional collaboration		i. Networking ii. Continous research
5th International Meeting of Experts on the Conservation of Earthen Architecture, Rome, Italy. 1987. Proceeding edited by: Alva, A. and Houben, H.			
Author	**Strategies relevant to this thesis**		
	Pre implementation strategy	**Implementation strategy**	**Post implementation strategy**
1. Agnew, N., et. al. (1987:3-12)	Scientific understanding of material		
2. Caperton, T. J. (1987:13-24)	i. Case studies ii. Defining realistic and achievable aim iii. Consolidation and safeguarding before intervention		
3. Chiari, G. (1987:25-32)	Scientific understanding of material		
4. Crosby, A. (1987:33-42)	Condition survey		
5. Hughes, R. (1987:59-70)	i. Historical investigation & evaluation ii. Condition survey		
6. Nardi, R. (1987:71-80)	i. Consolidation and safeguarding before intervention ii. Consideration of locally sourced materials iii. Prioritising and phasing		
7. Taylor, M. R. (1987:91-102)	i. Defining realistic and achievable aim ii. Scientific understanding of material		
8. Neumann, J. V. and Mehta, P. K. (1987:103-110)	Scientific understanding of material		
9. Stephens, A. F. A. (1987:81)	i. Local capacity building ii. Institutional collaboration iii. Community partnership	Onsite training	

APPENDIX 4:

Introductory Note, Samples of Summary of the Proposed Repair Framework, and Completed copy of the Validation Questionnaire

4.1. Introductory Note and Summary of the Proposed Repair Framework

Dear Participant,

My name is Theophilus Shittu, I am a PhD student at the University of Plymouth. My doctoral research focuses on the repair of non traditional adobe building in Nigerian urban settlements. The thesis aimed at developing a framework that can be efficiently use by all the stakeholders[44] to repair this type of building in Nigeria. Consequently, the tentative title for the thesis is: 'Development of a Framework for Sustainable Repair of Non Traditional Adobe Building in Nigerian Urban Settlement.'

If you can recall you were interviewed on this subject at the inception of this research in July or August 2006. Similarly, I have been in contact with some of the participants through emails and telephone on the same subject since 2007. I am glad to inform you all, that a repair framework has been developed based on your responses, condition survey of 20 adobe buildings and other case studies from various literature. However, to ensure that the framework meets your expectations in terms of the issues you raised during the survey, the proposed framework need to be validated by you being one of the people that participated in the survey in 2006.

Attached herewith are the summary of the proposed framework developed in the course of this research and a questionnaire. It shall be deeply appreciated if you can study this summary and respond to the questions in the accompanied questionnaire.

Please note that your participation is voluntary. Your identity shall remain anonymous if so wishes and you are free to withdraw at anytime in the course of this study. However, the researcher will not be able to retrieve any information after the thesis has been submitted to the University. Your responses and ideas shall be use only for this research and no part or whole of the information shall be use in future for any other purpose without your consent. Copy of the thesis shall however be made available to the public through the University library and the inter library loan in accordance with the Higher Education regulation in the United Kingdom.

If you have any query or need further explanation regarding the proposed framework or any other matter relating to this study you can contact me through this email: pecstheo@yahoo.com, or Linda Watson (l.watson-2@plymouth.ac.uk). You can also call any of these two telephone numbers: **+44 07530533374** and **+44 01437 773621** or the School of Architecture, Design and the Environment through this number: **+44 (0)1752 585150** ask for Linda, Mhairi or Theo.

Thank you.

[44] Stakeholders includes land lords, tenants, masons, architects, engineers, policy makers etc.

SUMMARY OF PROPOSED FRAMEWORK FOR SUSTAINABLE REPAIR OF NON TRADITIONAL ADOBE BUILDING IN URBAN SETTLEMENTS IN NIGERIA

Introduction

The proposed repair framework as explained above is developed in response to the findings from the field survey conducted by the author in 2006. After critical analysis of your responses to the questionnaires and during the interviews, the issues drawn out from your responses were divided into three themes, namely; (i) issues relating to land lords and tenants (ii) issues relating to repair techniques and (iii) issues relating to personnel involve in the repair process. In response to these issues the framework was developed in three parts to address these key themes, with each part having eight sections as follows:

PART ONE

Land lords and tenants' obligations in the sustainable repair of non traditional adobe building in Nigerian urban settlements

This part of the framework is concern with land lords and tenants responsibilities in the repair of non traditional adobe building in Nigeria. This is in response to the problem identified during the survey where buildings occupied by tenants are in various states of disrepair because neither of the two parties is aware of who is responsible for the repair of the buildings. Using relevant documents, such as the Nigerian Land Use Act (FRN, 1990), Law of Property Act (FRN, 1925), Nigerian Building Code (FGN, 2006) etc. a proposal was developed to address this conflict between the stakeholders as follows:

- The framework identified that there must be mutual agreement between land lords and tenants to facilitate building repair.
- The role of both the land lord and tenant in the repair of adobe building were specified in accordance with the Nigeria tenement law.
- It was also proposed that both parties must accepts their responsibilities for the repair of adobe buildings as agreed in the tenement agreement, which must be signed by both parties and a witness before the tenant is handed over the key(s) to the building.
- Having identified the technicalities involve in preparing such agreement, it was proposed that Estate Surveyor should be involved in preparing the initial tenancy agreement (the role of Estate Surveyor is discussed in detail in part 3 of the framework).

It is specified in the proposed framework that after the above requirement have been satisfied, the repair plan of action can commence as follows:

I. Section one: Identification of needs.

Determinations of repair scope, cost of repair, who to bear the cost, the skilled personnel to carry out the repair, date and time of inspections by the land and tenant in collaboration with qualified building repair specialist.

