INTEGRATING THE PRINCIPLES OF ENVIRONMENTAL SUSTAINABILITY IN THE DESIGN OF GBAGYI HOUSING IN ABUJA

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DEPARTMENT OF ARCHITECTURE,
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NIGERIA

OCTOBER 2016

DECLARATION

I declare that the work in this dissertation entitled "INTEGRATING THE PRINCIPLES OF ENVIRONMENTAL SUSTAINABILITY IN THE DESIGN OF GBAGYI HOUSING IN ABUJA" has been carried out by me in the Department of Architecture. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

BABA, AMINU RABIU …… ……

Student's Name Signature Date

CERTIFICATION

This dissertation entitled INTEGRATING THE PRINCIPLES OF ENVIRONMENTAL SUSTAINABILITY IN THE DESIGN OF GBAGYI HOUSING IN ABUJA by Aminu Rabiu BABA meets the regulations governing the award of the degree of M.Sc Architecture of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this project to my parents, Engr. Rabiu Baba and Hajia Nafisatu Rabiu Baba for their continued and unconditional love and support. May Allah reward you both with the best of rewards; Jannatul Firdaus. Amin

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Firstly, it is important to once again acknowledge the influence of Allah in all aspects of my life. It is by His supreme guidance that I write this dissertation and carry out all aspects of my life.

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ABSTRACT

In Abuja, rapid urbanization over the years has left indigenous Gbagyi settlements neglected even in the presence of overwhelming development. This has left what is essentially a modern city with small pockets of underdeveloped areas all over the city. This poses not only a problem for the city as a whole but also the environment in which they are located. This also means that the inhabitants live in sub-standard conditions amidst environmental degradation. The study aims to propose an alternative solution to the relocation model currently in place by the government, to design a settlement that will meet the needs of the inhabitants while also maintaining the integrity of the environment. The research poses key questions of what principles will be relevant in achieving the desired aim and how can a stepwise process be formulated for the integration of said principles into a design proposal. As the study is mostly qualitative in nature, most data is collected through a questionnaire survey and key informant interviews. The research also uses the case study approach in studying the current state of the Gbagyi settlements. The research finds that many of the settlements under study face the mostly the same problems of under development and overcrowding. In some cases they also face the problem of misappropriated land use. In conclusion, the thesis outlines the process for the implementation of the design of Gbagyi housing settlements within the prevailing city identifying the framework through which it environmental sustainability principles can be integrated into a design. It culminates in a demonstration of how a selected settlement could be designed using the process outlined in the framework.

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

This chapter serves as an introduction to the dissertation. It aims to shed more light on the topic, give a concise problem statement, provide a reasonable scope, state clear aims of the research and also outline why this research is significant in today's society.

1.2 Background of the Study

Housing provision is one of the major challenges facing mankind in the twenty-first century. Although studies have shown that the problem of housing is universal, it is however more critical in less developed countries (LDCs), including Nigeria. The challenge of housing the poor is particularly acute in the urban areas of LDCs where an explosive expansion of the urban population due to a high population growth rate and massive rural-urban drift has compounded the housing situation (Olotuah and Bobadoye 2009).

Housing is very fundamental to the welfare, survival and health of individuals. This is why international concern has been growing over the deteriorating housing conditions in urban areas of developing nations, Central and Eastern Europe (UN 1996). In view of this, housing provision for all citizens of a nation is not just an indicator of the success of that nation but also a fundamental human right.

The Gbagyi people are the original inhabitants of the land that Abuja occupies today. The challenges they face in the advent of massive transformation of their serene agrarian settlements is immense (Olabode, 2010). In recent times, the rapid development of the city of Abuja has engulfed many of the settlements of the Gbagyi

people. Unfortunately this development has always been around these settlements but never within them. The population of the city of Abuja in the F.C.T. has increased tremendously and is still on the increase due to urbanization. Urbanization refers to the expansion in the proportion of a population living in urban areas to those living in rural areas. It represents the movement of people from rural areas to urban areas with population growth equating to urban migration. Nigeria has been no exception to this trend as it has one of the highest urban growth rates in the world. Not only is the country experiencing one of the fastest rates of urbanization in the world, its experience has also been unique in scale, pervasiveness and historical antecedents. This process has resulted in a very dense network of urban centres of which Abuja is an example. The proportion of the Nigerian population living in urban centres has therefore increased phenomenally over the years. Over 40% of Nigerians now live in urban centres of varying sizes (Adesoji, 2011). Due to this rapid increase in population, there has been a great increase in housing demand in these urban centres.

Housing affordability has been widely recognized as an essential issue in creating sustainable built environment especially in the context of developing world cities. Consequently, global efforts at meeting human needs for shelter found expression in its inclusion among the objectives of sustainable development programme and the Habitat Agenda agreed to by the International Community at Istanbul, Turkey in 1996 (Afolabi, 2011). In Abuja, high property costs has compelled most residents to seek shelter in Gbagyi settlements within the city, satellite towns and in some cases neighbouring states. The settlements are very attractive to the lower income class who work in the city but want to avoid the long commutes associated with living in areas far from the city itself. As such, people view these settlements as pockets of affordable housing within what is otherwise an “expensive” city (Abdullahi, 2014).

When studying the goals, needs and possibilities of large scale residential restructuring, one frequently confronts the problem of adequate assessment of the current situation (Petras, 2013). The problems of population size and cost are some of the major factors to consider.

The subject, 'Sustainable development' is relevant and applicable to all areas of development and management. Its grand characteristics are its abilities to enhance, protect as well as sustain growth in all ramifications (Odebiyi, 2010). Housing is an important factor in the recognition of a society's success among nations. It is difficult to talk about the success of a nation, or a society within a nation without analysing its housing situation (Daniel, 2009).

1.3 Problem Statement

Since the capital of Nigeria was relocated to Abuja in 1991, the area has seen rapid development and also rapid population growth via the influx of people to the city in search of jobs and prosperity. According to Sarah (2010), Abuja grew at the rate of 139.7% between the year 2000 and 2010, making it the fastest growing city in Africa. Significant population growth and lack of basic infrastructure to support the population increase has left the Gbagyi settlements in a poor state. This has led to environmental degradation in these settlements which in turn leaves the people living in these areas vulnerable to disease and other dangers posed by poor environments.

The research problem is thus; Gbagyi settlements within the city of Abuja have not been integrated with the prevailing city using principles of Environmental sustainability, this has resulted in environmental degradation and generally low standards of living within the settlements.

1.4 Aims and Objectives

The aim of this research is to integrate existing Gbagyi settlements within Abuja with the prevailing city using integrated principles of environmental sustainability.

The objectives of this research therefore are as follows;

1. To identify the principles of environmental sustainability relevant to housing development.
2. To evaluate the state of Gbagyi settlements within Abuja.
3. To formulate a framework for the design of Gbagyi settlements based on identified environmental sustainability principles.
4. To demonstrate the design of a Gbagyi settlement using the integrated principles of environmental sustainability.

1.5 Research Questions

This research intends to answer the following research questions:

1. What principles of environmental sustainability are relevant to housing development?
2. What is the state of Gbagyi settlements in Abuja?
3. How can a framework be formulated for the integration of Gbagyi settlements?
4. Can Gbagyi settlements be designed using integrated principles of environmental sustainability?

1.6 Scope of the Study

This study covers the Abuja Municipal Area Council (AMAC) which is an area council of the F.C.T. It has been limited to AMAC because this area council represents the

planned area of the Abuja metropolis. It represents a modern city and studying this area will yield more relevant conclusions with regard to the context of modern cities worldwide. This will not give a total picture of the problems faced by the low income class in other parts of the country.

This study covers the socio-cultural issues in current low income settlements and will go into detail about specific housing units and their features in these environments.

This study also covers environmental sustainability. But due to the extensive nature of the aforementioned topic, it will only be limited to concepts of environmental sustainability that directly influence mass housing.

1.7 Significance of the Study

This research seeks to explore the possibility of integrating the Gbagyi settlements found in the F.C.T. as a solution to the problem of housing faced by the indigenes of Abuja whose land is being used up. This research addresses issues that directly affect the living conditions and quality of life as a whole of the affected people. This research is also timely as it addresses some of the issues outlined by the United Nations sustainable development goals program through the use of principles of environmental sustainability in demonstrating the integration of a Gbagyi settlement with the city of Abuja. This will ensure that the environmental challenges faced by the current settlements do not re-surface after integration. Conclusions drawn by this study can be used in addressing this same issue in other cities in the country and the world at large.

1.8 Limitations of the Study

This thesis is both theory based and survey based but due to the limited documentation of Nigeria as a whole and therefore the limited documentation of Abuja also, there is a possibility that it would give an incomplete picture of the area studied. The survey tries to compensate for the limitations of the documentation through physical surveys of the areas in the study. The thesis covers the understanding of environmental sustainability especially as it relates to housing development. It studies the socio – cultural and physical aspects of these environments, including details on specific housing units and their architectural features in these environments, but does not go into detail cost analysis for the construction and maintenance of these housing units.

1.9 Conclusion

This chapter has outlined in detail what this dissertation is about, further shedding light on the topic through a detailed background of study, clearly defining the problem it seeks to solve, outlining clear aims and objectives while also justifying the significance of the study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter aims to provide a theoretical background for this dissertation. It will review current and relevant literature with regards to the aims and objectives outlined in the first chapter. Literature to be reviewed include but are not limited to books, journals, articles, published and unpublished papers, newspapers, the internet etc.

2.2 The Concept of Sustainability

Sustainability is a broad concept which can be applied to almost everything from manufacturing to financial issues. In defining sustainability it is important to first understand the context in which you are discussing the matter. For the sake of this study, we would want to define sustainability in the context of architecture.

Truly sustainable architecture could be defined as the creation of buildings for which only renewable resources are consumed throughout the process of design, construction and operation. Sustainability status must also include the manufacture and transportation of materials, components and construction equipment. First Nations people were perhaps the last inhabitants of North America to have truly understood the meaning of sustainability and to have lived accordingly. The present day examples of truly sustainable architecture are rare, if not non-existent. (Royal Architectural Institute of Canada, 2010)

Generally, “Sustainable” is a derivative of Latin “sustenere” – (tenere-to hold; sus-up) – To “hold up” implies keeping up or maintaining something in a specified position. Sustainable

is the ability of something to continue for a long time (Summers, 2010). Sustainability has three (3) major components i.e.

1. Environmental sustainability
2. Social sustainability
3. Economic sustainability

2.2.1 Environmental sustainability

Environmental Sustainability can be defined as the capacity to preserve over time the three basic functions of the environment: the resource supply function, the waste receiver function and that of direct usefulness. In other words, within a territory (area / region), environmental sustainability means the capacity to increase and bring up the value of the environment and its peculiarities, while assuring the protection and the renewal of natural resources and the environmental patrimony (www.sogesid.it, 2015). It is essential to highlight that environmental sustainability is closely interconnected with the other components of sustainability. Environmental sustainability should therefore not to be perceived as independent, but rather as a systemic frame of elements that equally contribute to reach the same goal (as illustrated in figure 2.1).

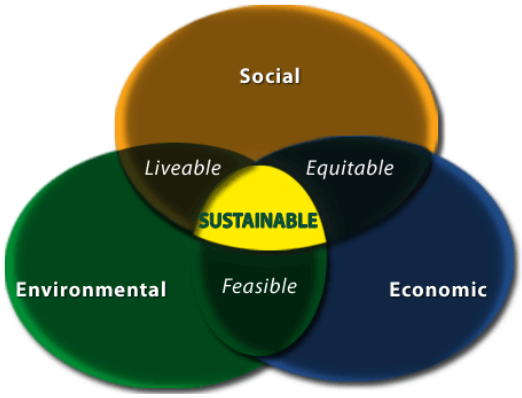


Figure 2.1 Interrelation between the 3 dimensions of sustainability. (Source: www.sogesid.it)

2.2.2 Principles of environmental sustainability

An environmentally sustainable system must maintain a stable resource base, avoiding over-exploitation of renewable resource systems or environmental sink functions and depleting non-renewable sources only to the extent that investment is made in adequate substitutes. This includes maintenance of biodiversity, atmospheric stability, and other eco-system functions not ordinarily classed as economic resources (John, 2000). With respect to this, principles of environmental sustainability must be adhered to in order to achieve an environmentally sustainable system. Principles of environmentally sustainable development were outlined in a study by Steven (1996) and another study by John (2011). They outlined the supporting principles of environmental sustainability. As this research is context based, only principles found to be relevant in the housing context were adopted.

1. Preservation of Biodiversity and Environmental Integrity

- Select raw materials that maintain biodiversity of natural resources.
- Use environmentally responsible and sustainable energy sources and invest in improving energy efficiency.
- Ensure the maintenance or the betterment of the quality of the environment when introducing elements that constitute a change to the environment.

2. Reuse and Recycle

- Design for re-usability and recyclability.
- Design (or redesign, as appropriate) manufacturing and business processes as closed-loop systems, reducing emissions and waste to zero.
- Integrate recycled materials in the course of design implementation.

3. Effective Management of Unsustainable Systems

- Activities which are likely to cause potential or actual harm to the environment shall be preceded by a thorough Environmental Impact Assessment (EIA).
- Develop transportation criteria that prioritize low-impact transportation modes over conventional ones.
- Waste generation that cannot be eliminated should be kept within the assimilative capacity of the receiving ecosystems without unacceptable degradation of its future waste absorptive capacity

2.2.2.1 Sustainable housing construction

In keeping with the principles cited above, a more environmentally friendly approach to construction should be adopted in the provision of housing. More than ever before, sustainable housing is becoming an enormous challenge to developing and developed countries dealing with it. The situation has been exacerbated by the cost of construction materials which is exorbitantly high in many countries. Construction materials can take up to 60% of the whole construction cost. Construction experts are advocating for intensive and extensive adoption of innovation and technology in a bid to significantly reduce the cost of materials and the building process (Anthony, 2015). It is at this point that we ask, what construction technologies are feasible? According to Babajide (2010), the feasible technologies available in Nigeria include:

1. Traditional sand-crete blocks, cast concrete columns, beams and slab structures.
2. Other masonry unit construction methods such as fired brick, compressed earth blocks (interlocking or non-interlocking).
3. Industrialized systems using precast panels.

4. Modular form work for cast in place concrete (plastic metal and wood form systems).

The above mentioned construction methods cannot be said to be environmentally sustainable as they incorporate very little recycled materials in their processes as stipulated by the principle of reuse and recyclability. To achieve this, we turn to a relatively new construction method called 3D-print construction. According to Michelle (2015), 3D (short for 3 Dimensional) printing technologies first became visible in the 1980s, at which time they were called rapid prototyping technologies. This is because the processes were originally conceived as a fast and more cost effective method for creating prototypes for product development within industry. Recently 3D printing has found many applications in fields ranging from medicine to aerospace research and more recently, construction. In March 2014, a Chinese company -WinSun- successfully 3Dprinted 10 houses in the space of 24 hours. Some of the housing units can be seen in Plate I below.



Plate I - Examples of 3D printed house. (Source: Kira, 2015)

Printing was carried out using a proprietary 3D printer (see Plate II) that uses a mixture of ground, construction and industrial waste such as glass around a base of quick drying cement mixed with a special hardening agent (Michelle, 2015).



Plate II - WinSun 3D printer. (Source: Kira, 2015)

The 3D printer array developed by Ma Yihe stands at 6.6 meters high, 10 meters wide and 40 meters long. This fabricates the parts in large pieces at WinSun's facility. The structures are then assembled on site, complete with steel reinforcements and insulations in order to comply with official building standards. A CAD (computer aided design) design is used as a template and a computer uses this to control the extruder arm to lay down the material. The walls are printed hollow with a zig-zagging pattern inside to provide reinforcement. This also becomes space for insulation and conduiting if need be. According Michelle (2015) some advantages of using this system include the following:

1. Reduction of construction waste by 30-60%.
2. Reduction of production times by 50-70%.
3. Monetary savings on labour and material cost of up to 50%.

4. Environmentally friendly construction due to use of recycled materials during print.

2.2.2.2 Environmental impact assessment (EIA)

The principle of environmental sustainability which stipulates that unsustainable systems must be managed effectively requires that an environmental impact assessment precede any activity likely to cause potential or actual harm to the environment. It is therefore important to have a better understanding of an E.I.A. The International Association of Impact Assessment (IAIA) (1999) defines an environmental impact assessment as the process of identifying, predicting, evaluating and mitigating the bio-physical, social and other relevant effects of development proposals prior to major decisions being taken and commitments made. Ifeanyi (2002) explains that EIAs became necessary through international agreements/conventions/protocols and national laws, regulations and bye-laws which apply concurrently. In Nigeria, the need for and E.I.A. is backed by legislation cited in section 20 of the 1999 constitution which states; "the state shall protect and improve the environment and safe guard the water, air, land, forest and wild life of Nigeria."

According to the United Nations Environmental Program an EIA report should contain the following in the order stated below:

a) A description of the proposed activity.
b) A description of the potentially affected environment, including specific information necessary for identifying and assessing the environmental effects of the proposed activity.
c) A description of practical alternatives, as appropriate.

d) An assessment of the likely or potential environmental impacts of the proposed activity and alternatives, including the direct, indirect, cumulative, short-term and long-term effects.
e) An identification and description of measures available to mitigate adverse environmental impacts of the proposed activity and alternatives, and an assessment of those measures.
f) An indication of gaps in knowledge and uncertainties which may be encountered in compiling the required information.
g) An indication of whether the environment of any other State or areas beyond national jurisdiction is likely to be affected by the proposed activity or alternatives.
h) A brief, non-technical summary of the information provided under the above headings.

2.2.2.3 Sustainable mass transit systems

Mass transportation is a system whose measure of sustainability lies in its effective management. In keeping with the earlier stated principles of environmental sustainability, transportation criteria should be developed that will prioritize low-impact modes of transportation over conventional ones. Sustainable transport systems make a positive contribution to the environmental, social and economic sustainability of the communities they serve. Transport systems exist to provide social and economic connections and quickly take up the opportunities afforded by the increased mobility (Schafer, 1998). This shows that outside providing the usual benefits of mass transit i.e. efficient transport of goods and services in large quantities, there is also the added advantage of the of positive contributions to the environment in which the sustainable

systems are being implemented. This could be anything from cleaner air to cleaner water.

Recent research carried out by the world energy council (2007) show that transport systems have significant impact on the environment, accounting for 20% to 25% of the world energy consumption and carbon dioxide (CO_2) emissions. The negative impacts of transport systems can be reduced by improving the walking and cycling environment in cities and by enhancing the role of mass transport, especially electric based systems (Shigeki and Suzana, 2007). This is an issue that can be tackled by designers of communities and cities at large. The integration of bike paths, pedestrian routes and proper planning to allow for adequate proximity to various services can help achieve this goal.

The enhancement of public transport systems can be achieved using "green vehicles". According to petrolprices.com (2015), a green vehicle is one that is considered to be environmentally friendly, use less petrol than conventional vehicles or use renewable energy sources to fuel its engine. One such example of the green vehicles is the Exqui City Design Mettis (see Plate III). It is a 24 meter long, bi articulated vehicle with a hybrid (diesel-electric) drive that is used for public transport in and around the city of Metz in France. It has been in use since September 2013.



Plate III - Exqui City Mettis hybrid bus. (Source: www.vanhool.be)

The bus has the following advantages over conventional diesel powered buses;

1. Recovery of braking energy
2. Emissions reduction
3. Reduced fuel consumption
4. Reduced noise pollution

Comprehensive can be found at http://www.vanhool.be.

In the case of low cost developments, it is wise to use systems that can be incorporated for use with traditional infrastructure. Using new systems that require new infrastructure to be installed can be costly and thus jeopardize the economic viability of such projects.

2.3 Sustainable Housing

The above is a combination of two separate concepts that when examined concurrently tend to mean more than the sum of their parts. Sustainable housing can mean different things depending on the context each separate concept is taken in.

Oktay (2001), states that housing areas are the places where the problems of the environment touch most people's quality of life, the planning and design of housing

environments requires a sensitive approach promoting sustainability. This is the premise with which he discusses sustainable housing.

This aforementioned does not concur with the view of Agbo (2012) which posits that sustainable housing conjures the notion of continuous housing development to contain not only the present people but also meeting the demands of upcoming population. It is a process whereby the private sector plays an interminable role in housing through perpetual active participation in construction activity and provision of habitable units.

