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Assessing the Design Elements for a Sustainable Neighbourhood: A Case Study of Talba Housing Estate Minna, Nigeria

John Augustine Buwah
Research Officer, Department of Building Research,
Nigerian Building and Road Research Institute, Nigeria
Mohammad Abubakar Sadiq
Research Officer, Department of Building Research,
Nigerian Building and Road Research Institute, Nigeria
Shuaibu Onoze Abdullahi
Research Officer, Department of Building Research,
Nigerian Building and Road Research Institute, Nigeria
Akilu Aliyu
Research Officer, Department of Building Research,
Nigerian Building and Road Research Institute, Nigeria

Abstract:
Urbanization and increase in population have led to an upsurge demand for sustainable and environmentally friendly neighbourhoods, these designs include a variety of aspects that increase resource efficiency, mitigate environmental impacts, improve quality of life, and encourage community interaction. The study focuses on identifying and analysing the various design aspects implemented within the housing estate in order to evaluate their effectiveness in promoting sustainability. By examining features such as accessibility, infrastructure, green spaces, energy efficiency, and waste management, the research evaluates the delivery and impact of sustainable design in Talba housing estate. The study employs a mixed-methods approach, combining qualitative interviews, observations, and quantitative analysis to gather comprehensive data. The findings of this case study will contribute to a broader understanding of the importance and implications of design elements for establishing sustainable neighbourhoods, thereby offering valuable insights for urban planners, policymakers, and housing developers in their pursuit of creating environmentally friendly and resilient communities.

Keywords: *Urbanization, sustainability, population, infrastructure*

1. Background to the Study

1.1. Introduction

Urbanization and population growth have led to an increasing demand for sustainable and environmentally friendly neighbourhoods. The design of a sustainable neighbourhood encompasses various elements that promote resource efficiency, reduce environmental impacts, enhance quality of life, and foster community engagement (Steven Jige Quan, 2019).

The need for sustainable neighbourhood design arises from the urgency to address pressing environmental challenges such as climate change, depletion of natural resources, and pollution (UN-Habitat/Shan Zheng 2015). Traditional urban development practices often prioritize short-term economic gains at the expense of long-term sustainability. However, sustainable neighbourhood design attempts to create a balance between economic viability, social equity, and environmental responsibility (Ivan Turok & Gordon, M., 2013).

In Egypt, the expansion of urban limits owing to urban sprawl and population increase is a serious issue, resulting in the construction of communities to accommodate a high number of people with little green space in compacted built-up regions. These neighbourhoods also lack sufficient pedestrian infrastructure and green buildings, which contributes to excessive energy usage (Gihan Mossad et al.).

Talba Housing Estate in Minna provides an ideal case study due to its significance as a residential development with considerable potential for sustainable design implementation. By analyzing and evaluating the design elements of Talba Housing Estate, this research aims to identify successful strategies that contribute to sustainability while also taking into consideration the unique social, economic, and geographical characteristics of the area.

Some key design elements that will be investigated include energy-efficient building design, green spaces and landscaping, pedestrian-friendly infrastructure, waste management systems, water conservation, and community participation. By assessing the effectiveness of these design elements in Talba Housing Estate, valuable insights can be gained to inform sustainable neighbourhood development in similar contexts.

The outcomes of this research will not only contribute to theoretical knowledge in the field of sustainable urban planning and design but also offer practical recommendations and guidelines for policymakers, urban planners, architects, and developers involved in creating sustainable neighbourhoods. Ultimately, the aim is to assess the design elements of the case study area with a view to creating a blueprint for sustainable neighbourhood design that can be replicated and adapted to different contexts, with the potential to address the challenges posed by rapid urbanization and promote a more sustainable and resilient future.

1.2. Statement of Research Problem

The peculiar problems of neighbourhood Estate noise, traffic, vandalism, and trash on the streets represent potential indicators of physical decay and/or social disorder.

2. Research Methodology

This chapter involves the description of the procedures that will be used in the collection, presentation and analysis of data that will be collected from the field.

2.1. Research Design

For the purpose of this study, the survey method will be adopted because it involves collecting data and information necessary for the research work. It will be accomplished via interview, physical observation, and the use of a questionnaire oral interview.

2.2. Population and Sampling Technique

Population is the total of the number constituting the target group defined by the objectives of the study. In this regard, the population for this study will be the total number of people who visit the park.