II. Section two: Adobe building repair planning.

It is specified that both land lord and tenant shall be fully involve in decision making from inception.

III. Section three: Adobe building repair research

It is specified that the person in charge shall consult both the land lord and tenant when determining the causes of deteriorations.

IV. Section four: Adobe building repair design

It is specified that both land lord and tenant shall be involved in identifying the most sustainable repair strategy in collaboration with the specialist.

V. Section five: Adobe building repair interpretation

It is specified that both the land lord and tenant shall be involved in identifying sustainable technique and material in collaboration with specialist in the adobe building repair.

VI. Section six: Adobe building repair evaluation.

It is specified that both the lord and tenant shall be involved in assessment of proposal prepared by the specialist.

VII. Section seven: Adobe building repaired in use.

It is specified that the specialist in charge of repair shall prepare report for land lord and tenant on how to use the building upon completion of repair.

VIII. Section eight: Adobe building future repair plan

It is recommended that specialist report for land lord and tenant shall include future repair of the building.

PART TWO

Technical consideration in the planning for sustainable repair of non traditional adobe building in Nigerian urban settlements

The second part of the framework consists of step by step procedure in the preparation of work plan for sustainable repair of non traditional adobe building in Nigeria. The eight sections are summarised as follows:

I. Section one: preliminary investigation

In this section the methodology for preliminary investigation towards finding the possible causes of deterioration were proposed.

II. Section two: statement of intention

The methodology for determination of the goal of the repair is proposed in this section. It is proposed that repair goal should be informed by the diagnosis and consultation of stakeholders including the planning authority if the repair is envisaged to be extensive.

III. Section three: reconnaissance survey

The methodology for preliminary survey of the building is proposed in this section.

IV. Section four: condition survey and analysis of condition

The methodology for identifying the cause(s) of deterioration and method of analysing the cause(s) were proposed in this section. This process of diagnosis and prognosis is called the condition survey.

V. Section five: adobe building repair proposal

Several tried and tested repair philosophies were proposed in this section in line with the problems identified during the field survey. The sustainability of the proposed framework in terms of economy, social and the environment were of paramount importance in the development of the framework. Consequently, repair philosophies such as the use of like material in repair (e.g. earth based render for adobe walls), use of locally sourced material, respects for the environment when sourcing the material, use of tried and tested material, etc. were considered in proposed framework. Furthermore, a more explicit methodology for presenting architectural, electrical, mechanical and structural drawings was proposed. The methodology proposed ensures that these drawings can be easily interpreted by all the stakeholders, including the tenants and landlords that are likely not to be skilled professionals. This section also included methodology for calculating cost of repair proposal using the Standard Methods of Measurement (SMM-6)[45].

VI. Section six: preparation of work

Programme schedule for implementation of repair of non traditional adobe building was developed in this section. The proposed schedule was designed with aim of ensuring that every aspect of the repair is planned well ahead of time before moving to the site. These have several advantages and are explained in the proposed framework. One of the advantages is that planning ahead will save not only time but money on equipment such as scaffolding. This is because hiring scaffolding only when required will ensure that this equipment is not paid for, when not in use, thereby saving cost. Furthermore, it will reduce delay that can result as a result of waiting to erect the scaffolding if not planned ahead of time.

This section included work plan for material, craftsmanship, cost planning, transportation, application for development approval, insurance and references to relevant documents that may be needed in preparing this programme schedule, e.g. the SMM-6.

VII. Section seven: implementation process

The methodology for repair implementation of non traditional adobe building was proposed in this section. It was proposed that the work plan prepared ahead of time shall be strictly adhere to.

[45] RICS & BEC (1988) *Standard Methods of Measurement of Building Works*. Coordinated Building Project Information
RICS – Royal Institute of Chartered Surveyors
BEC – Building Employers Confederation

However, if there is any cause to adjust the work plan it shall be with the consent of all the stakeholders and this must be noted in the work plan.

VIII. Section eight: post implementation process plan

The methodology for preparing future repair action plan was proposed in this section. This is aim at ensuring that the stakeholders are informed of how to maintain the building in a more sustainable manner after repair and when the next repair will be due.

PART THREE

The statutory requirement for professional practice of sustainable repair of non traditional adobe building in Nigerian urban settlements

Some of the major findings from this research are: the non-existence of technical literature on the repair of non traditional building in Nigeria, lack of a place for this technique (non traditional adobe) in the contemporary Nigeria building industry and in the National Building Code. These findings have resulted in lack of knowledge in this field among Nigerian building professionals. In response to these short comings, the author proposed in this part of the framework the role and responsibility of architects, engineers, quantity surveyors, building technologists, estate surveyors, etc. towards the sustainable repair of the non traditional adobe building in Nigerian. This part is also divided into eight sections as follows:

I. Section one: preliminary investigation

In this section the role of architects, builders, civil engineers and masons in the initial inspection of the building were identified and the methodology of carrying out this inspection were specified in the context of non traditional adobe building.

II. Section two: statement of intention

In this section architect, civil engineer and or builder were recommended as the skilled personnel that can define the repair aim and scope of repair after carrying out the preliminary inspection.

III. Section three: reconnaissance survey

An architect is recommended for carrying out the reconnaissance survey in order to prepare architectural drawings for the existing building as surveyed, having identified from the field survey that none of the buildings had any drawings.

IV. Section four: condition survey and analysis of condition.

Architects, civil engineers, masons and or builders were identified as the personnel that should carry out this task.

V. Section five: adobe building repair proposal

In this section it was specified that the personnel that carried out the condition survey should in collaboration with the contractor (if different from the personnel that carry out the survey) developed the repair proposal. The proposal shall include all relevant drawings mentioned in part two, specifications and costing (prepared by quantity surveyor).