For the purpose of this research we will be taking the context in which Oktay (2001) discussed sustainable housing as it establishes a direct link between housing, sustainability and the environment which are the three variables of this research.

Since housing is defined as more than just the provision of housing units but the provision of all the things mandated for ensuring the sustenance of the livelihood of the end users. These include transportation infrastructure, basic services, and social infrastructure. For sustainable housing in the context accepted by this research, it should include components that are not harmful to the environment. This means the use of environmentally friendly construction methods, sustainable mass transit systems and green services like recycling.

2.4 Affordable Housing

Affordable housing refers to housing units that are affordable by that section of society whose income is below the median household income (Economic Times, 2015).

Though different countries have different definitions for affordable housing, its aim is largely the same i.e. affordable housing should address the housing needs of the lower

and middle income households. Affordable housing becomes a key issue especially in developing nations where majority of the population are not able to buy houses at the market price (Economic Times, 2015).

In Nigeria, there is a significant gap between larger single family houses, small tenement houses/flats and squatter settlements. Even families that earn relatively good middle class incomes find it difficult to purchase or build their first home. This is not because of a lack of demand but rather a lack of adequately targeted housing product coupled with almost non-existent or difficult to obtain financing tools. An interesting opportunity is the construction of small but good quality housing units that meet the basic needs of young working families enabling them to start making their way up the property ladder (Babajide, 2010).

2.4.1 Affordable housing design

The design of affordable housing poses a number of challenges, chief amongst which is reducing construction cost. This is the biggest concern as it directly affects the cost at sale of the building or the rates at which the housing units are offered up for rent.

Another major problem is that of end user requirements. This is so because most affordable housing is done in the form of mass housing schemes. Nigeria is believed to be made up of people of different cultures and beliefs. These two factors can be expressed in different forms ranging from living patterns, marriage type and privacy demands. It is therefore logical to conclude that if some of these factors are to be addressed by the architect, then the housing units in mass housing schemes in Nigeria should not be the same. The problem of providing generic houses has contributed to the rate of housing modifications witnessed in these housing schemes, despite these

modifications architects working on mass housing schemes have continued the same trend (Adebayo, 2012).

One way of getting around this problem is to have families (or users) be involved in the design process. This was the case in the experimental initiative from Mexican architecture firm S-AR. Rather than building houses for families in need- like the habitat for humanity might- S-AR is working with locals who own land to custom design and construct their houses (Margaret, 2015). This particular project was a pilot scheme which involved one family that already owned land. If this method were to be scaled up to mass housing proportions, it would pose serious logistical problems which might end up making the project more costly than originally intended.

A more feasible solution to the problem of generic houses would be to propose different designs for the same housing unit. This would give prospective users of the houses greater freedom of choice and greater design freedom for the architect.

2.5 Housing Development

According to Microsoft's Encarta encyclopaedia (2009), housing refers to provision of accommodation in the form of houses and other buildings considered collectively. A study by Ismail (1988) refers to housing as the most common of buildings in the world that has received considerable attention from planners and critics alike.

Housing is not only concerned with the design of a specific number of housing units, but rather the design of a whole environment that provides accommodation, jobs, education, health services etc. within a context that is accessible, safe, beautiful and sustainable.

Ural (2002) believes that social and economic wealth can only exist with good housing. This shows that good housing is not only a goal of every society but also an indicator of economic prosperity. This is backed by the view of Vehbi et al (2009) who stated that, housing is a reasonable and potentially powerful medium for monitoring the social, physical, environmental and economic characteristics of a community.

A housing environment as an entity can be divided into the following components

1. Living space
2. Recreational space
3. Sanitary facilities
4. Water and power supply
5. Protection from weather
6. Insulation
7. Circulation (Vehbi et al, 2009).

2.6 Informal Settlements and their integration

The definition of informal settlements is context-specific. Various definitions have thus been proposed, but that suggested by the UN Habitat Programme is probably the most widely applicable. This defines informal settlements as:

i) Residential areas where a group of housing units has been constructed on land to which the occupants have no legal claim, or which they occupy illegally.

ii) Unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing).

Many other terms and definitions have been devised for informal human settlements, for example: unplanned settlements, squatter settlements, marginal settlements, unconventional dwellings, non-permanent structures, inadequate housing, slums, and

housing incompliance (United Nations Centre for Human Settlements, 1995). For the purpose of this research we will be taking the second (ii) definition of informal settlements as it better suits the architectural context which this research is based on. The problems posed by the informal settlements of the chosen definition can be solved through a step wise architectural approach.

Informal settlements are symptoms of immigration phenomenon. This migration started as a movement from rural to urban areas in the industrialization period. According to Bayram and Mehmet (2004), this action was realized long before in developed countries, it is still a continuing process in developing countries. This is true of the phenomenon we see in the F.C.T. as people flocking in search of economic prosperity and even security.

Over the years several responses have been developed to combat the issue of informal settlements and substandard housing in developing cities in the world. According to Napier (n.d.), the earliest self-help commentators based their housing theories on growth patterns and construction methods that they were seeing in informal settlements. Latin America tended to lead the world in the application of more enlightened responses in place of the previous approach of the mass removal of squatters. As theories and practice became entrenched, donor agencies began to formulate policies to address inadequate shelter in developing countries. Countries in the sub-Saharan region did not escape the influence of large international funding bodies such as the World Bank, the International Monetary Fund and a range of bilateral donor agencies. In that sense, responses to informal settlements have been to some extent shaped by the (neoliberal) policies of these bodies (Durand-Lasserve, 2000). Many theorists have sketched the

changes in approach to the funding of housing responses by large donor agencies over the years. Figure 2.4 shows the changes in these approaches over the years.

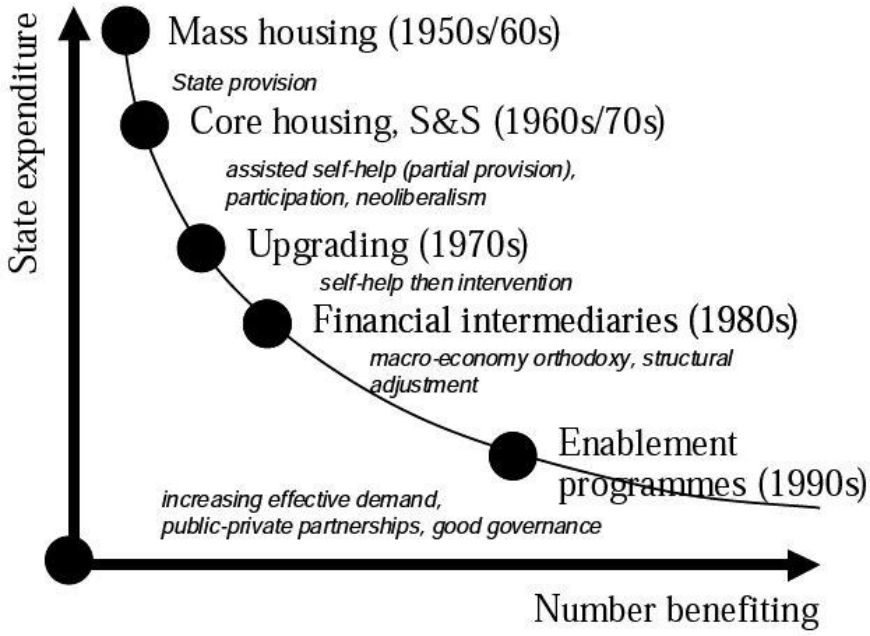


Figure 2.2 Stages in donor funding. (Source: Napier, n.d.)

A new model was proposed by Bayram and Mehmet in 2004 on how to combat the issue of slums; "Respect to this method, slums will be evacuated and only one flat will be given to the each slum owner in this new settlement pattern. This method will not introduce a new financial charge to local authorities and also will provide opportunity for low-income society units to have dwellings with low-cost in these areas.

2.7 Gbagyi Housing

According to a study carried out by Mahbur and Moukhtar (2011), Gbagyi housing has undergone a transformation in recent times. The study classified the transformation into 3 different stages based on the time periods in which they happened. The stages were the incipient stage, the intermediate stage and the consolidated stage. During these stages the features commonly found in Gbagyi houses underwent changes. Gbagyi

Housing transformation was predicated on socio-culture, acculturation, development control, rental income, nature of existing building, and retained core values. Acculturation, development, rental income, and socio-culture related more to motivation. However, retained core values are housing characters. Below is a table showing the transformation pattern of housing features.

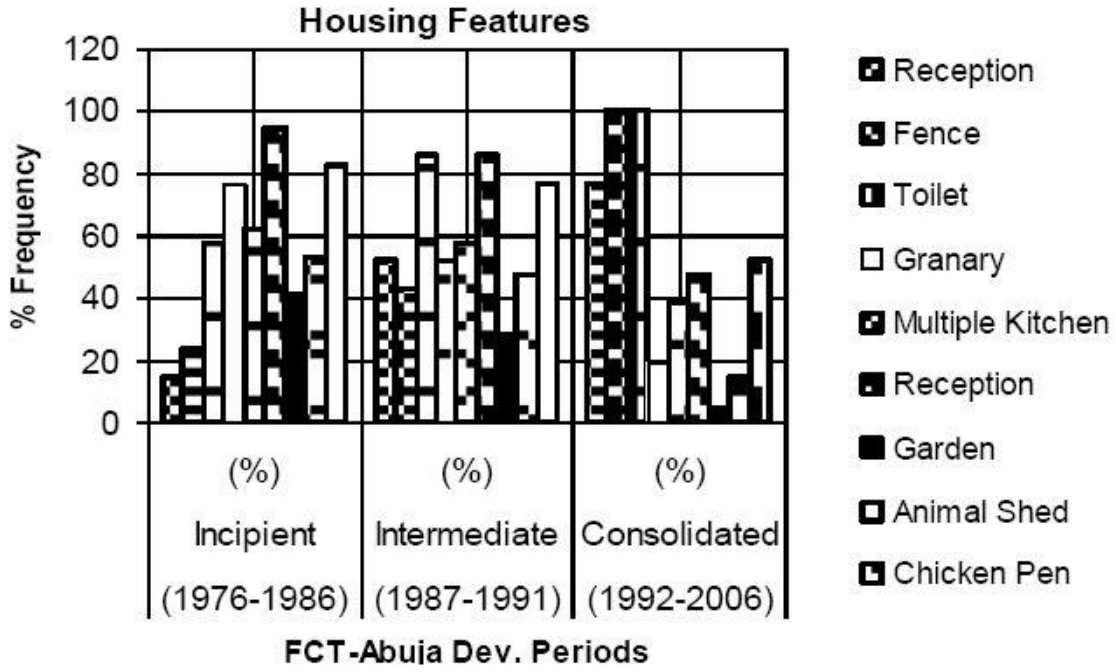


Figure 2.3 Transformation pattern of Gbagyi housing features. (Source: Moukhtar and Mahbubur, 2011)

2.8 History of Mass Housing

Housing development has existed since man's early days. Man has always strived to make his shelter better, always trying to suit his ever changing needs.

As much as 90% of the human population was rurally based before the industrial revolution. This revolution which started in the second half of the 18th century lead to a huge migration of the population to urban centres to look for work as a result of large industries being put up in urban centres due to technological advancements (Pitts, 2004).

2.8.1 Housing units in mass housing

In every mass housing scheme, the major components in the housing scheme are the housing units, which are in line with what is obtainable in the case of privately commissioned housing. In mass housing schemes, the housing units are usually generic in nature which is not the situation in personally designed houses (Adebayo, 2012).

Low income housing design is usually in the form of high density housing. This is done because the land owner (government or private) usually wants to make the optimum use of the available land area.

High density housing is defined as multiple-unit housing where density is greater than unit 1 unit per 80m² of the site area. Typically, high density housing is centrally located in apartment buildings (Bin et al, 2004). High rise buildings are popular in medium to low income housing projects in the United States of America (USA). A high-rise building is a structure whose architectural height is between 35 and 100 meters (see example in Plate IV). A structure is automatically listed as a high-rise when it has a minimum of 12 floors, whether or not the height is known. If it has fewer than 40 floors and the height is unknown, it is also classified automatically as a high-rise (www.emporis.com).



Plate IV - High rise housing. (Source: Ben, 2013)

Contrary to conventional wisdom and public perceptions, high rise public housing is often successful in a great many different locations. For instance, most public housing for the elderly in the United States is in high-rise buildings; generally, it is excellent. There is also much good high-rise, low-income family housing (Fuerst & Roy, 1991).

2.9 Relocation: Problems Associated

In order to make the argument for the non-relocation of the existing Gbagyi settlements within Abuja, it is important to understand the challenges associated with the process. Relocation by definition means; "to move or establish a new place". This could be said for both business and residential relocations. Marcia and James (1991) concluded in a journal that nearly all individuals will find relocation at least minimally stressful and will experiences some stress related symptoms such as emotional reactivity, irritability and exhaustion. Those who find ways establish security and meaning in their new situation within a reasonable time (2 to 6 months) will suffer less turmoil. When the stress of relocation continues beyond a reasonable time, individuals experiencing excessive psychological discomfort must seek professional help.

Stress associated with relocation are sometimes more apparent in children. Children do not have the maturity to understand the change as adults do. School aged children often have friendships that will be interrupted by the move and this can be a source of anxiety and sadness. Experts found that people who moved at least once had an increased risk if poor overall health and some of these could be down to changing schools. The human bodies develop anti-bodies harmful elements in its immediate environment. Changing environments can expose the body to new elements which the body is not equipped to tackle. This is mostly seen in adults. Children in their developmental years can produce new anti-bodies easier than fully developed adults (Alyssa, 2015).

2.10 Housing Policy

Housing policy may be defined as government action to achieve housing objectives. These objectives could include the improvement of the quality of the housing stock of dwellings or dealing with homelessness. Another definition of housing policy would be government intervention in the housing field. The difference is that some interventions in the housing field may be directed at objectives outside the field. Examples could be the regulation of housing finance markets to influence activity in the national economy or restrictions on the amount paid in subsidy to low-income households to encourage incentives to work. Research shows that increasingly more housing policy is directed at economic objectives of efficiency in the national economy with the result that housing policy is increasingly becoming intervention in the housing field to achieve economic objectives. (David, 2010)

2.10.1 Abuja land swap initiative

The Abuja land swap initiative (LSI) simply means that developers will be awarded a percentage of large hectares of land for the provision of engineering infrastructure. More specifically, the essence of the LSI is to give an investor a particular percentage of the land in a district or area in exchange for the provision of infrastructure in the earmarked district. The LSI is therefore an incentivised solution to the persisting urban challenges, with the primary objective of fast-tracking housing and infrastructural developments in some identified areas. Among other things, the developer furnishes the Federal Capital Territory Administration (FCTA) with a design detailing agreed kilometres of storm water drains, foul water drains, water distribution lines, electrical power distribution lines, street lighting lines, telecommunications ducts, and mini

sewage treatment plants. After developing the areas into fully serviced estates, the private developer-investors can then sell/rent out the completed housing units to the public at a profit (Victoria, 2013).

The LSI is backed by the land use act which was added to the Nigerian constitution in 1978. The policy can facilitate the integration of the informal settlements of the F.C.T at virtually no cost to the government if the areas to be allocated to the private investors were to include such settlements within them.

2.11 Conclusion

This chapter has explored various concepts relevant to this research through a review of their theoretical framework. Through this literature review, objective 1 from section 1.4 in the previous chapter has been achieved. Furthermore, through the review of existing housing policies put in place by the government, a better understanding of how to formulate a framework has been gained. A case has also been made for allowing the indigenous Gbagyi people reside in their original locations as opposed to the relocation model currently in place. Other lessons learned from this literature review include the identification of strategies through which the various identified environmental sustainability principles can be adhered to. Also, various housing types and documented living patterns of the Gbagyi people have been studied to aid in making better informed decisions in the final design proposal.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The chapter aims to show in detail how the research is to be carried out. It outlines how data is to be identified, collected and analysed. It explains how various data collection tools such as questionnaire surveys and key informant interviews are designed. The various sources of data are also outlined in this section.

3.2 Case Study Design

A case study is an in depth study of a particular situation rather than a sweeping statistical survey (Martyn, 2008). The case study was designed to focus on the individual settlements which are present in the established portion of the Abuja master plan. The narrowing of the study allowed for the collection of only relevant data to the study.

As a case study, the research concentrates on some selected cases in Abuja, which is in the Federal Capital Territory of Nigeria, and tries to analyse its existing Gbagyi housing developments by looking at three cases, which include Galadimawa village, Garki village and Kucci Goro village.

The cases studied were selected through limiting of the area of study as outlined in the Scope and limitations section of chapter one. The case studies focused on the individual housing units, zoning of the various spaces and functions of the settlements, available infrastructure in these settlements and the socio-economic characteristics peculiar to the Gbagyi settlements. The case studies were conducted in person through visits to these

settlements. Firstly, permission to conduct these studies were obtained from the district heads after they were interviewed, through the presentation of a letter of introduction previously obtained from the office of the head of department of architecture. Subsequently, a tour of each settlement was carried out on foot during which visual observations were noted and questionnaires were administered. Data and observations were noted down in a note pad before subsequent analysis.

3.2.1 Visual observations

It must be noted that visual observation were carried out as a third party. This differs from participant observation in which the researcher is an active member of the phenomenon he under study. The visual observations were used to gather as much qualitative information as possible. Visual observations were noted over the course of the case studies. The activities and features noted were those identified as relevant to the study in the course of the literature review carried out. Noted observations ranged from state of roads and other infrastructure to the manner in which the markets operated in each settlement.

3.2.2 Questionnaire Survey

A questionnaire is defined as a set of questions for obtaining statistically useful or personal information from individuals. (Merriam-Webster, 2014)

The questionnaire was designed to be as straight forward as possible. It was found that respondents were reluctant to answer questionnaires so all forms of personal information such as name of respondent, address of respondent, phone number etc. were not included in the questionnaire. This went a long way in ensuring the success of the

survey as the respondents felt more comfortable answering the questionnaire. The questionnaire sort to gather as much quantitative information as possible.

The questionnaire was distributed to the residents of the selected settlements and collected immediately after they had responded to its questions. The questionnaire was designed to be respondent completed but in some cases the questions on the questionnaires had to be read to respondents and the answers they gave were recorded by the issuer. The recipients of the questionnaire were chosen at random after the required sample size had been calculated. The method employed in the distribution of these questionnaires ensured that everyone who agreed to receive the questionnaire returned a completed copy. Though a small percentage of questionnaires filled by respondents were not useable as the responses to certain questions did not tally maybe due to a lack of proper understanding of the questions.

The questionnaire had a combination of close and open ended questions. Close ended questions were responded to with true or false while the open ended questions had a broader range of possible responses. Other questions gave respondents certain items and asked them to rate them in order of importance or rate the degree to which they agreed or disagreed with a specified opinion. See appendix for administered questionnaire.

3.2.3 Key Informant Interview

Key informant interviews are qualitative in-depth interviews with people who know what is going on in the community. The purpose of key informant interviews is to collect information from a wide range of people including community leaders, professionals, or residents who have first-hand knowledge of the community. These

community experts with their particular knowledge and understanding can provide insight on the nature of problems and give recommendations for solutions.

For the purpose of this research, the key informants were identified in each settlement to be studied. Community leaders were targeted as key informants but could not be reached in all occasions. In Galadimawa village, the district head responded to the interview while secretaries to the district heads were interviewed in both Garki and Kucci Goro village. The interviews were conducted in the offices/residences of the district heads. The questions asked in the interview were read from a previously prepared interview schedule. The questions were structured in such a way as to give more insight into issues that cannot be addressed by the questionnaire. One such issue is that of security provision and land allocation in the settlements. The responses to the questions were noted down in a note pad and also recorded using the voice recorder on a mobile phone. See appendix for full interview schedule.

3.3 Sampling

Sampling is simply the selection of a subset from a population to estimate the characteristics of the entire population. The sample for this study was is in two parts. The first being the Gbagyi settlements selected for case study analysis. The second being the number of people in each case to be issued questionnaires. The first part was determined by limiting the geographical scope of the study. Only settlements within the developed area of the Abuja municipal area council were studied or settlement within a 10km radius from the city centre.

The questionnaires were targeted at household heads since the aim was to try and understand different households function. Preliminary study found that the density of

these areas put the number of households at about 60 per hectare of land. For every hectare of land, the questionnaire was administered to 20% of households. This amounted to a total of 12 households per hectare of land. About 90% of questionnaires filled were useable which amounts to 10 questionnaires per hectare. The households were chosen at random since the households within the settlements were not laid out in any specific manner.

