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DRIVERS, BARRIERS AND AWARENESS OF SUSTAINABLE GREEN BUILDINGS IN KANO STATE, NIGERIA
NEU
2021

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A THESIS SUBMITTED TO THE INSTITUTE OF GRADUATE STUDIES

NEAR EAST UNIVERSITY

BY
MUKHTAR SABIU YAHUZA
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In Partial Fulfilment of the Requirements for the Degree of Master of Science in Architecture

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Approval of Director of Institute of Graduate Studies

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I Mukhtar Sabiu Yahuza hereby declare that all information in this thesis is attained and presented in accordance with academic regulations and ethical behaviour. I correspondingly declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original in this work.

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ACKNOWLEDGEMENT

Special thank goes to God for granting me the chance to accomplish this great task of completing this thesis. I want to also thank my supervisor Prof. Dr. Ozge Ozden for her support, encouragement, dedication and her time to check the work and approve it, thank you very much professor. My parents Hon. Justice Sabiu Yahuza rtd. and Hajiya Hadiza Yusuf were my heroes which I do not think the right word to use to show the appreciation of their support does not exists to me, thank you very much too, you mean the world to me. I want also thank all my teachers in the department of Architecture here in Near East University, like Prof. Dr. Zeynep Onur, Assoc. Prof. Buket Asilsoy, Asst. Assoc. Dr. Çilen Erçin among many others who taught me. My co-supervisor Asst. Assoc. Dr. Havva Aslangazi helped me in this research, thank you. My research team will also not be forgotten Feven Hailu Taddesse, Sadiq Mahmoud Ahmad and to all my friend and family thank you for your support towards this great achievement.

This research is dedicated to my Father Hon. Justice Sabiu Yahuza rtd., who support me aimlessly throughout my career, I would have not achieved it without him. I also dedicated this to my Mom, Hajiya Hadiza Yusuf for her support.

To my family…

ABSTRACT

More than 40% of the energy use around the globe is consumed by conventional buildings (UNEP & SCBI), which contribute to the current environmental issues and global warming. Starting from air pollution such as carbon emission, land degradation, depletion of the ozone layer, water pollution and many other harmful gasses emitted into the atmosphere. These issues can be addressed when the buildings we live-in were sustainable green building. Different kinds of literature were revised in this research to discuss the past problems of the research topic and suggest a solution to it. Also, using descriptive quantitative analysis, a case study was chosen in the study area which was analysed based on BREAM and LEAD assessment criteria. However, 251 questionnaires were distributed and analysed based of energy consumption, source and natural features incorporation of the existing buildings in Gwale ward of Gwale Local Government Area of Kano state Nigeria. The result reveals the existence of green building in Nigeria with a remarkable percentage. However, government policies, motivation or incentives and enforcement were not enough to promote green building provision. Similarly, architects and other building professionals attract the problems of green building in Kano state due to increase in conventional building designs neglecting the incorporation of green features. The use of local materials during construction is recommended in this research to reduce the cost of construction materials, so also orientation of the building, incentives, motivation, government policy review towards green building and its provision. Also, recommend the intervention of Green Building Rating System organizational body will help in green building provision in the state and the country as a whole. Further research might be required to determine the total number of green building in Kano state and also ways of improving the quality of the local construction material requires a gap of knowledge to fill-in.

Keywords: architecture; green building; green construction; green building rating system; renewable sources; sustainability; global warming; greenhouse effect.

ÖZET

Dünyadaki enerji kullanımının% 40'ından fazlası, mevcut çevre sorunlarına ve küresel ısınmaya katkıda bulunan yaygın olarak kullanılan binalar (UNEP & SCBI) tarafından tüketilmektedir. Hava kirliliğinden başlayarak atmosfere salınan diğer birçok zararlı gaz, karbon salınımı, arazi bozulması, ozon tabakasının incelmesi, su kirliliği gibi sorunlar, yaşadığımız binalar sürdürülebilir yeşil bina olduğunda çözülebilir. Bu araştırmada, araştırma konusunun geçmiş problemlerini tartışmak ve ona bir çözüm önermek için farklı türlerde literatür gözden geçirilmiştir. Ayrıca, nicel araştırma yöntemi kullanılarak, araştırmada BREAM ve LEAD değerlendirme kriterlerine göre analiz edilen bir alan çalışması seçilmiştir. Bununla birlikte, 251 anket dağıtıldı ve Nijerya Kano eyaleti Gwale Yerel Yönetim Bölgesi'nin Gwale bölgesinde mevcut binaların, kaynak ve doğal özelliklerine göre enerji tüketimi analizi yapılmıştır. Sonuç, dikkat çekici bir yüzdelik ile Nijerya'da yeşil bina varlığını ortaya koymaktadır. Ancak, yeşil bina sağlamayı teşvik etmek için hükümet politikaları, isteklendirme veya teşvikleri ve yaptırımı yeterli değildir. Benzer şekilde, mimarlar ve diğer bina alanında çalışanlar, yeşil özelliklerin dahil edilmesini ihmal eden alışılagelen bina tasarımlarındaki artış nedeniyle, Kano eyaletinde yeşil bina sorunlarını çekmektedir. Bu araştırmada, yapım esnasında yerel malzemelerin kullanılması inşaat malzemelerinin maliyetini düşürmek için önerilmektedir. Aynı zamanda binanın yönelimi, teşvikler, isteklendirme, yeşil bina ve hükümlerine yönelik hükümet politikası gözden geçirmesi önerilerdendir. Ayrıca, Yeşil Bina Derecelendirme Sistemi organizasyon kuruluşlarının tavsiyeleri ile aracılığı, eyalette ve bir bütün olarak ülkede yeşil bina sağlanmasına yardımcı olacaktır. Kano eyaletindeki toplam yeşil bina sayısını belirlemek için daha fazla araştırma yapılması gerekebilir. Ayrıca yerel inşaat malzemesinin kalitesini geliştirmenin yolları, doldurulması gereken bir bilgi boşluğu gerekliliğidir.

Anahtar Kelimeler: mimari; yeşil bina; yeşil yapı; yeşil bina derecelendirme sistemi; yenilenebilir kaynaklar; Sürdürülebilirlik; küresel ısınma; sera etkisi.

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CHAPTER 1

INTRODUCTION

1.1. Overview

The global dependence on basic amenities by both domestic and public houses were growing every day, this is because the population is growing alongside demand in new and existing constructions which leading massive settlement expansion around the globe. About 62% of the rural areas in Kano state, Nigeria have difficulties access to clean water (Y. R. Tasi'u, Iguisi, & Mallam I, 2016). According to UNEP and SCBI buildings consumes over 40% of the global overall energy produced, generates one-third ($\frac{1}{3}$) of the carbon emission worldwide and forecasted to increase by 34% two decades (20 years) (Akande et al., 2015; Ampratwum, Agyekum, Adinyira, & Duah, 2019). However, these buildings result in environmental pollution, like land degradation, noise and air pollution etc. One of the prominent ways to lessen such problems and decrease dependency on public energy and sanitary services to buildings is through the provision of independent buildings that rely on renewable energy sources, thereby, houses independently generate the essential indoor lighting, portable water and energy from the surrounding nature to provide thermal comfort within both outdoor and indoor environments. This reduces bill to the individual possessing the house, likewise saves energy and time in the tax payment process, making it sustainable to mankind survival around the globe (Yahuza et al., 2020). Relevant scholars indicated that green building can be attained by sunshade provision; the installation of renewable energy for electric supply (wind, solar, hydro, organic etc.); borehole provision and storing rainwater then filtered and disinfected for potable water supply; making windows on two or more sides of every room for both lighting and cross ventilation; methane gas produced from organic matter (decayed kitchen waste, human and animal faeces) as gas for cooking, wall and roof insulation to prevent temperature exchange between outdoor and indoor etc. Consideration of the climatic conditions should be kept in mind to provide conducive building environment. Efforts were made to provide housing for all individuals as stated in the millennium goals, by the use of the local material and enhancing these local materials can increase cost saving in buying imported materials. It also saves time during the construction processes, therefore; it is easy for individuals to

build it house. The main aim of sustainable architecture is environmental sustainability, while the architect's design can assist in mitigating the environmental problems we have. However, the green building rating system is very vital in establishing green guidelines, standards and a healthier approach to environmental issues and focusing on sustainable built environment development (Komolafe et al., 2016; Okeke et al., 2018). The use of high energy material content involves high energy demand during the process of construction, and thus, leads to a high level of harmful gas emission. Building material production, processes of building construction, rehabilitation and renovation leads to greenhouse gas production released into the atmosphere (Olotuah et al., 2018).

1.2. Background of Research Problem

Some traces of green building can be found in Nigeria, however, awareness is lacking, also enabling environment and economic situation, like government legislation and policies makes the construction of new green buildings difficult in Nigeria. Therefore the encouragement is minimal to potential clients to construct or purchase a green building (Dahiru et al., 2018). The Nigerian currency has depreciated which also leads to unfortunate building constructions and the building materials and optimal standards were also lacking, these problems attract the use of substandard material during the construction procedures (Abiodun Olukayode Olotuah et al., 2018). This practice is against the sustainable goals, and it will attract multiple disasters in the country. The promulgation of national housing policy by the Nigerian government (NHP, 1991) was designed to reduce the housing problems. The enactment of a legal framework was done to accomplish a National Housing Scheme (NHS). However, for National Housing Policy to attain goals in the housing sector, it must tender the appropriate solutions to the housing predicaments (Festus et al., 2015). Festus et al. (2015) described the factors causing a shortage of housing in Nigeria were high urbanization rate around the urban centres, high cost of construction materials, unemployment and poverty. This makes the mainly rich repeatedly benefits from Nigerian NHP (Kabir, 2004).

The issues regarding power supply in Nigeria is very critical, whereby electric power holding company of Kano region (i.e. Kano Electric Distribution Company is also known as KEDCO) do not supply sufficient electricity to the public, many areas inside Kano city are currently spending days of electric supply problem (Amadi, Okafor, &

Izuegbunam, 2016; Asia, 2012). Also, sources of water in the residential building in Kano is majorly local wells or boreholes and 60.7% of the people in Kano are buying portable water from local water vendors (Y. R. Tasi'u et al., 2016). For a very long period, the public potable water supply company (Water Resources and Engineering Construction Agency is also known as WRECA) is inefficient and not pumping enough water to serve the population. However, heat energy sources were firewood or kerosene which produces a lot of toxic gas fumes into the surrounding. These problems can be reduced when the architects all over Nigeria can invent a self-reliant building which can depend on renewable environment-friendly sources, like solar, wind, hydro and organic energy by using the concept of green sustainable building mechanism.

1.3. Statement of the Research Problem

Demand on clean water, electric energy and other building's basic needs is increasing in Nigeria because of the population growth also increases rapidly in the country, contributed by improper governance and corruption, inactive development control enforcement, building regulations and legislative issues and uncontrolled birth rate. The need to minimize such demand is indispensable to achieve sustainable goals. In Nigeria, many areas have high storm-water run-off problem and can lead to flooding of an entire ward, landslide, polluting rivers and ponds and soil erosion. Most buildings in Nigeria requires warming and cooling in every building during both harmattan hot, dry, rainy and cold season. This demand increases the amount of energy use to a total of 60% along with other energy use all over the country (Otegbulu et al., 2015). Barriers like shortage of green building motivations towards its practice from both private and government sectors also increase the problems by discouraging both clients and architects towards the green construction practices (Zhang et al., 2011). The climate changes in Kano state evolves with time influenced by numerous climate features which the temperature is at the core. Obviously, the surface temperature escalates, the temperature surfaces increases considerably between 1986 to 2016. The lowest and highest surface temperature for 1986 to 2016 have been observed as 11.4–27.9°C to 17.4—56.2°C correspondingly (Mohammed, Hassan, & Badamasi, 2019). This shows the huge climate change difference of approximately 2^{o}C in Kano city was mainly caused as conventional building and industrial activities grow in the city.

1.4. Aim and Objectives

1.4.1. Aim

This research aims at determining the drivers, barriers and awareness and perception of green residential buildings among the residential occupants in Kano state Nigeria

1.4.2. Objectives of the study:

1. To investigate extensively the green building existence in Kano State, Nigeria;
2. To identify the importance and challenges regarding green building and passive design in hot climate nature of the case study;
3. To evaluate green user's satisfaction and perception around the study area;
4. To propose effective techniques of societal awareness regarding the importance of green building in Kano.

1.5. Research Context

Kano city has a total of 44 local government and 5 local government areas within the city wall, which are Gwale, Nassarawa, Kano Municipal, Fagge and Tarauni Local Government areas. This paper will only cover one ward in Gwale local government area in Kano state. There are 10 wards in gwale LGA, these are Dandago, Diso, Dorayi, Galadanchi, Goron Dutse, Gwale, Gyaranya, Kabuga, Mandawari, Sani Mai-Nagge. This is chosen because the researcher has a vast knowledge of the locality and the population of buildings in the area was also a remarkably large number.

Gwale Local Government Area has a total number of 362,059 population in Kano State, Nigeria. It has headquarters besides the veterinary building of Gwale within the city wall of Kano, with a total land coverage of 18 km² (2006 census).

1.6. Limitation of the Study

In northern Nigeria were most resident were Muslims and privacy is very strict, most residential owners may not be comfortable with strangers looking inside their various parts of the house, therefore, personal observation will be hindered in such manner. The total number of buildings in Kano from the Ministry of Housing is unavailable, also the record of green buildings does not exist, and the researcher got this information through a phone call from the ministry in Kano state. However, there are fewer publications of green building in Kano state which gives limited online resources in this study.

CHAPTER 2

LITERATURE REVIEW

2.1. Overview

There are several principles or framework for assessing green buildings, which are relevant studies on the current condition of green buildings in Nigeria. The factors included negligible pollution from the supporting population, safe climate, low energy usage, healthy economy, careful utilisation of resources, enhancement of biodiversity, recycle and reuse, competitiveness and profitability (Komolafe et al., 2016). The procedure for making affordable housing provision, which benefits society and the surroundings by the practice of environmentally safe activities and alleviating the harmful impacts of buildings on land is sustainable housing. There are environmental consequences caused by the overall lifecycle of a building, the magnitude of the consequences relies on the taste of materials to be used in the building (Baba et al., 2015; Okeke et al., 2018). Further reasons that delay Nigerian development of green buildings are the lack of knowledge and a lack of conducive environment (regulations and government politics). The environmentally friendly approach to ecological housing and a low financial cost will aid the sustainable housing development in the country (Dahiru et al., 2018; Olotuah et al., 2018). The "MDG" also known as Millennium Development Goals have a total of eight objectives: environmental protection, the advancement of maternal health, eradication of hunger and poverty, sustainable development, the war against infectious diseases, universal primary education, gender equality and the eradication of infant mortality. Unfortunately, accommodation is an important feature in all 8 MDG targets, where the MDG targets in Nigeria are still not reached (Baba et al., 2015). Housing is a basic necessity for all individuals, it is a sanctuary for humanity, vital to human well-being, welfare, survival and health of humans from both animal and human hazards. Housing thus acts as a significant symbol of a person's quality of life and social standing, dwellings offer access to comfort, protection, accessibility, hygiene, aesthetics, shelter and social amenities, conversely unhygienic, dangerous, unhealthy housing or household defects can impact human privacy, health and protection. The performance of the housing industry sector is therefore an indicator of a nation's health (Festus et al., 2015).

World Health Organization's (WHO, 1961) Characteristics of a Decent House

1. A decent roof for protection against the harsh weather like strong wind rain, and sun out;
2. Walls and doors Quality for safety against harsh weather and animals attacks;
3. Doors and Windows covered using nets to protect insect from the interior, particularly mosquitoes, while also allowing ventilation;
4. The compound should be surrounded by sunshades for protection from direct sunlight during severe weather.

In short, from its physical appearance, the standard of a building can be measured.

2.2. Problems of Housing.

In Nigerian cities, housing issues are largely qualitative in rural areas and quantitative in urban areas. Qualitative shortcomings such as the location of the home, its value, the material used in its construction are predominant in rural areas, while examples of the quantitative issue are the insufficient number of houses to meet the demand and increase in costs associated with the demand. Nigeria also lacks basic services like potable water provision, public roads and electricity, suitable drainage systems (Festus et al., 2015; Wahab, 1993). An urbanization challenges also were related to inadequate maintenance culture of the current amenities, insufficient waste management, squatter settlement, health hazards, urban sprawl, obsolete systems, slums, weak sanitation, improper ventilation (Ibimilua, 2011).

Nigeria's housing sector in most parts has been plagued by problems that include poverty, lack of usage of indigenous materials, ineffectual housing funds, lack of financing to enable housing funds, dramatically high building material prices, a lack of facilities and land procurement authorities responsible for (C of O) also known as Certificate of Occupancy and building plans endorsement (Festus & Amos, 2015).

2.2.1. Factors Driving Housing Developments

There are environmental consequences throughout the building life cycle and the material decisions made during construction process influences the overall efficiency of the building, before Nigeria introduced foreign architecture, green building materials were used for construction, however now most of the architects adopt building designs that do not conform to climate conditions, this occurred after the dominance of the modern architecture (Okeke et al., 2018).

There are many factors that drives housing development in Nigeria; some of the most important of these factors include policymaking and government stimulus for the promotion of green building. However additional considerations may include lack of interest by consumers, construction industry and stakeholders in the aspect of sustainable building material (Dahiru et al., 2018). According to Wang & Adeli (2014), energy demand can be reduced by the use of natural light and cross ventilation, plant and courtyards. The dependence on public energy and fossil fuels can be mitigated by the use of solar, wind, hydro, biodiesel and geothermal sources. Solar power can also be used for cooking, water heating not only for electricity. Similarly, in so many other domestic applications, other sources listed above can be included.

Sustainable green buildings do not raise any unique challenges in Nigeria, but a variety of issues must be noted. It has been proven that a strong driver of sustainable housing is personal interest in green housing growth (Persson et al., 2015). The essential elements that contribute to the growth of green buildings are the drivers. These drivers fulfil the sustainable green development priorities in Nigeria, which according to Falkenbach et al., (2010) can be divided into the following three factors:

- External driver;
- Corporate drivers and
- Property-level drivers.