VI. Section six: preparation of work plan

In this section it is proposed that the personnel in charge of the repair shall prepare programme schedule specifying when each task shall commence and end, as well as material procurement and delivery.

VII. Section seven: implementation process

The roles of architects, builders, civil engineers and masons in the implementation of sustainable repair of non traditional adobe building were explained.

VIII. Section eight: post implementation process plan

It is specified that the Estate Surveyor shall play a crucial role in ensuring that the future repair plan of action is implemented as proposed by the personnel that shall carry out the repair.

4.2. Copy of one of the completed validation questionnaires

Date of administering question : 7/8/11
Duration of call : 30 minutes

Questionnaire No.: 1

Validation Questionnaire

for

The Proposed Framework for Sustainable Repair of Adobe Building in Sabon Gari

A. **Respondent's Personal Data**

Please go to question 2 if you reside in an adobe building in Sabon Gari

1. Respondent's occupation:

Retired Mason

Please do not answer question 2 if you are not residing in an adobe building in Sabon Gari

2. Respondent's status in the adobe in Sabon Gari (tick the appropriate box please)

Land lord ☐ Tenant ☑

3. Respondent's name (optional):

Mr. A. A. O

3. Respondent's email (optional):

/

5. Respondent's phone no. (optional): 00234 8028619705

B. Part One of the Proposed Framework

6. Please assess the sustainability of the strategy proposed in part two of the repair framework by ticking (√) the appropriate column in the table below

Proposed strategy	Sustainability of the proposed strategy								
	Economically viable			Socially acceptable			Environmentally friendly		
	Yes	No	I don't know	Yes	No	I don't know	Yes	No	I don't know
a. Involvement of landlords and tenants in decision making from inception to completion of repair	√			√			√		
b. Use of some relevant sections in the National Building Code for adobe building repair framework	√			√			√		
c. Use of like material	√			√			√		
d. Use of tried and tested new materials	√			√			√		
e. Option not to involve building professionals such as Architects, Civil Engineers, etc. in adobe building repair	√			√			√		
f. Use of original technique except if ascertained to be inappropriate	√			√			√		
g. Introduction of maintenance manual and documentation of entire process	√			√			√		

C. Part Two of the Proposed Framework

5. Please assess the sustainability of the strategy proposed in part one of the repair framework by ticking (√) the appropriate column in the table below

Proposed strategy	Sustainability of the proposed strategy								
	Economically viable			Socially acceptable			Environmentally friendly		
	Yes	No	I don't know	Yes	No	I don't know	Yes	No	I don't know
a. Involvement of both land lords and tenants	√			√			√		
b. Introduction of tenancy agreement	√			√			√		
c. The use of tenancy act	√			√			√		
d. The introduction of caretaker as an alternative to the use of Estate Surveyor	√			√			√		

kkkk

D. <u>Part Three of the Proposed Framework</u>

7. Please assess the sustainability of the strategy proposed in part three of the repair framework by ticking (√) the appropriate column in the table below

Proposed strategy	**Sustainability of the proposed strategy**								
	Economically viable			**Socially acceptable**			**Environmentally friendly**		
	Yes	No	I don't know	Yes	No	I don't know	Yes	No	I don't know
a. Consideration of some Codes of professional practices in Nigeria in the design of the statutory framework for the repair of adobe building in Sabon Gari	√			√			√		
b. The adoption of relevant traditional practice			√	√			√		
c. The formulation of a statutory framework for repair of adobe building with considerations of the following:									
i. The Kaduna State building regulations	√			√			√		
ii. The Nigerian building Code	√			√			√		
iii. The Nigerian Town and Country Planning Act	√			√			√		
iv. The Nigerian Tenancy Law	√			√			√		

IIII

E. The Strength, Weaknesses, Opportunities and Threats of the Framework

8. Please analyse the proposed framework in terms of strengths, weaknesses, opportunities and threats (SWOT analysis) by ticking (√) the appropriate column in the table below

The Proposed Strategy	SWOT Analysis			
	Strength	Weakness	Opportunity	Threat
a. Involvement of both landlords and tenants	✓			
b. Introduction of tenancy agreement	✓			
c. The use of tenement act	✓			
d. The introduction of caretaker	✓			
e. Use of some relevant sections in the following documents in the design of the statutory framework for the repair of adobe building in Sabon Gari : • Nigerian Building Code • Kaduna State's building regulation • Codes of practice of building professional bodies in Nigeria		✓		
f. Use of like material	✓			
g. Use of tried and tested new materials	✓			
h. Option not to involve building professionals such as Architects, Civil Engineers, etc. in adobe building repair	✓	~~✓~~		
i. Use of original technique except if ascertained to be inappropriate	✓			
j. Introduction of maintenance manual and documentation of entire process		✓		
k. The conceptualisation of the strategy in line with the Nigerian code of practice for conventional building material and relevant traditional practice	✓			
l. **Other issues relating to the successful implementation of the framework:**				
i. Low literacy level of the occupants and land lords of the adobe building				✓
ii. CECTech Jos as the only earthen architecture training institution			✓	
iii. Training of building artisan in Nigeria through informal apprenticeship			✓	
m. **Please suggest and also assess other issue(s) that is (are) of relevant to repair of adobe building not mentioned above if any**:				
i. There is the need for				
~~ii.~~ translation of the frame-				
~~iii.~~ work into the local				
~~iv.~~ language Hausa.				
v.				
vi.				
viii.				