3.3.1 Data Collection and Analysis

There will be 2 types of data to be collected over the course of this research:

1. Qualitative data
2. Quantitative data

Qualitative data is one which approximates or characterizes but does not measure the attributes, characteristics, properties etc. of a thing or phenomenon. Qualitative data aims to describe the state of things. Quantitative data on the other hand aims to define a thing or phenomenon by measuring its magnitude (www.businessdictionary.com). Qualitative data was collected through the following open ended protocols; observations, interviews and open ended questions posed in the questionnaire survey. Quantitative data was collected through structured data collection instruments like the close ended questions posed in the questionnaire survey and also the use of Google earth satellite imaging software to obtain precise maps of the settlements under study. These two forms of data were analysed in different ways. Qualitative data was analysed through a range of processes and procedures. The analyses was based on interpretative philosophy (examining the meaningful and symbolic content of qualitative data). Opinions of respondents of the questionnaire and the key informants interviewed were studied to identify trends and patterns that would prove useful to this research. For

example, the question of how liquid waste was disposed of by the respondents was an open ended question. The answers they gave helped explained why there was a high number of open gutters in these areas. Quantitative was analysed using statistical data analysis methods. Since this type of data could be quantified, it was easy to convert responses into numerical equivalents. For example, the use of a 5 option Likert scale (see Figure 3.1) to rate the respondents views on a stated opinion. A Likert scale is a psychometric response scale primarily employed in questionnaires to obtain preferences or the degree of agreement with a statement or set of statements (Bertram, 2007). Close ended (true or false) questions were also had responses converted to numerical equivalents by collating the number of respondents who answered one way or the other. The numerical data was subsequently converted into pie charts with percentages assigned to certain responses. The mean and frequency of these responses were used to identify trends relevant to this study. For example, the question of housing ownership was close ended in that the respondents could only either own or rent their houses. The responses were converted into a pie chart showing the percentages of people who own or rent their houses.

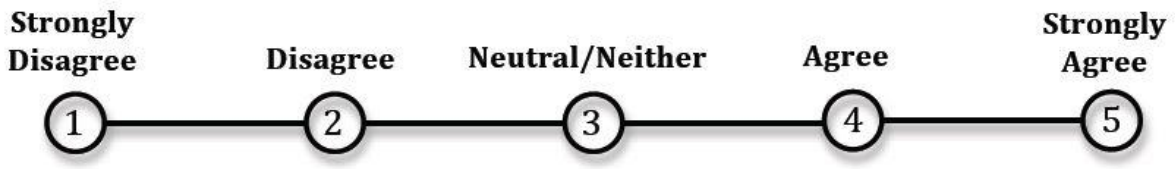


Figure 3.1 Five option Likert scale (Source: Maina, 2014)

Google earth is a geo-browser that accesses satellite and aerial imagery, ocean bathymetry, and other geographic data over the internet to represent the earth as a 3 dimensional globe (serc.carleton.edu. N.D). Satellite images obtained using Google earth software were measured and scaled within the software. Boundaries of the various settlements were obtained from within the software using the “add path” tool. The

"ruler" tool was used to measure out the path previously drawn using the "add path" tool and calculated to obtain the precise areas they occupy.

3.4 Conclusion

This chapter has outlined in detail the specific processes involved in carrying out this research. It has clearly defined methods of data collection, data analysis and the tools used to do both. The questionnaire and interview schedules can be found in the Appendix I and II respectively. The design of both the questionnaire and interview schedules was made as easy and concise as possible to avoid over bearing the respondents and also ensuring that only relevant data was collected.

CHAPTER FOUR
CASE STUDY FINDINGS AND DISCUSSION

4.1 Introduction

This chapter aims to discuss the findings which resulted from the numerous case studies that have been carried out to achieve objective 2 in section 1.3 of chapter 1. There are 3 different cases to be discussed in this chapter. The cases will be discussed under relevant topics previously identified through the literature review section of this research.

4.2 Case Studies

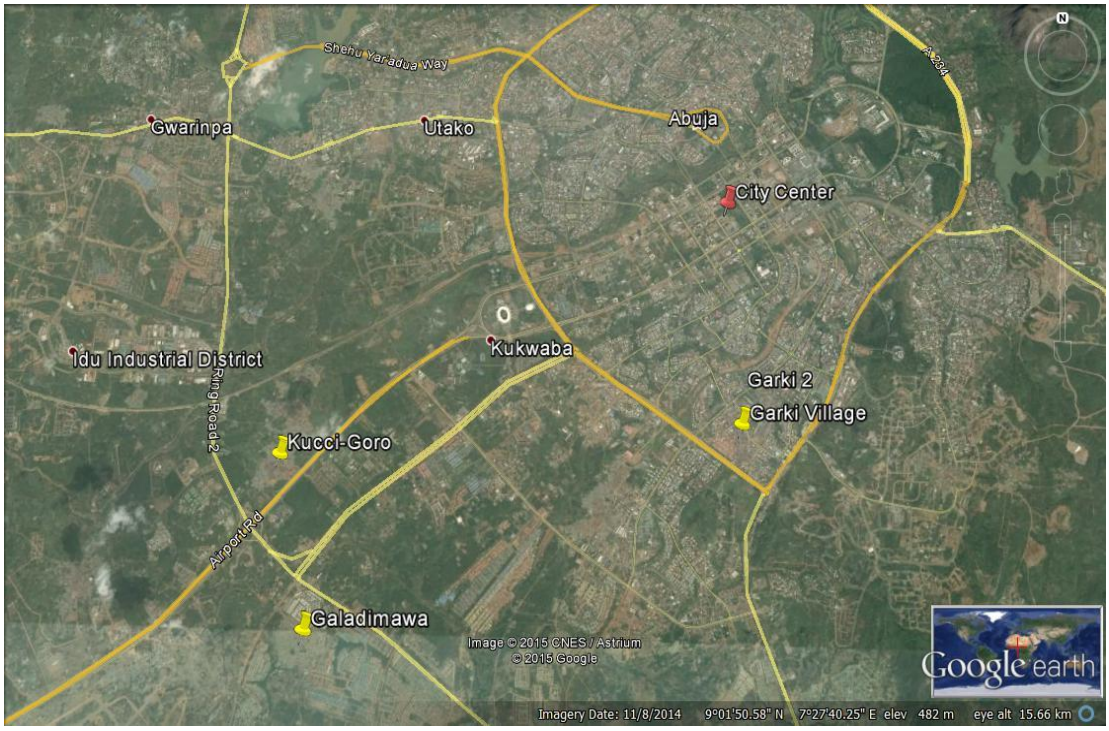


Plate V - Satellite image showing locations of selected cases. (Source: Google Earth)

4.2.1 Galadimawa village

This is one of the informal settlements in AMAC. The settlement was established more than a century ago when the Gbagyi people moved from Zaria because they were not ready to accept Islam in the 1800s. This is contrary to the popular opinion that the settlement sprung up due to the creation of the F.C.T. in the 1980s. It occupies an area of roughly 46 hectares and a distance of 9.5km from the city centre.

The settlement is bound by recently developed housing estates including the AMSSCO platinum city in the north, Sun City in the east and the Saraha Royal Maccido estate in the west (see Plate VII for site boundary). To the south of it is the yet to be constructed highway which connects the city and Kuje area council directly. The situation of the settlement is peculiar as it has been earmarked for resettlement as the land there is to be used for the development of more housing estates.



Plate VI - Satellite image showing Galadimawa settlement. (Source: Google Earth)

4.2.2 Kucci-Goro village

This is an informal settlement which like the Galadimawa village has existed for many years. They moved to their current location from Suleja in Niger state. It occupies a land area of roughly 41.5 hectares and is at a distance 8km from the city centre. The settlement is located off the Shehu Yar'adua express way just 3.7km from the Abuja city gate. Unlike Galadimawa, it is not bound by housing developments as the immediate land surrounding it is yet to be developed. The village has developed in a random pattern as can be seen in the oddly shaped boundary in Plate VIII. According to the development map of Abuja, the land occupied by the village is to be used for the Kukwaba national park. This means that eventually the village will have to be relocated to make room for the planned development. As of the time of this research, no resettlement plans have been made for this settlement.



Plate VII - Satellite image showing Kucci-Goro settlement. (Source: Google Earth)

4.2.3 Garki village

This settlement has also existed for many years, far preceding the establishment of the F.C.T. it is the seat of the most senior traditional ruler in AMAC. It covers an area of roughly 24.3 hectares. It is located in the middle of the Garki 2 district just 3.5km from the city centre.

The settlement has been earmarked for resettlement since 2013. It is surrounded on all sides by residential and commercial developments of the Garki 2 area. The boundary line of the site shows how the village is being boxed in by the development surrounding it (see Plate IX). This settlement differs from the first two in that it contains some form of formal housing within the informal setting.



Plate VIII - Satellite image showing Garki Village. (Source: Google Earth)

4.3 Density of Settlements

Both Galadimawa and Kucci-Goro settlements have predominantly bungalows. This makes for a density that is high in the horizontal dimension but low in the vertical dimension. This coupled with slim to zero setbacks between buildings makes for a high population per square area. Another contributing factor to the high density is the number of people found in each household. A high percentage of dwellings in Galadimawa and Kucci-Goro are of the 1 bedroom configuration.

Garki village on the other hand has a combination of both bungalows and duplexes. Even though visual survey carried out during the field studies indicate that the bungalows outnumber the duplexes by a considerable margin. The presence of the multi-storey buildings indicates a better density distribution between the horizontal and vertical dimensions than in the other 2 settlements. From the questionnaire survey carried out, majority of dwellings in Garki village are also 1 bedroom while the average family size is at an average of 1-3 persons as can be seen in Figures 4.1 and 4.2.

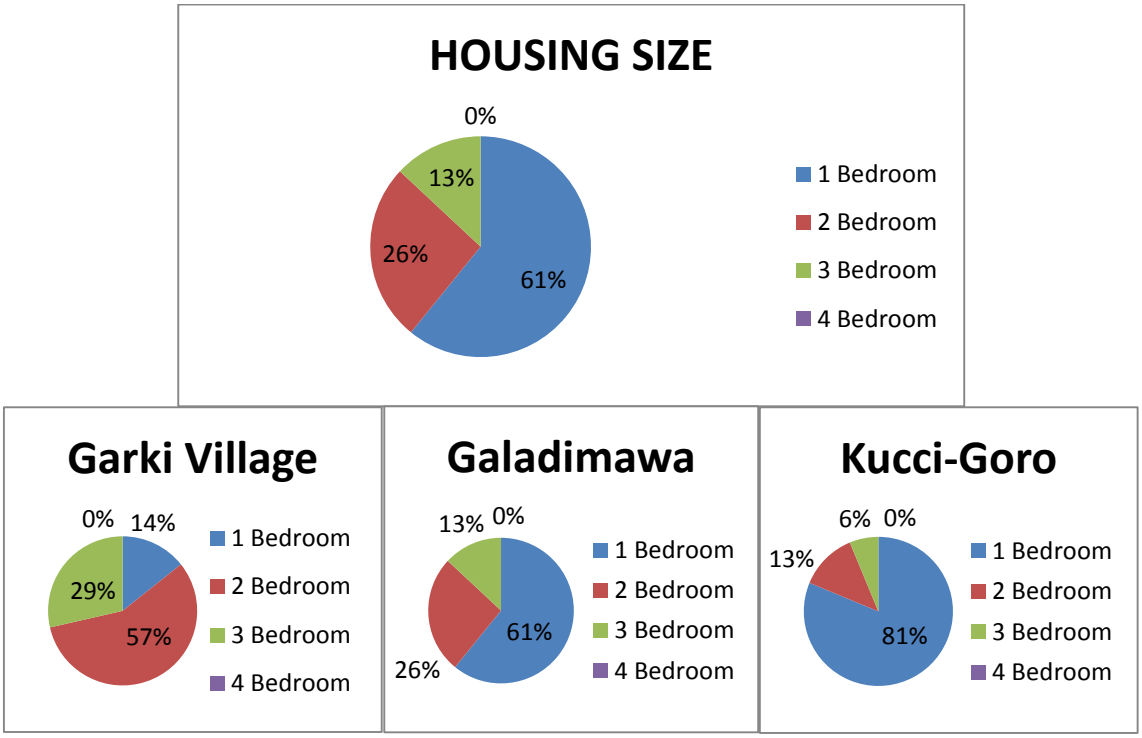


Figure 4.1 Statistics of housing size (Source: field work, 2015)

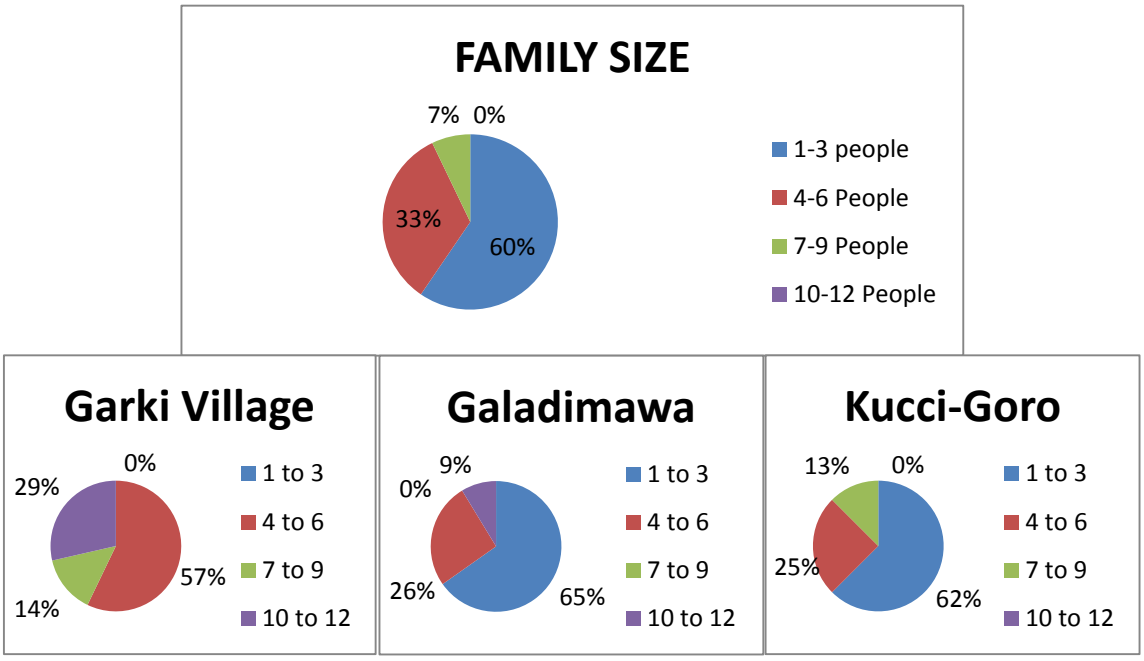


Figure 4.2 Showing statistics of family size. (Source: field work, 2015)

4.4 Zoning of Settlements

It was apparent from the field studies that these settlements were not designed. The lack of proper zoning for different types of activities further supports this. All 3 of the

settlements studied are highly residential. In the case of Galadimawa and Kucci-Goro, there are designated areas within the settlements that were identified as major markets. Garki village on the other hand has a more sparse distribution of commercial activities. Houses tend to have shops/stalls attached to their frontages for selling goods or offering services (as shown in Plate X).



Plate IX - Shops attached to houses. (Source: field work, 2015)

Commercial areas are intertwined with residential areas. This makes it difficult for proper noise control and provision specialized services. The major markets identified were found along the major road passing through the settlement or in the areas preceding the main residential areas. In the case of Kucci Goro both the major commercial and institutional areas are met in the spaces preceding the major residential area (as can be seen in Figure 4.3). This is not to say that small pockets of commercial activity cannot be found in the greater residential area.



Figure 4.3 Zoning for Kucci Goro settlement. (Source: field work, 2015)



Figure 4.4 Zoning for Galadimawa. (Source: field work, 2015)

Garki village was found to have no institutionally zoned areas. No schools or offices were found there. The zoning of Garki village can be seen in Figure 4.5. The only identified areas were residential and commercial. It is suspected that this due to the development of the Garki district around the settlement. This has removed all

institutional buildings like schools, hospitals, banks and offices from the settlement and they can now be found in the areas surrounding it. This is emphasised in Plate 4.8.



Figure 4.5 Zoning for Garki village. (Source: field work, 2015)

Institutions have very little presence in these areas. Especially those that are considered as amenities e.g. hospitals, fire stations etc. This issue of lack of proper health care centres within these settlements was identified through key informant interviews. As at the time of this research, no hospitals were present in all three settlements. Only a few pharmacies which offered basic first aid care are present in these settlements.

Commercial institutions are not present in these areas. This is mostly due to a lack of formal business establishments in these areas as they have mostly moved their businesses to the more developed parts of town. Most businesses found in these areas are small scale businesses.

There are educational institutions present in Kucci Goro and Galadimawa but none was found in Garki village. The schools found in both Kucci Goro and Galadimawa cater for students in primary and junior secondary schools only. In all cases, there were no

educational institutions that catered for education beyond the junior secondary school level.

4.5 Available Infrastructure

Provision of basic infrastructure within all three settlements can be said to be poor. In Galadimawa and Kucci-Goro, there is absolutely no provision of tarred roads. The unpaved roads making for very uncomfortable commutes within these settlements (see Plate XI). Garki village however has one tarred road present. It leads from the main road to the entrance of the gates of the Sa'apeyi's palace.



Plate X - Untarred road. (Source: field work, 2015)

Electricity distribution is done through overhead distribution cables. These are potentially dangerous due to the haphazard nature with which they were laid out. Overhead distribution cables also make it easy for people to make illegal connections to the grid. The entangled power lines, like those seen in Plate XII also make maintenance difficult for the electricity distribution companies.



Plate XI - Haphazard electrical connections. (Source: field work, 2015)

Waste collection in Galadimawa and Kucci-Goro is done via local authorities. Waste is usually gathered and taken to dump sites (as seen in Plate XIII) where they are usually burned. No sorting is done to the different types of waste generated. In these same areas, some people still resort to burning their waste by themselves. Figure 4.6 shows the different methods of waste disposal employed in these settlements. This is done mostly within the environs of the residences. This is very unsafe as burning is done on bare ground without the use of incinerators. This generates air polluting fumes which cause possible health hazards. In Garki village, no landfills were found in and around the settlement during the field studies. After further investigation, it was ascertained that waste management in this area was handled by the municipal authorities i.e. Abuja Environmental Protection Board (A.E.P.B).



Plate XII - General refuse dump. (Source: field work, 2015)

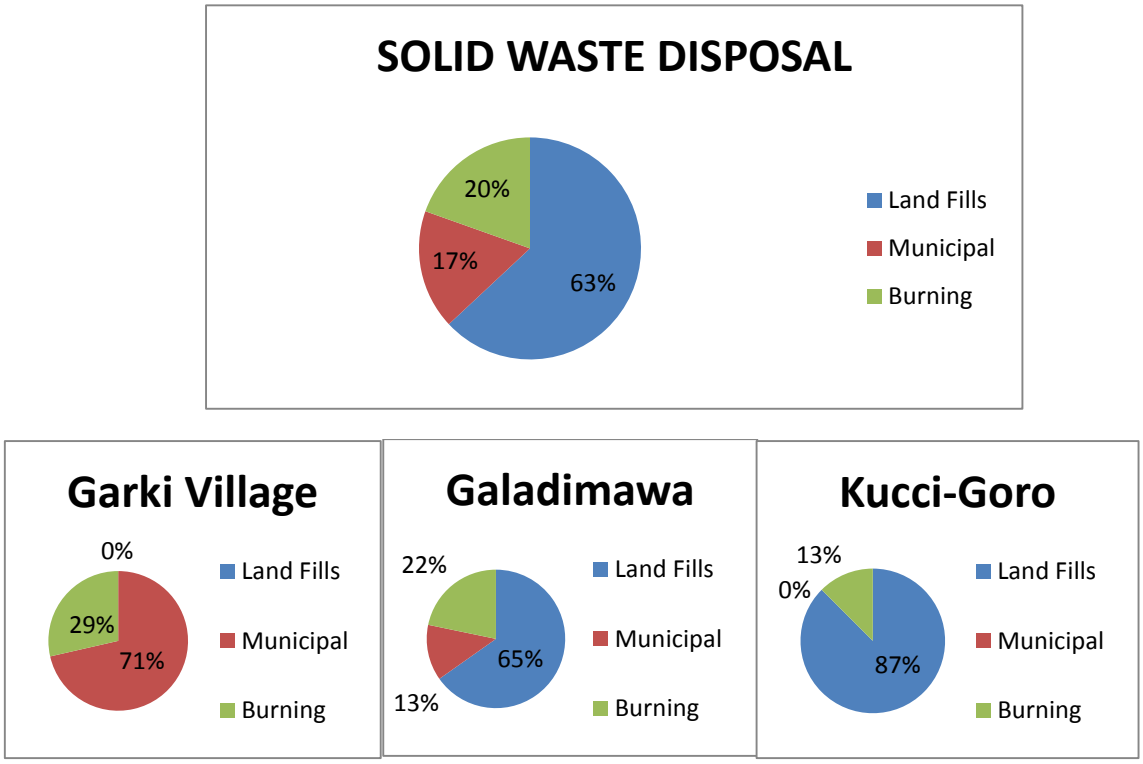


Figure 4.6 Statistics of solid waste disposal methods. (Source: field work, 2015)

In all three cases studied, no central water supply was found. The mains water supply did not reach these settlements. Water supply in these areas is done using individually

sunk bore holes and distributed through water kiosks as shown in Plate XVI. Due to the expensive nature of these bore holes, they are few in number. They have been turned into business opportunities for various members of the community. This has led to the establishment of water kiosks in various locations around the settlements. Cart pushers popularly referred to as "mai-ruwa" fill up jerry cans at these water kiosks and deliver it to people's houses for a fee.