Another classification was further made by Darko et al. (2017), he made into five categories:

- Project-level drivers ;
- External drivers;
- Corporate-level drivers;
- Individual-level drivers and
- Property-level drivers**.**

1. External drivers

External actors like the (UN) i.e. United Nations, labour unions, States, consumers, European Union (EU) etc. have developed these drivers. The government is showing an interest in green building in many countries around the world, thereby promoting the

green building industry. This is very important for the construction of green buildings. Consumers are also an important force of green building market demand and awareness (Arif et al., 2012).

2. Corporate-level drivers

Some corporate bodies, such as businesses and stakeholders, have also embraced ways to reduce risks, maximize and produce optimum results in sustainable buildings to comply with potential prospects and laws in building design (Sayce et al., 2007). By winning the competitive market, corporate bodies will benefit by implementing future green building features as a trademark in their construction (Zhang et al., 2011).

3. Property-level drivers

The many drivers at the property level include the large demand for green buildings by tenants/customers, continuous property prices and decreased risk. (Darko et al., 2017). In order to mitigate the environmental impacts and expenses, stakeholders who might be tenants continuously request green construction. However, other stakeholders are seeking to minimize the cost of building and increase the benefit from the property acquired by using green building materials (Richard et al., 2005).

4. Project-level drivers

The general expenditure of the building established at a certain stage; the majority of decisions taken now have a lifetime impact on the home. The use of green building materials and methods keeps within a reasonable range the cost of construction (Dwaikat & Ali, 2016). The drivers of green buildings can at this stage involve the usage of locally produced resources, like bamboo, mud bricks, wood and other sturdy building materials. The reduced construction length, minimal labour demand, improved safety during the construction process, achieving good building quality and minimal waste of construction material are other project-level drivers (Niroumand et al., 2013).

5. Individual-level drivers

Incentive by people can help people in society grow an interest in green building design, normally people don't like being pushed into anything different or not in their lifestyle. Consequently, motivation and education will help immensely in promoting the growth

of the green building market in Nigeria which will boost green building construction (Murtagh et al., 2016; Wilkinson, 2013). This indicates that persuasive techniques can be employed to manipulate human actions to accomplish a purpose. Clearly, humans function in many ways, beginning with controlled or extrinsic motives and then intrinsically or autonomously. Extrinsic incentives come externally from the person, as stated earlier, such as financial benefit and regulations from enhanced turnover. Contrastingly, the intrinsic motives are volitional, elastic and usually separate from outside controls, enabling people to behave freely. The Individual drivers are essentially intrinsic and explain what motivates people to work on sustainable practices or to attempt green building practices on their residences. Through the literature review, four other individual-level drivers of green construction were recognized: personal engagement, customs and behaviours, personality and religious or social necessity. The practices driving green building adoption, these drivers were found to be very critical, however, the quantity of experiential research regarding it is very little (Niroumand et al., 2013).

2.3. Holistic Approach to Sustainability (HAS)

It is stated that the best suitable method for addressing the issue of Sustainable housing within Nigeria nation is found to ne the Holistic Approach to sustainability (also known as HAS). Environmental and socio-economic perspectives are taken into account by this method. HAS can also be used to solve sustainable development values of the society along with the boundaries of environmental technology (Baba et al., 2015). HAS is a modern method intended at recognising, investigating and solving the challenges and potentials related to sustainable development of housing in the country. This method considers the main principle of sustainability, environmental, and socioeconomic in addition to the folklore of the concepts of sustainable development (SD), techno-environmental limitations and social necessities. It was suggested HAS can outline the green housing problems and its potentials.

2.3.1. Socioeconomic factor

Poverty, unnecessary or inconsistent policies and financial bottlenecks form the majority of the socioeconomic challenges to housing in Nigeria. Nigeria is recognized as a low-income country, extreme poverty is the main contributor to most housing

problems, for most individuals, the cost of accommodation is out of reach, compelling them to live in low-quality structures and homes in both urban and rural areas. The huge cost of materials and limited use of those materials of indigenous origin (28) both add to the socio-economic factors troubling the provision of housing in Nigeria It is important to remember in the construction of houses that building materials form the major proportion of the expense (60-65%), therefore the cost of materials inevitably contributes to higher prices of complete buildings. This definitely proves the need for a transition by Nigeria to the sustainable housing model. Some other socio-economic factors include a deficiency in Nigeria's financial instruments for construction and Authority, the tangible lack of creative construction technology, unregulated growth, poor social infrastructure and inadequate maintenance culture, which add up to the shortage of housing in the country. Subsequently, entire policies enacted in Nigeria, the NHP is formed from laws, statutes and organisational structures. They must in the interest of the public, adhere to the basic values of democracy, justice and equality. However, due to the lack of policy reforms over the years, the NHP were unable to address needs of Nigerians in housing provision adequately, as provided within the statute of its power. As a consequence, this has led to its roles being replicated and its efficiency has been limited. The NHP must therefore be reconstituted in order to address the needs of Nigerians today by taking into account the country's current socio-economic and political environment. The NHP must therefore be put into the state's laws and constitution in order for it to correct the discrepancy that has compromised housing provision, land ownership and funding.

2.3.2. Techno-environmental factors

The details involved in the choice of construction materials, building construction and environmental land practices are the techno-environmental difficulties of the provision of housing in Nigeria. Factors such as an insufficient culture of maintenance, climate change (Odemerho, 2014) and limited amount of technical training experts within the sector also accrued to deprived housing in Nigeria (Bobbo, Garba, Ali, & Salisu, 2015). In the cost, sustainability and overall building’s life cycle, also the choice of construction materials plays a significant role. Selecting for foreign building materials is the natural choice of professionals in the construction industry in Nigeria. Building materials represent more than 60 percent of the entire building construction costs,

therefore most of the building constructed in Nigeria are outside the affordable capacity of the people financially and thus, are prohibitively expensive. The importation and use of international construction materials often contribute to increased greenhouse gas (GHG) and particulate emissions, impacting adversely the life cycle and environmental quality of the country's buildings (Odemerho, 2014). In the short life cycle of buildings, the long-term consequences manifest, triggering an unfortunate sequence of failed buildings throughout Nigeria. The renewable construction materials introduction, continuous lifecycle and maintenance evaluation in the construction sector would further improve the country's housing provision (Bashir, Mohd, Adetunji, & Dodo, 2013; Yakubu A Dodo, Nafida, Zakari, & Elnafaty, 2020; Nwokoro & Onukwube, 2011). The usage of minimal price sustainable and green construction materials locally obtained, especially waste of agricultural produce, urban solid and lumber industries, for all levels of government, the construction industry and also for the user should be mandatory (Adesanya & Raheem, 2009; Bashir et al., 2013; Yakubu Aminu Dodo, Ahmad, & Dodo, 2014; J. & Baba, 2014; Nyakuma, Johari, Ahmad, & Tuan, 2014; Olanipekun, Olusola, & Ata, 2006; A. O. Olotuah, 2002; Ugochukwua & Chioma, 2015). Environmental change and land practices (Salisu, Maconachie, Ludin, & Abdulhamid, 2015) are other factors that influence the provision of housing in Nigeria. The availability of land and its regulatory laws and statutes directly affect the affordability of housing, and the actions of specialists in Nigeria's construction urban development industry and agriculture, may also temper with the housing delivery. To boost land supply, practices and usage for successful housing delivery, these fundamental dynamics need to be updated, reformed and revisited (Abimaje, Akingbohungbe, & Baba, 2014), the provision of housing (Ndalai, Binti, & Elegba, 2015).

2.3.3. Sustainable housing prospects

To analyse the prospects potential of housing sustainability in Nigeria, the anticipated Holistic Approach to Sustainability (HAP) will be used. Perspective sustainable housing can therefore measure the basis of techno-environmental and socio-economic considerations. Nigerian housing delivery can stimulate the country's socio-economic and sustainable development. Housing will also increase the level of literacy among village children and women, foster equality of gender, maternal health care,

productivity, fight infectious diseases spread, according to the MDGs charter. The impact would be to grow the country's human resources, including productive women and children, on a long-term socioeconomic basis. In addition, the provision of affordable housing would boost job opportunities, disposable income and better living conditions for individuals in society. Safe building materials will in turn be brought, so as to reduce nation's greenhouse gases (GHG) and pollutants emission. The average life span of the country's buildings will also be improved. Likewise, the uses of sustainable green buildings materials will foster research on materials science and construction technology at national tertiary institutions, research facilities and centre of excellence. This HAS implementation would aid in the idea prioritization of building industry constraints and requirements. This would minimize waste, excess and unnecessary building and construction costs and help push down the country's housing prices. The affordability of housing increasing, the homelessness sequence, rampant crime and malnutrition attributable towards the shortage of necessary social facilities in the societal wellbeing and can considerably decreased. General, the socioeconomic outlook for the provision of affordable housing in Nigeria would boost the country's social well-being and economic activity. The technical know-how and environmental protection of the country will theoretically boost the techno-environmental prospects of sustainable housing provision. Present industrial practices have contributed to an undue environmental burden due to inefficient use of resources, poor energy usage, poor management and maintenance of waste in buildings. Such diseases will be relegated to the past by better reforms and the implementation of sustainable practices. This can only be accomplished, however by reforming Nigerian construction industry laws, preparation and skills development for building professionals. As a result, the progress of such initiatives can purposefully transpose the nation to a centre for construction management and sustainable green building innovative technology within African nations. In the end, it would draw considerable funds for the academic research and building sectors. Such achievements, if reached, would improve UN and international partnership and coordination on projects under the (CDM) also known as Future Clean Development Mechanism.

General, the prospects of techno-environmental provision of sustainable housing have a significant effect on Nigeria's building sector through enhanced skills, training and

financing aimed at enhancing the country's building supply, affordability and life cycle. Likewise, housing delivery can develop the institutional system, advancement strategies and upgrade land settlement, provide adaptable housing funds, lower construction material and building expenses, and help the activation of the private sector in areas like the examination and assessment of future sustainable housing projects and plans in the nation.

2.3.4. Public Awareness of Green Building

It is shown that the construction design related to green building has a great potential to maximize the realization of customer/owner benefits through energy efficiency; the organizational level of productivity and reduce the cost of operating building lifecycle in Nigerian commercial buildings. This can only be done if the customer is well aware of the short and long-term advantages to be gained. Despite all global stakeholders calling for a paradigm change from conventional design and construction activities, there is still a lag in the Nigerian construction industry's understanding of green buildings for greater customer benefits. The presumption is that a lack of sufficient consumer understanding of the potential benefits and high costs associated with design and construction are seen as key obstacles to the construction industry's delivery of green and sustainable buildings. In view of the principle of the Community of Practice (CoP), it is the corporate social duty of stakeholders in the construction industry to increase the current level of recognition of green buildings by consumers and the realization of benefits. The lack of public knowledge is argued to be a significant setback to the implementation of green building programs (Ibrahim & Raji, 2018). The Smart Green Building industry (SGB) has gained significant global attention in recent years because of the rapid growth of state-of-the-art technologies, creative products and services. While different cross-domain experiments and practices are ready for action with regard to IGB ventures, the concept and benefits of the IGB are still unclear and debatable. It shows that the proposed solution could be a valuable method for investigating parallels and variations in strategy preferences between designers and consumers and that these results could effectively minimize the communication barrier for future IGB design (Juan, Huang, & Chen, 2014).

Comparing their energy use patterns, the final usage of energy consumption of some selected residential buildings in Kaduna and Kano in the northern part of Nigeria was

analysed. As-built (Conventional) and when retrofitted with green features, the energy use and intensities of the buildings were analysed and the effect of the green retrofits recorded. An Analysis of Variance (ANOVA) was performed at 0.05%, suggesting a substantial difference in the use of energy in the six study areas between the traditional and green features. According to the report, Kaduna's annual energy intensity for traditional buildings is 25.24kwh/m^2. A dramatic reduction in the annual energy consumption of buildings was reported with the introduction of green appliances, which stood at 20.57 kWh/m^2 reflecting a decrease of about 18.26% in annual energy consumption, which implies a major energy saving. In Kano, VAC consumed 12.49kwh/m^2 of the overall consumption of all end-users with the highest energy. The consumption decreased to 7.95 kWh/m^2 when replaced with energy-efficient appliances, reflecting a 34.14% reduction. It is recommended that energy-efficient appliances be used (Irimiya, Humphery, & Aondover, 2013).

2.4. The BREAM and LEED Assessment Criteria

2.4.1. The BREEAM

In building's and infrastructure in master project planning, Building Research Establishment Environmental Assessment Method (BREEAM) is the biggest sustainability evaluation criteria widely used in the world. The significance of high-performance resources in the developed setting, starting with fresh buildings to those in-use and restored ones, were reflected and recognized through using a set of criterion provided by BREEAM, this is achieved by certifying the third-party assessment economic, environmental and social sustainability performance of the asset. BREEAM rated buildings are therefore sustainable environments which enhance people's value of life, protect raw materials and increase the allure of property investment. This is done by identifying and evaluating a wide variety of scientific and rigorous standards that go beyond existing policy and procedure. BREEAM aims to promote continuous performance improvement and progress of facilities using five basic categories which are Governance, Social and economic wellbeing, Resource and energy, Land use and ecology and Transport and movement. It however empowers those owning, commissioning, supplying, maintaining, consuming the infrastructures of the communities to meet their sustainability goals, hence create trust and value through their certification that proves benefits to society as a whole. There are currently 591,822

certificates issued in 87 countries worldwide, 2,310,077 Registered Buildings (BREEAM, 2020).

Table 2. 1: The BREEAM rating benchmarks for the BREEAM Communities 2012 scheme

BREEAM Rating	% Score
Outstanding	≥ 85
Excellent	≥ 70
Very good	≥ 55
Good	≥ 45
Pass	≥ 30
Unclassified	< 30

Source: (BREEAM, 2017)

2.4.2. The LEED

About 1.85 million ft^2 of certified built spaces every day, leaders around the globe have made Leadership in Energy and Environmental Design (LEED), the most frequently implemented ranking system of green building around the globe. Certification using LEED allows independent guarantee of green characteristics features of house or an entire neighbourhood, encouraging cost-effective, energy-saving, safe, high-performance buildings to be built, planned, maintained and managed. The triple bottom line in motion is LEED, helping individuals, the world and profit. Usable for nearly entire forms of building, LEED offers a structure for sustainable, very effective, and saving cost in the green building. Certification of LEED is internationally identified as a mark of success and guidance in sustainability. All forms of building in LEED, entire stages of construction, containing new interior and construction arrangement, heart and shell, operations and repair. In LEED-certified buildings around the world, millions of individuals are living, working and studying. Learn more about the importance of qualification under LEED. The certification program has been in existence since 2002 for the design, development and operation of high-performance green buildings. This mark of excellence is recognised all over the world and four levels of excellence are

available. LEED certification means a cleaner, more productive places, decreased environmental stress by supporting buildings that are resource-efficient and energy-efficient, and benefits from better-quality building worth, advanced rental prices and reduced costs of the utility. Buildings that are certified by LEED can bring $29.8 billion straight into the United States economy by 2018th Grow Domestic Product.

The certification is classified into four, these are:

a) Platinum (scores ≥ 80 points)
b) Gold (scores between 60 to 79.99 points)
c) Silver (scores between 50 to 59.99 points)
d) Certified (scores between 40 to 49.99 points)

2.4.3. Determination of user's need and comfort in green building

Towards the design work conclusions, architects may have trouble interpreting the needs of consumers of green buildings, causing difficulties. In the event of a misunderstanding in the green-building design phase of the client's briefs (Thyssen, Emmitt, Bonke, & Kirk-Christoffersen, 2010), this could result in little consumer appreciation or numerous adjustments in project planning and design plans, which result in needless expense, conflicts or even unwanted legal action within the Contract Team. Many stakeholders have inadequate information in the briefing stage, which contributes to an inadequate interpretation of the project, which then leads the architect to misinterpret the whole project. Architects must make sure that customer briefs are properly understood during every phase of the development process. Careful analysis, inference, simulation and testing of consumer knowledge will solve this problem (Smith, Kenley, & Wyatt, 1998).

Table 2.2: Green Building Features in Comparison with Users Need (Yahuza & Erçin, 2020)

S/N	Features of Green Building	User Benefits and Need
1.	Energy-efficient uses minimum energy)	Less bills and saves cost
2.	renewable energy Production from natural sources	Environmentally friendly and has less hazardous effects
3.	Indoor ventilation and natural light production	Natural lighting and ventilation free from the surrounding nature
4.	Using cheap local materials during construction process	construction cost reduction through the use of local materials
5.	Generation less waste	Less efforts in waste management through, recycle, reuse etc.
6.	Sustainable and environmentally-friendly	Sustainable goals can be attain easily

2.5. The Concept of Green Building

2.5.1. Development and emergence of green building concept

In United Kingdom, the green building early guidelines were declared in 1990 as the "Building Research Establishment Environmental Assessment Method (BREEAM, 2007)". Accordingly, the number of green building laws continues to rise worldwide, approaching around 23 nations in 17 years (WGBC, 2007). The various instruments utilized by organizations toward successful mobilization of guidelines of green building have been environmental sustainability considerations, which are increasingly recognized as a critical factor for the successful adoption of green approaches and the resolution of environmental problems. Together with the broader awareness and publications on the growth of sustainability, the green building concept is evolving and it has been recognized as a separate area of learning in recent years. Despite the current awareness and study, the origins of green building theory, their direction, the elements which create it, when or how the impacts of users needs remain unclear. Contemporary research ties the concept of green building towards the various facets of entire environmental efficiency and environmental management across the Pacific of Asian (Li, Huang, Liu, & Cai, 2011; O'Donohue & Torugsa, 2016; Paillé, Chen, Boiral, & Jin, 2014; Subramanian, N., Abdulrahman, Wu, & Nath, 2016).