9. Please add any other suggestion or comment (optional):

mmmm

4.3. Sample of Bill of Quantities (BoQ)

DESCRIPTION	QTY	UNIT	RATE (₦)	AMOUNT (₦)
BoQ FOR PROPOSED REHABILITATION OF EXISTING BUILDINGS BY CENTRAL BANK OF NIGERIA AT BAREWA COLLEGE ZARIA				
GEOPHYSICAL INVESTIGATION				
Geophysical investigation to determine the most suitable location for the borehole	1	sum	100,000.00	100,000.00
MOBILIZATION				
Mobilization of drilling equipment, materials and personnel to site and demobilization after successful completion of drilling	1	sum	150,000.00	150,000.00
Carryout out all preparatory works including site clearings setting up of base camp/security and all necessary safety structures, etc.	1	sum	50,000.00	50,000.00
BOREHOLE DRILLING				
Construction of mud-pit for drilling process	1	sum	20,000.00	20,000.00
Drilling of soft and hard rock including hammering in fresh basement at appropriate depth in line with Geophysical Survey to accommodate 125mm dia pvc casings and screens (Provisional depth 40m)	40	m	12,000.00	480,000.00
Carry out geophysical borehole logging: Gamma Ray and Caliper-log, including reports.	1	sum	30,000.00	30,000.00
Carry out grain size analysis for appropriate screen selection.	1	sum	30,000.00	30,000.00
Supply and installation of high pressure 125mm pvc casing and screens	40	m	5,000.00	200,000.00
Backwash and installation of appropriately sized filter packing consisting of alluvial gravel in borehole annular space around screen area.	15	m^3	5,000.00	75,000.00
Fill top of annulus with cement grout of approved mix to 1.5m minimum depth.	1	sum	50,000.00	50,000.00
Carry out borehole development and cleaning by airlifting with a compressor including jetting until water is clear and free of sand.	1	sum	120,000.00	120,000.00
Carried to Collection				**1,305,000.00**

DESCRIPTION	QTY	UNIT	RATE (₦)	AMOUNT (₦)
BOREHOLE DRILLING (Cont'd)				
Initial Chlorination of Borehole.	1	sum	10,000.00	10,000.00
Supply and Install Mild Steel Borehole cover treated with red oxide and blue paint finish.	1	sum	5,000.00	5,000.00
Construction of chamber measuring 650X650mm complete with mild steel cover.	1	sum	30,000.00	30,000.00
Pumping test of the borehole to determine its maximum yield.	1	sum	20,000.00	20,000.00
Water sample laboratory analysis.	1	sum	50,000.00	50,000.00
PUMP INSTALLATION AND ACCESSORIES				
Supply and install Submersible pump of appropriate capacity in line with the borehole yield complete with all necessary installation and operational accessories.	1	sum	210,000.00	210,000.00
Supply and install Electrical Control Panel for the borehole pump complete with pump starter, automatic water level controlling electrodes, phase failure detector and over voltage/overload relay {autotransformer}	1	Set	120,000.00	120,000.00
Supply and install with conduit pipes 4x4mm^2 flexible underwater copper cable NOCACO make (The cable shall extend to pump house).	600	m	400.00	240,000.00
Supply and install 32mm dia. 10bar high pressure upvc pipes complete with all required accessories as riser pipe and to extend to the ground tank.	600	m	600.00	360,000.00
Supply and installation of safety nylon rope {16mm single} to firmly secure the submersible pump.	1	sum	6,000.00	6,000.00
Supply and installation of Cable Jointing Kit and other complimentary accessories.	1	sum	30,000.00	30,000.00
Allow for electrical connection of the borehole pump to the electrical installation at the pump house.	1	sum	50,000.00	50,000.00
Allow for the piping and reticulation of the borehole to the nearest water tanks and also to the VIP toilets and the hostels		sum	500,000.00	500,000.00
Carried to Collection				**1,631,000.00**

DESCRIPTION	QTY	UNIT	RATE (₦)	AMOUNT (₦)
PROPOSED REHABILITATION OF EXISTING BUILDINGS BY CENTRAL BANK OF NIGERIA AT BAREWA COLLEGE ZARIA				
BOREHOLE DRILLING				
Collection for 1No. Borehole				
Page 1				**1,305,000.00**
Page 2				**1,631,000.00**
				2,936,000.00
			VAT 5%	**146,800.00**
TOTAL FOR DRILLING OF 1No. BOREHOLE				**3,082,800.00**
Total Cost for drilling of 1 No. Borehole: THREE MILLION EIGHTY-TWO THOUSAND, EIGHT HUNDRED NAIRA				

APPENDIX 5:

Publications

Conference Paper

The Changing Technology of Adobe Construction in Nigeria

Theophilus Shittu[1] and Linda Watson[2]

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Abstract

Earth has been use as construction material in Nigeria for many centuries. Each region has adopted a technique suitable to it local conditions. The three methods of earth construction methods that exist in Nigeria are adobe, cob and wattle and daub. Adobe construction is widely used particularly in the Northern Nigeria. This system of earth construction though still in use, has undergone changes in techniques in response to the modernisation of the construction industry. The traditional adobe is a conical or pear shaped, hand kneaded brick made up of raw earth mix with straw, and then sun dried before use. However, in the last thirty years this conical shape brick has been gradually replaced with adobe block, which is made of the same material but using rectangular moulds in its production. This major change in shape and size had a significant effect on the design, construction method, architectural language and form. This paper will discuss these changes and their effect on earth construction in Nigeria.

Keywords: *Tubali, Adobe block, Makuba, Karo and Datsi*

Introduction

Nigeria experienced rapid urbanisation and population increase in the 1970s, which was accelerated by the oil boom, and consequently led to unprecedented rural to urban migration. Therefore, in response to pressure on existing housing stock and the need for new dwellings, adobe construction, being the traditional and affordable means of construction, became the popular choice for housing the urban poor that migrated to the cities in search of jobs and better living conditions. Consequently, there was a need for a faster way of adobe construction and this led to the major innovation, which is the transformation of the traditional adobe brick called *tubali*[1] to a bigger rectangular shaped adobe block. This had a great impact on the built environment until today. The adobe brick (tubali) has since been abandoned in preference to adobe block. The impact of this change is such that ten years ago almost half of Nigerian population lived in earth house made of mainly adobe with a few from *tubali* (CECTech, 1995).