Plate XIII - Water kiosks. (Source: field work, 2015)

As in the case of water supply, no central system for sewage collection was in place as of the time of this research. Though there are channels dug in some areas for removal of sewage from houses, they cannot be referred to as a central system since they act independently of one another. Some houses are fortunate enough to have septic tanks. They are evacuated periodically when full. The rest of the population dispose of their liquid waste on bare ground outside their homes. The open sewage channels as seen in Plate XV make for unsightly streets and contributes to the poor living conditions usually associated with informal settlements. The survey carried out shows that in all the areas studied, less than half of the houses have proper means of sewage disposal (see Figure 4.7).



Plate XIV - Open sewage. (Source: field work, 2015)

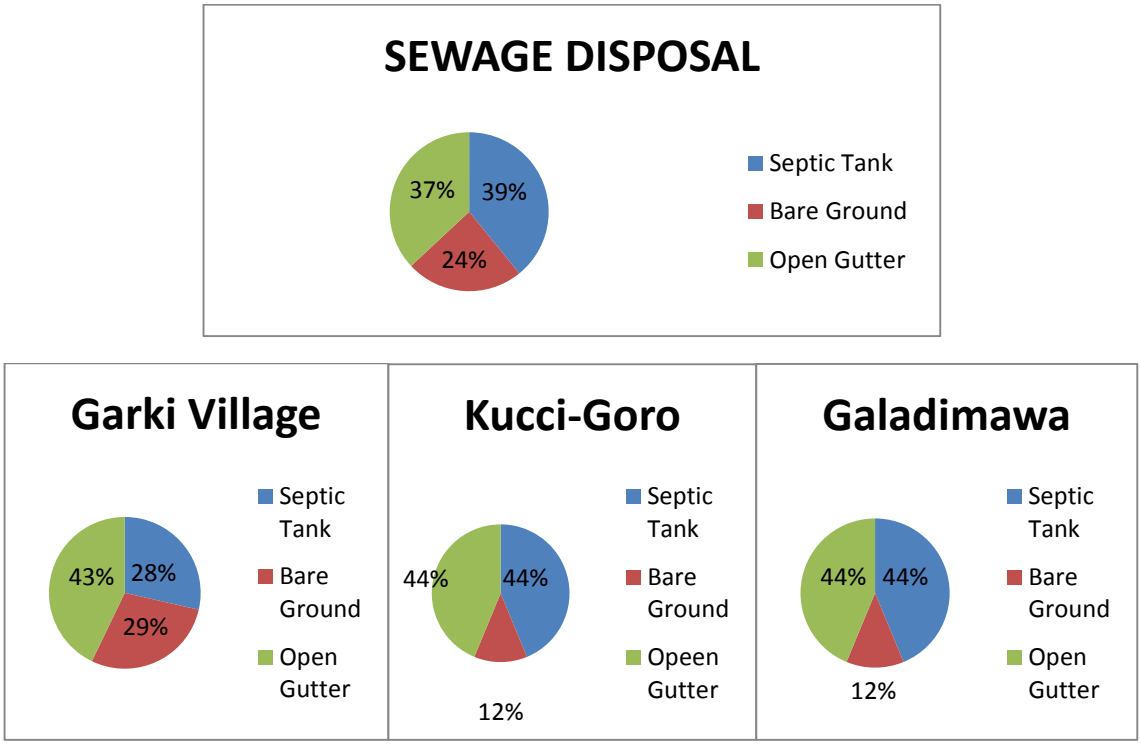


Figure 4.7 Statistics of sewage disposal methods. (Source: field work, 2015)

4.6 Public Outdoor Spaces and Their Spatial Quality

As of the time of this research none of the settlements under study contained pre-defined public outdoor spaces such as recreational parks. This is mostly due to the demand for land for housing purposes by the population which leaves little to no consideration for recreational areas. Spaces that would be otherwise earmarked for

parks and other outdoor spaces are made into houses and shops instead. The playgrounds in the schools in Galadimawa and Kucci-Goro (as seen in Plate XVI) can be said to be pseudo public spaces. Though they were originally meant to be used by the students of the school during school hours they are left opened to the public even after school hours.



Plate XV - School's football field. (Source: field work, 2015)

4.7 Transportation

Residents of these settlements all get around using either private or public vehicles. They do differ however in the vehicles used for public transport. In Galadimawa and Kucci-Goro settlements, vehicles used for public transport are motor cycles and the Keke Napep tricycles. In Garki village on the other hand, public transport is done exclusively through the use of the Keke Napep tricycles as shown in Plate XVII. This is by virtue of the location of the settlement. Due to its proximity to the city centre, it was affected by the October 1st 2006 ban on the operation of commercial motor cycles in the city. Survey shows vehicular transportation favours the use of public rather than private transport vehicles. Unfortunately no vehicles that facilitate mass transit are found in these settlements even though majority of the populace of these settlements do

not own private vehicles (see Figure 4.8). This presents a unique opportunity to introduce sustainable mass transit systems as earlier discussed in chapter 2.



Plate XVI - Commercial tricycles. (Source: field work, 2015)

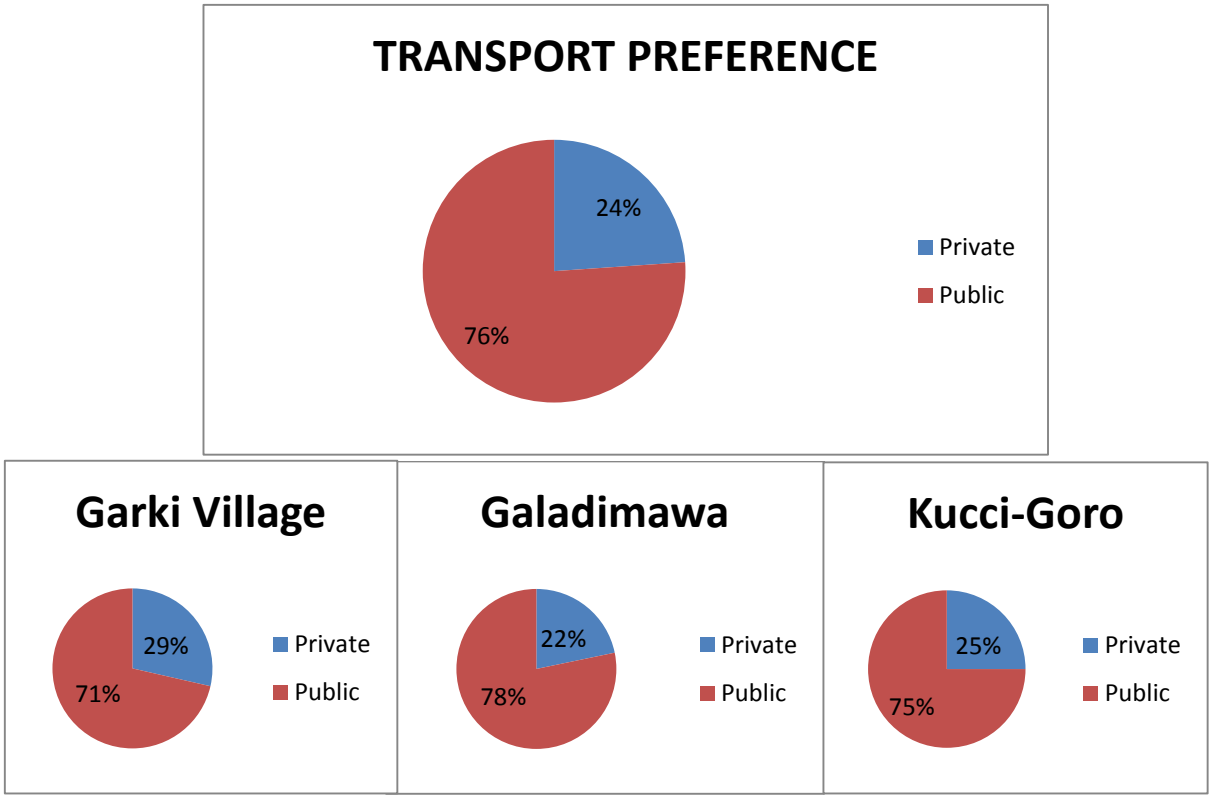


Figure 4.8 Statistics of transportation methods. (Source: field work, 2015)

Even though there is a high volume of pedestrian circulation within these settlements, the roads/streets found in them make commutes very unsafe for pedestrians. As seen in Plate XVIII below, most of the streets have been eroded by action of rain and other vehicles. This makes for uncomfortable pedestrian commutes as stones and other objects protruding from the surface can cause injuries to the commuters. There is no indication or demarcation for pedestrian walkways or paths. The roads/streets are basically that allow for all forms of vehicles to move along them.



Plate XVII - Poorly defined streets. (Source: field work, 2015)

4.8 Housing Design and Perception

As these settlements are unplanned, there are no predetermined designs for the houses found there nor a pattern of housing design. The housing units found are designed mostly by impulse. Survey showed that most of the houses found in these settlements have been rented out to their occupiers. This shows that most of the people in these settlements do not have direct control over the design of the houses they live in. This in conjunction with the lack of financial resources available to most of the occupants is the result of mismatched average family size and average house size earlier discussed in this section 4.2 of this chapter.

A survey was carried out to assess the perception of the residents of these settlements with regards to the quality of houses they live in (see figure 4.9 for results). A Likert scale was used for the survey to gauge how the respondents viewed the opinion "the house you live in is of good quality". The following results were obtained from the survey.

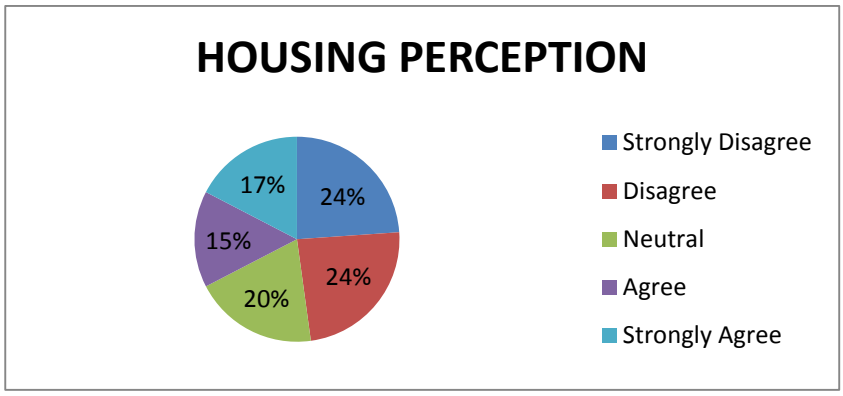


Figure 4.9 Statistics of housing perception. (Source: field work, 2015)

Another factor that contributed to the perception that the occupants had of their houses is the mode of construction and materials used in building them. Most responses of “agree” and “strongly agree” were from occupants of houses made from sandcrete blocks. Residents of houses made from wood and earth tend to disagree with the notion that their houses were of good quality. This show that occupants of these settlements is given the choice, would not want to live in houses made with more traditional building materials and construction methods. Visual survey established 4 major methods of construction for the houses found in these settlements. They include:

1. Sandcrete blocks and cement construction
2. Earth block construction
3. Earth block and cement used in combination
4. Wood frame and cladding

4.9 Wildlife and Vegetation

Since it was established that the Gbagyi people rear animals in their homes in section 2.6 of the literature review, it was important to establish whether this was still the case in these settlements today. A survey was carried out ascertain the presence of animals in these settlements. It is important to note that the animals referred to in this study are those kept for commercial purposes. Animals kept as pets were not factored in as their presence in a household is completely subject to preferences of the residents and thus cannot be used as a socio-economic indicator. The animals that were found include chickens, sheep, and goats. The results presented in Figure 4.10 below who that only 28% of the population own animals. Though this is a lesser portion of the population, it is significant enough to warrant a provision for in the subsequent design proposal.

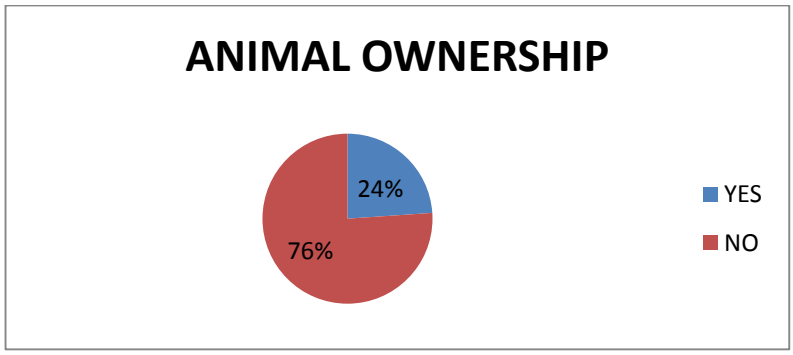


Figure 4.10 Statistics of animal ownership. (Source: field work, 2015)

Vegetation in these settlements was found to be sparse at best. Green areas were all but non-existent with areas previously used for farming by the Gbagyi people now used for constructing houses instead. The trees present were ones common to the geographical area. Key informant interviews carried out revealed that no endangered plant life existed in these settlements.

4.10 Conclusion

This chapter has explored the current state of the Gbagyi settlements under study. Through this discussion it can be seen that these settlements are in a deplorable state. Due to lack of basic infrastructure, a great level of environmental degradation has set in. Information gathered through the discussion of the findings obtained during the case studies directly influence the final design proposal. The size and type of housing to be provided, the public spaces and functions to be provided for as well as various other activities that are peculiar to the settlements under study. It is also evident from the discussions carried out in this chapter that the settlements are not properly zoned therefore making it difficult for adequate service delivery to different parts such as the school, market etc. All this will have to be addressed in the design proposal.

CHAPTER FIVE
SITE SELECTION AND BRIEF FORMULATION

5.1 Introduction

This chapter seeks to achieve two things; firstly to outline the criteria for site selection. Secondly, to develop a precise and all-encompassing brief. Both the site and brief will be used as basis for the intended design proposal. The site will be selected from the three cases studied.

5.2 Site Selection

This outlines the process used in the selection of the site that was used in the demonstration of the findings of this research. Three sites were considered for the proposal. They are made up of the three settlements visited during the field studies of this research namely; Kucci Goro, Galadimawa and Garki village. A scoring system was developed to assess the sites. A 0-10 point based system was used to rate the sites on different criteria. The criteria include the following;

1. **Size**- this refers to the physical size of the site. A site with larger size will be favoured as it will allow for greater flexibility of design.
2. **Appropriated land use**- this refers to the intended use of the land according to the Abuja master plan. Sites that are located in residential areas will be favoured as they will be in line with the planning authority's requirements.
3. **Expandability**- this refers to the ability of the project to expand after completion. A site with a higher ability to expand will be favoured in this regard.

4. **Accessibility**- this refers to the ease with which goods and people can be transported to and from the site ensuring that the site is not in a non-accessible area. A site with greater ease of access will be favoured.

Kucci Goro village



Plate XVIII - Satellite image showing boundary of Kucci Goro village. (Source: Google Earth)

LOCATION: The settlement is located off the Shehu Yar'adua express way just 8km from the city centre.

SIZE: 41.5 hectares

Table 5.1 Scores attained by Kucci Goro village.

ATTRIBUTES	SCORE
1. SIZE	**7/10**
2. APPROPRIATED LAND USE	**0/10**
3. EXPANDABILITY	**10/10**
4. ACCESSIBILITY	**10/10**

Galadimawa village



Plate XIX - Satellite image showing boundary of Galadimawa village. (Source: Google Earth)

LOCATION: The settlement is located in the Galadimawa district of the city. About 9.5km from the city centre.

SIZE: 43 hectares

Table 5.2 Scores attained by Galadimawa village.

ATTRIBUTES	SCORE
1. SIZE	**10/10**
2. APPROPRIATED LAND USE	**10/10**
3. EXPANDABILITY	**7/10**
4. ACCESSIBILITY	**9/10**

Garki village



Plate XX - Satellite image showing boundary of Garki village. (Source: Google Earth)

LOCATION: It is located in the middle of the Garki 2 district just 3.5km from the city centre.

SIZE: 24.3 hectares

Table 5.3 Scores attained by Garki village.

ATTRIBUTES	SCORE
1. SIZE	**4/10**
2. APPROPRIATED LAND USE	**10/10**
3. EXPANDABILITY	**0/10**
4. ACCESSIBILITY	**10/10**

Table 5.4 Tally of scores attained by the different sites.

	KUCCI GORO	GALADIMAWA	GARKI VILLAGE
1. SIZE	7/10	1/10	4/10
2. APPROPRIATED LAND USE	0/10	10/10	10/10
3. EXPANDABILITY	10/10	5/10	0/10
4. ACCESSIBILITY	10/10	9/10	10/10
TOTAL	**27**	**34**	**24**

As can be seen from the above Table 5.4, Galadimawa village scores the most cumulative points and thus will be used to demonstrate the design of an integrated Gbagyi settlement.

5.3 Site Analysis

Site analysis is a vital step in the design process. It involves the evaluation of an existing or potential site. In relation with the development program. It identifies environmental, program and developmental constraints and opportunities. A well-executed site analysis forms the foundation for a cost effective, environmentally sensitive and rational approach to the project development (Floyd, 2000). The selected site is to be analysed and the in the following ways;

i. Site climate
ii. Site topography and vegetation
iii. Site views and adjacent activities

5.3.1 Site climate

The site is located in a hot dry climate. It therefore adopts the macro climate characteristics that can be attributed to that type of climate as graphically represented in

Figure 5.1. These characteristics include an average rainfall of 7 days per month. Average sunlight time of 12 hours. The relative humidity a high of 77% during the peak of the rainy season which is usually in the month of August. For the months of the year without rainfall, the average relative humidity is about 28%. The temperature range for this climate is 38°c to 14°c with temperatures peaking in February and March. The average daily temperature difference does not exceed 10°c. Seasonal winds in this climate come from two major directions, the north-east and south-west. The north-east trade winds are accompanied by dust and cold air ushering in the "harmattan" season. The south-east trade winds bring rain towards the middle of the year. The analysis of the site climate informs the following;

i. Orientation of buildings having their aides with the smallest surface area in the direct path of the sun.
ii. The use 15% to 35% of buildings surface area as openings.
iii. Use of buffers to reduce the amount of dust reaching the buildings via the trade winds.
iv. Use of courtyard design where possible to enhance thermal comfort.