African greenhouse buildings are both rapidly growing and uncertain in nature. Green architecture does occur in Nigeria, but there is a lack of knowledge of it so that

environmental and economic considerations can also be permitted, such as regulations and government policies that would encourage green building growth in Nigeria. Therefore, prospective patrons have negligible incentives to purchase or create green buildings. The weakening of the Naira further attracts negative economic conditions and triggers shortages of materials for building, issues in construction and low quality of the building, this leads to the use of materials that are nonstandard during the project construction. It is unsustainable, resulting in several tragic incidents, such as the collapse of buildings in Nigeria. The Nigerian government adopted the National Housing Policy (NHP, 1991) that will provide a National Housing Scheme (NHS) which will reduce housing issues through a legal framework provision. When it proposes a viable solution to housing challenges, NHP will meet housing objectives. An exponential rate of urbanization inside the larger metropolises, the price increase of construction materials, poverty etc. were among other problems of housing shortages in Nigeria, allowing only the rich appreciate the NHP (Dahiru et al., 2018; Festus & Amos, 2015; Kabir, 2004; Abiodun Olukayode Olotuah et al., 2018).

A bank called First City Monument Bank Capital Markets Limited, is a Nigerian subsidiary bank of investment that spent $65,000,000.0 in the green building of “Heritage Place”, among the Nigeria's first examples Green Construction, one of Nigeria's first green buildings, looking forward to connecting the space in Lagos State, one of Nigeria's largest commercial centres with a favourable office environment. In the company’s speech, this was said; “This is a specifically and proudly undertaken construction with environmental sustainability principles in mind and an embrace of innovative technologies to achieve current and future environmental expectations, the building (Heritage Place) is the first commercial green facility that achieve the LEED endorsement in design and architecture in Nigeria. There are 14 floors in this building, covering approximately 15,730m^2 of house offices with sufficient parking, café/cafeteria, a square and meeting rooms”. In contrast to other traditional buildings across Lagos state, the opportunities were great for the green building to achieve 30% to 40% savings in energy. The features used in the design of this building are primarily eco-friendly practices introduced during the building phase of the project, such as the recycling and reuse of water and waste, the installation of automated high-quality lighting and sensors, extremely effective sunshade glazing, thermal external envelope

and the building's proper alignment of fully exploit natural light and airflow. A few minutes from the Central Business District (CBD) of Lagos, Victoria Island, is where the green, eco-friendly building is situated. First Idea and Properties Limited (FCP), a Special Purpose Vehicle (SPV) of Nigeria operated in Sub-Saharan Africa by a personal equity investor known as Actis, were the other supporters of the initiative (Sotunde, 2014).

2.5.2. The concept of green building

World Green Building Council organisation WGBC says; any building that removes or avoids negative effects on our atmosphere, natural environment and can create beneficial effects through its architecture, construction or operation is regarded as a green building. Green buildings preserve natural resource valuables which improve the standard of our lives. In his study of the green construction concept. However, Islam et al., (2015) found that it encompasses a building planned, installed, managed, sustained or reused to protect the health of the occupant, enhance the productivity of workers, wisely use natural resources and reduce the environmental impact. In other words, in any level of building design, the green building process integrates environmental concerns. This method focuses on the phases of planning, operation, maintenance and construction which considers the effectiveness of many development and design, water and energy efficiency, resource use, quality of indoor environment, owners building maintenance and the overall buildings' environmental impact. (Singh, 2018). A modern approach to saving water, energy and material capital in the design and maintenance of buildings is envisaged in the Green Buildings definition and can minimize or eradicate the undesirable buildings' environmental effects towards the occupants. The green building's ideology started through the sustainability concept, widely known as the Common Future, which was first started as a collective activity as drawn up in the United Nations Brundtland Report (Umar & Khamidi, 2012).

Sustainability is seen as growth that does not obstruct tomorrow's needs while fulfilling current necessities. The sustainable development ideology varies from the conventional method to grow by simultaneous incorporation, taking into account economic development, environmental conservation and social inclusion (Connelly & Smith, 2012). With regard to the characteristics of growth sustainably, the essence of an ecosystem is connected towards the actions of the society reaching the degree which

takes the form of the environment artificially (Dubois & Dubois, 2012). The drivers of the contemporary environmental popular between the 1960s-1970s, was subjected to the world's harmful human activities. Increased community knowledge which anxiety about potentially harmful environmental practices led to the development of modern institutions, which implemented numerous methods of business administration which brought new support activities across social, political and economic aspects. These contributed to wide varieties of regulations which mitigate these environmental practices adversely, which have become evident as a result of rapid environmental hazzard (Bansal & Hunter, 2003).

The current conceptualizations of green building relies upon two schools of thought. Taylor, et al., (2012) specified theories that green building in a sustainable environment fetches a double role. Initially, consumers necessities has to have an effect directly on the driven variations by the environment, hence this idea of green building were also treated as an environmental management process of human need. The real utmost significant conceptualization developed by contributions of the ancient researchers linking the 2 area of green building and user demands studies shows that this opinion emphasizes the understanding of the potential significance which the acceptance of one or numerous fixed amount of practiced users need to refine their environment's efficiency. In the green building publications, however, preparation, development performance and compensation, recruitment and management remained between those commonly examined in the purposes of users need aspects (Jabbour & Jabbour, 2016; Jabbour & Santos, 2010; Renwick, Redman, & Maguire, 2013; Wehrmeyer, 1996).

Going through the 2nd school of thought that extends the concept's domain by realizing that green building is equally aimed at encouraging the behavioural and attitude changes of users as well as enhancing the ecological efficiency of the green building. A group of scholars emerged to take a broad view of green building with regard to this school of thought to include both collective and individual user needs capabilities that trigger green action, motivation and commitment. Accordingly, researchers started to expand their research viewpoint beyond purely consumer criteria and instead analyze broader work characteristics related to the realization of environmental benefits. Consoli, et al., (2016) discovered improvements in social behaviours that impact the application of the environment and identified that users of green buildings consistently have higher levels

of interpersonal and cognitive skills compared to non-green buildings. The green design teams were established to clarify the goal of the team (involuntarily or voluntarily) to address environmental problems and increase environmental efficiency (Ehnert, 2009; Guerci & Carollo, 2016; Jabbour & Santos, 2010; O'Donohue & Torugsa, 2016).

2.5.3. Green building description

Green building literally means any shelter that minimizes or eradicates undesirable environmental impacts in its service, design or construction phase and offers positive sustainable results for the natural environment and climate. Green buildings conserve important resources for the natural world and boost the quality of human life as well. Green building features include the following:

1. Any design which makes it possible to adapt to environmental change;
2. Runs on renewable energy e.g. wind, solar, hydro, and bioenergy;
3. Usage of eco-friendly, non-damaging, sustainable and ethical materials;
4. Sufficient indoor and outdoor air quality;
5. Environmental awareness during the building's construction, operation and design
6. Usage of water, electricity and other essential consumables to a minimum;
7. Minimize environmental pollution and waste generated, by recycling and re-use process;
8. Considering the standard of the comfort of users when planning, constructing and running the building.

Any shelter can be regarded as a green building irrespective of its form or use, given that it has any of the above factors. In this regard, it is clear that green buildings around the world vary because of variations in the climatic conditions of the country or area or some physical social, cultural, economic, conventional, a wide range of environments or various styles and ages of construction, social preferences and religious beliefs; all of these considerations form a magnanimous approach to the differences in green building construction (WorldGBC, 2020).

2.5.4. Green building problems in Libya and Singapore

Findings indicated that poor implementation of green buildings in many current construction projects. Results also demonstrated that current encouragements are not

sufficiently effective at promoting green construction in Libya; consequently, many construction firms are reluctant to participate in the green building market. Moreover, outcomes explaining the lack of green buildings in Libya include price hike, unavailability of green products, supply of green materials, and ignorance about green buildings. Similar research which has been carried out in Singapore indicated that workers' experience, available technology, planning were the most critical factors affecting green building construction projects (Hwang, Zhu, & Ming, 2017). Results underlined that government incentives and desirable subsidies, such as structural incentives, rebate programs, or voluntary rating systems, tax incentive schemes, low-interest mortgages loans, market and technology aid, improvement of workers' experience could eliminate many barriers and motivate green building development in Libya (Mohamed, Awaili, Uzunoglu, & Özden, 2020).

2.5.5. Marketability of green building

A study conducted by Robinson et al., 2016, examined requests for office green building features among tenants in offices across the United States. A sample of tenants was randomly selected using the online internet survey in around 17 U.S. markets of which the majority were officers. The respondents offered their point of view on green buildings and demonstrate the green office building Willingness to Pay or Purchase (WTPP) due to the benefits attached to it. With regard to improved indoor air quality and natural lighting, the highest WTPP has been reported. Results indicate that the energy and IT industries and businesses almost certainly paid for or purchased buildings rated green or energy-saving. Demographic and geographic priorities are expressed in the WTPP and feature rankings. Findings of the Robinson et al., 2016 study findings will provide a forum for stakeholders and policymakers to establish green buildings with features considered to be very important green building practices and decide how the demand for green features can differ across the globe. Green building demand in Nigeria, however, is also growing, as people seem to understand the process behind it and the fact that the Nigerian government has failed to provide the public with adequate energy supplies. Similarly, the Kano renewable energy market also continues to expand as people lose confidence in the public energy supply they tend to find alternative sources for themselves. The same also applies to the public supply of water that has not been seen in some part of Kano city for decades, so domestic users tend to be more

drawn to boreholes, energy-saving appliances, renewable energy sources such as solar panels and water heaters, wind turbines, biogas and biodiesel.

2.5.6. Criteria for design green building

During the construction and application of eco-friendly materials, the use of low-energy manufacturing materials helps achieve successful green building construction. Mentioned below are several of the parameters used here:

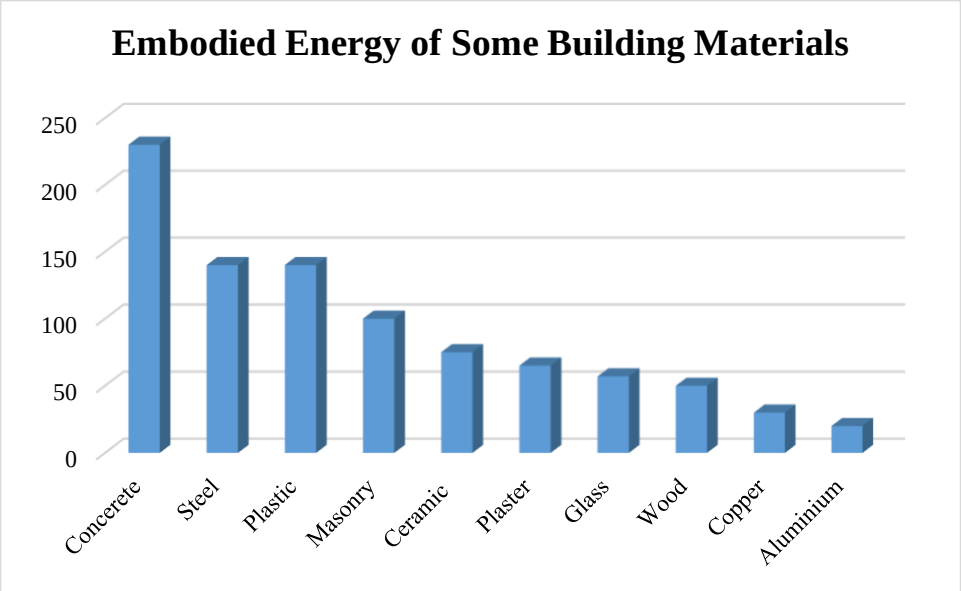

Figure 1: Embodied Energy of some Building Materials (Tudora, 2011).

Here the above figure 1 shows the energy needed during the construction phase to process certain building materials. Concrete bears a higher proportion, while the lowest is borne by aluminium. This implies that the energy needed in the production of cement is very high, starting from the wining of limestone, transport, crushing and pulverizing, screening, packaging to the point of placing cement in construction processes, it may also require higher fossil fuels that generate high volumes of toxic gasses to the sky in return, causing global warming. These requirements for the choice of material to be used during the construction process would allow the green construction process to be able to maintain itself. In the evaluation of green buildings around the world, the Building Research Establishment Environmental Assessment Methodology (BREEAM) and Leadership in Energy and Environmental Design (LEED) have also been used (Yahuza & Erçin, 2020).

CHAPTER 3

METHODOLOGY

3.1 Research Design

This research is intended to determine the awareness and perception of green residential buildings among the architects and residential occupants in Kano state centred on the aspect of green building in Kano city. Presently there is a limited number of green building in the city from which little sample of these green buildings will be picked and analysed using green sustainable features of the architecture. This research will highlight the issues faced by the architect and clients when designing green building and an appropriate solution will be suggested. This research methodology also discusses the data sources that will be used in this research, sample frame, the procedure of sampling and other research instruments or tools that this paper adopted, likewise analysis and presentation of data will be conducted to evaluate the green building in Kano city.

3.2 Research Methodology

The adoption of both secondary and primary data will be used in this project, this is necessary because both instruments are needed to collect enough data for a successful data presentation and analysis in this study. Primary data will be acquired on-site at each building's individual locations. Coordinates will be collected with a GPS device, while pictures will be taken with camera and measurements with measuring tapes among other numerous information required. Conversely, internet sources, ministry of housing, housing financial institutions like mortgage banks, other relevant government and non-governmental parastatals etc. were among the secondary data used in this research. Also, a different type of computer software will be devised to get both processed and raw data and will be presented after being analysed in the study. Example of different computer applications are Matlab, Microsoft Word and Excel, SPSS, Google Earth etc.

Table 3. 1: Data Collection

S/N	Objectives	Type of Data	Method of Data Collection	Method of Data Analysis
1)	To investigate extensively the green building existence in Kano State, Nigeria.	Primary data.	Questionnaire GPS	Descriptive
2)	To identify the importance and challenges regarding green building and passive design in hot climate nature of the case study.	Primary data. Secondary data using an internet map.	Questionnaire; Personal observation; Interview and Google map.	Descriptive
3)	To highlight the features driving or hindering practices green building construction in Kano.	Both secondary and primary.	User's perception. Interview with students. Field observation. Questionnaire.	Descriptive
4)	To evaluate green user's satisfaction and perception around the study area;	Primary data.	Questionnaire Personal interview and observation	Descriptive
5)	To propose effective techniques of societal awareness regarding the importance of green building in Kano	Both secondary and primary.	Analysis results in this research.	Descriptive

Table 3. 2: Data Types used

S/N	Data	Sources
1.	Building Census	Secondary
2.	Map and locations	Secondary
3.	Measurements	Primary
4.	Green building assessments on sustainable features.	Primary

3.3 Data Sources

In this research, both secondary and primary data sources regarding this research are required. Government offices and internet sources were the Secondary data sources used in this paper. While field personal observation, direct interview, questionnaire site measurements were the primary data used in this paper.

Primary Data

In this research primary data was attained using questionnaire administration to the respondents related to this research together with field surveys such as physical observations and measurements. However, personal interview of respondents will be carried out in this research to fetch the appropriate data needed.

Secondary Data

This data was gathered from sources such as past literature, magazines and internet sites which gives more light in assessing the existing condition of green development in Kano state.

Instruments

This paper contains many instruments which were employed in data collection for both primary data and secondary. The instruments used are; questionnaire is used as the major tool followed by an oral interview, field observation, government and non-governmental agencies, Global Proxy System (GPS), telephone conversation, and camera recording instruments.

3.4 Sampling Procedures

This study took about 12 months to complete, which began with literature review in an effort to formulate the title, aim and objectives of the research within 2 months. Chapter 1 was partially complete in 2 months, chapter 3 was developed before chapter 2 in 2 month, which give the researcher the idea on how to conduct the whole research and precisely sorting the kinds of literatures that would be relevant in the study. Later, chapter two was developed within the period of 2 months. Questionnaire development and approval took a duration of 1 months also. Data collection and analysis also took the researcher a period of 1 month usually done online with the use of Google Form and telephone conversation. Finally chapter four and five took 2 month to complete, which data analysis, data presentation, data summary, conclusion and recommendation was carried out in these 2 chapters. However, references was done using Mendeley software, which was done the research advances.

Unit of measurement

This study will employ residential buildings as the unit of measurement in the study area. Other parameters of green building features will be considered as well in rating the green buildings in the study area like the BREAM and LEED rating systems. Units like meters, mass and volume will be kept in their standard international units e.g. temperature "^{o}C", Distance "m", mass "Kg" speed "m/s^{2}" and volume "m^{3}" etc. as they will be useful to assess the green buildings in the study area. However, quality, satisfaction and capital etc. are also considered in rating the standard and comfort of the green building.

Sample frame/population

This study emphasizes green building around Kano city and energy-efficient building around this area as the target sample. These samples was be picked from the residential buildings in Kano state at random. One of the building was be picked in systematic way, and is used analysed as the case study using BREEAM and LEED rating system, this enables the researcher to have a unique dimension in attaining the accurate result.

Sample size

There is no record of data regarding the total number of buildings in Kano state, it is therefore becoming very difficult to conduct this research without making an estimation. The sample is estimated from the total population of Kano state in 2006 census and divided five (5) number of a household size approved by the Federal Government of Nigerian during President Jonathan Goodluck's regime around the year 2012, because of lack enough data from the housing governing body in Kano state. The total number of the population in Kano state is 11,058,300 (Census, 2006), which is divided by the total number of household. Mathematically:

$$\frac{11{,}058{,}300}{5} = 2{,}211{,}660\ Households\ in\ Kano\ state$$

These $2{,}211{,}660$ houses in Kano state will now be subdivided into 44 local government in Kano state to get the houses in Gwale local government area:

$$\frac{2{,}211{,}660}{44} = 50{,}265\ Houses\ in\ Gwale\ L.G.$$

There are 10 wards in Gwale local govt. area, which are; Dandago, Diso, Dorayi, Galadanchi, Goron Dutse, Gwale Yan-Alawa, Gyaranya, Kabuga, Mandawari, Sani

Mai-Nagge. The research paper is going to be conducted in Gwale Yan-Alawa ward which has:

$$\frac{50{,}265}{10} = 5{,}026.5\ Houses\ in\ Gwale\ L.G.$$

To determine the sample size in this research the following formula was adopted to determine the number of respondents required. 5% of the total sample will be picked at random and is mathematically presented below:

$$Sample\ Size = (Total\ number\ of\ Buildings\ in\ Gwale\ L.G.) * (\frac{5}{100})$$

$$Sample\ Size = (5{,}026.5) * \left(\frac{5}{100}\right) = 251.325\ Houses \text{ (Respondents)}$$

Therefore, a total of 251 houses will be shared a questionnaire per house at random in Gwale Yan-Alawa ward, which the data collected will be presented and analyzed later in this research.