For the purpose of this project, three residential neighbourhoods in Minna that are classified as High (1, 2, and 3 quarters located opposite the old state secretariat road), low (commissioner's quarters known as type A quarters), and medium (Zarumai Quarters known as the type B quarters) densities will be administered with questionnaires to fill.

Sampling is a process by which an element of the target population is selected to find out something about them to know something about the whole population. Moreover, in this study, a random sampling method will be used for the high-density neighbourhood, while a 100% survey will be done for every other residential neighbourhood.

2.3. Method of Data Collection

The data relevant to this study will be collected by administration of questionnaires. Also, photographs will be taken during observation. The plate will be made available in this report.

2.3.1. Materials/Instruments for Data Collection

The various materials and instruments that will be used to collect data from the field include the following:

- Field Observation: This refers to the circumstances of being in or around an ongoing social setting for the purpose of making a quantitative analysis of the setting.
- Questionnaire: A questionnaire is a set of questions prepared and distributed to the respondents for completion by them (Fapounda, 1983 and Stacy, 1969).
- Oral Interview: This refers to unstructured and open-ended answers a respondent is allowed to give in response to a question. Under this technique, it is more difficult to process information in the electronic medium than the questionnaire or the research schedule.
- Photographic element: This refers to a photograph of the area of study using the geo satellite image of Nigeria (Google Earth).

2.3.2. Procedure for Collection of Data

The procedure for collecting data will include the following:

- Primary Data: This involves generating fresh data from sites by the plan maker himself. This is usually done through the use of questionnaires, research schedules, observation and controlled experimentation, interviews and the use of electronic and photographic equipment.
- Secondary Data: This refers to data already collected, processed, analysed, and sometimes interpreted and reconstructed by other researchers, either in the site or other sites. Usually, they are presented in tables, diagrams, figures, charts, textbooks, monographs, reports, and information from newspapers; electronic media belong to this category.

2.3.3. Methods of Data Analysis

The method of data analysis will be descriptive statistical tables and the use of simple charts, e.g., bar charts, histograms, etc. This is so because data analysed in tables and charts give precise information and ensure quicker understanding.

2.3.4. Data Presentation

The presentation of data will be in tables, Frequency tables, cumulative frequency, pie-charts and bar charts. It explicitly explains the data.

3. Data Analysis of the Existing Situation

This chapter tends to analyse the existing condition of residential behaviour of selected neighbourhood within Niger state. In this chapter, the data will be properly ordered and broken down into constituent parts. The results of these inferences pertinent to the research relations (occupants) will be made and a conclusion about the relation will be drawn approximately.

In order to facilitate the data collection process, a method of administering questionnaires was adopted. Ninety (90) questionnaires were administered. Out of them, fifty (50) were administered to randomly selected respondents within the 1, 2, and 3 quarters along old secretariat roads; twenty (20) were administered to the type A quarters (commissioner's quarters) and another twenty were administered to the type B quarters (Zarumai quarters). All the variables determining the status of the respondents and the general facilities and infrastructural conditions have been collected and analysed and shown in tables and charts.

3.1. Data Analysis

In the area designed for this research work. 90 respondents responded to the questionnaire. Socio-economic characteristics include age and household size.

3.1.1. Gender

In figure 1, the sex of the respondents from the entire three residential neighbourhoods in Minna shows that the males (54.4%) are more than the females (45.6%).

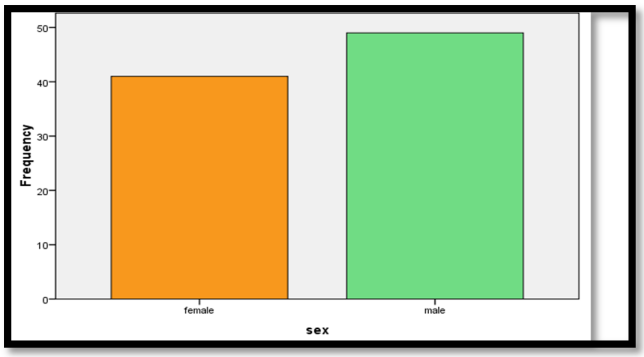

Figure 1: Sex Distribution Percentage
Source: Field Work 2012

3.1.2. Household Size

Figure 2 shows that 15.6% of the respondents' household size is less than five (5), 27.8% have between five (5) and seven (7), and 56.7% have above seven (7) people.