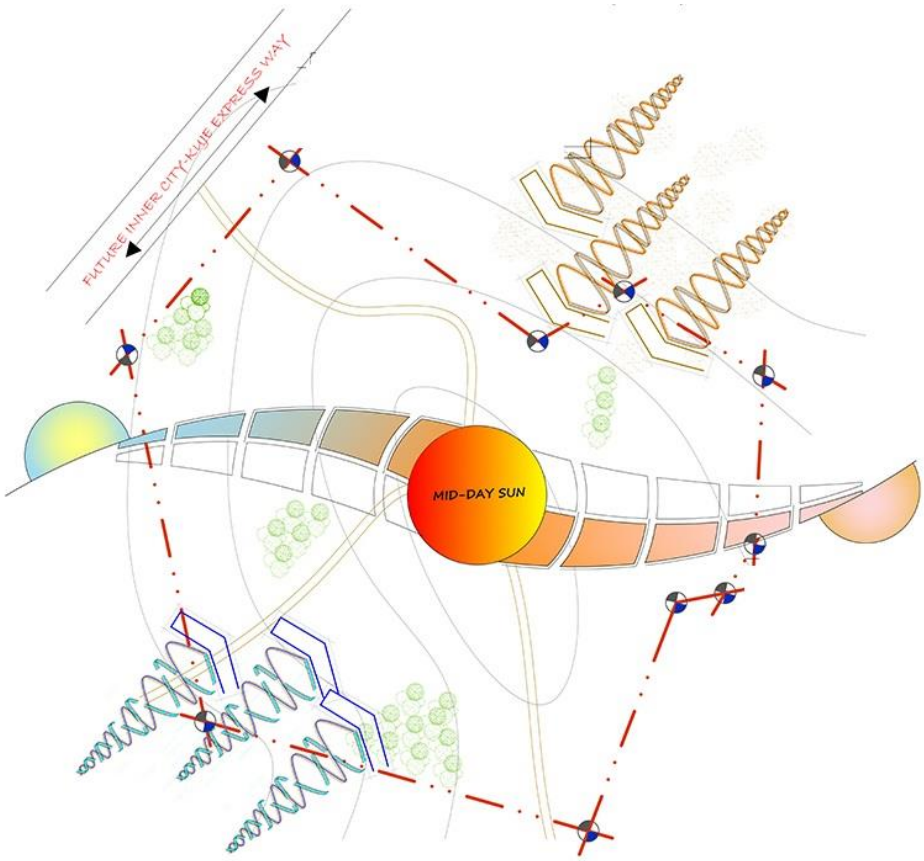


Figure 5.1 Analysis of site climate. (Source: field work, 2015)

5.3.2 Site topography and vegetation

The topography of the site describes the shape and relief of the land. Topography is a measurement of elevation while the slope is the percentage change in the elevation over a distance. The elevations are indicated with lines that connect points representing the same elevation. These lines are called topographic contours. The slope is measured by calculating the difference in the elevation from one point to another divided by the distance between the points. The maximum slope on the site is 0.047. The shape of the site is that of a gentle hill. The contour lines drawn on the site form concentric shapes thereby placing the highest point in the location relatively in the middle of the site. The gentle slope obtained informs that drastic measures need not be taken during construction. Construction activities like cutting and filling will not be required here.

The soil quality found on the site was found to be of good bearing capacity. The top soil is less than 1m deep giving way to laterite soil of good compaction.

Vegetation found on the site is sparse as most of the site has been over taken by small buildings ranging from shops to dwelling units of various sizes. Grass in virtually non-existent on the site. The few trees found on the site include (but are not limited to) mango trees and canopy trees. There are no endangered plants on the site that would require special attention. Figure 5.2 below graphically illustrates the topography and existing vegetation found on the site.

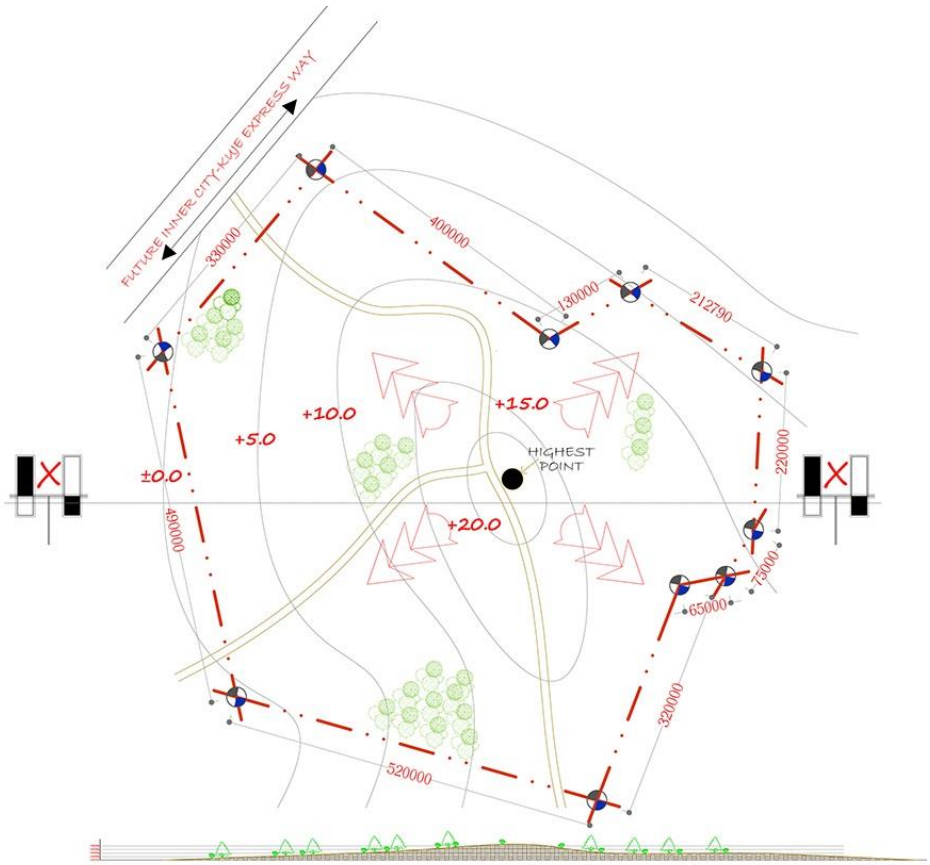


Figure 5.2 Analysis of site topography and vegetation. (Source: field work, 2015)

5.3.3 Site views and adjacent activities

The activities and/or buildings that surround a site can influence certain design decisions. Activities that generate a lot of noise or heat will inform the introduction of buffers and proper zoning to counteract the negative effects they might produce. The orientation of buildings can also be affected by the resultant views the will offer to their occupants.

The site surrounded majorly by housing estates having the housing developments on three sides of the site as seen in Figure 5.3. On the southern side however, there is an open field corridor which could be used as an avenue for future expansion of the development. There are 3 major sources of noise that can be found adjacent to the site. The main road on the north-western side, construction activities in the housing development to the west and noise coming from the market area in the middle of the site. There are no particular natural features or monuments near the site that would warrant taking advantage of the views they provide.

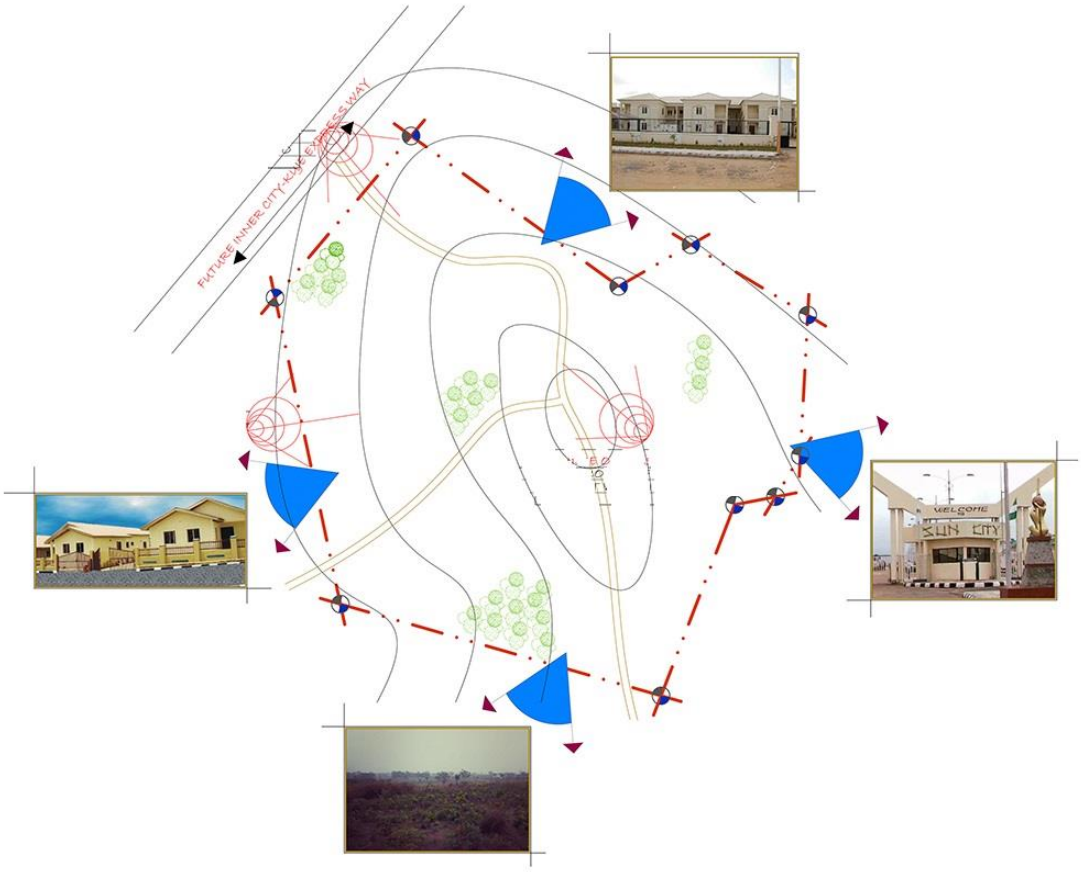


Figure 5.3 Analysis of site views and adjacent activities. (Source: field work, 2015)

5.4 Brief Formulation

A design brief is a guide used in producing an architectural design. It differs from a design concept in that it outlines the actual parameters of the physical design. Various spaces and activities that need to be accommodated are all outlined in the design brief. As with the concept formulation for this design, the brief is to be in different parts for different aspects of the design.

5.4.1 Layout design brief

The overall layout of the proposed housing development is to be constituted of different functions and spaces. The different spaces to be provided for came about as an

intersection of the identified requirements of the settlements through the case studies discussed in chapter 4 and the general requirements of a housing development as seen in the literature review carried out in chapter 2. Literature points to the need to understand housing as more than just provision of dwelling units, but also the spaces that will allow for the comfortable existence of the residents of the housing development. The provision of public spaces like recreational parks, schools and community markets among others no longer become optional but rather necessities in the design of a properly functioning housing development. These auxiliary spaces and functions are referred to as social infrastructure.

Over the course of the various case studies carried out, it was observed that a vast majority of the settlements did not possess the required social infrastructure or in some cases did not have them in the appropriate manner. For example, no recreational areas were identified in any of the settlements that were studied. Schools were present in most of the settlements but were over crowded due to the overwhelming population of pupils that attended them. The little facilities available to the schools were dilapidated as a result. Another issue was the absence of community centres in these settlements. Due to the nature of the societies found in these settlements i.e. where district heads have a lot of influence over what goes on in the settlements, it was necessary to provide community centres so as to create a space where community meetings and other functions can be held.

From the field studies and literature reviews carried out, the following were outlined as spaces and activities that should be catered for in the design in conjunction with the various densities of housing.

i. Organized market and commercial areas
ii. Police station
iii. Community centre
iv. Fire station
v. Primary health care facility
vi. Basic education school
vii. Recreational areas
viii. Efficient transportation network
ix. Waste management facility

The existing density of housing found in these settlements is about 60 houses per hectare of land. This is too high and only reflects the high density aspect of housing and even at that reflects a greater density than that allowable for high density housing especially considering that the houses are bungalows. Since the proposal considered 3 different densities of housing, an average density was used to compute the amount of houses to be provide in the proposal. The 3 different densities used are 10 houses/hectare for low density housing, 20 houses/hectare for medium density housing and 40 houses/hectare for high density housing. This makes an average of 23 houses/hectare. For this proposal, 60% of the land is going to be used for the provision of houses given that other services and functions are going to be provided for on the site. The selected site has a total area of 43 hectares, 60% of which is 25.8 hectares. Using the average housing density earlier stated, the desired number of housing units to be provided should be 593 in number with an allowable margin of 10% (59 units). Given the nature of the housing development, the housing densities should have the following hierarchies in terms of number of units; high density>medium density>low density.

5.4.2 Dwelling units design brief

Though the dwelling units are primarily aimed at the indigenous people found in these settlements, it is also important to note that for this new design proposal to be successful, the non-indigenous population must also be catered for. Therefore some of the housing units should be designed with the knowledge that they might not be used by the Gbagyi people. The design of the dwelling units aimed primarily at the Gbagyi people should be based on documented requirements for Gbagyi houses. As discussed in section 2.6 of the literature review, over the past few decades the spaces and activities found in Gbagyi dwellings have been undergoing a change. The frequency of appearance of some spaces in Gbagyi dwellings, such as animal pens and home gardens, shows a shift from domestic forms of agriculture. Most animals found in Gbagyi houses studied were there as pets. Perimeter fences and individual toilets are some of the new features that have increased in frequency of occurrence over the decades. Other features of Gbagyi houses like receptions and outdoor kitchens have maintained a strong presence over time and are still found today.

During the field studies, it was found that there was a prevailing trend of home expansion among the residents of these settlements. These are more often than not unsanctioned by the planning authority and lead to demolitions of structures within these settlements. In order to check this trend, provision for future expansion should be made where possible. This will give the end users of the buildings the freedom to customize the building to suit their needs should the need for that change arise.

In keeping with the principles of environmental sustainability, the construction methods should be as environmentally friendly as possible. From the principle of reuse and recyclability, as much recycled materials should be incorporated into the buildings.

Since existing structures are going to be demolished to make way for the new proposal, the use of that waste in the construction of the new houses will not only make the process environmentally friendly, but also more economically viable as well.

5.5 Accommodation Schedules

Table 5.5 Schedule of accommodation for site layout.

Spaces	Units	Floor area(m2)	Remark
1. Low density housing	70	70,000	Stand-alone bungalows with adequate space on site.
2. Medium density housing	180	90,000	Stand-alone buildings possibly duplexed to conserve space.
3. High density housing	300	75,000	High rise buildings containing multiple apartments.
4. Community market	1	40,000	Containing several market stalls
5. Police station	1	2400	
6. Fire station	1	2400	
7. Basic education school	1	10,000	
8. Community center	1	6,000	
9. Bus terminal	1	2,400	
10. Restaurant	1	2,400	
11. Shopping center	1	6,000	
12. Community mosque	1	8,500	
13. Community church	1	8,500	
14. District head residence/office	1	5,000	
15. Waste recycling plant	1	8,500	
16. Recreational areas	5	30,000	
17. Paved roads		60,000	

Table 5.6 Schedule of accommodation for low density housing units.

Spaces	Units	Floor area(m2)	Remark
1. Entrance and reception (zaure)	1	12	Combination of spaces to act as buffer as seen in Gbagyi houses.
2. Living room	1	20	
3. Courtyard	1	45	
4. Circulation	-	10	
5. Indoor kitchen	1	15	
6. Pantry	1	3	
7. Outdoor kitchen	1	15	
8. Bedroom	4	60	
9. Bathrooms	4	10	Including guest bathroom that is accessible from the living room.
10. Animal pen	1	30	Provisional space to be allowed for on-site.
11. Parking	3	250	Parking space for three cars and vehicular circulation within the site.

Table 5.7 Schedule of accommodation for medium density housing units.

Spaces	Units	Floor area(m^2)	Remark
1. Entrance	1	3.5	
2. Living room and dining area	1	30	Single space combining the functions of living room and dining room.
3. Indoor circulation	-	20	To include entrance corridor, lobby connecting bedrooms and stairwell.
4. kitchen	1	12	
5. Pantry	1	3	
6. Outdoor kitchen	1	12	
7. Bedrooms	3	45	
8. Bathrooms	3	9	All bathrooms have their access from the bedrooms.
9. Open balcony for future partitioning	1	25	Accessed from the lobby connecting the upstairs bedrooms.
10. Service entry	1	3	
11. Parking	2	15	Parking space for two cars on site per apartment.

Table 5.8 Schedule of accommodation for high density housing units.

Spaces	Units	Floor area(m2)	Remark
1. Entrance porch	1	5	
2. Living room and dining area	1	30	Single space combining the functions of living room and dining room.
3. Indoor circulation	-	12	Combination of entrance corridor and lobby connecting the bedrooms.
4. Bedrooms	2	30	Containing several market stalls
5. Bathrooms	2	6	
6. Kitchen	1	10	
7. Pantry	1	3	
8. Balcony	1	5	
9. Service entry	1	3	
10. Parking	2	25	Each unit is allocated two parking spaces.

Table 5.9 Schedule of accommodation for community market.

Spaces	Units	Floor area(m^2)	Remark
1. Stall block	60	90,000	Each block contains 12 market stalls making for a total of 720 stalls.
2. Market administration	1	100	
3. Sanitary facilities	2	90	Two blocks of bathroom stalls. One for each sex.
4. Parking	300	8,400	This includes parking for both customers and offloading areas.
5. Pedestrian circulation	-	17,000	

Table 5.10 Schedule of accommodation for basic education school.

Spaces	Units	Floor area(m^2)	Remark
1. Administrative section	1	500	Spread over two floors
2. Classrooms	48	3,000	Classroom blocks contain 12 classrooms per block. 4 classroom blocks total.
3. Activity rooms	6	600	These include a library, computer room, workshops and laboratories.
4. Sanitary facilities	2	50	2 separate blocks of bathroom stalls one for each sex.
5. Assembly ground/circulation	1	3,500	
6. Play ground	1	800	
7. Sports field	1	2,400	
8. Shops	1	40	
9. Staff parking	10	500	Space including vehicular circulation space.

5.6 Conclusion

This chapter has shown in detail the process taken in choosing a suitable site for the proposed design. The process took into account many factors for the successful implementation of a housing development. The selected site was thoroughly analysed. Site climate, vegetation, topography and existing infrastructure on and around the site

were all taken into account during the analysis. This will make for better informed decision making over the course of the design process.

A full brief was also developed in this chapter. The brief took into account all activities and facilities deemed necessary in a housing development of this nature. The brief was accompanied by a full schedule of accommodation. The schedule gives a detailed breakdown of the size of all buildings, functions, and spaces to be included in the design proposal. This is will be used as a guide in allocating portions of land to the various functions.

CHAPTER SIX
DESIGN REPORT

6.1 Introduction

This chapter describes the design proposal for the housing development. Due to the large size of the proposal and its many component parts, not all aspects provided for in the layout have been designed in detail. The components of the layout that have been designed in detail include the following; housing units, basic education school and community market.

The chapter also describes in detail the construction process used in the proposal. This is necessary due to the fairly new type of construction proposed. The specific manner in which 3D print construction is used in this proposal is to be documented in this chapter. Various services present in the proposal ranging from waste collection to mass transit within the housing development have also been documented in this chapter.

6.2 Concept Formulation

A concept design implies a design intent. It explores the resolution of the brief, implied or set out in the feasibility and assessment stage (Mike, 2015). Alternatively, a concept could be any idea which leads to a solution of design problem.

In the context of this design, the concept formulation was carried out in two parts. The first concept is concerned with the layout design and the second part is concerned with the design of the individual buildings. This is because the two aspects of the design have different requirements and therefore should have different approaches in resolving the problems they pose.