Sampling techniques

Several aspects were taken into consideration in determining the appropriate sampling technique that will yield optimal result in this research. Starting with Questionnaire administration using Random Sampling Techniques in the study area. There are 251 samples of buildings which will be selected using a random sampling technique. This will be the best method to acquire the target aim and objectives of this study.

3.5 Sampling procedure

The 5% of the green building samples was later determined by Simple random sampling technique. These samples will be drawn randomly from different areas of the city to enable a fair trial of each sample. One case study will be selected at random and analysed thoroughly based on ambient factors such as physical observations, floor plan, lighting and BREEAM/LEED rating systems. Questionnaire administration is also devised here to have insight based on personal, socioeconomic income and expenditure and finally analysing the green building features and user's perception based on comfort and maintenance cost.

3. 6 Data analysis

Descriptive statistical data analysis was adopted because it is the best method of achieving the objectives of this research. Several computer applications will be used in

this research because it is invariable impossible to conduct the research and finish within the stipulated time without these computer software applications. This software includes Statistical Package for Social Scientist (SPSS), Microsoft Excel and Word, MatLab and PowerPoint for creating shape-files, editing pictures and presentation slide preparations.

3. 7 Data presentation

The data analysed will be displayed by means of tables, charts, maps and photographs. The explanations of each data presented will follow beneath it.

3.8 Study Area

The people surrounding villages in Kano state mostly practice subsistence agriculture. Kano is one of the 36 states of Nigeria which is the highest populated state in Nigeria and economically, Kano is called the Centre of Commerce, due to commercial activities going on all over the state. The vegetation of Kano state is Sudan Savannah with traces of Guinea Savannah towards the southern part of the state in the border with Kaduna and Bauchi states (Iloeje, 2001). The northern and eastern parts of the state are typically Sudan savannah. Kano is located in the northwestern part of Nigeria, created on May 27, 1967, by former Military Head of State Yakubu Gowon. Kano state shares boundaries Kaduna State to the south-west, Bauchi State to the south-east Jigawa State to the north-east and Katsina State to the north-west.

Table 3. 3: Information about the study area

s/n	KANO	FIGURE
1	Density	470 People/km^2
2	Coordinates	11°30′00”N 08°30′00”E
3	Climate/Vegetation	Sudan Savannah
4	Duration of Rainfall	April-October
5	Maximum Temperature	35 to 40ºC
6	Total land coverage	20,131 km^2 (7,773 mi^2)

(2006 Census; Mortimore, 1989; World Bank, 2019 and United Nation, 2018).

Table 3.3 displays relevant information regarding the study area. Information like

density of 470 people per square kilometre shows how big the population is in a regular interval all over the state, coordinate 11°30′00”N 08°30′00”E can be used to locate Kano state on the map, vegetation or climate of the state is Sudan savannah, rainfall begins around April and ends in October with minimum temperature of <10ºC and a maximum of 40ºC, while the total land coverage of the state is 20,131 km^2 (7,773 mi^2).

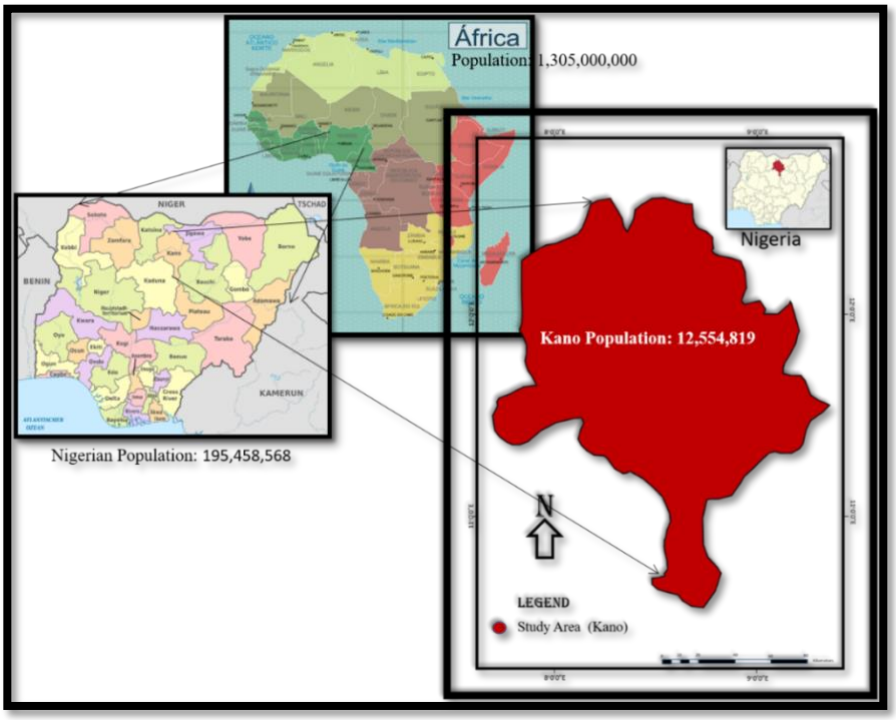

Figure 2: Study Area and Population (Census, 2006)

Fig. 2 displays map of the Kano state which is located in Nigerian map in African continent. The population of the entire African nation was presented in the map as 1,305,000,000. Nigerian population is about 195,458,568 people and Kano state has 12,554,819 people living in the state, which is why it was selected for this studies. The map is aligned to north at a remarkable scale depending on the focus of the study. Political boundaries were shown in African and Nigerian maps to show the precise demarcation of the city selected in this study. However figure 3 shows a summary of the entire world’s population, Africa, West Africa, Nigeria and Kano state along with their percentages. While figure 4 displays the projected population of Nigeria (195,458,568) and Kano state 12,554,819, representing 6% of Nigerian population in 2019.

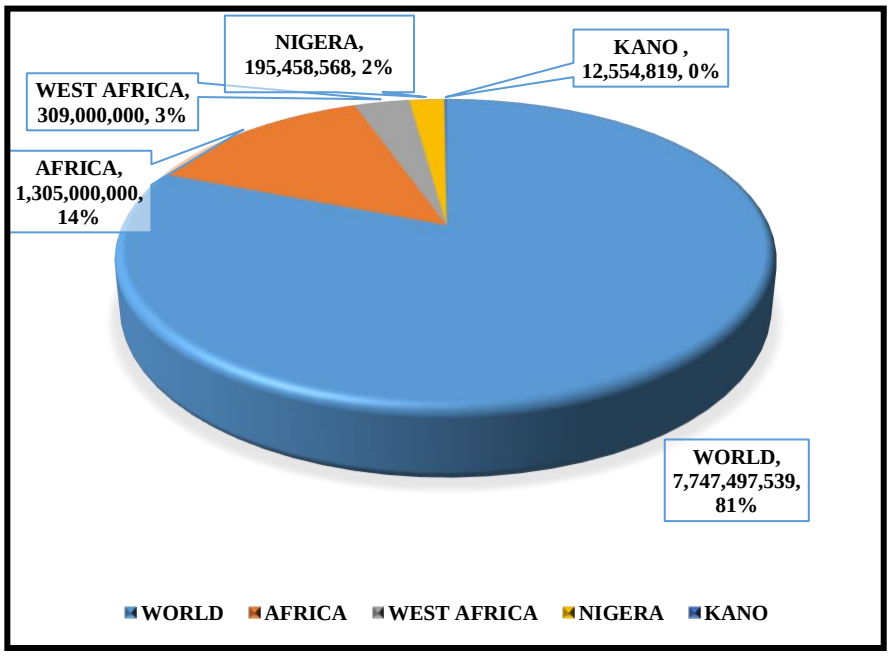

Figure 3: Summary of the Population Figures in 2006 (Census 2006)

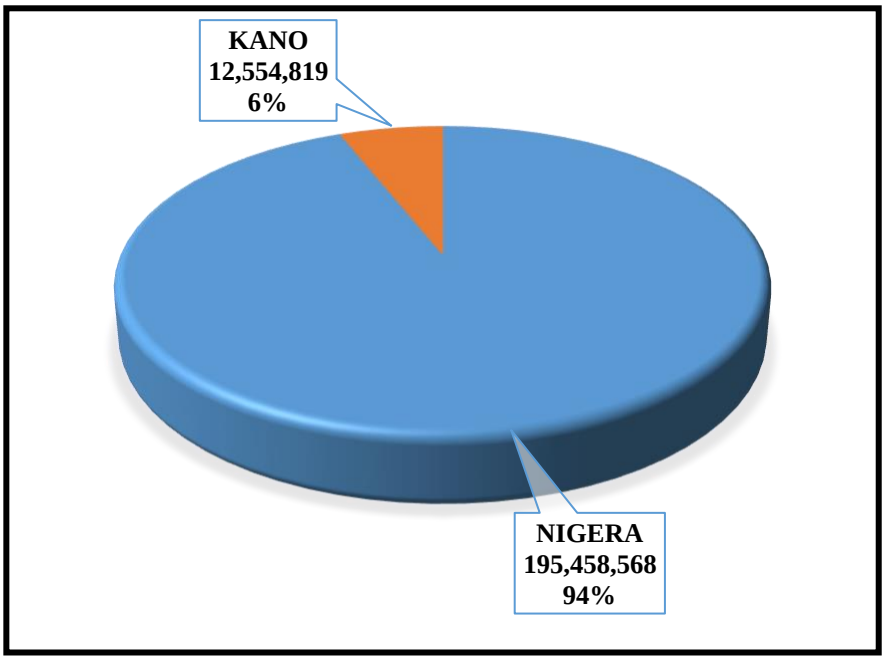

Figure 4: Projected Population Figures of Kano in comparison with the Nigerian population in 2019

Figure 5: Satellite View of the Study Area (scale 1:500m, aligned to north)

Table 3. 4: The Case Study

S/N	Parameter	Total Number
	The total number of building in Kano state	2,211,660
	The total number of building in Gwale Local Govt. Area	2,211,660
	The total number of green building (GB) in Gwale Ward	234 GB out of 251 samples

This table presents the total number of both green and non-green building in Gwale LGA, Kano state. The values presented here were estimations from the population census of 2006 which was conducted in Nigeria in ratio to the number of approved household size in the Federal Government of Nigeria. This was used to give precise green building sample size required to conduct this research. While the total number of 234 green building was determined using the questionnaire. Figure 5 shows the satellite image of the buildings that were examined as the study area chosen Gwale ward also known as Gwale Yan-Alewa quarters. Further research might be required to determine the total number of green building in Kano state.

3.9 The Case Study of a Green Building in Kano State

The criteria used in choosing the green building as a case study was done at a systematic

ways, these include privacy permission to access the building, the green features available in the building must be more than 50% in both BREAM/LEED certification and the building must be within the chosen study area. Although there are limited pieces of literature regarding green architectures in Kano state, there are several design elements of buildings in the Gwale Local Government district. The Tracking coordinates stated in the table below indicates the four pegs (*see table 3.5 & fig. 6 below*) in the parametric shape of the green environment, situated in the neighbourhood called Yan-Alawa quarters, found in Gwale ward of Gwale local government area of Kano state, Nigeria.

Table 3. 5: Coordinate Table of the Green Buildings' Location (Google Earth, 2020)

S/N	Pegs	Coordinate of the Building	
		N	E
1.	A	11°59'12.31"N	8°30'22.24"E
1.	B	11°59'12.45"N	8°30'22.55"E
2.	C	11°59'11.74"N	8°30'22.85"E
3.	D	11°59'11.61"N	8°30'22.34"E

Figure 6: The Demarcation of the Green Building on Google Earth software "satellite map" (Rectangular pegs A, B, C, D, and E) (Google Earth, 2020).

In the rectangular box of figure 6, there are coordinates displayed in Table 6 which are oriented to the north, with a map of 60 feet per centimetre, which equates to 18.29

meters per centimetre. A lake is located on the eastern side of the building and a path to the west faces the house. This building has undisclosed and insecure access to public electrical sources, while water pipes have since been connected with the principal public power supply pipes, but water has been seen in the area for years. The south portion of the house is attached to a nearby house with one wall only, but there is total protection and privacy since the two are not connected with the entry door. A strip of land caged with a cardboard metal wall is located in figure 6 from the northern part of the property. Both forms of winds in Nigeria are the winds from north-east to south-west, the wind from the northeast is typically cool, dry, and dusty, whereas the sun, high humidity, and rain come from the south-western winds. The building is configured in both locations to absorb winds and has interior cross ventilation.

Figure 7: Showing the arrangement of windows and solar shading red bricks in the green building in Gwale LGA, Kano (Field Survey, 2020).

At the top of this building are the overhead water tanks to provide water to the building using gravity force and which can be accessed using the metallic ladder at the left side of the building in Figure 7 above. These tanks were filled with water, which was supplied either with solar or public electricity by electric borehole water. The backyard, however still covers a lot in the building, including safeguarding, air circulating in the rooms, children's park, parking lot, leisure area, and protection. In the dry season, a north-east wind will reach this portion of the property.

Figure 8: The solar system installed in the green building (Field Survey, 2020).

The renewable energy panels on the top of the roof used for charging these 24 batteries have now been put in Figure 8. However, non-energetic, energy-efficient equipment such as electric heaters is not needed while the solar panel provides the building with power. This solar system will supply the building for about 24 hours.

Figure 9: Showing façade of the house in Gwale Yan-Alawa Kano (Field Survey, 2020).

However, windows contain a network to mitigate injection into the spaces, Figure 9 reveals the face of certain leaves, minimizing the effect of the sun and the wind in some

areas of the house. In the rainy season, the southwest breeze in this section of the building is probable.

Figure 10: Showing the corridor, the Inverter Air Conditioner, the solar shading bricks, windows and enough lighting during the day (Field Survey, 2020).

Compressor air conditioner: an electrical system transforming existing speed. Solar cell air conditioning. In addition to air conditioning (as shown in Figure 10), this apparatus was mounted in various domestic electronic devices, which control electrical voltage, frequency and current. While the inverter air conditioner sets the speed of the compressor and monitors the coolant (gas) flow rate such that the machine requires a minimum of electric energy and heat.

A B

Figure 11: A: Cross ventilation/light within the rooms B: Elaborating the control of light using thick curtain

(Source: Field Survey, 2020)

The existence of indoors, natural sunlight access, privacy, and safety bars in this building are demonstrated by Figures 11 A and B, but insecticides are still protected by a net covering the windows.

The following are the features of this green building:

1. Usage of solar energy in the house to produce electricity and energy-friendly equipment;
2. The supply of an upper reservoir with a water supply that runs through the pipe to the kitchen and the toilets inside the house;
3. The existence of interior cross-ventilation and sufficient lighting;
4. Included in the oxygen production compound with greenery;
5. Location of bricks with sun-screen to prevent early morning sunlight on the east side of the house;
6. Underground tank design for rainwater harvesting and, development;
7. Disposability of pit latrine and kitchen wastewater handling and treatment.

The challenge of public energy services in the Kano urban centre, along with the high problems associated with street sanitation and unsuitable waste management systems, this green building has significant importance in the building's capacity to supply most basic needs around its vicinity.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Data Collection

The data collection of this research was majorly done with a questionnaire which in this chapter, the 251 questionnaire responses were presented and analysed based on a descriptive approach. Most of the questions had a similar number of responses (251) from the respondents except the type of evaporative cooling system the building which has 24 responses. Due to religious restrictions, physical or personal observations within the interior parts of the houses were impossible, as most of the residents denied access to their private property. Therefore, most of the data were collected at the frontage of the buildings in Gwale neighbourhood.

4.2 Personal data

Age Range of the respondents

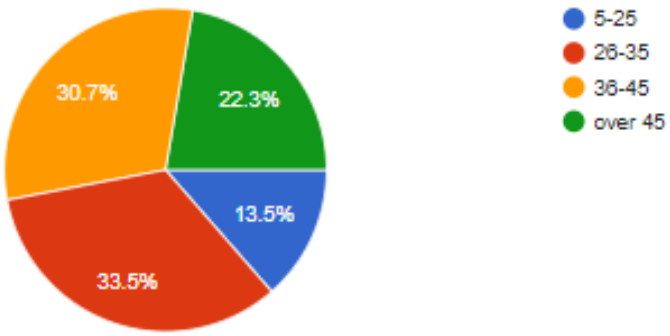

Figure 12: Displaying the various age groups of the respondents (251 responses)

Class 5-25 of the respondents were 13.5%, 26-35 has 33.5%, 36-45 has 3.7% and over 45 has 22.3% responses. This indicates that most of the respondents were between 26 to 35 years of age. However, this goes in line with the fact that Nigerian life span expectancy was approximately 54years (World Bank), looking at the record of over-45 years of age group is the least among all the age groups.

Gender

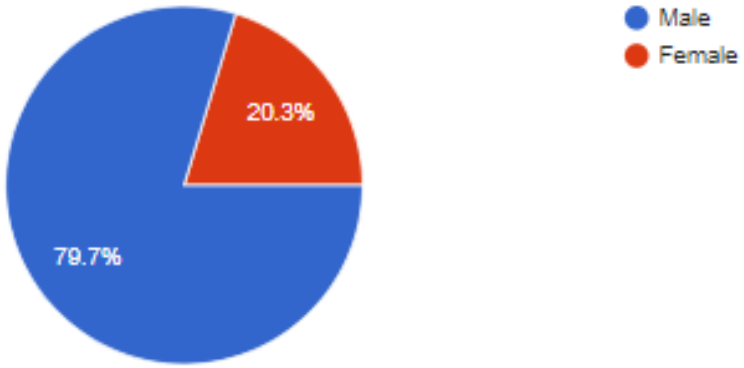

Figure 13: Gender of the respondents (251 responses)

In this fig. 13, 79.7% of the respondents were male and female were 20.3, this makes the majority of the respondents to be male. This is because in Hausa land (Northern Nigeria) has a religious and cultural belief that most women not to live alone, unless when she in some rare cases.