Though the material (earth) remains the same, there is a slight variation in production and construction method. The traditional adobe brick is shaped by hand, and the earth is generally in soft, doughy, plastic state, with up to 30% clay. Straw is usually added, as it is believed to improve the tensile strength of the soil, it also lowers the weight of the brick and reduces shrinkage during moulding (Norton, 1986). The size of the *tubali* is not usually regular due to the fact that it is hand shaped. The diameter of the base ranges between 100 and 120mm, while the height is between 150 to 200mm (Figure 1). On the other hand, the rectangular adobe block requires a mould. The mould is made of wood, and the size varies according to needs (Figure 2). However, despite the use of moulds, construction with adobe block is usually faster, because it is bigger than the traditional tubali in size. The size of the block varies between 400 x 400 x 150mm, 400 x 200 x 100mm and 300 x 150 x 100mm (L x B x H) (CEC Tech. 1995).

The coming of adobe block contributed also to the adaptation of a new architectural form in the vernacular architecture of the Hausa tribes of Northern Nigeria. Circular plans, which used to be a common feature in Hausa dwellings, were substituted with rectangular plans that used to be synonymous only with their institutional buildings (mosque and palaces). Though these traditional institutional buildings are originally built of *tubali,* it was later substituted with adobe block. The main reason for the adoption of the rectangular adobe block is their size and geometry. Whilst it makes it very difficult to

[1] *Tubali is a pear- shaped, sun dried earth brick.*

construct circular buildings, the speed of adobe construction is faster compare to *tubali* construction, which makes bigger buildings achievable within a very short period of time and budget. This change in architectural form did not interfere in anyway with the traditional concept of Islamic type of compound system in the Hausaland[2], but it instead blended and also improved the circulation spaces in their interior.

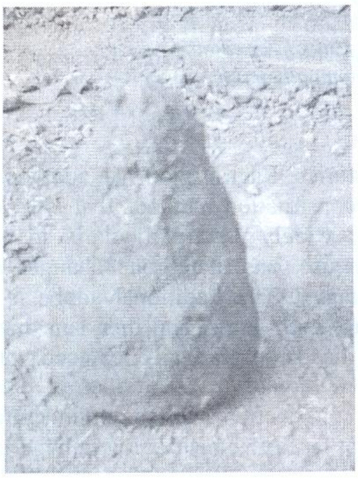

Figure 1 Tubali (pear shaped earth bricks)

Figure 2 Adobe blocks production.

Furthermore, corrugated roofing sheet replaced earth domes, flat earth roofs, and thatch. The geometry of the adobe block makes it easier to anchor the roof's wall plate and the geometry of the plan form the corrugated sheeting supported by roof trusses. This was not possible with *tubali.* Because the construction method is very much close to that of *sandcrete block*[3], adoption became very easy, particularly by artisans that are already use to concrete block and other migrants that have no tradition of adobe construction. Since most of the residential buildings in the growing urban centres were self-built, adobe block became very popular among the multi cultural inhabitants of the Nigerian cities. It became a symbol of unity by responding to individual cultural and religions needs. Various concepts, forms and layout became achievable using this material, and above all the speed and relatively cheaper cost of realising houses using this material and technique is a major factor.

Nigeria being in the Tropics, experiences long hot and dry season particularly in the north, where some area experience eight months of dry season, which makes adobe construction possible. New adobe buildings are usually constructed at the end of every rainy season around October and November. This is because water is very scarce in most of the villages and towns in the north, therefore, construction is usually done before ponds, stream and rivers dry up, since most of them rely on rain water. Nowadays, adobe blocks are usually moulded along pond, stream and river banks in order to reduce cost of transporting the water to the construction site. Though this has it own disadvantage of risks of damage to the blocks in the process of transportation.

Repairs works (i.e. wall rendering, water proofing of domes, rebuttressing of foundation etc) are usually carried out at the beginning of every rainy season (April or May). All repair works are done after the first or second rain in the year. This is because the rain water is usually collected for the repair works, furthermore, the rain helps in opening up places that will need urgent repairs, and cracks caused by drying of earth renders are minimal during rainy season. In addition, because there are always dry days between the first rain and the next it always give enough time for the earth renders to set. Though there is an issue of soil erosion as result of extensive extraction of soil for adobe construction in some settlements where adobe construction is popular, this can however be tackle with strong legislation.

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[2] *Hausa: one the three major tribes in Nigeria. Hausaland is the territory in Northern Nigeria occupy by the Hausas.*
[3] *Sandcrete block: Nigerian name for concrete block.*

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Soil Use for Adobe Brick and Blocks

Soils use for adobe brick or block is generally free from topsoil and vegetable matter. The soil is usually excavated manually using simple handle tools. The grains sizes are usually not larger than 10mm, and the particle distribution are usually in these ranges: Sand 40 to 75%, silt 10 to 30%, clay 15 to 30% (Houben & Guillaud 2001). A higher sand content lowers moisture absorption and improves resistance to abrasion, while high clay content provides cohesive strength. However, sandy soils do not have sufficient cohesive strength to avoid crumbling, so also clayey soils are susceptible to water and swell when wet, or shrink and crack when dry (Fig 3). A soil that combines both characteristics is always preferred (Norton, 1986). Through trial and error, the traditional builders have been able to master the technique for choosing suitable soil for adobe, through visual identification. Visual identification of soil for adobe building is usually quite easy, this is because the lateritic soils usually used, are relatively dark in colour, ranging from ochre through red, brown or violet to black.