6.2.1 Layout concept

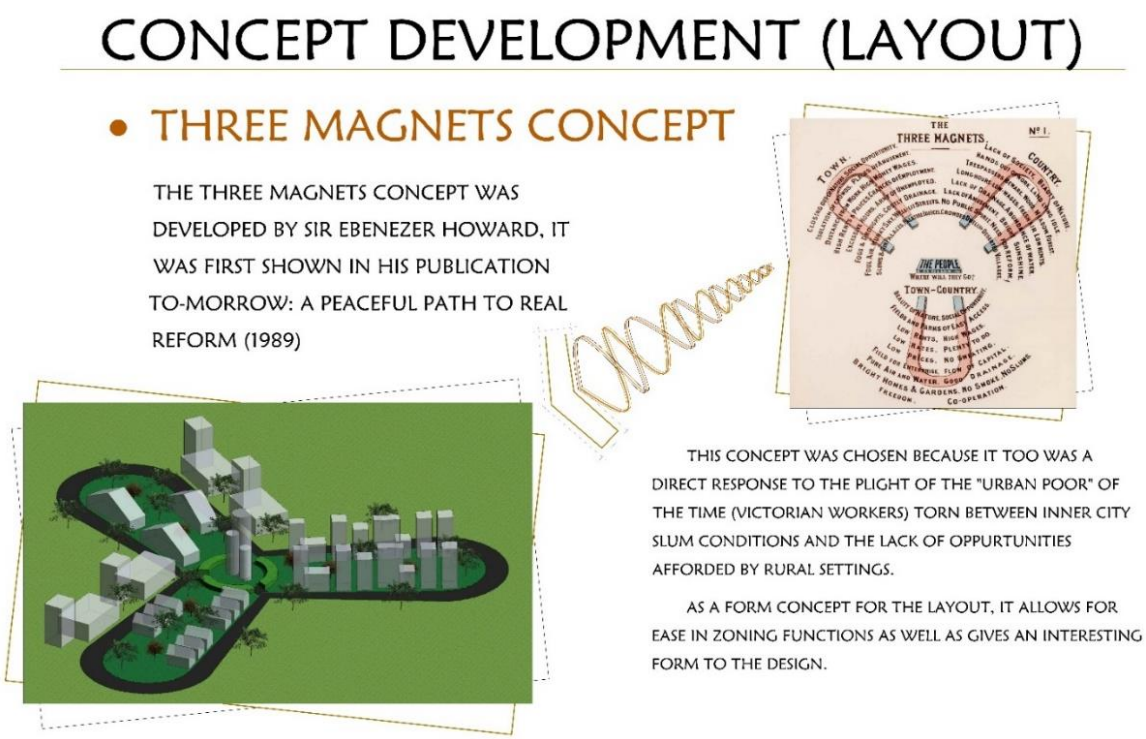


Figure 6.1 Concept development for layout design.

6.2.2 Building concept



Figure 6.2 Concept development for building design.

6.3 Design Proposal

6.3.1 Layout design



Figure 6.3 Site layout design.

The layout design caters for the requirements of a housing development of this scale as specified in the brief. As shown in Figure 6.3 above, the layout is designed in a radial pattern with 3 major roads breaking the pattern at 120° intervals. In the centre of the pattern is an intersection of the major roads in the layout in the form of a roundabout. This is landscaped with a water feature and flanked by the residence of the district head. Outward form the centre is located vast green areas in the form of recreational parks

landscaped with walkways and intentionally planted trees. The access into the development is a wide street which serves as a boulevard connecting most of the public spaces. This designed such that people that are non-resident in the development can easily make use of the school, restaurant and other public spaces without constituting a traffic problem to the rest of the development. The community market is located near the entrance so as to allow for easy movement of goods and services to and from it. The housing types are grouped according to their densities. The high density houses are accessed through streets that are similar in size to the main access to the development. All streets in the design are flanked by pedestrian walkways on both sides. The three major streets also have bike paths alongside the pedestrian walkways. To further make pedestrian circulation easy within the layout, numerous green ways have been provided through which pedestrian walkways cut through. These are important because they reduce the distance it would take to move between different streets and thus making pedestrian circulation easier. Pockets of green areas are distributed throughout the site to reduce the amount of hard landscape and the disadvantages it comes with. The pockets of green also harbour numerous plants thereby giving better air quality to the site as a whole.

6.3.2 Low density housing unit

Low density housing refers to housing which accommodates a relatively low number of dwelling units per area of land. There is no definite low density zoning ordinance as different planning authorities tend to enact its own ordinance based upon the needs and preferences of the area. For this design, the low density housing allows for an average of 10 dwelling units per hectare of land.

Each unit contains all the essential makings of a typical Gbagyi house according to reviewed literature and field work. Spaces that were left out include those that were found to be disappearing from Gbagyi houses as time progressed. These spaces include the granary, chicken pen, and animal shed. The design of the unit depicts that of a traditional Gbagyi house having multiple huts in one compound. As shown in the floor plan in Figure 6.4, the rooms are a series of hexagonal shapes with the spaces connecting them used as bathrooms and storage spaces. All of the rooms are connected by a major courtyard which not only serves as aid for natural ventilation, but a communal area in Gbagyi households as research has shown. The entrance and outdoor kitchen are bound by the basket form which not only provides definition and shade to these spaces, but also ties the design in with a recognizable element of Gbagyi culture (see figure 6.5).

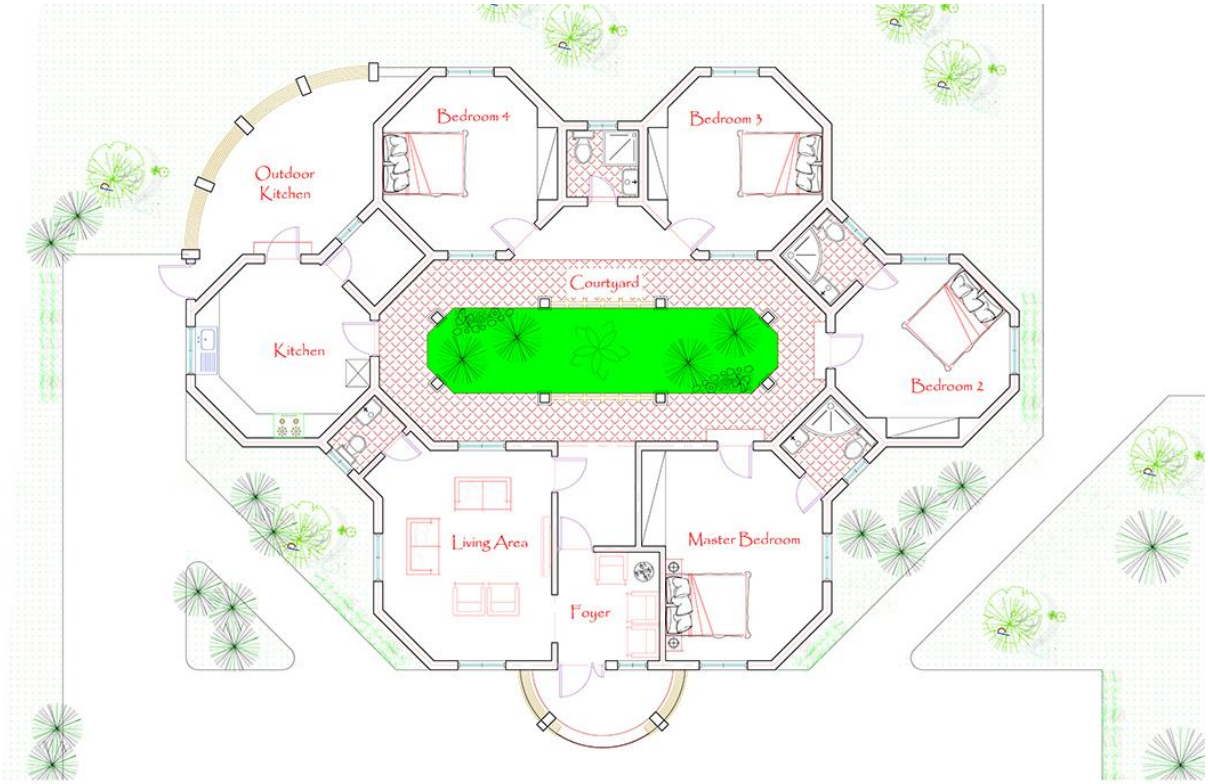


Figure 6.4 Floor plan of low density housing type.



Figure 6.5 Isometric view of low density housing type.

6.3.3 Medium density housing unit

Medium density housing refers to residential areas with higher densities than the standard low density housing found within the same area. It can be in form of stand-alone houses, terraced houses or apartments. Medium density housing accommodates a higher amount of dwelling units per area of land than that of the low density housing. For this design the medium density housing allows for an average of 20 dwelling units per hectare of land.

Future expansion was considered in the design of these units. The idea was to accommodate small families that would later grow to require more space. Planned expansion was necessary as it was noticed that the Gbagyi people had a tendency to make alterations to their houses over time. Sometimes these expansions do not adhere to building regulations and lead to demolition of these houses. This informed the decision

of making the unit a single storey building so as to leave enough land for each unit to expand. Parts of the house on the first floor were left open to support expansion without the need for additional cost on foundation works.

The building is designed to be as simple as possible. As seen in Figure 6.6, the building is made up of simple rectangular spaces connected by a singular corridor on the ground floor and a lobby on the first floor. Since this particular unit is meant to cater to both Gbagyi and non Gbagyi users, a dining area has been incorporated into the design. Also the outdoor kitchen is now detached from the building and can be left out to save cost if the users wish. In this design, the basket form is used as a shading device for the walls of the living area (see Figure 6.7). This became necessary due to the presence of the concrete deck over that space which might increase the amount of heat transferred into the space. The shading device reduces the heat absorbed by the walls therefore aiding in cooling the living space behind them.

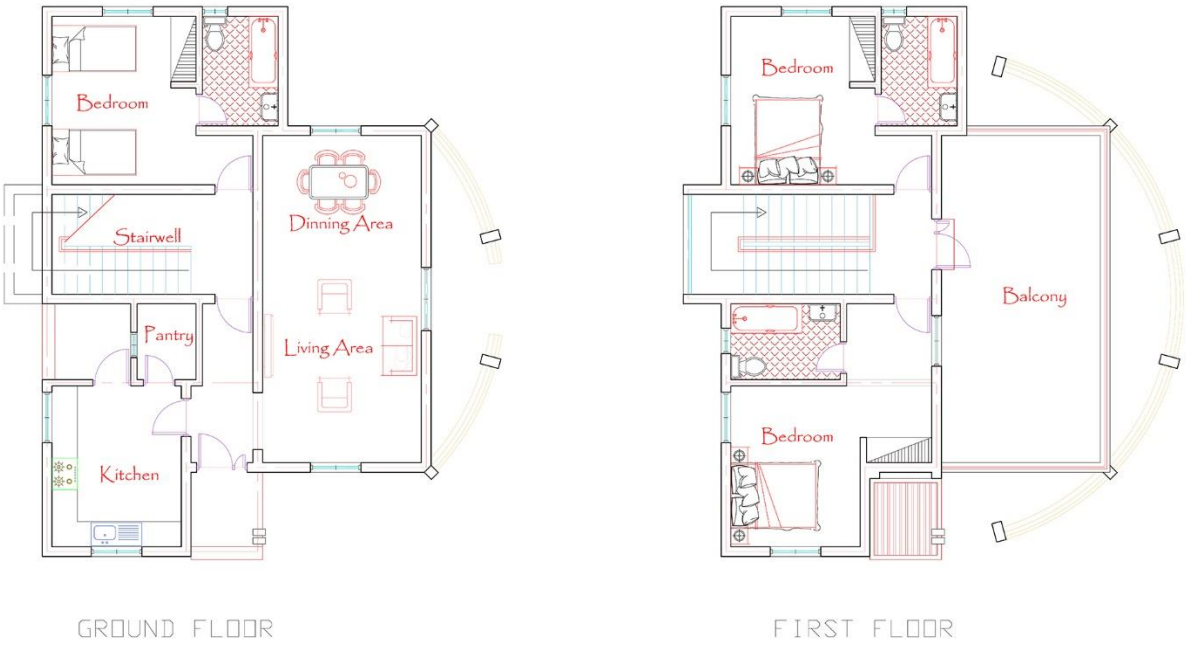


Figure 6.6 Showing floor plans for medium density housing type.



Figure 6.7 Showing isometric view of medium density housing type.

6.3.4 High density housing unit

High density refers to residential areas designed to accommodate the optimum number of dwelling units per area of land while keeping to local building codes for set-backs, easements etc. They are usually in the form of high rise buildings to maximize land use. This means that dwelling units do not only occupy space on the ground nut in the air space above as well. For this design, the high density housing allows for an average of 40 dwelling units per hectare of land.

The dwelling units in the high density areas are designed as small two bedroom apartments. There are a total of 6 dwelling units in each building. There two units on each floor. The building has a main staircase in the middle which separates the two units on each floor while providing access to the upper floors. There is also a spiral

staircase located at the rear of the building which serves as a fire escape and also access to the service areas of the upper floors. The plan form of the building, as seen in Figure 6.8 is that of two arms at 45^{o} angles and a sweeping curve which connects them at the front. The front also has 4 large buttresses with curved sides as can be seen in Figure 6.9. The buttresses rise from the ground all the way to the top of the building. These carry the shading devices which shade the entrance porches of all the apartments while also providing an extra level of privacy to the users when entering and exiting their apartments. The apartments are designed to be as economical as possible since they are aimed at small families with minimal space requirements. Circulation spaces have been kept to a minimum in this design. The living area has designed in such a way that the space between the living room and dining room can be used for passage from the entrance corridor to the bedroom area. Of the two bathrooms in the apartment, one of the bathrooms has its access from the lobby connecting the bedrooms and the living area. This is so that it can be used by any visitors who might not be allowed access to the bedrooms.

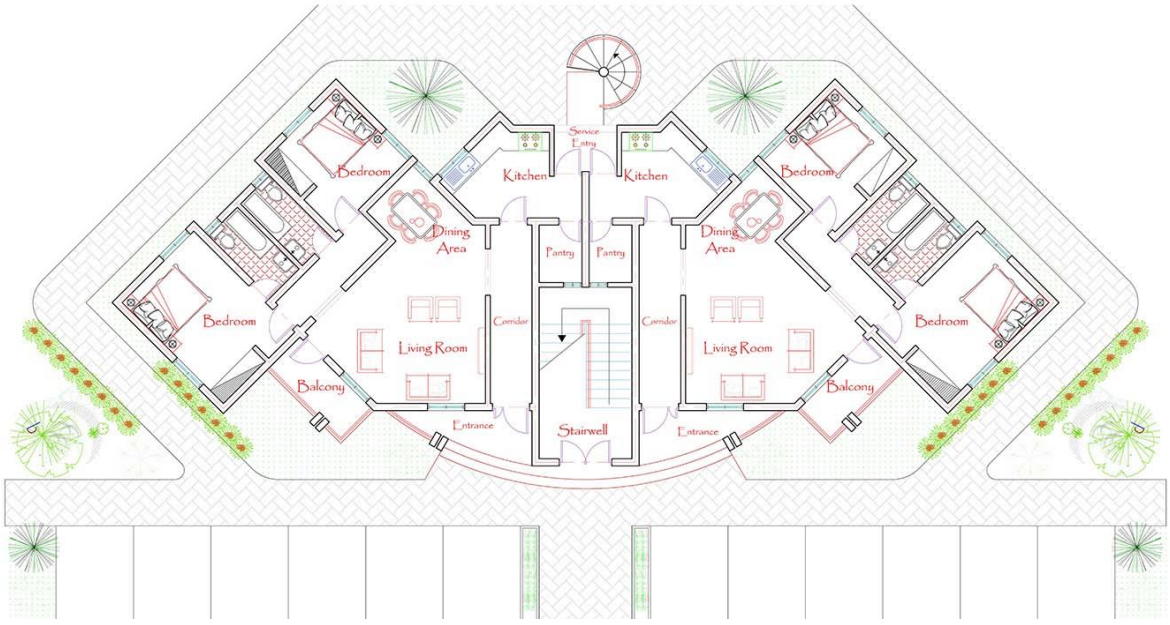


Figure 6.8 Ground floor plan for high density housing type.

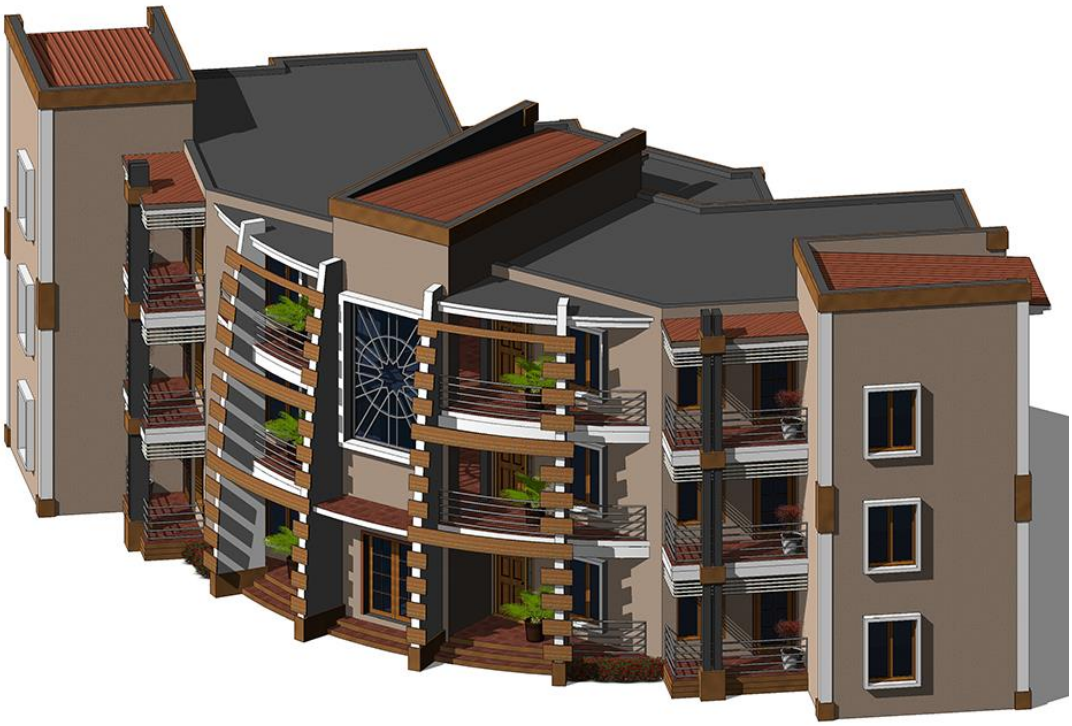


Figure 6.9 Isometric view of high density housing type.

6.3.5 Market design

From field studies it was realized that commercial activities in these settlements were not properly organized within the existing arrangements. Commercial activities were not zoned accordingly and as such, the services they require could not be provided. For this reason, a more detailed design of the market area had to be proposed for this design. The design is that of an open market. This type of market design was chosen as it is in keeping with what is found in the existing settlement and thus would not be foreign to the end users. The market is laid out in a simple grid pattern with straight streets and corridors between buildings as seen in Figure 6.10. This gives clear lines of site throughout the market which will make for navigation for pedestrians easy and non-confusing. Green islands are present within the large paved areas mean for pedestrian circulation. These islands which have trees planted in them also have benches for the

pedestrians. The presence of the green islands will reduce the surface area taken up by the hard landscape and thus reducing the amount of heat reflected into the surroundings while also giving a better aesthetic quality to the market environment as a whole. The market is made up of mostly market stalls grouped into stall blocks. Each stall block is made up of 12 market stalls. The stalls were designed to reduce the amount of artificial cooling they would require to achieve thermal comfort within the individual stalls. This informed the use of a double roof system on each unit as can be seen in Figure 6.11. This essentially keeps most of the building shaded during the day time which reduces the amount of heat transferred into the space.



Figure 6.10 Site layout for proposed community market.



Figure 6.11 Stall block in proposed community market.

6.3.6 Basic education school design

The basic education school is laid out in an enclosed manner. This has the classroom blocks and administrative section enclosing a common area in the middle as can be seen in Figures 6.12 and 6.13. This concept is useful in a school design as it makes for easy supervision of students as it gathers all students in a common space. The school has one entrance from the main boulevard leading into the housing development. The proposed school for the housing development follows that of the new basic education system of Nigeria. This makes for a mandatory completion of classes from primary school through to junior secondary class 3. This makes for a total of 9 different classes in the school. A total of 48 classrooms are provided in the school contained in 4 classroom blocks of 12 classes each. Each block has 3 floors with 4 classrooms per floor. Each class is allocated 5 classrooms and with 3 classrooms used as nursery classes. The classroom blocks are single banked to provide the classrooms with windows on both sides. This reduces the need for artificial cooling and lighting. On each floor the classrooms are linked by a single corridor with a staircase on each end. On the upper floors, corridors are bound by high railings to help prevent accidents. The last block houses the library, laboratories

and other activity rooms. There is a single administrative building in the school. This houses all staff offices, meeting rooms and admin offices. It is placed in the middle of the school and overlooks the assembly ground and play ground of the school. The playground is a large green island in the middle of the paved pedestrian circulation area in the middle of the school. It has been covered in grass and not paved in order to reduce the danger of injuries that might happen to children on the playground. The school also has a sports field at the back for physical education and other sports related activities that the school might want to undertake. Sanitary facilities are placed between classroom blocks for easy access by students. The sanitary facility is made up of bathroom stalls with access on opposite sides for both sexes of students.