Education level:

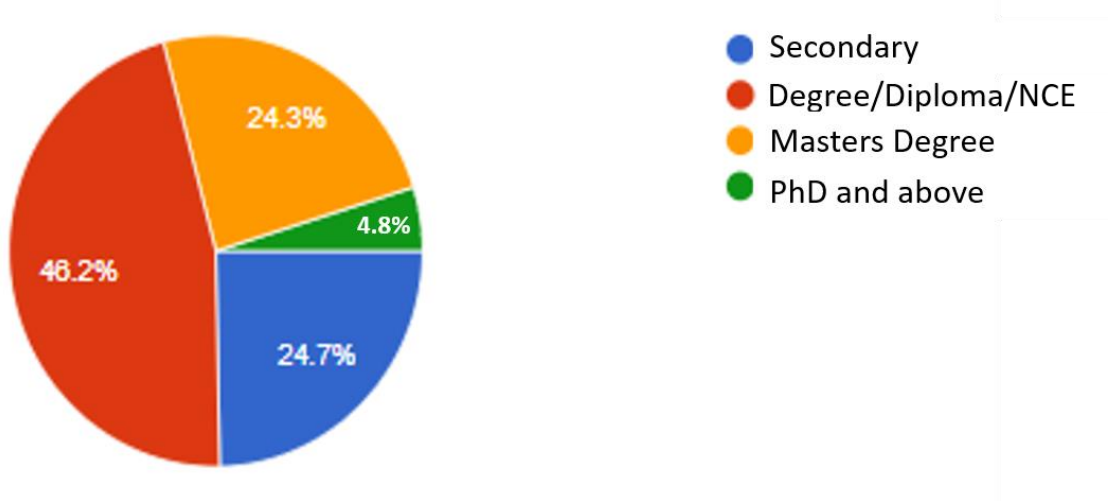

Figure 14: The Educational Level of the Respondents

The educational level of the respondents was presented in fig.14 which shows secondary school holders have 24.7%, higher institution like National Diploma ND, NCE and First Degree (B.Sc and B.tech) holders have 46.2%, Masters Degree (M.Sc. and M.Tech) holders have 24.3% and PhD. holders have 4.8%. This shows Degree/Diploma/NCE as the highest among other responses, this is because most of the

elderly and middle-class age group in the study area were educated and has at least a higher studies certificate.

Field of study;

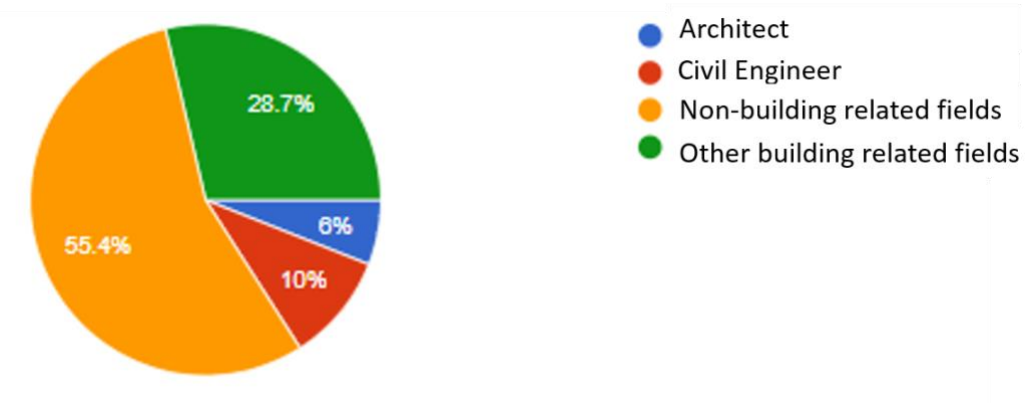

Figure 15: The Respondent's Field of Study

In this section, 6% of the total respondents were architect, civil engineers were 10%, other building-related field was 28.7% and non-building related field were 55.4%. This shows that non-building related fields were the majority with 55.4% of the total respondents in the study area. This is because most of the respondent were civil servants or merchants.

Nationality

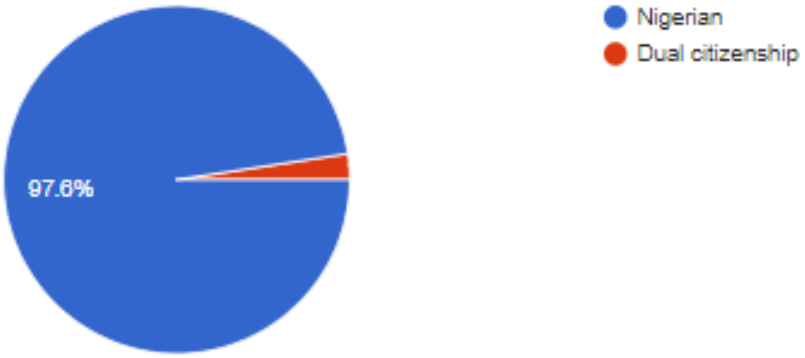

Figure 16: Nationality of the respondents

Almost all of the respondents were Nigerians with 97.6% and those that have other countries citizenship combined with Nigerian citizenship were 2.4% of the total household responses recorded in this research.

Marital status

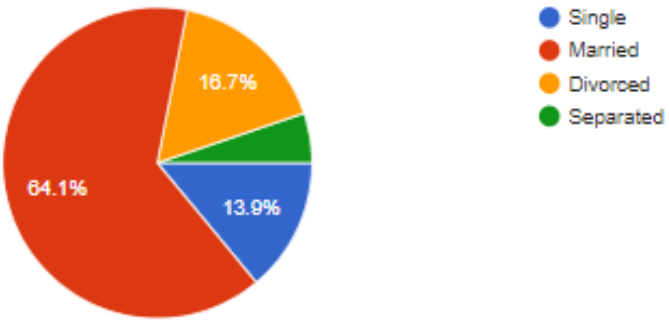

Figure 17: The marital status of the respondents

About 13.9% of the respondents were single and living alone in the house, 64.1% were married, divorced respondents were 16.7 and separated were 13.9%. This indicated that married respondents were the majority with 64.1%, this is because most of the respondents were family.

4.2 Socio-Economic Data

Occupation

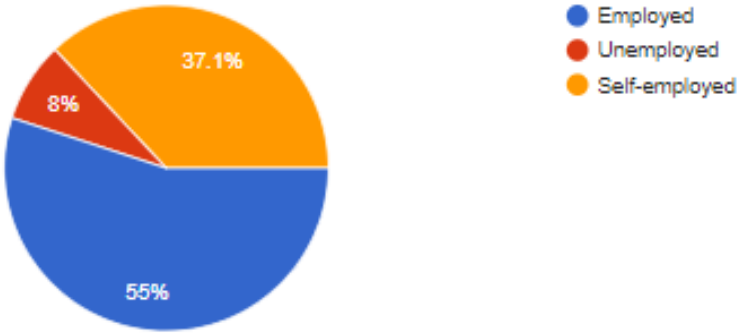

Figure 18: Occupation of the respondents

Most of the respondents were employed in this study area with about 55%, while unemployment and self-employed has 8% and 37.1% respectively. This indicates that most of the respondent either work for the government as civil servants or work under certain non-governmental organization or industries. Self-employed with 37.1% were mostly merchants and individuals who own small and medium enterprises SME's.

Ownership of dwelling unit

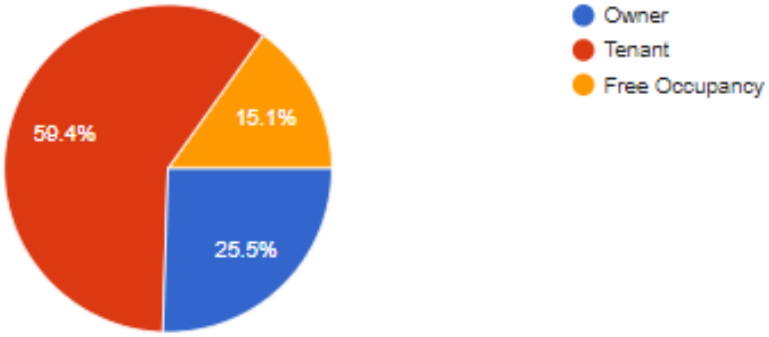

Figure 19: The ownership of the occupant's dwelling unit

Here only 25.5% of the respondents own their housing units, free occupancy had 15.1%, while tenants had the highest responses with 59.4% of the total questionnaire responses in the study area. This depicts that tenancy was majorly practised in Gwale ward of Gwale LGA.

Number of occupants in a dwelling unit (household);

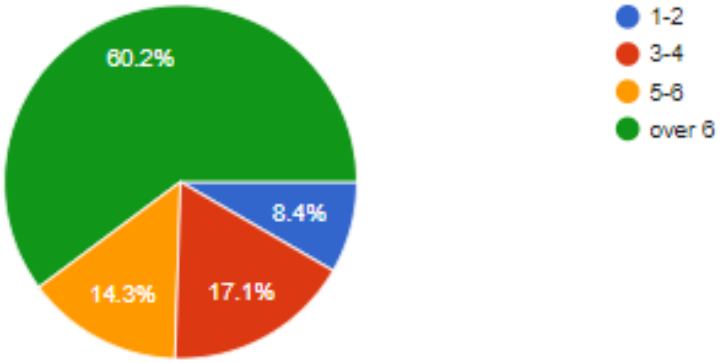

Figure 20: The class groups of household size in a dwelling unit

The first class is 1-2 persons which had 8.4% of the total responses, 3-4 persons per dwelling had 17.1%, 14.3% responses goes to 5-6 of the respondents. Most of the over 6 persons per dwelling unit had 60.2% responses, this explains why Kano have a very high population figure in Nigeria.

Monthly income range (Naira N);

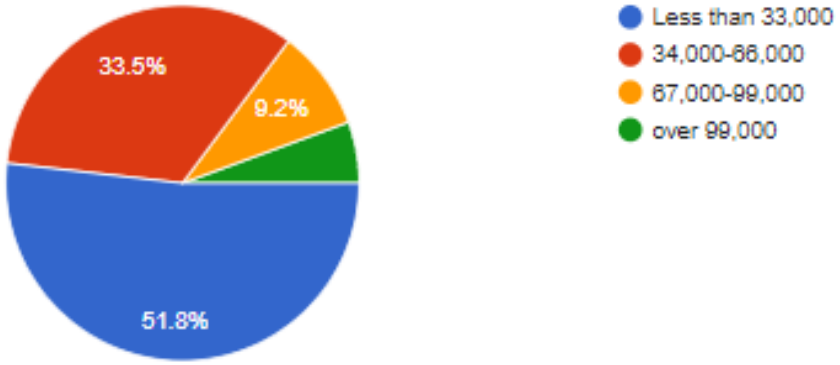

Figure 21: The income-earning range of the respondents monthly in Naira (₦)

The income group 34,000-66,000₦ has 33.5% responses as shown in fig.21, 67,000-99,000₦ had 9.2 responses, over 99,000N income group had the least responses of 5.6%. While the majority of the respondent here earn below 33,000₦ wage with 51.8%, which 30,000 naira was the minimum wage officially approved by the Federal Government of Nigeria. This indicates the level of poverty hardship in the study area.

Monthly expenditure (Naira N);

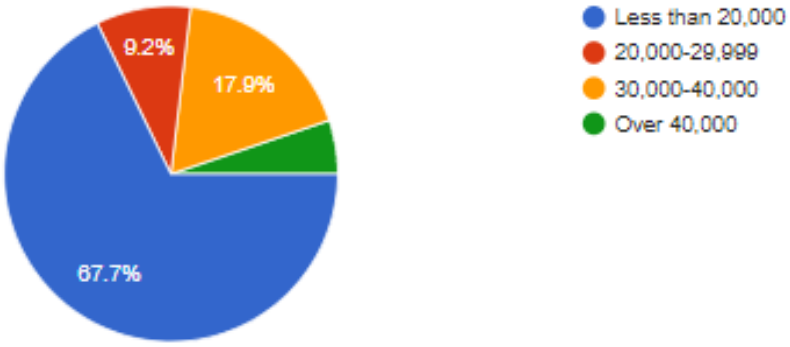

Figure 22: Average monthly expenses in the study area

Fig.22 shows a total of 30 days average spending on basic needs by the respondents examined using the questionnaire in this research. Less than 20,000₦ class has a total response of 67.7%, 20,000-29,999₦ has 9.2%, the 30,000-40,000₦ class has 17.9% and over 40,000₦ has the least percentage among them with 5.2% of the total responses. This is obvious considering the income rate in fig.22 is below 33,000₦ wage the expenditure also has to be within the total earnings of the respondents.

Monthly expenditure on water and energy;

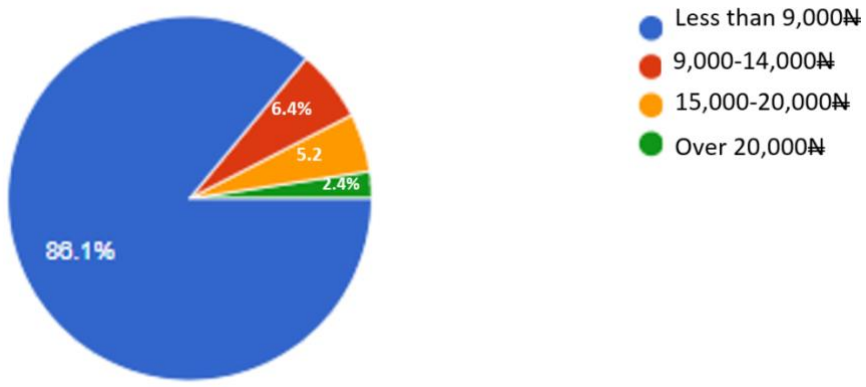

Figure 23: The monthly expenditure on water and energy of the respondents

This question was asked in order to determine the amount the residents around spends on water and energy in relation to bill and energy saving in both cooking and electric source. The responses of less than 9,000N group were 86.1%, the 9,000-14,000₦ class is 6.4%, the 15,000-20,000₦ class is 5.2% and lastly over 20,000₦ has the least response of 2.4%. The highest responses recorded here is less than 9,000₦ expenditure on both water bill, heating source, electric bill and any other related domestic energy need. This is because most of the houses use energy-saving bulbs and at least has a 'Well' for fetching water used in domestic activities. Though the water from the well is hard-water, most of the residents still buy water from local water vendors called 'Dan-Ga-Ruwa', which in most cases the water from Dan-Ga-Ruwa is portable.

Monthly expenditure on house maintenance and renovation;

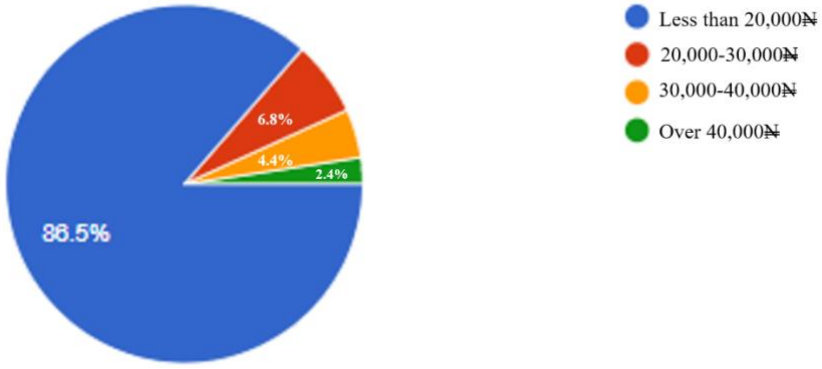

Figure 24; The current monthly expenses on house renovation and maintenance

The figure above (fig.24) shows records based on monthly expenditures on house

maintenance and renovation. The first option (i.e. less than 20,000₦) has the highest record of 86.5%, the second option (i.e. 20,000-30,000₦) has a record of 6.8%, the third option (i.e. 30,000-40,000) has 4.4%, while the last option (i.e. over 40,000) has the least record of 2.4% among them. This indicates that the building around the study area requires less than 20,000₦ cost on the overall building maintenance and renovation monthly.

4.4 Green Building

Green Building Awareness?

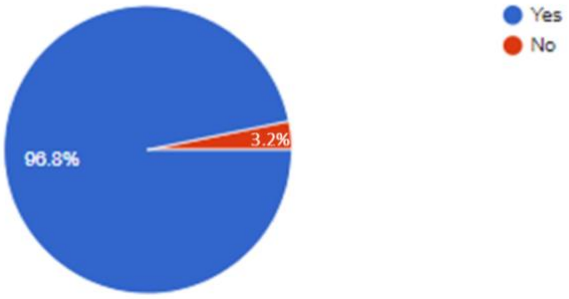

Figure 25: Awareness of Green Building technology

This question in the pie chart above (see fig.25) present the awareness rate of the residents in the study area. There is a high awareness of about 96.8% of the total responses from the residents of this locality. While on the other hand, those who were not aware of the green building were just 3.2%. However, this question answered the first objective of this research work.

Availability of Green Building Features per Dwelling

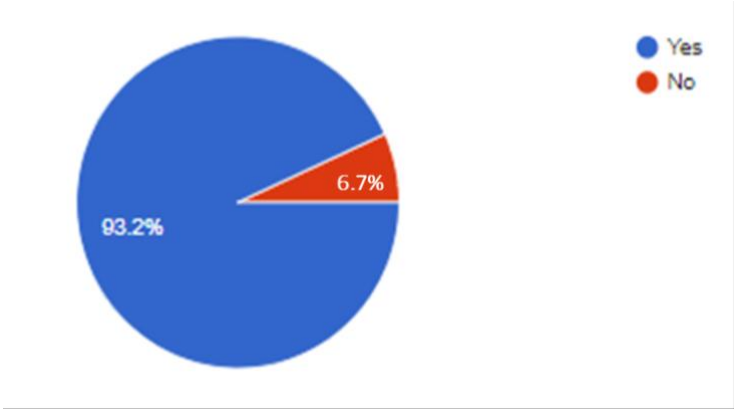

Figure 26: Availability of Green Building features

The researcher tries to examine each dwelling unit for the availability of green building features by asking the households. The response received was “yes” of about 93.2% while those who say “no” 6.7%. The response gotten from the use of green building features was remarkable in the study area, which indicates that green building was long been practised in Kano state.