Nowadays, various scientific tests have been developed to determine the characteristics of soil. Soil analysis and testing of the material are very important and complimentary in adobe building. It helps in developing understanding of the soils for optimum result. Apart from the field test which include sensory observation (i.e. smelling, touching or soapy test, colour and appearance observation), cigar test, drop test, bar test etc, more accurate laboratory test can be carried out in Nigeria in various government laboratories like that of *CECTech*[4], *NBRI*[5], and university's laboratories in addition to privately own soil laboratories. Simple to complex test like particle size analysis, compaction test etc can be carried out.

Moulding of Tubali

The traditional adobe brick (tubali) does not require any mould. The conical shaped brick is moulded by hand. The process involves spreading and mixing the earth with straw. Water is then added to this mixture and trampled upon by foot until it reaches the consistency of thick paste. It is then left for a couple of days to dry and then wetted and trampled again before being formed into *tubali*. The actual manufacturing of *tubali* requires simple hand tools including, hoes for digging and breaking of lumps of earth, shovels, and a head pan for carrying earth mix. Three people are required in manufacturing of *tubali*: the first person is usually the carrier who brings the material from the heap by head pan, then the second person, usually a small boy who makes *churi*[6] (lumps of earth), and the third is the *tubali* maker, who receives the moulded ball of earth from the boy, he then shapes the pear shaped *tubali* using his bare hands.

Preparation of *churi* is usually the first job of an apprentice mason's. The churi maker sits on the ground with heap of mixed earth, he then detaches from the mass a lump which is between 25 to 35 centimetre in diameter, rolls it twice on the flat ground, squeezes it from both sides into a solid loaf and throws the prepared *churi* to the *tubali* maker. The *tubali* maker who is usually very close to the *churi* maker begins to roll the *churi* on the ground just as a baker kneads his dough, using fine sand instead of flour to prevent sticking. He then shapes the material first into a short cylindrical shape and then into a double cone, thick in centre but pointed at both ends. The final shape is achieved by lifting the double ended cone lump in both hands about half a metre from the ground and then thrown down with one hand in such a way that one of the pointed ends flattens against the ground. The fairly loose particles of mixed earth contracts violently forming the final shape of *tubali*. This phenomenon can be described as an organic formation, which is realised when the molecules of the mixed soil adjust themselves during the short moment of impact to the natural stresses working between them.

The *tubali* are left to dry for about two weeks maximum. During this time, the molecules will be immobilised in this position within the conical, slightly bulging, static shapes, making the *tubali* almost pre-stressed. *Tubali* are generally made within the vicinity of the building site under the supervision of the master mason, thus, reducing the cost of transportation. The material is usually source within the vicinity of the site, and where is not possible to do so raw earth is transported usually on a donkey's back to the

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[4] *CECTech: Centre for Earth Construction Technology.*
[5] *NBRI: Nigerian Building and Roads Research Institute.*
[6] *Churi: a lump of mixed earth for making tubali.*

building site. To produce quality adobe semi-solid earth is prepare so that the water content will be enough to hold the entire particles together and at the same time not sticking to the mould.

Moulding of Adobe Block

In principle, the components and method of preparing earth for adobe block are the same as that of tubali, however, the adobe requires a mould to produce it. The mould is made of wood, with sides and handles but no base. The sides are sometimes reinforced with metal stripes at the four ends to avoid irregular sizes of blocks that may result due to bulging of the wooden moulds. Adobe block production is so simple that one, two or three person can produce it effectively. The site is usually clean, levelled, and wet to reduce rapid dehydration of the blocks when setting. For easy de-moulding the moulds are sometimes wet, or rub with sand or oil. The mould is then filled with sufficient sized lump, and then flattens by hand to make sure that all the voids are being filled with earth. The de-moulded block is sun-dried for minimum of two weeks before use.

The production rate depends on the skill of the moulders, but usually around 1500 blocks a day, this amounts to 250 blocks an hour. With larger moulds, the number may be lower.

Construction Methods

Foundation of Tubali Wall

The Northern region of Nigeria experience longer dry season than the south, this makes adobe construction very popular and simple. The foundation trenches are always very shallow approximately 100 to 150mm, and the plinth are usually made of *tubali* or stone. The foundation footing are usually thicker than the walls, it is also being buttress by up to about 300mm above ground level. The buttress protects the walls from erosion and abrasion. It also serves as a protection against animals and humans. Stone foundations are sometimes used where this material is available. Stone foundation allows moisture due to capillary action to escape without causing damage to the walls. However, stone is not readily available in most part of North of Nigeria and as a result; *tubali* is usually used, with buttress from the ground level up to 300mm height.

Foundation of adobe blocks walls

The depth of the foundation trenches of adobe block walls are usually deeper than the traditional *tubali,* approximately 150 to 200mm depth. Sometimes concrete blocks are used with mass concrete floor slab. In general, adobe block or stone foundations are common.

Mortars for Adobe Construction

The soil use in making *tubali* and adobe block is always use for the mortar. This rule is strictly adhered to, because soils from different sources have different characteristics. The process of consecutive breaking, wetting, trampling and drying of the mortar mix is repeated more than twice. Sometimes if the soil is too clayey, sand is usually added to the mortar. The most common traditional additives are the horse manure, *datsi*[7] and *makuba*[8]. In addition, cement is sometimes used in mixing soil for mortar in order to provide a key to cement-based external render. However, this is not a good practice, this is because the chemical content of the mortar will now be strong than that of the adobe and as a result the adobe will absolve all the water in the mortar causing rapid dehydration that will result to very week bonding or no bonding at all.