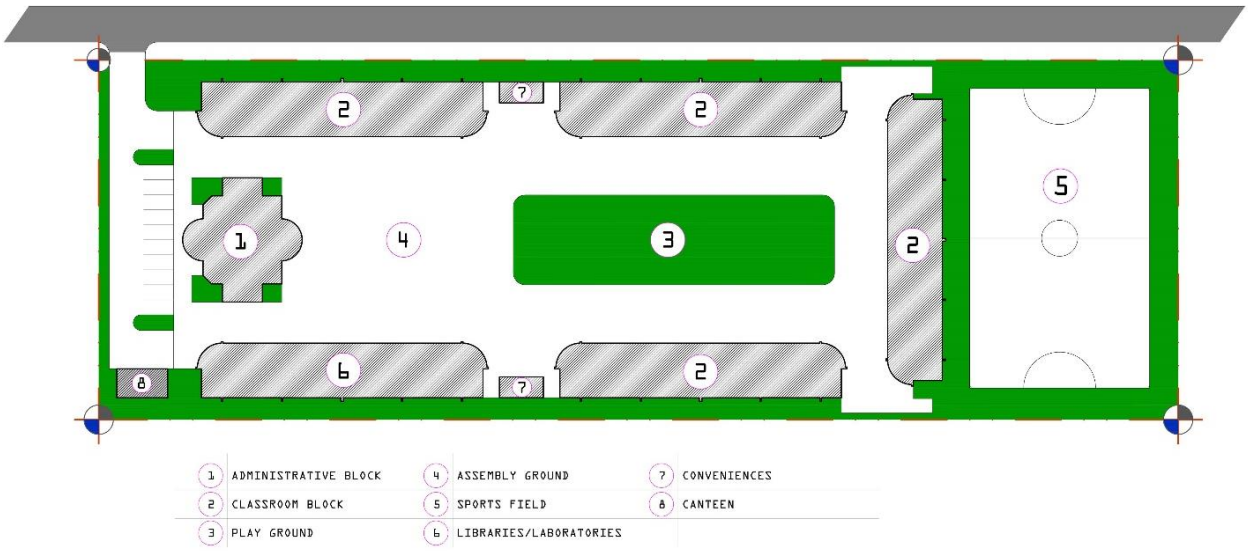


Figure 6.12 Site plan for proposed basic education school.

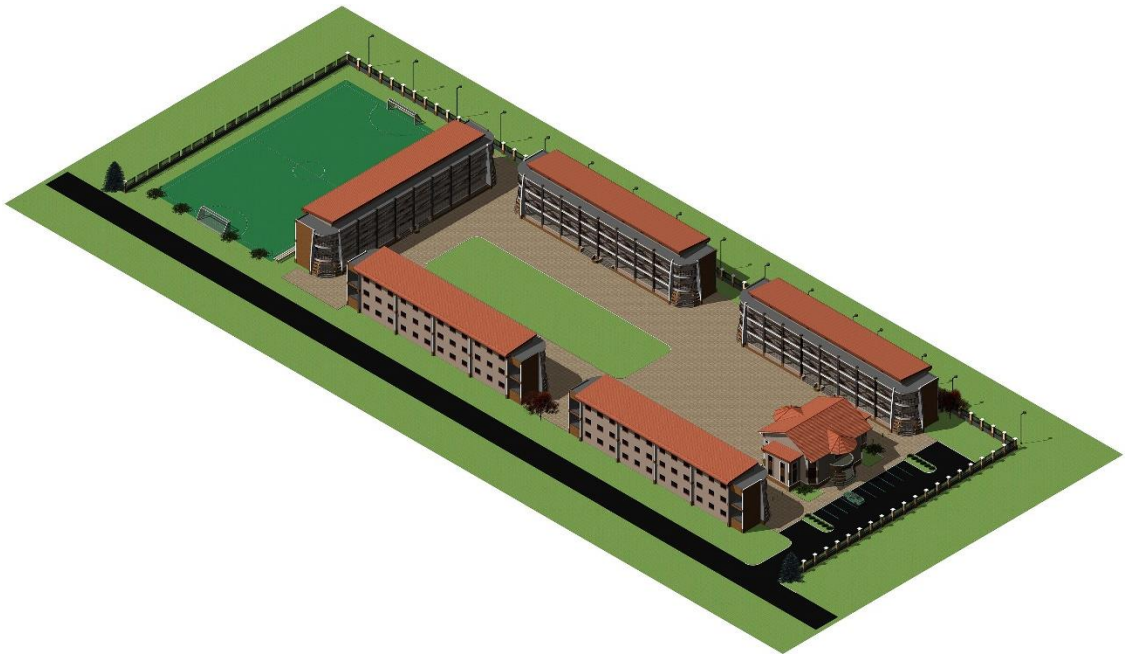


Figure 6.13 Isometric view of basic education school.

6.4 Construction Process

The design is intended to be constructed using a combination of two construction methods. The first is mostly conventional using sandcrete blocks and concrete to make the foundations, floors and structural frame where applicable. The second a relatively new type of construction method; 3D print construction. It consists of panels that are made in a factory using a proprietary 3D printer. These panels are then transported to site and installed as required.

3D print construction has some similarities with conventional prefabrication using concrete, but the major difference is in the way the panels are produced and the materials used to produce the panels. The foundation is constructed first using conventional methods with sandcrete blocks making up the foundation walls and concrete floors made to structural engineer's specification. The 3D printed walls are the attached to the floors using grouting holes and reinforcement rods cast into the floor at intervals as shown in Figure 6.14.

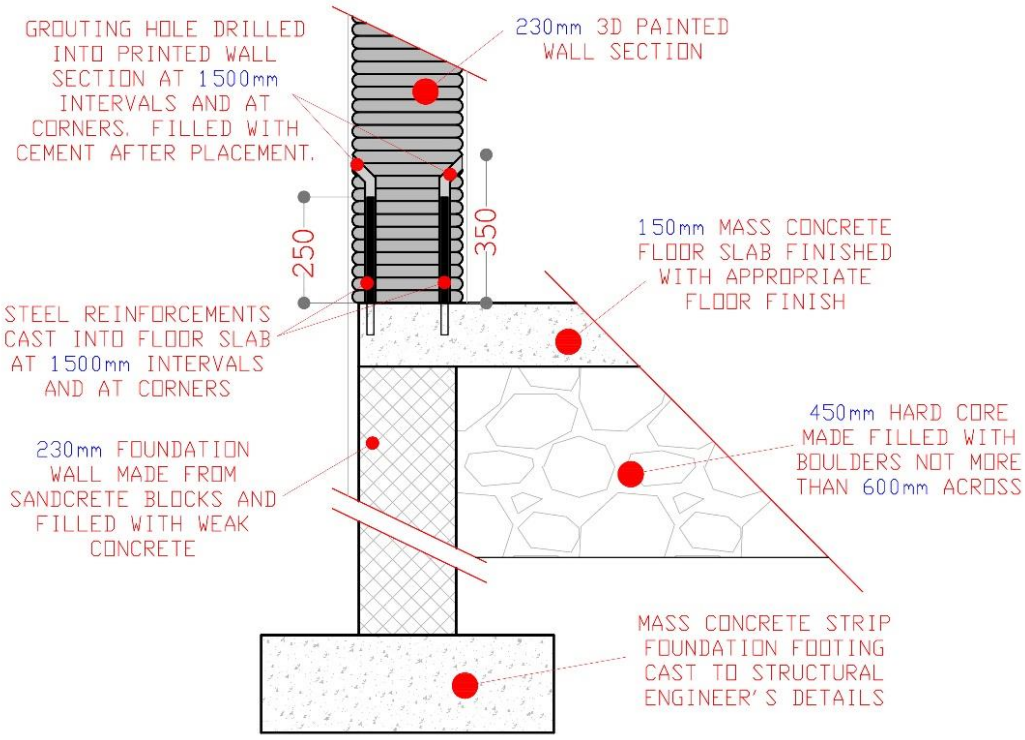


Figure 6.14 Detail at A – 3D printed wall connection to floor and foundation.

In cases where a structural frame is required, the columns are cast into spaces in the walls where their reinforcement is already placed as shown in Figure 6.15. These spaces would have already been provided for in the manufacturing process of the wall segments themselves. This system eliminates the need for formwork in casting columns for the structural frame and ultimately reduces the cost of construction.

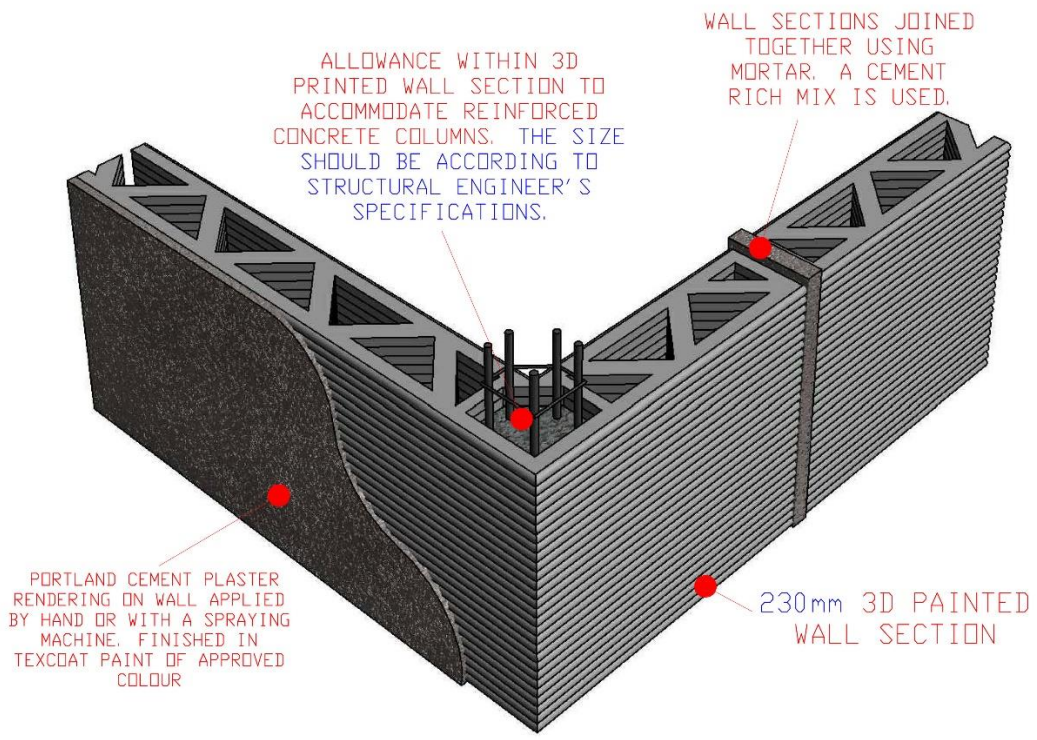


Figure 6.15 Detail at B - 3D printed wall joints and column spaces.

The roof members are attached to the walls using purpose made steel brackets. Steel bolts are used to anchor the brackets to the walls as well as the tie beams to the bracket as shown in Figure 6.16. The walls are finished using cement based plaster as with most conventional buildings. The ruff surface which the 3D printed walls provide will make the job of plastering easier and more economical as the plaster will have a better base to stick on to.

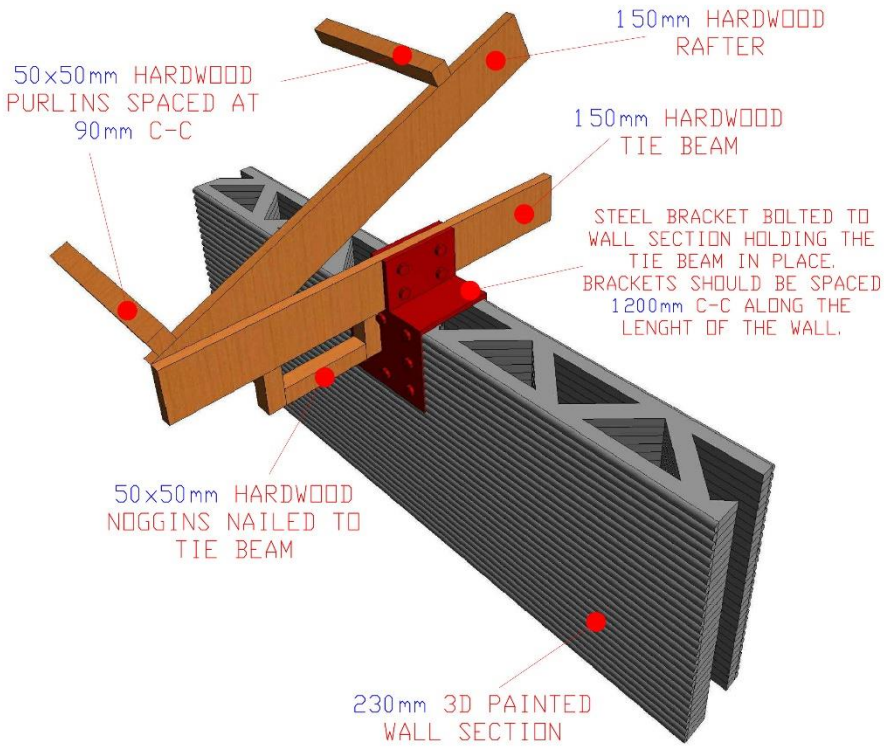


Figure 6.16 Detail at C – 3D printed wall connection to roof structure.

6.5 Materials and Finishes

The materials and finishes were selected in such a way as to achieve two aims, the first was to achieve efficiency in construction while the second was to achieve some level of reuse and recyclability as stipulated in the principles of sustainability mentioned in the previous chapters.

The first aim was achieved by using as many conventional building material as possible. These include wood, cement and finishes like ceramic tiles and texcoat paint. These materials are all common place in the indigenous building industry. This means that local builders and artisans which reside in the settlement can be engaged in the construction of the new proposal.

The second aim was achieved by incorporating as much as possible salvaged materials from the demolished structure. This includes broken down cement based elements like sandcrete blocks which are used in the process of 3D printing walls for the new buildings and wood that can be treated and used for some of the aesthetic elements on the buildings. It is worth noting however that all salvaged wood materials are not to be used for structural members such as rafters, but rather are only used as aesthetic elements in the construction of the perimeter fence.

6.6 Services

6.6.1 Water supply

The development will have to make use of bore-holes for their water supply needs as there is no mains supply of water near the site. Houses can be grouped into numbers of 4 or greater and have a single bore hole supply them with water. The larger buildings within the development such as the high rise buildings, school etc. will have individual bore-holes for each of them due to their greater water demand.

6.6.2 Electricity supply

Electricity will solely be supplied to the development using the distribution infrastructure of the Abuja Electricity Distribution Company (A.E.D.C). The electricity distribution infrastructure within the development is to be of a sub-surface nature. This is in line with modern housing developments of this nature and also giver a cleaner more organized look to the surroundings.

6.6.3 Waste and sewage management

A small sewage treatment and waste recycling plant is to be built within the development. It is to be situated in the south-eastern corner of the layout so as not to cause any nuisance to the inhabitants of the development. Liquid waste from various buildings will be passed through an integrated sewage collection network that will lead to the sewage treatment plant where it will be properly processed. Solid waste on the other hand will be sorted by the inhabitants into collection bins labelled “recyclable waste” and “non-recyclable waste”. The non-recyclable waste will be evacuated by the Abuja Environmental Protection Board (A.E.P.B) for offsite processing while the recyclable waste such as plastic bottles, polythene bags, and glass etc. will be taken to the on-site recycling plant for processing.

6.7 Conclusion

This chapter has described in full detail, the proposed design of a Gbagyi housing development. The design demonstrates how the environmental sustainability principles outlined in the previous chapters were integrated to make a design proposal. This in turn achieves the final objective of this research. The design report describes the design of all buildings and spaces as required by the brief. The chapter also describes the construction method to be adopted for use in the actualization of the design. Various services such as waste management, electricity and water supply were discussed in this chapter to better give a full picture of the intended final design.

CHAPTER SEVEN
CONCLUSION AND RECOMMENDATIONS

As architecture is a considerably large field of study, it is important to state that this research is an in depth study into the housing discipline of the field of architecture. Its aims and subsequent resolutions are all intended to be viewed in the context of that discipline.

This research set out to integrate the existing Gbagyi settlements in the F.C.T. This has led to conscious decisions that concern the mode in which this research was to be carried out. Environmental sustainability was chosen as a guide for this research because the intended result would have a direct impact on the environment in which it would be situated.

In achieving the aims of this research certain objectives were set out in the introductory chapter. These objectives were achieved through a combination of desk and field studies. The desk studies were in the form of relevant literature identification and analysis. This analysis yielded the following;

1. The identification of theories in which were later morphed into the principles that guided the final proposal.
2. Existing government policies that could support the implementation of the final proposal were identified.
3. Innovative construction practices such as 3D print construction to reduce the impact of waste and reduce building cost.

The field studies carried out for this research were in the form of case studies of the settlements in the F.C.T. Interviews of key personalities as well as questionnaire

surveys were carried out over the course of the case studies. The field studies yielded the following:

1. Better understanding of the current state in which the settlements exist. This included the identification of how various services were provided for within the settlements.
2. Identification of appropriated land use plans for the areas in which these settlements are located.
3. Identification of specific requirements of the intended end users of the housing development in the final proposal.

Ultimately, all the information gathered culminated in a design proposal demonstrating how all the information gathered over the course of the research could be used in the design of a housing development. The design aims to solve the problems identified over the course of this research.

This research has shown that it is possible to methodically integrate the existing Gbagyi settlements in the F.C.T. with the modern metropolis that is Abuja. Furthermore, by taking advantage of existing government policies like the land swap scheme of the F.C.T. the integration of the settlements can be done at virtually no cost to the government.

As regard the implications of this research on the field of architecture, it has provided a new approach to the design of housing developments at various scales. The principles that guided the design can be adopted in the design of singular buildings or mass housing developments as a whole. These were previously not laid out in a context relevant to this form of design. Furthermore, the research has shown that an integration of innovative construction practices with more conventional methods can be used to

achieve better efficiency in the construction process of buildings as well as greater flexibility in building design especially in Nigeria.

7.1 Contribution to Knowledge

The process used in the design of the Gbagyi settlement in this research has proven to be methodical. The results of the design can be said to be positive after a full environmental impact assessment has been carried out. The design has achieved two things; the provision of housing for the indigenous population and the protection of the integrity of the environment in which it was carried out. The methodical process employed in this research can be used in other cases to provide housing for other groups of people in a similar situation as the Gbagyi people living in these settlements. The process is as follows;

1. Identify target population (end users).
2. Conduct survey to identify specialized needs of target population.
3. Identify geographical area (site) for implementation.
4. Formulate brief.
5. Conduct survey to understand environmental needs of geographical area.
6. Generate design proposal using the principles of environmental sustainability to tackle identified environmental problems.
7. Conduct environmental impact assessment (EIA) to check if the proposal will yield positive changes to the environment.

If the results of the EIA are positive, then the proposal can be implemented. If the results prove negative, then revert back to step 5 and redo the stepwise sequence from there.

Another major contribution to knowledge of this research is in the form of the 3 principles of environmental sustainability that guided the final proposal. These 3 principles differ from the general principles of environmental sustainability in that they are taken in the housing context. The principles were previously not synthesized from the general principles. They were brought about as products of this research through the careful analysis of the existing principles, cross referencing them with the various issues that need to be addressed in the proposal of a housing development.

The principles of environmental sustainability in the housing context as produced by this research are as follows;

1. Preservation of Biodiversity and Environmental Integrity

2. Reuse and Recycle

3. Effective Management of Unsustainable Systems

7.2 Recommendations

From the research carried out, it is clear that the quality of life afforded to the inhabitants of Gbagyi settlements within Abuja is not as should be. It is therefore recommended that all existing settlements within the city be put through the process outlined by the proposed implementation framework. This will go a long way in increasing not only the quality of life of the inhabitants but also the quality of the environment in which they are situated. It is also recommended that future developments of cities such as Abuja be done with considerations made for the indigenous population before any physical development is initiated. This will allow for the proper infrastructural investments to be made in such areas thereby reducing the potential for environmental degradation.