The number of rooms that are in the building

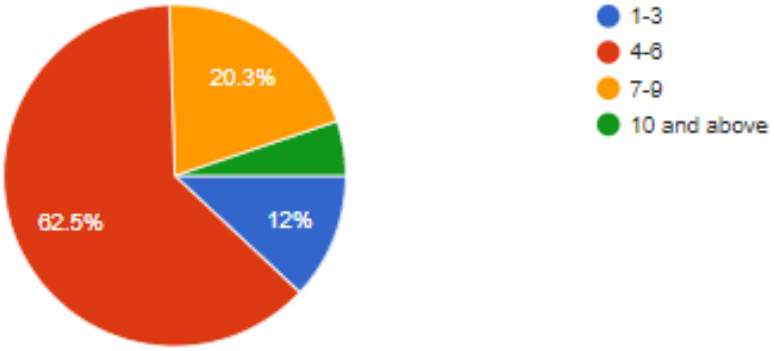

Figure 27: Number of rooms in the building

The number of was asked and the responses was 1-3 room dwelling was 12%, 4-6 rooms were 62.5%, 7-9 rooms were 20.3% and more than 10 rooms were 5.2%. This result shows that most of the houses were mainly within 4 to 6 rooms. This means that there is a remarkably high number of occupants in the buildings around the study, which might result in high water and energy demand to satisfy them.

Number of windows present per room

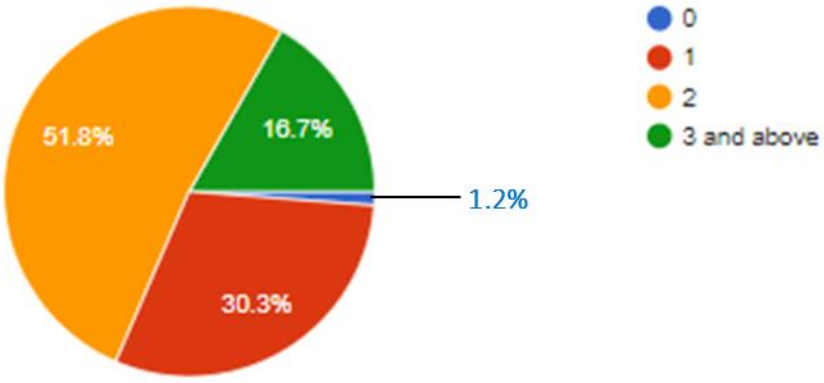

Figure 28: Number of windows are present per room

Those that say there is no window in their rooms at all were 1.2%, while those with only 1 window per room has 30.3%, those with two windows per room has 51.8% and 3 or more windows has 16.7% of the total questionnaire administered. Here most of the respondents use averagely 2 windows per room, which indicates cross-ventilation within the indoor environment.

The Overall windows in the whole building

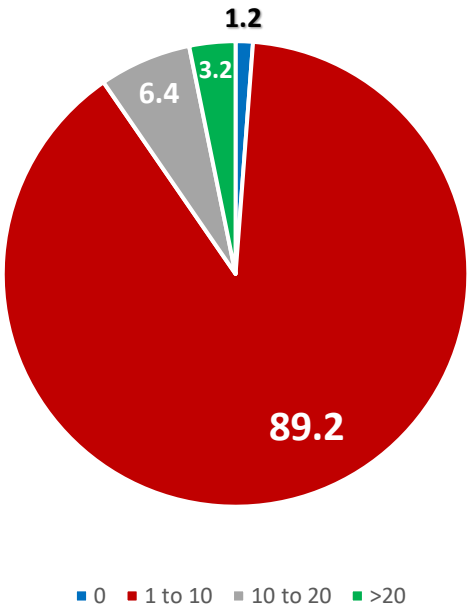

Figure 29: The number of windows in the whole building

This question (fig.29) is linked to the question before it (see fig.28), the individual windows in the house are counted and was recorded here. Houses with no window at all were 1.2% and houses with up to 10 windows 89.2%, 10-20 windows have 6.8%, and over 30% have 4.4%. most of the houses have about 10 windows in total.

The number of light bulbs in the building

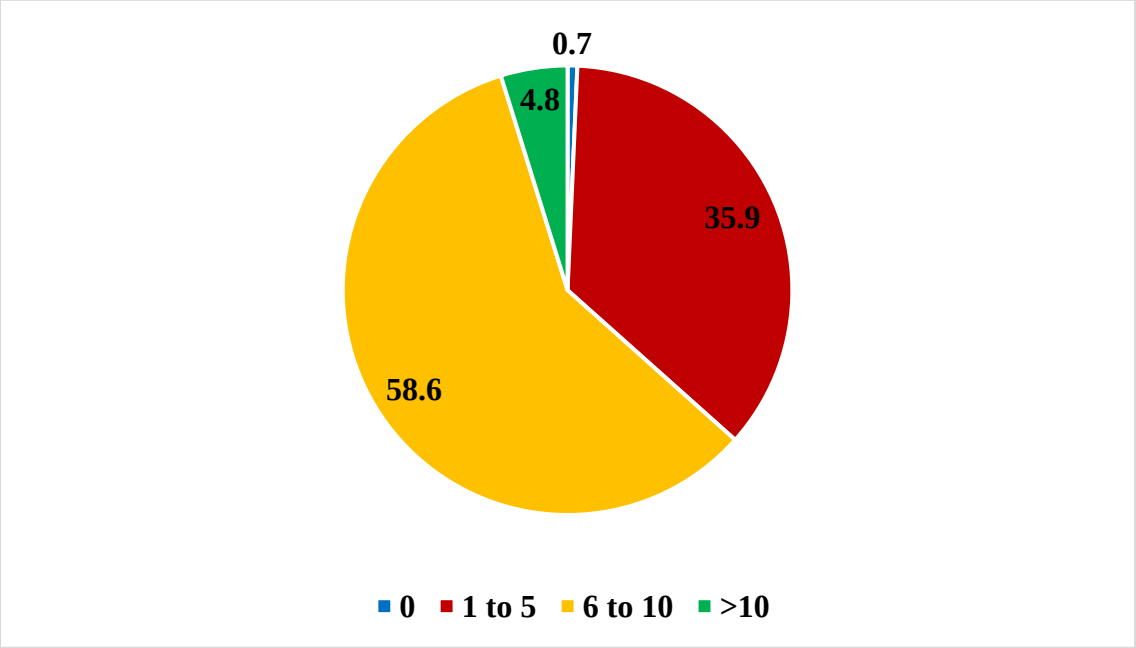

Figure 30: The number of light bulbs are there in the building

This question tries to examine the extent to which the building is energy-efficient. Responses that indicate 0 bulbs are 0.7%, while 1-5 option has 35.9% responses, 6-10 options has 58.6% responses and finally over 10bulb option has 4.8%. This indicates that the majority of the houses in the study area uses about 6 to 10 bulbs in their houses.

The number of electric fan in the building

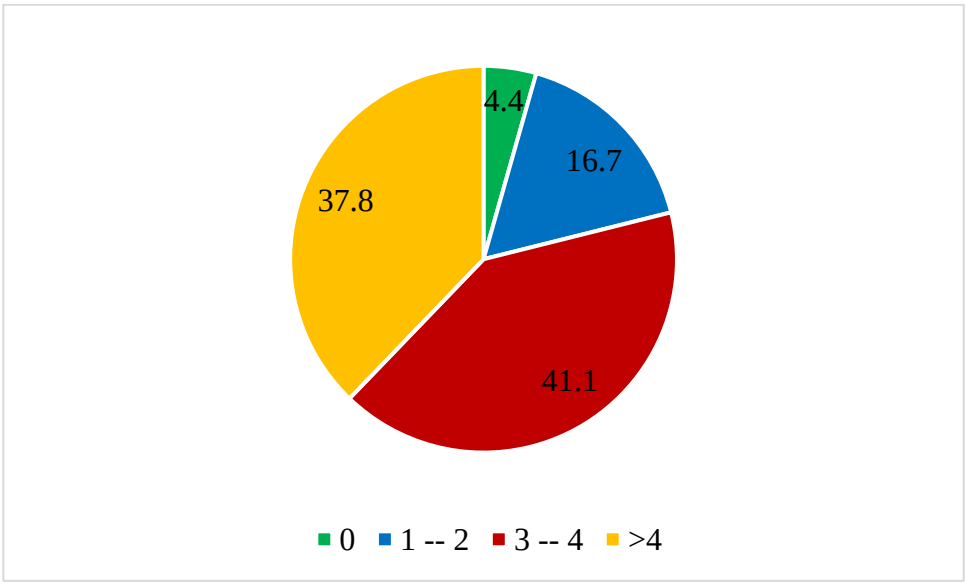

Figure 31: Number of electric fans in the building

Most of the houses in Nigeria uses either ceiling or standing fan to cool their room during the hot season. Those building that has no electric fan at all (0) were 4.4% responses, while 1-2 fans have 16.7% responses, buildings with 3-4 fans have 41% response and over 4 electric-fans has 37.8%. The majority of the houses has 3-4 electric fans in the house with. Therefore almost every house has at least one fan in the study area.

The number of television in the building

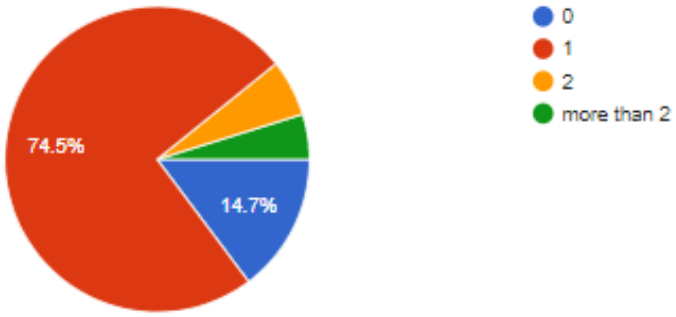

Figure 32: The number of televisions in the building

Here, houses that indicate 0 responses are 14.7%, houses with only one television have 74.5%, while a house with 2 and more than 2 televisions has 6% and 4.8% respectively. This result proves that most houses use only 1 television in their houses.

The number of Air Conditions in the building

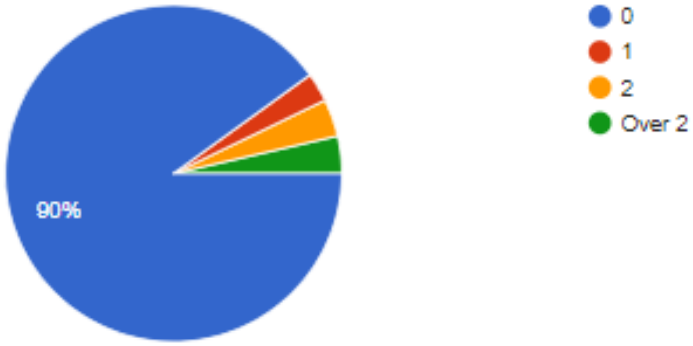

Figure 33: The number of air-conditions in the building

This question above in fig.33 indicates that most houses in the study area do not have air conditions installed with about 90% responses. Those that have 1, 2 and over 2 air-conditions in their houses are 2.8%, 3.6% and 3.6% respectively. This is because most

houses cannot afford to buy air-condition and pay the electric bills from using it.

The energy-saving appliance in the buildings

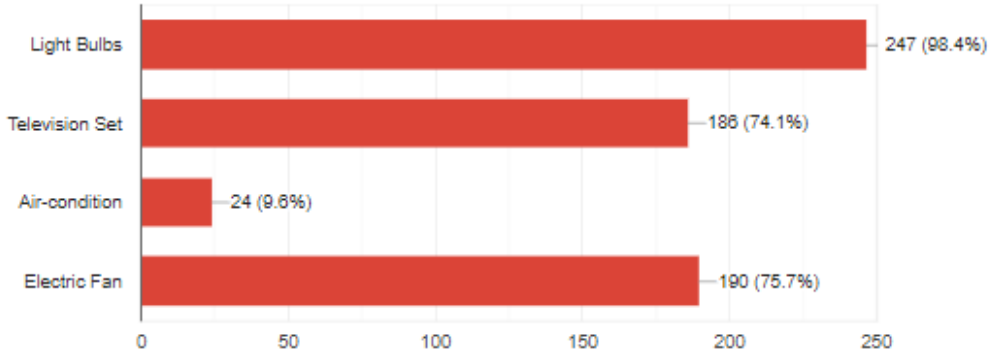

Figure 34: Which of the energy-saving appliance was recorded in the house?

Here the question is a multiple-choice question, whereby the respondent can choose more than one option. About 98.4% of the respondent uses energy-saving light bulbs in their houses, 74.1% chooses television sets, 9.6% said their air-condition is energy-saving, while 75.7% said they use an energy-saving electric fan. This is pointing at the direction of most of the households is heading toward green building techniques to save cost in electric bills.

The natural light intensity perception within in the rooms during the day

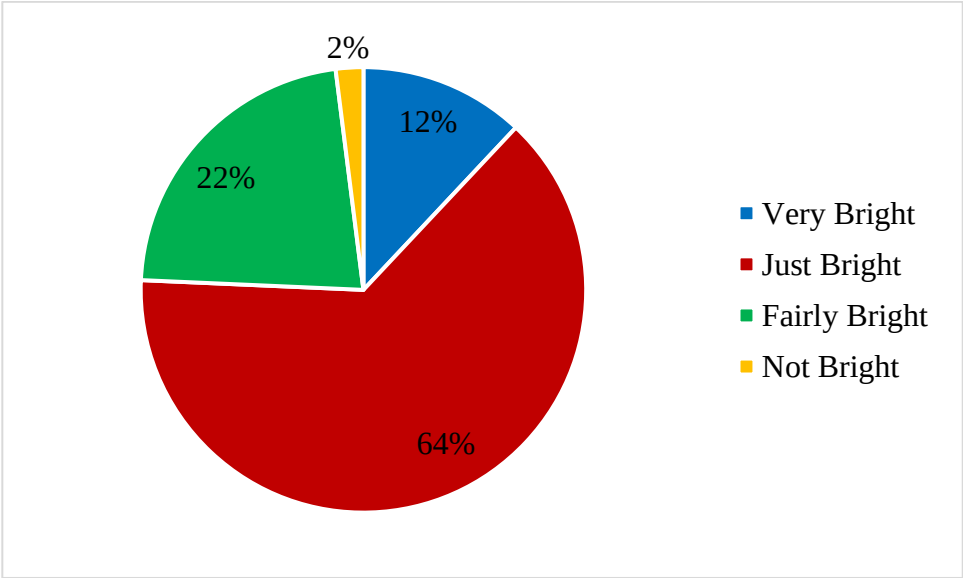

Figure 35: The natural light intensity in the rooms during the day

The natural light intensity was measured within the rooms during the day by asking the

users perception of the houses. Very bright has 12%, just bright has 63.7% fairly bright option has 22.3% while, not bright at all has 2% only. This indicates that most of the buildings in the study area do not need an electric bulb or firelight to see within the interior of their rooms during the day time between 7-6 pm (see fig.35).

Availability of a courtyard within the respondent's buildings

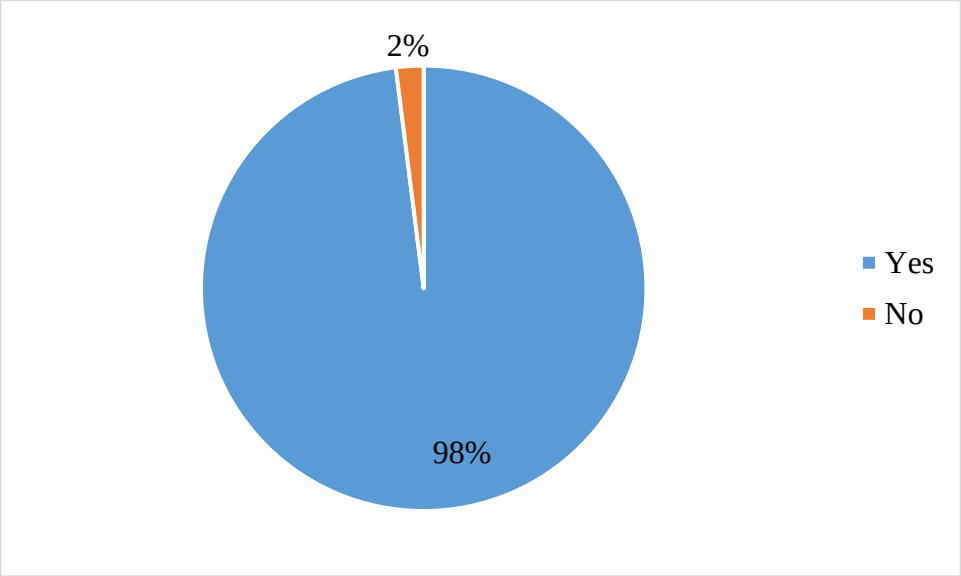

Figure 36: The Courtyard Availability in the Buildings

In this question, about 98% uses courtyard building type, while those building without courtyard is just 2%. This shows that most of the respondents are aware of the importance the courtyard serves in their building.

Is the interior environment thermally comfortable?

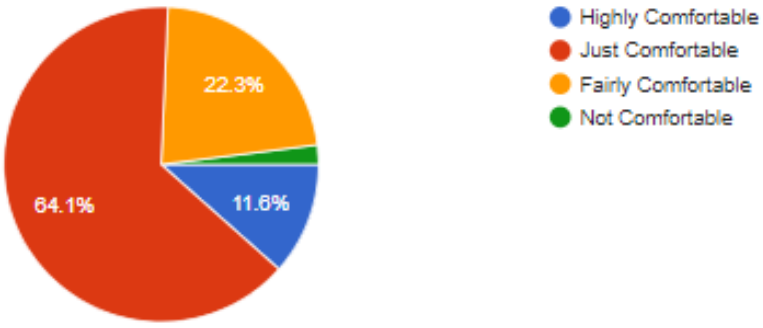

Figure 37: The thermal comfortability of the interior environment

The comfort perception of the interior parts of the respondent's houses thermally.