Laying of Tubali

Wall thickness depends on the storey height and the type of roof. A course consists of between 2 to 4 rows of *tubali* that are usually laid on earth mortar bed. The gaps between the rows of *tubali* are equally filled with the same mortar (Figure 3). Greatest care is given to outermost and innermost rows of *tubali*, as these determine the shape of the wall face. When approaching the aperture of the building, the mason

[7] *Datsi: Straw use in mixing soil for tubali, adobe and mortars.*
[8] *Makuba: glutinous fluid made from pounded locust beans, used in plaster for water proofing and plastic qualities.*

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usually leaves a gap of about a metre and carefully set up the corner, and then if there is any gap that a full brick can not fit in, the brick is then either chisel off or laid up side down. The mason does not use any tool in laying. The eye serves as spirit level, building lines etc, while hands serve as trowel. Finished building with Tabali wall is shown in Figure 4.

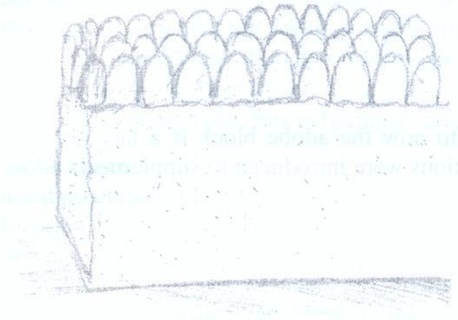

Figure 3 Tubali wall laid in earth mortar

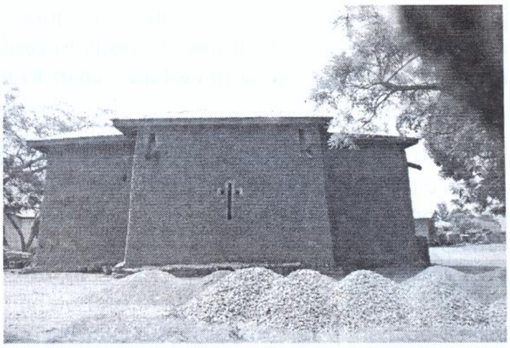

Figure 4 Tubali building with stone foundation and buttress

Laying of Adobe Block

Single leaf walls are usually used, except in cases were we have earth domes then double walls laid in Flemish bond are use. The blocks are laid on a mortar bed using English or Flemish bond. Simple hand tools like trowels, lines, spirit level, building square etc are used, which encourages better bonding and block alignment. The sizes of the blocks also enhance the speed in which adobe block are being laid.

Earth Roofs

Traditionally there are two methods of roof construction using earth. These are: dome and flat earth roofs. The arches are constructed using *azara*[9] (palm tree) as reinforcement to the earth ribs. The dome is then given three layers of coating; the first coat fills the gap between the reinforcement and the arches, and is usually a mixture of earth and straw. Here the quantity of straw is much to reduce the weight of the earth. The second coat is the water proofing membrane made of mixture earth and *katsi*[10], while the third layer is the sacrificial layer that needs annual or biannual renewal. It is a mixture of earth with *makuba* and *Karo*[11] (gum Arabic). This provides enough water proofing that will survive about two rainy seasons, and whenever repairs is to be carry out it is this layer that is usually remove and additional *makuba* and *karo* is added to the mortar. This system helps to keep the weight of the dome constant in addition to the effective method of material recycling.

Flat Roof

Flat earth roofs are constructed using almost the same principle as dome construction. The difference here is that the earth arches in the dome becomes beams in this case. The flat surfaces are then made laid to fall to the spout to allow rain to drain out easily. The surface treatment is also the same.

Earth Renders

Traditionally, *tubali* walls are usually render with earth mortar stabilised with *makuba, dafara*[12], *or kasti*,. These are all traditional adhesive found locally, a combination of one or two of these additives are usually used as stabiliser in earth renders. Apart from the protection it provide to the walls, the inherent colours of these additives, when combine with earth adds to the overall aesthetics of the building. Method of

[9] *Azara: palm tree trunks,*
[10] *Katsi: This is a fine, light grey powder made from indigo found in dye pits*
[11] *Karo: Gum Arabic.*
[12] *Dafara: a wild vine plant, use for making laso (smooth plaster finish).*

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preparation is the same as that of the mortar. Because of the chemical composition of the mix, it requires multiple turning, trampling and remixing to achieve homogeneous consistency.

The traditional material and rendering still proves to be most effective. Though cement rendering is a common practice these days, however, this has proves to be non-effective. This is because cement does not adhere to earth, and the danger with this practice is that, the damaging effect to the wall will go unnoticed for a very long time, until it eventually damages the building. The cement renders traps the moisture in the walls, which usually leads to condensation, and often at times the damage, is so severe that it leads to collapse of earth building, apart from the health hazard it poses to the occupants.

Innovations

There is no doubt that the transition from traditional *tubali* to now the adobe block is a key factor to sustenance of earth construction in Nigeria. Numerous innovations were introduced to supplements adobe construction, but all have failed, either due cost or the technology could not be adapted to local condition effectively. An example is the Compressed Earth Bricks (CEB) that was introduced by the Centre of Earth Construction Technology (CECTech), Jos, through CRATerre (1991), France in 1988. Despite various workshops, campaigns, demonstration buildings and training, the technology is still at infant state and there is doubt if this material will ever become popular. So many reasons have attributed to the easy adaptability of adobe system of earth construction in Nigeria, these are:

1. The technology is the same as the traditional *tubali*, the only difference is the size and method of moulding. Therefore, adaptability becomes easier, despite some differences.
2. It solves some existing problems that are synonymous to *tubali,* i.e.: construction of corners, construction of larger buildings, speed of construction, used of corrugated sheet that are not easily achievable with *tubali*, etc
3. It was seen as a status symbol, being closer to concrete block.
4. Element such as arches and domes became easier with adobe block. Construction of these elements was achieved without reinforcement, which reduces the cost of construction, and improved the aesthetic value of the buildings.
5. It gave room for innovations. However, all of the innovations were not successful.
6. This change (from *tubali* to adobe block) was the people's initiative in response to their needs; it was not forced on them.
7. Skills and experience are required for laying of *tubali*, while little skills is require in laying of adobe block. This is because the shape and size of the adobe blocks made it easier to use simple tools like spirit level, lines, builder's square etc as guide.
8. Most of the adobe buildings are self-built, due to the above factor.
9. Adobe walls became easier to protect using corrugated roofing sheets, this is because roof with wide overhangs are commonly used in Nigeria, thereby drastically reducing annual conservation work.

Challenges

Despite numerous advantages this material and technology have in Nigerian architectural landscape, there are two major problems that need to be addressed for the sustainability of this technology, these are:

1. The use of cement as mortar and in rendering, which have contributed to the failure of many earth buildings. And the cement is expensive due to the fact that 70% of the cement used in Nigeria is imported. This problem can be address through constant education and training.
2. The second is the issue of environmental degradation cause by indiscriminate excavation of earth for adobe construction. Because of this phenomenon, it has become a common a sight to see ponds all over settlement were adobe construction is still a practice. These ponds usually become breeding ground for mosquitoes and other water borne diseases. This can be avoided through legislations that will restrict excavation, as almost all the soil needed for building can be source from the foundation trenches, soak away pits, septic tanks, pit latrines and drainages around the buildings, if all these are done before commencement of adobe moulding. However, apart from the foundation trenches all other activities are usually suspended until after the main building is completed. Furthermore, earth can be source from hills and mountains, though this will add to the overall cost of building.

Conclusion

More than half of the population of Northern Nigeria still live in earth buildings, and the majority of these buildings are made of adobe block, while the rest are the few surviving *tubali* (earth brick) buildings. The survival of the earth system of construction is mainly due to the availability of appropriate sub soils, simplicity in design and accessible methods of construction. Earthen architecture also responds to culture and religious belief and is empowering for local communities. Furthermore, the changes that came with the introduction of adobe block were a response to existing problems related to climate and culture of different ethnic groups found in this region. Yet the architectural output was able to continue the cultural identity very important to the communities. This technology will continue to dominant the landscape of Nigeria for a long time, this is because currently no any other material posses all the advantages of adobe.

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Poster Presentation

COLLABORATION AND DISSEMINATION: A JOINT PROJECT BETWEEN UNITED KINGDOM and NIGERIA for TRAINING and EDUCATION IN EARTHEN ARCHITECTURE

TERRA 2008 10TH INTERNATIONAL CONFERENCE ON THE STUDY AND CONSERVATION OF EARTHEN ARCHITECTURAL HERITAGE

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Examples of earth buildings in Nigeria

ABSTRACT

The British University of Plymouth and the Ahmadu Bello University, Zaria, Nigeria are collaborating to ensure effective dissemination of knowledge for the conservation of earth buildings. Whilst each university has its own catchment area with regional distinctive earthen architecture and culture, the methodology to ensure their conservation has many similarities, particularly the shared concern for sustainable solutions and the continued occupation of the heritage. Hence this collaboration aim is to be mutually beneficial.

INTRODUCTION

This poster presentation summaries the intention of this collaborative project. It is an on-going project still searching for more technical and financial partners at local, national and international levels.

AIM OF THE COLLABORATION PROJECT

To develop education materials for teaching and dissemination of knowledge in earthen architecture and conservation appropriate to the two regions.

METHODOLOGY

To ensure the mutual benefits of this collaboration the progress made to date by the two universities is critically appraise, so as to design a strategy for an effective education and training framework that will be useful to both parties. Emphasis is given to the following:

❖The need for in-depth understanding of particular architectures, their construction techniques and modes of failures.

❖Collaboration with practitioners.

❖The need for appropriate dissemination techniques for professionals and owner/occupants.

The University of Plymouth through it Centre for Earthen Architecture (CEA) , and it Postgraduate Programmes (PgDip, MA and PhD) in Architectural Conservation have over the years carried out research in the conservation of earth buildings in the county of Devon. Modules of these postgraduate programmes are designed for both professionals that want to improve their skills and enthusiast that need the basic knowledge in conservation of earth buildings.

The Ahmadu Bello University with over 50 years experience in architecture education in Nigeria, have incorporated earthen architecture in its undergraduate architecture programme. Drawing inspiration from the glorious past of Zaria and its environ, but faced with current issues concerning the continuity of these traditions, the two universities proposed this joint collaboration in order to put up a coherent structure in training and education in earthen architecture and conservation.

In response to the existing needs this collaborative project is designing teaching materials that focuses on sympathetic conservation, and its sustainability within culture and traditions, taking into cognisance the fact that many of the traditional masons in Nigeria cannot read nor write. This teaching material is design to be used in training of the traditional masons as well as the undergraduate students, and professionals that are in architectural conservation. The design and development of a dissemination tool that can be use by illiterate persons is almost completed.

Conclusion

The use of unsympathetic methods of repairs such as cement rendering are common causes of earth buildings failure in Nigeria, and the high illiteracy level among the traditional masons is a hindrance to the dissemination of the available information, therefore, the combine experiences of University of Plymouth in training of masons, house owners and other professionals how to mend earth buildings and that of Ahmadu Bello University in traditional earthen architecture of Nigeria is used in developing appropriate teaching materials.

Practical sessions at the University of Plymouth

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