The conclusions reached by this research have answered some questions but have also raised others. The research has shown the potentials of using the principles of environmental sustainability as a guide in the design of housing developments but other areas can be further researched into to ascertain the benefits these same principles could on other design proposals. Firstly, research should be made into the potential benefits this design will have on the design of large scale public spaces like markets and sports arenas. Secondly, further research is recommended into how traditional construction methods found in Nigeria could be used in achieving the same results as those found when using 3D print construction. Lastly, research should be carried out into how 3D print construction can be streamlined and harnessed for solving the housing problems in Nigeria especially those faced by the low income class.

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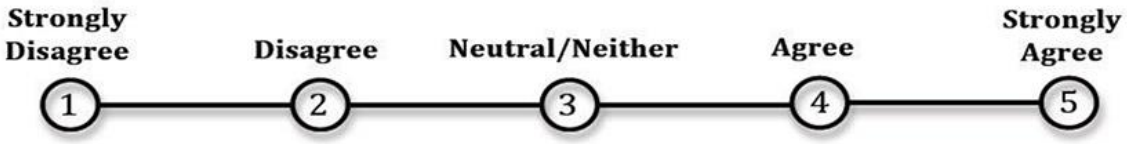
APPENDICES

Appendix I: Questionnaire

AHMADU BELLO UNIVERSITY

DEPARTMENT OF ARCHITECTURE- M.Sc THESIS QUESTIONNAIRE

- What type of housing unit do you live in (number of rooms)?
- What is the size of your family (total number of occupants)?
- Do you own or rent your house?
- How do you dispose of liquid waste?
- How do you dispose of solid waste?
- What is your primary means of transportation?
- Do you rear animals in your house? (YES/NO). If yes, please specify type
- The house you live in is of good quality



✓ *Please tick the desired option*

- Please rate the following in order of importance to you. (5 being most important and 1 being least important).

- Security ☐
- Sanitation ☐
- Electricity ☐
- Clean water supply ☐
- Good road ☐

Appendix II: Interview schedule

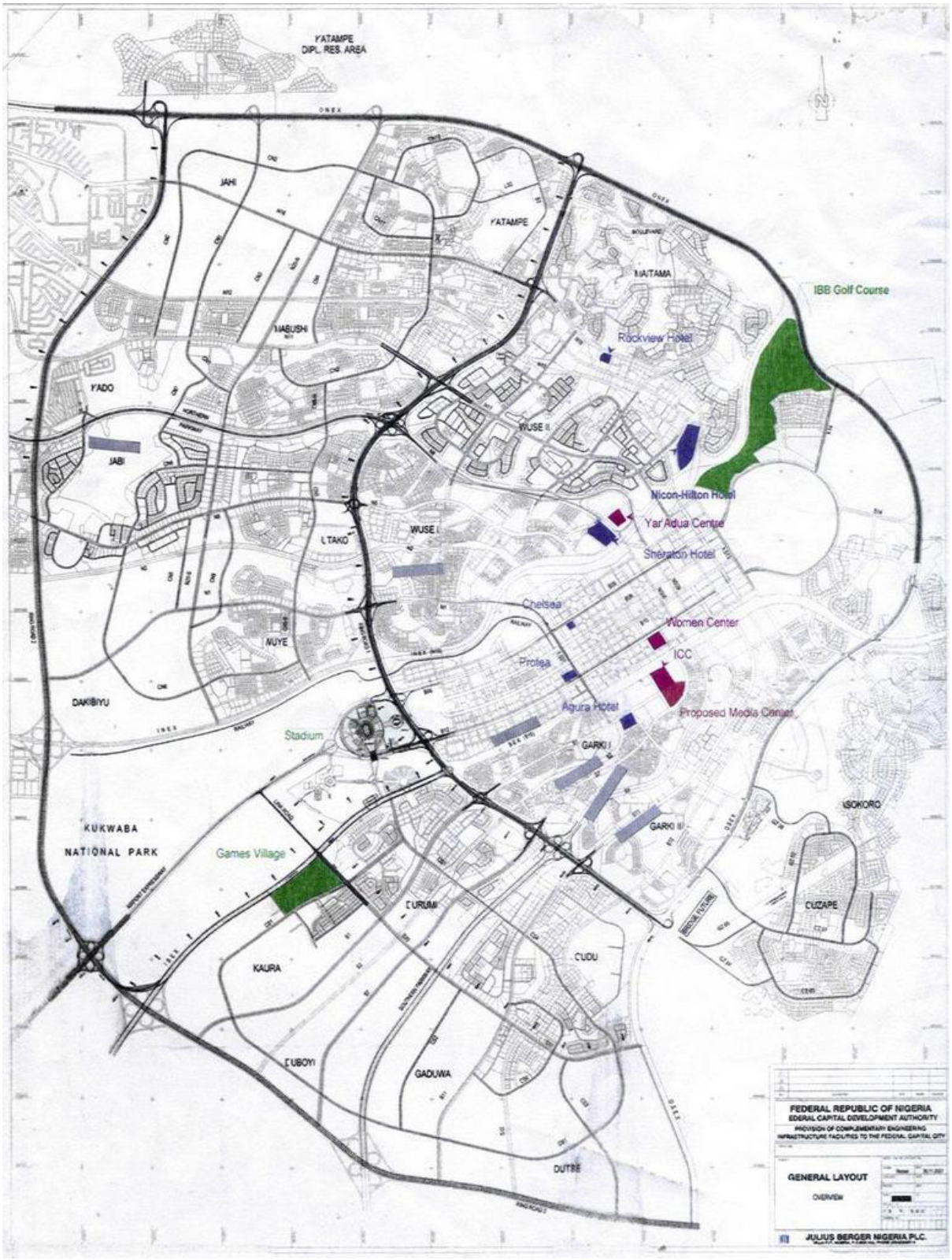
AHMADU BELLO UNIVERSITY

DEPARTMENT OF ARCHITECTURE- M.Sc DISSERTATION INTERVIEW SCHEDULE

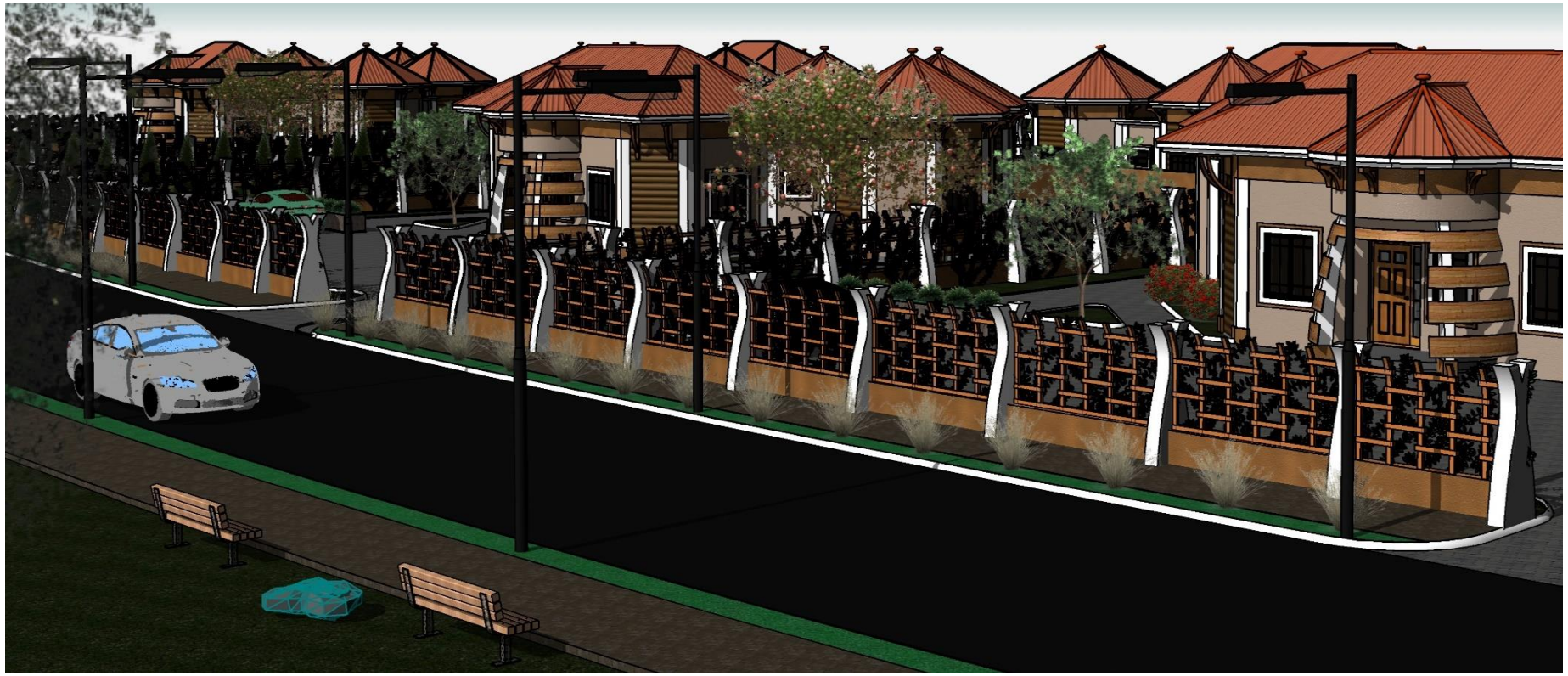
- Please state your full name
- What position do you hold (if any) in this (state name of area) society?
- Do you reside in said society?
- If yes, for how long?
- Can you give us a brief history of this settlement?
- What would you say are the most pressing concerns of the residents here?
- What is the major occupation of the residents?
- If I wanted to put up a structure here, what would be the procedure?
- How is waste managed in this settlement?
- How is water supply handled in the community?
- What measures are in place to ensure security of the residents here?

Thank you for your time.

Appendix III: Figure showing the development map of Abuja city



Appendix IV: Street view of low density housing area.



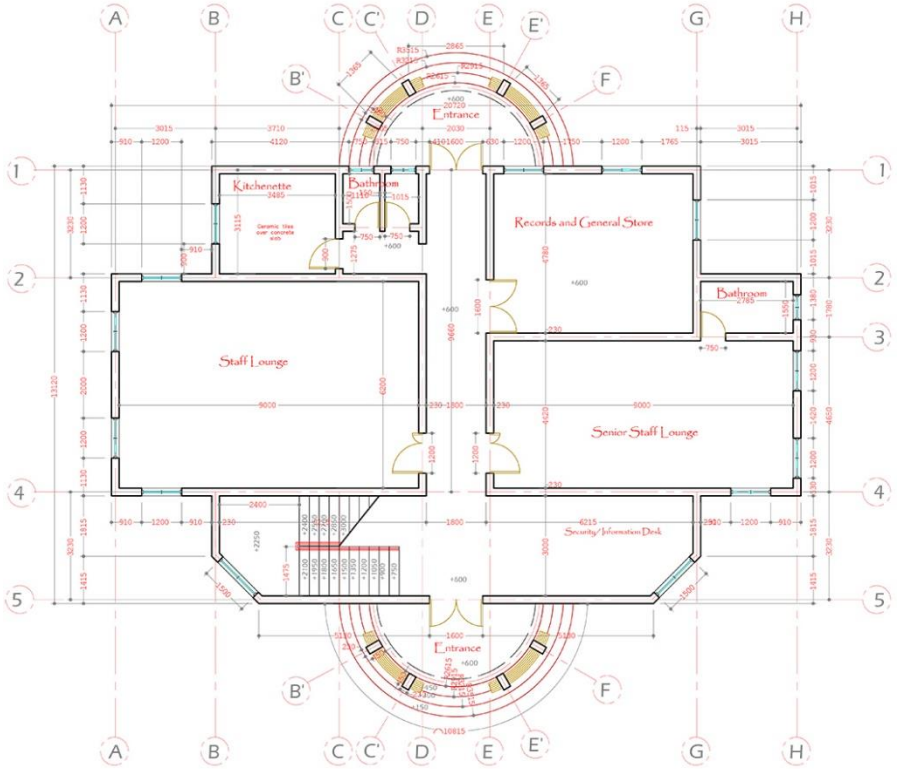
Appendix V: Street view of medium density housing area.



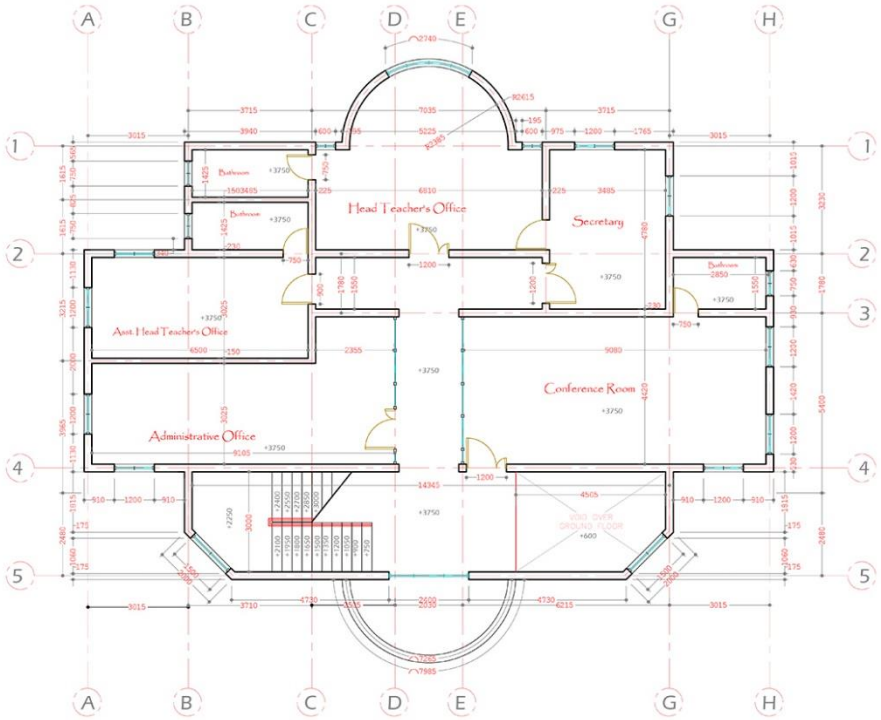
Appendix VI: Street view of high density housing area.



Appendix VII: Floor plan for admin block of school.

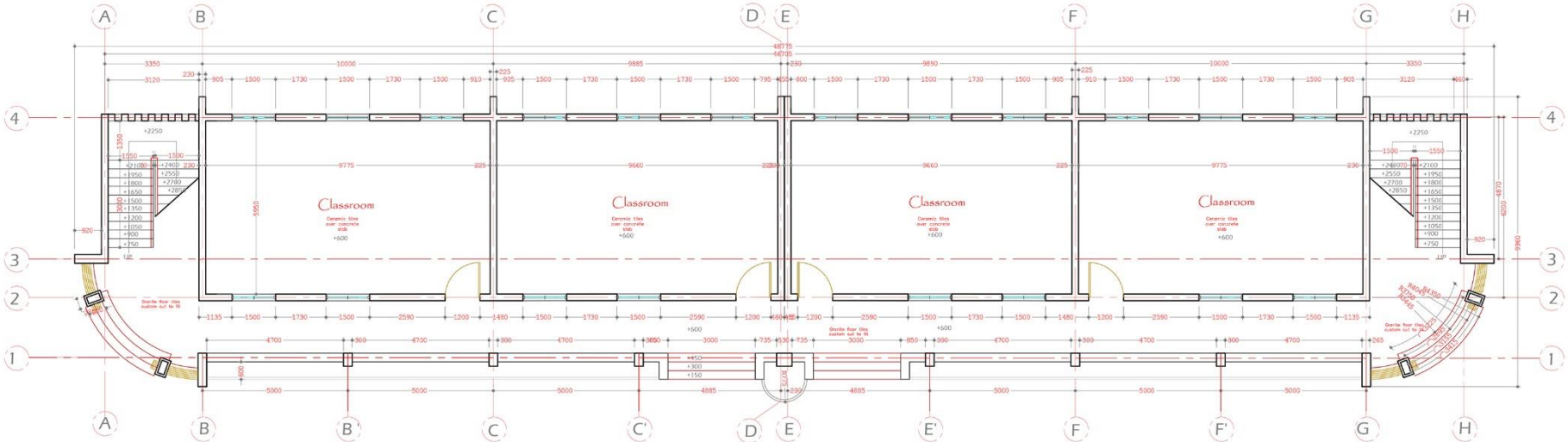


GROUND FLOOR

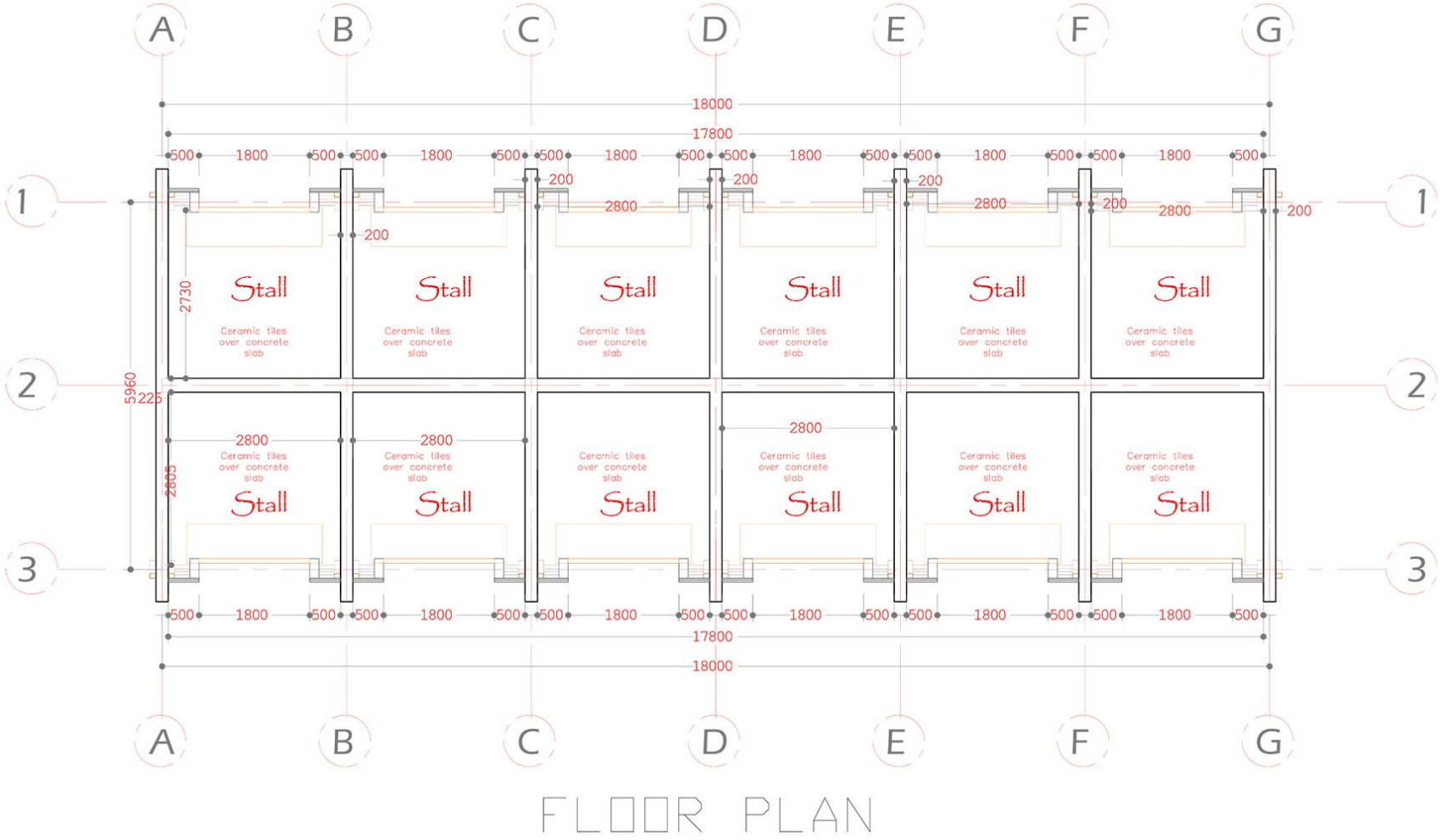


FIRST FLOOR

Appendix VIII: Floor plan for classroom block of school.



Appendix IX: Floor plan for block of stalls in community market.



FLOOR PLAN