Highly comfortable has 11.6%, just comfortable has 64.1%, fairly comfortable has 22.3% and only 2% said they were not comfortable in their rooms. This indicates that most of the building's interior is comfortable, either by cross-ventilation within the rooms or the walls do not conduct the high temperature from the sun, or the use of ceiling fan or air-condition to cool down the temperature of their buildings.

The presence of the natural evaporative cooling system in the building

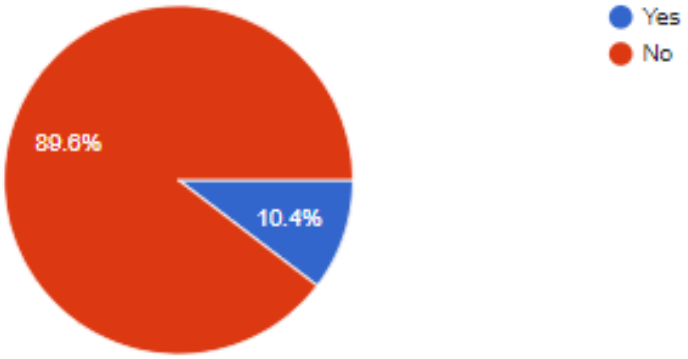

Figure 38: Availability of natural evaporative cooling system in the building

Most of the houses do not have an evaporative cooling system in the study area with about 89.6% responses. While those building that has evaporative cooling system 10.4% of the total responses. This means that majority of the building within the local case area has no evaporative cooling system.

The type of evaporative cooling system used in the building

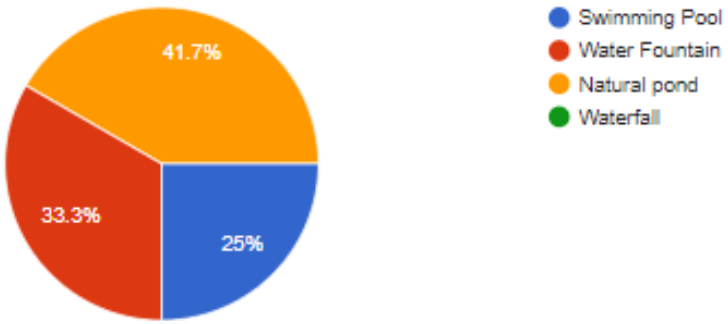

Figure 39: The evaporative cooling systems in the building

Among the 10.4% (a total of 24 respondents) that says they have a natural evaporative cooling system in fig.39 above, 25% of them says they have swimming pool 41.7% says water fountain, 33.3% says natural pond. The availability of two (2) natural pond in the

study area makes most the 24 respondents here choose it more than any other option.

The material used in the walls of the building

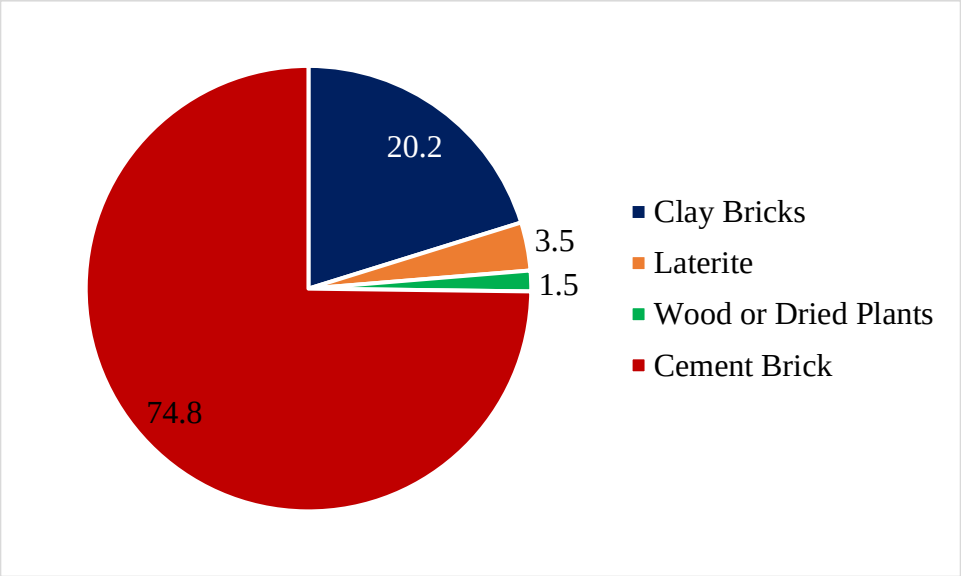

Figure 40: Existence of Different wall materials in the buildings

The houses that are made up of clay bricks have 20.2%, while, 3.2% and 1.6% chose wood or dried plants and laterite usage on the walls of the building. However, cement brick has the highest responses of about 74.9% of the overall responses.

The number of toilets in the building

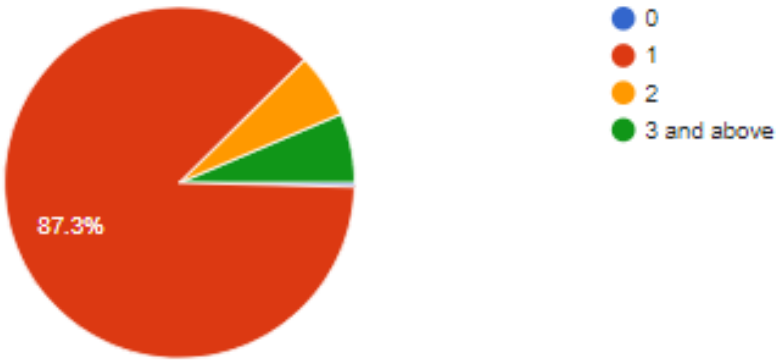

Figure 41: The number of toilets in the building

The number of toilets can be used to determine the water usage and maintenance in the house. There are 0.4% indicating no toilet in their house at all, which was only 1 house in the study area. While, houses with 1 toilet has the responses of 87.3% of the total responses, a house with 2 and more than 2 toilets has 6% and 6.4% respectively. Results

deduced that most building in Gwale ward uses mainly one (1) toilet in their houses.

The number of kitchens in the building

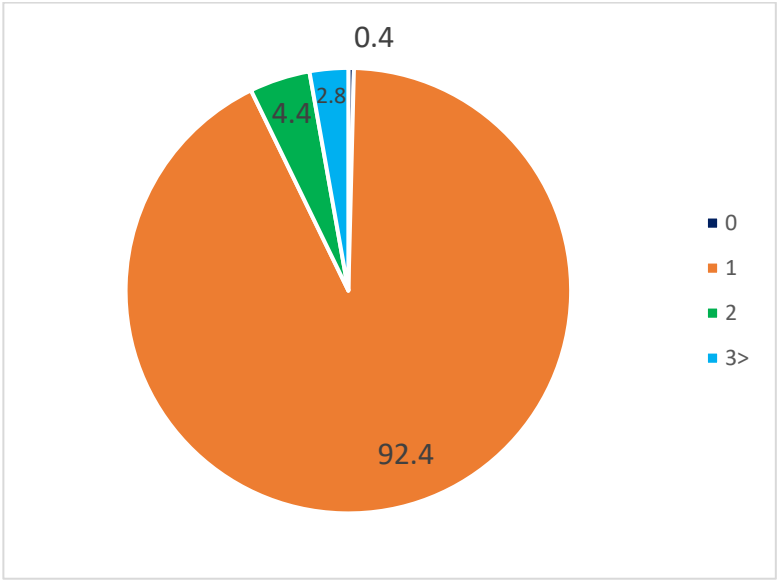

Figure 42: The number of kitchens in the building

Similarly, the number of kitchens here will determine the water and cooking energy use in the building. Only one (1) respondent says the house does not has any kitchen amounting to 0.4% which makes the least among all the options chosen. However, those having only 1 kitchen has about 92.4% which is the highest score among the entire options. While those having 2 and above 2 kitchens has 4.4% and 2.8% respectively. This is an indication that most respondents have mainly (1) kitchen in their respective houses. Some respondent choses more than one kitchen because they have firewood kitchen along with cooking gas or kerosene kitchens.

How is waste collection and disposal carried out in the building?

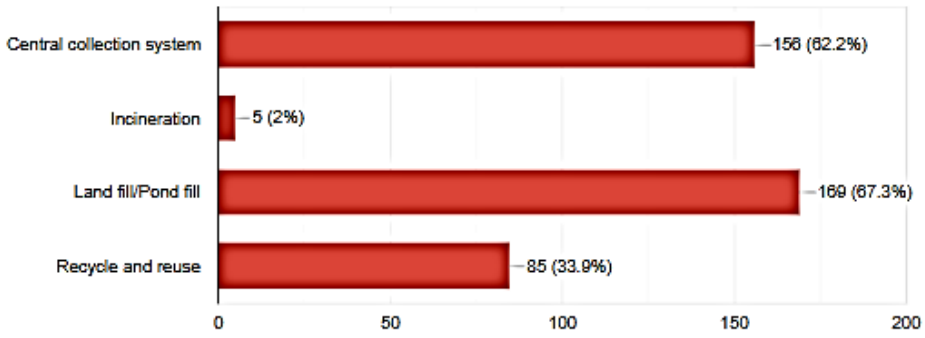

Figure 43: The waste collection and disposal systems

This question tries to determine the extent to which waste is disposed-off. It is also a multiple option question whereby respondents can select more than one choice. The responses 62.2% for the central collection system, incineration has only 2% as most houses don't engage in burning waste within the house, considering most of the domestic waste is wet and non-flammable. Land or pond fill has 67.3%, while, 33.9% were for recycling and reuse. This shows that most of the residents either dump their waste in the nearby land or pond (with 67.3%) to fill it or took their waste to the central collection point (with 6.2%). However, some houses reuse and recycle wastes (with 33.9%), while some even sold it to waste scavengers around the neighbourhood. Reuse and recycle is sustainable it therefore highly encouraged.

The electric energy sources installed in the building

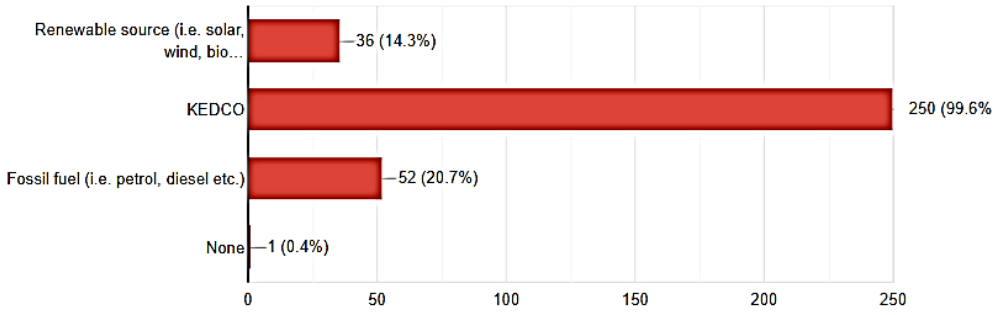

Figure 44: The electric energy sources in the buildings

Regarding electricity, the respondents chose 14.3% for renewable energy (i.e. the use of solar panels, wind turbines, or biodiesel), 99.3% KEDCO (Kano electric Distribution company, which is the public electric supply company), 20.7% fossil fuel in the process

of using combustion engines to generate electricity and those that chose none are 0.4%. This shows that majority of the respondents uses mainly KEDCO as a means of electric supply.

The cooking energy sources used in the building

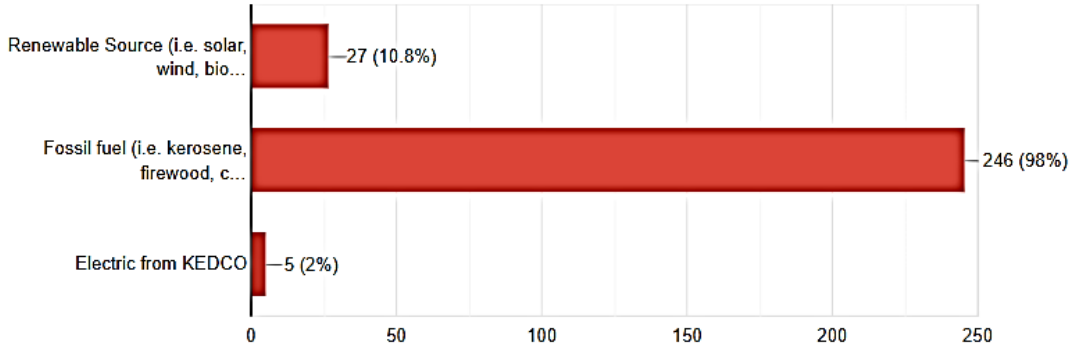

Figure 45: The cooking energy sources in the building

This question is very vital, looking at the cooking energy problems around the globe and sustainable issues that are related to it. However, this is also a multiple-choice question giving room to choose more than one option. Renewable sources have 10.8% of the total responses, while fossil fuel carries the highest response of 98% of the total sample examined and lastly electric from Kano Electric Distribution Company, KEDCO (the public electricity supply company) has only 2%. Because the public electricity supply KEDCO is not reliable and expensive most residents do not find it a better alternative for cooking food. However, the renewable energy sources were either not strong enough to support the electric cooking enamel stoves or they tend to be slow during the process of cooking. Also, most residents were not aware of the natural sun cookers and the new technology of methane gas flare, known as Jatropha Jelly (a biodiesel source) and meathane gas extracted from kitchen wastes or any form of organic matter. Therefore, the most common source they found cheap is fossil fuels like kerosene, firewood and common cooking gas (also known as Liquefied petroleum gas).

The water sources in the building.

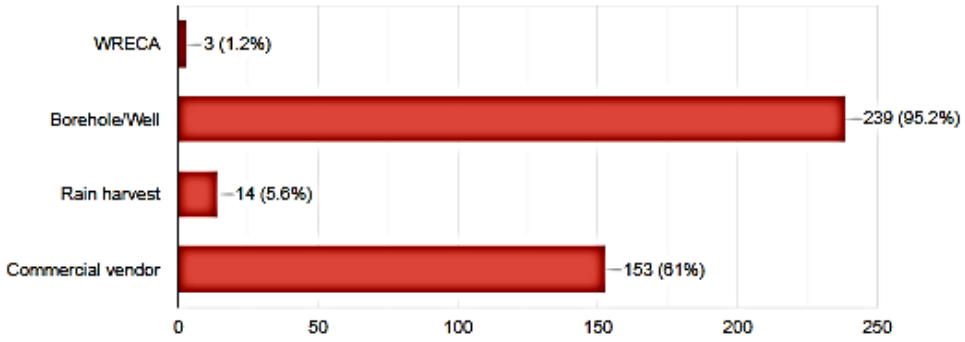

Figure 46: The water sources in the building

Fig.46 shows the response recorded from different respondents in the study area. Water Resources Engineering and Construction Agency (WRECA) has 1.2%, borehole and well has 95.2%, rain harvest has 5.6%, the commercial vendor has about 61% which makes it the second-highest water source used after borehole and well source. Public water supply problem from WRECA in most parts of Kano city was never a new issue. Therefore, most residents used the well or borehole water (which is usually hard water) in domestic sanitation and bathing, while the commercial vendor which is soft water is used in cooking and drinking.

Responses from building wall insulations.

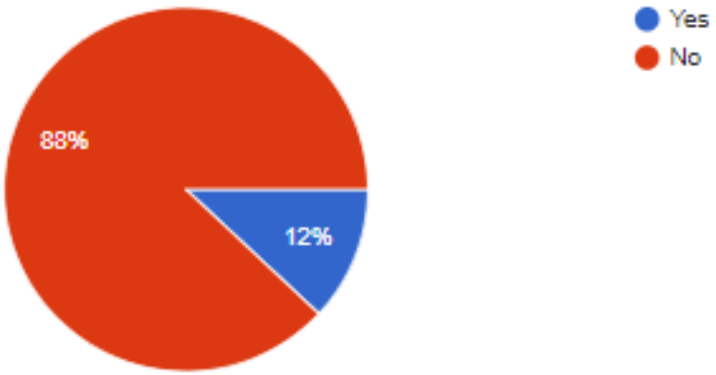

Figure 47: Insulation system availability in the walls of the building

In fig.47 88% of the respondents say that their building does not has wall insulation, while 12% indicates they have insulation in their walls. Therefore most of the building does not have wall insulation in the study area.

Is there any insulation system on the roof of the building?

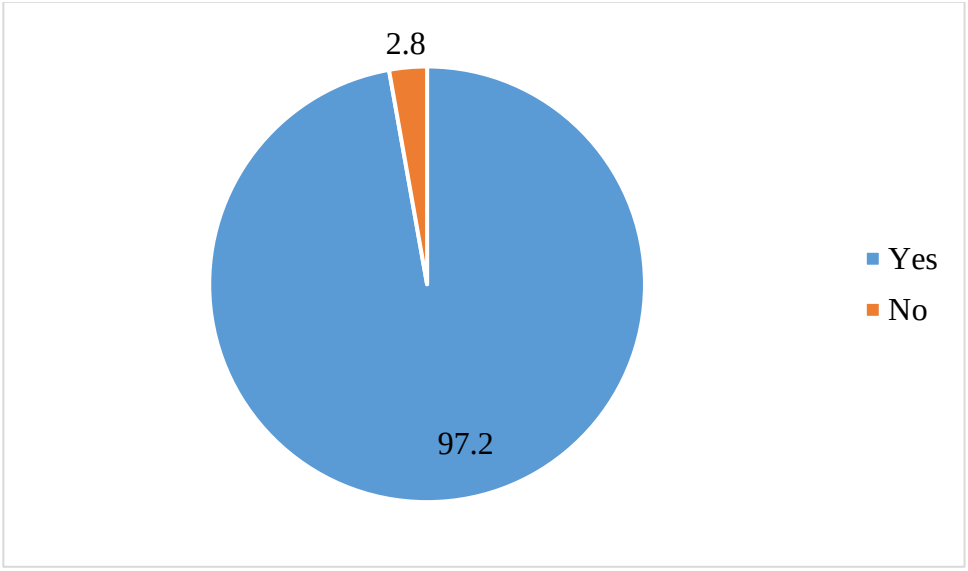

Figure 48: The insulation system availability on the roof of the building

Similarly, this question in fig.48 has 97.2 respondents who say that they have insulation in their roofs, while 2.8% says they do not have. This is because most of the respondents use the ceiling to insulate the heat from the roofing sheet used in covering the roof of the building.

Green Building Perception in Saving House Maintenance Cost

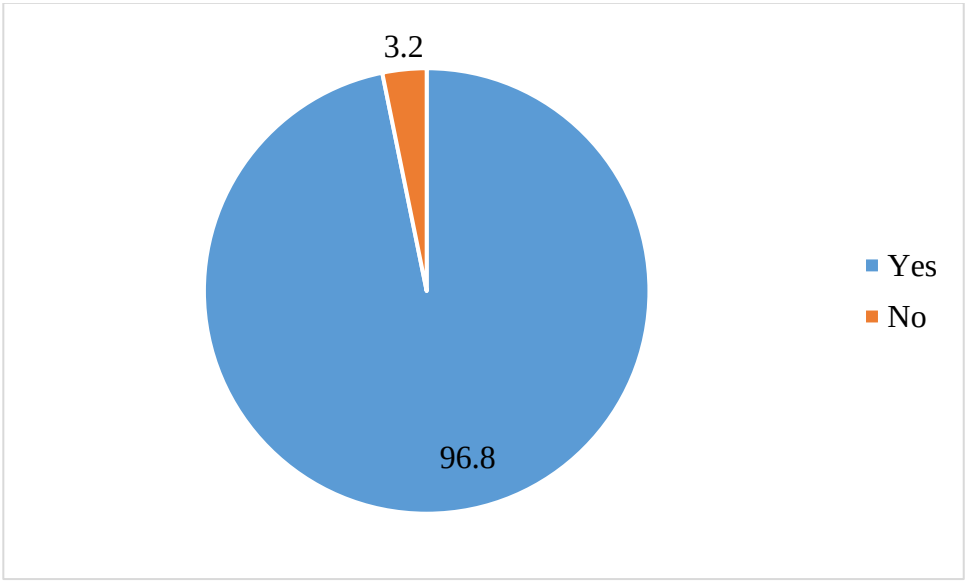

Figure 49: Does green building system helps saves cost in house bill and maintenance?

The response from this question is remarkable, looking at the fact almost all the respondents feels green building system helps them save cost in house bill and maintenance positively with about 96.8% responses. On the other hand, 3.2% of respondents feel it is not helping them in any way.

The general perception of the green building system satisfaction

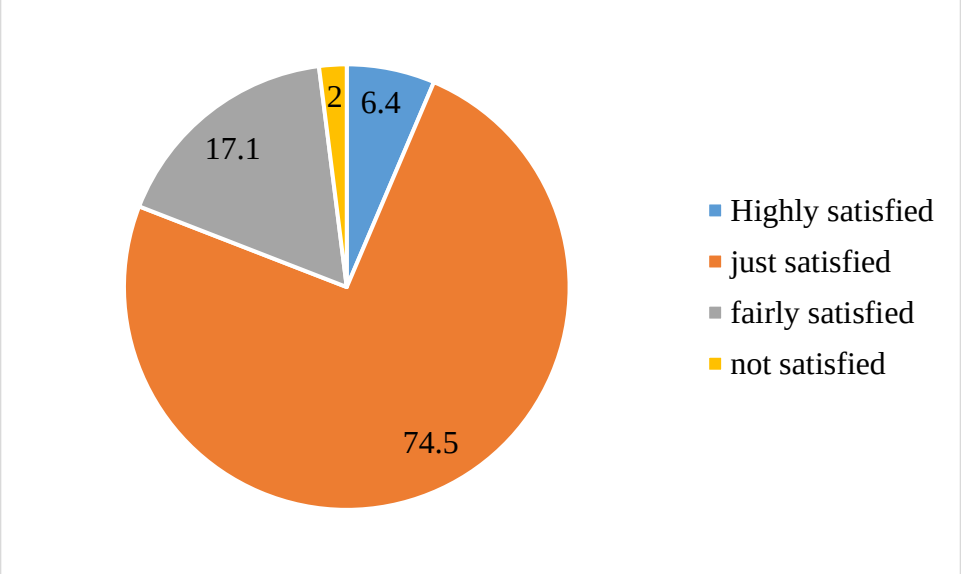

Figure 50: Generally how would you rate the satisfaction of your green building system (e.g. in terms of comfort, bill, maintenance and global warming)?

This is the last question in the questionnaire which will answer the 3rd objective of this study. Highly satisfied has 6.4%, just satisfied receives 74.5% responses, fairly satisfied has 17.1%, while not satisfied has 2%. This result shows that most of the resident in the study area who were using green building system was satisfied with the overall green building technology they have in their houses.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

In this research, the questionnaire has been examined and the results are summarized below

1. Most of the respondents were between 26 to 35 years of age;
2. The majority of the respondents were found to be male;
3. Results show that the highest qualification of the household heads is Degree/Diploma/NCE in the study area;
4. Most of the respondents were non-building related fields.
5. Almost all of the respondents were Nigerians
6. Most of the respondents were married;
7. Results indicate that most of the respondent employed or employers;
8. Results depict that tenancy was majorly practised in the area;
9. Most of the respondents were over 6 persons per dwelling unit,
10. The majority of the respondent here earn below 33,000₦ minimum wage;
11. The respondents mostly spend below 20,000₦ as monthly expenditure;
12. The respondents spend less than 9,000₦ monthly expenditure on both water and electric bill;
13. Most of the building around the study area requires less than 20,000₦ cost on the overall building maintenance and renovation monthly;
14. There is a very high awareness of green building system in this locality;
15. Results indicate that green building was long been practised in Kano state;
16. This result shows that most of the houses were mainly having 4 to 6 rooms;
17. There is cross-ventilation in most of the houses around the study area;
18. The overall houses have up to 10 windows total windows per dwelling unit;
19. The use 6 to 10 bulbs in the houses of this study area was commonly practised;
20. Almost every house has at least one fan in the study area;
21. This result proves that most houses use at least 1 television in their houses;
22. Most houses in the study area do not have air conditions installed;
23. About 98.4% of the respondent uses energy-saving light bulbs in their houses.

24. This indicates that most of the buildings in the study area do not need an electric bulb or firelight to see within the interior of their rooms during the day time between 6 am-6 pm;
25. Most of the respondents are aware of the importance the courtyard serves in their building;
26. The respondents also indicate that most of the building's interior is just comfortable,
27. Most of the houses do not have an evaporative cooling system in the study area
28. The availability of two (2) natural pond in the study area makes most the 24 respondents chose it;
29. Cement brick has the highest responses of about 74.9% of the overall responses.
30. Results deduced that most building in Gwale ward uses mainly one (1) toilet in their houses.
31. Most respondents have mainly one (1) kitchen in their respective houses.
32. Most of the residents use the central waste collection point or land/pond fill to dump waste produce;
33. Majority of the respondents uses mainly public supply (KEDCO) as a means of electric energy supply.
34. The most commonly used cooking source is fossil fuels like kerosene, cooking gas and firewood.
35. Most of the residents use the well or borehole water (which is usually hard water) in domestic sanitation and bathing, while the commercial vendor which is soft water is used in cooking and drinking.
36. Most of the building do not have wall insulation in the study area.
37. Almost all the respondents feel green building system helps them save cost in house bill and maintenance positively;
38. Most of the resident in the study area who were using green building system was satisfied with the overall green building technology they have in their houses.

5.2 Discussion

Majority of house owners and stakeholders invest less in green building around Kano state because awareness is lacking towards the implication of global warming in the

construction sector in both Kano and Nigeria in general. Similarly, S.Wilkinson, (2013) found that house owners and stakeholders both consider fewer measures of building construction sustainability and considers sustainability prospects not essential in the real estate market. The research was conducted around the Central Business District of a city called Melbourne located in Victoria, Australia. Clients, researchers and stakeholders, has to join efforts collectively to encourage practices of green building in the state. This will help reduce the greenhouse effects produced in Kano state. Similarly, Murtagh et al., (2016) specified some varieties of features, for example, national economy, legislation and market demands of the construction industry remained affected, likewise, individual's psychological decision-making and processes affect their taste of green building and influence the market sector. When comparing this with the current population condition in the state, it is experiencing minimal fiscal profit of green building market because of lack of demand from the clients and residents in Kano state. Similarly, the national legislation and government policy regulating the green construction development in Nigeria is also unsuccessful, thereby attracting individuals demands conventional building instead of green building. Some important guiding principle and measure should be introduced here to consider green building construction develop in Kano state. Intervention especially in socioeconomic conditions of the society can be put-in-place also towards the improvement of the green building construction and transformation by both the private (stakeholders and clients) and government organizations. Also both the internal and external drivers of green building can be possible to develop the situation of green building market in Kano state and Nigeria as whole.

5.3 Conclusion and Recommendations

5.3.1 Conclusion

In Nigeria, traces of green building features are seen among the houses in the past especially in Kano state, this corresponds with the high awareness rate of green building features in the city. Although most of the green buildings were shrinking in figures because of the introduction of modern contemporary architecture, most clients and architects prefer modern conventional building designs. Findings in this research reveal that there is extreme dependence on the unreliably public electric energy supply (also

known as KEDCO) contributed to the major power problems in Nigeria. Likewise, the case is worst when compared to the population of Kano state. Equally, most architects participate less in green building design in Kano, Nigeria; this why most of the buildings examined in this study do not have wall insulation, which protects the exchange of temperature with the outdoor environment. This further adds up to the overall environmental sustainability issues in the state. Conversely, majority of building construction companies in the country practise the consumption of high energy materials contents like concrete, steel, combustion engines etc. during construction, this lead to the high demand of energy during the construction process, therefore, the production of the high amount of construction waste, waste management efforts, hazards and global warming issue escalates.

Another discovery reveals that government policy regulations in building conservation, reduced cost of green building construction materials, green building program schemes, government incentives, green building marketing, the use of energy-saving appliances, awareness enlightenment and environmental protection are amongst the forefront elements of green building drivers. The drivers are further categorized into; property-level, corporate-level, individual-level, project-level and external drivers (Darko et al., 2017).

The building material price hike is linked to the construction materials importation in Nigeria. However, the majority of architects attempt to neglect the use of construction materials that are available locally and sustainable in Kano. The significance of using the local building materials was seen as a sustainable measure to reducing the cost of building construction materials, considering the point that most of these local building materials are cheap, readily available and sustainable. However, most of the local building materials are characterised with a short lifespan and minimal quality which will decrease the duration of the building, advance research is required to increase the quality these local building construction materials (Dwaikat & Ali, 2016).

Result in this thesis show that most of the respondents uses fossil fuels in cooking and warming the indoor environment, this is not sustainable as it causes air pollution, affect human health negatively, damage the nature surrounding us through deforestation to make firewood, extinction of both plant and animal along with their habitat destroyed. Even though most of the respondent that are using green building shows their utmost

satisfaction of it, more efforts are lacking in this regard to attain the sustainable goals ahead.

Finally, architects and stakeholders' design in selecting materials during the construction process, indoor ventilation and lighting, determination of water source, evaporative cooling system provision, refuse management were all insufficient and the absence of wall insulation is causing indoor-outdoor temperature exchange which leads to high energy demand to reach comfort zone in the buildings.

5.3.2 Recommendations

The holistic approach to sustainability may be considered in resolving many green construction sustainability issues. Socioeconomic status and environmental condition of the society is regarded as efforts of attaining sustainable development in a particular nation. Hence, Kano state and the Nigerian government should join efforts to implement this method to solve the green building problems in the nation. It is important to encourage architects, clients and stakeholders invest more in green building by educating them regarding the significance of the green building and include these green elements in their architectural designs. This may assist the society in acquiring an affordable and cheap green building and reviving the globe from harmful human activities. Similarly, the private stakeholders and government must gather efforts to emphasize the utilization of green features during building construction in the state, in order to profit from the numerous economical benefits of energy-saving, human sustainability and building maintenance.

The scarcity of electricity in the country is getting bigger every day because of excessive pressure on the public electric supply in the country, due to high population growth, rapid urbanization and many construction developments to provide shelter to the masses living in the state. Passive-houses was highly recommended here to solve these sustainability issues, through the use of energy-saving buildings built with materials found locally and cost-saving in both the finished and construction stages. These cost-savings can be informed of water or electricity bill, heating and cooling of the indoor environment. Finally, the housing policy review by the government regarding green building is highly recommended, enforcement of the utilization of local building materials in residential buildings, create more awareness movement to educate the public and encourage green construction through incentives provision to the people.

However, the government should provide enough central collection points and enhance the existing refuse management system in the state, land and ponds should not be used as sites for dumping waste, likewise, incineration should be discouraged, rather encourage recycle and reuse of the waste. Further research is recommend to determine the total number of green building in Kano state.

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APPENDICES

Appendix 1
Questionnaire

Hello! My name is Mukhtar Sabiu Yahuza, from Near East University, Cyprus. I am a masters student in the Depart of Architecture. I will be very happy if you can spare a few minutes to fill my questionnaire about Green or Sustainable Building, the information you provided here will be strictly used for academic purpose. Thank you

Building GPS Coordinates: _____N, _____E
Note: The Global Positioning System coordinate of the building should be like this e.g. 41°24'12.2"N 2°10'26.5"E, and can be found in Google Map on the internet browser or Google Earth software. Though, you can skip this question if it seems impossible to you.

Personal Information

1. Age range;
   a. 15-25 b. 26-35 c. 36-45 d. over 45
2. Education level;
   a. Secondary b. Degree (BSc) c. Master (M.Sc.) d. PhD and above
3. Field of study;
   a. Architecture b. Building c. Civil Engineer d. others _____
4. Nationality;
   a. Nigerian b. Dual citizenship c. others _____
5. Marital status;
   a. Married b. Single c. Divorced d. Separated
6. Occupation;
   a. Employed b. Unemployed c. Self-employed d. others_____

Socioeconomic Data:

1. Ownership of dwelling;
   a. Owned b. Tenant c. Free occupancy d. other _____

2. Number of occupants in dwelling unit
   a. 1-2 b. 3-4 c. 5-6 d. over 6
3. Monthly income range (Naira ~~₦~~);
   a. 33,000 b. 34,000-66,000 c. 67,000-99,000 d. over 99,000
4. Monthly expenditure (Naira ~~₦~~);
   a. Less than 20,000 b. 20,000-29,999 c. 30,000-40,000 d. Over 40,000
5. Monthly expenditure on water and energy;
   a. Less than 9,000 b. 9,000-14,000 c. 15,000-20,000 d. over 20,000
6. Monthly expenditure on house maintenance and renovation;
   a. Less than 20,000 b. 20,000-30,000 c. 30,000-40,000 d. above 40,000

Green Building:

1. Are you aware of Green Building technology? Yes ☐ or No ☐
2. Does your dwelling has Green Building features? Yes ☐ or No ☐
3. How many rooms are there in the building?
   a. 1-3 b. 4-6 c. 6-9 d. 10 and above
4. How many windows are present per rooms?
   a. 0 b. 1 c. 2 d. above 3
5. How many windows are there in the whole building?
   a. 0 b. 1-10 c. 11-20 over 20
6. How many light bulbs are there in the building?
   a. 0 b. 1-5 c. 6-10 d. above 10
7. How many ceiling fans are there in the building?
   a. 0 b. 1-5 c. 6-10 d. above 10
8. How many television are there in the building?
   a. 0 b. 1-5 c. 6-10 d. above 10
9. How many air conditions are there in the building?
   a. 0 b. 1-5 c. 6-10 d. above 10
10. Which of the following appliance is energy saving in the house? *(tick all that apply)*
    a. Light bulbs ☐ *b. Television Set* ☐ *c. Air-condition* ☐ *d. Electric fan* ☐
11. How do you rate the light intensity in the rooms?
    a. Very Bright b. Bright c. Fair d. Not Enough
12. Is there a courtyard in the building? *Yes* ☐ *or No* ☐
13. Is the interior environment thermally comfortable?
    a. Highly Comfortable b. Just Comfortable c. fair d. Not Comfortable
14. Is there a sun-shading in the building? *Yes* ☐ *or No* ☐
15. Is there an evaporative cooling system in the building? *Yes* ☐ *or No* ☐
16. If *yes* what type of evaporative cooling system used in the building?
    a. Swimming pool b. water fountain c. natural pond d. all of the above
17. How many toilets are there in the building?
    a. 0 b. 1 c. 2 d. 3 and above
18. How many kitchens are there in the building?
    a. 1 b. 2 c. 3 d. 4 and above
19. How is waste collection and disposal carried out in the building?
    a. Central collection system b. Incineration c. Landfill/Pond fill d. Recycle and reuse
20. What are the electric energy sources installed in the building? *(tick all that apply)*
    (Note: KEDCO means Kano Electric Distribution Company of Nigeria)
    a. Renewable source ☐ *b. KEDCO* ☐
    c. Fossil fuel ☐ *d. others* _____
21. What are the cooking energy sources used in the building? *(tick all that apply)*

a. Renewable Source ☐ *b. Fossil Fuel* ☐

c. KEDCO ☐ *d. others* _____

22. What are the water sources in the building? *(tick all that apply)*
(Note: WRECA means Water Resources & Engineering Construction Agency of Kano state, Nigeria)

a. WRECA ☐ *b. Borehole or well* ☐

c. Rain harvest ☐ *d. Commercial vendor* ☐

23. Is there any insulation system in the walls of the building? *Yes* ☐ *or No* ☐
24. Is there any insulation system on the roof of the building? *Yes* ☐ *or No* ☐
25. Does green building system help saves cost in house bill and maintenance? *Yes* ☐ *or No* ☐
26. Generally, how would you rate the satisfaction of your green building system (e.g.in terms of comfort, bill, maintenance and global warming)?
    a. Highly satisfied *b. Just satisfied* *c. Fairly satisfied* *d. Not satisfied*

Thanks for your time.

Appendix 2
Plagiarism Report

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