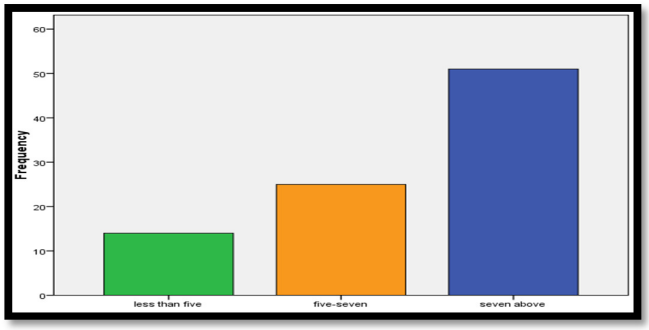

Figure 2: Household Size Distribution
Source: Field Work 2012

3.1.3. Power Supply

From the field survey, 27.8% enjoy power supply less than eight (8) hours a day, 67.8% have access to power supply between eight (8) and twelve hours (12) a day, while the remaining 4.4% have access to the power supply of above twelve (12) hours a day as shown in figure 3.

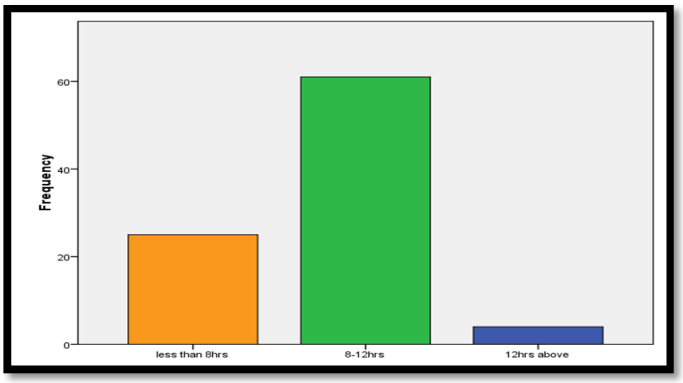

Figure 3: Power Supply Distribution.
Source: Field Work 2012

3.1.4. Alternative Source of Power Supply

As part of the challenges of power supply, 26.7% make use of candles/lanterns as their source of light, 7.8% use inverters, and the remaining 65.6% use generator sets. This is represented in the figure 4.

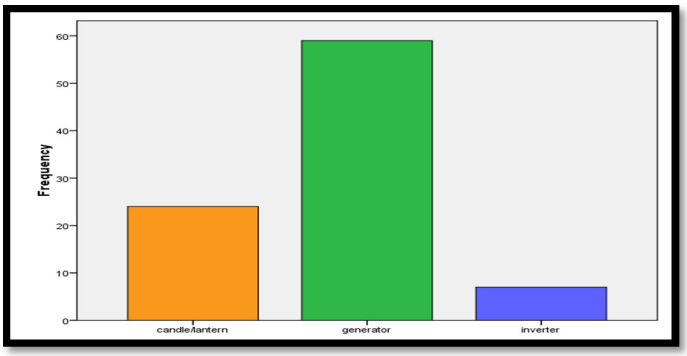

Figure 4: Alternative Electricity Distribution
Source: Field Work 2012

3.1.5. Water Supply

Figure 5 represents the source of water supply for the respondents. 42.2% of the respondents depict the State Government's action to provide water for the residential neighbourhoods, 31.1% of the respondents decide to source water from the water vendors by buying at the rate of N20/gallon during the rainy season and N40/gallon during the dry season, and 26.7% of the respondents dig wells and electrified boreholes for their source of water supply.

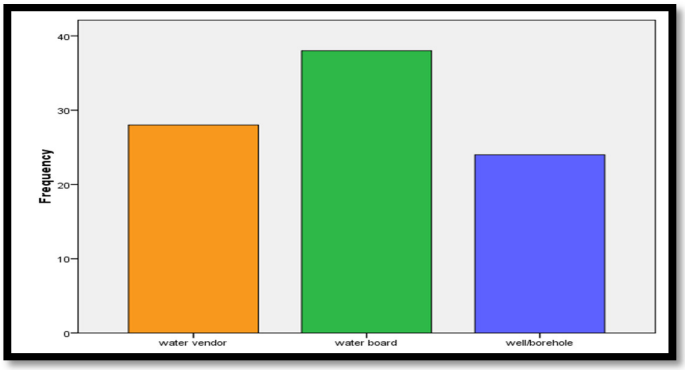

Figure 5: Water Supply Distribution
Source: Field Work 2012

3.1.6. Nursery and Primary School

The respondents of the total percentage of 91.1% have access to nursery and primary school within their neighbourhood, while the 8.9% do not have access to nursery and primary school, as shown in figure 6.

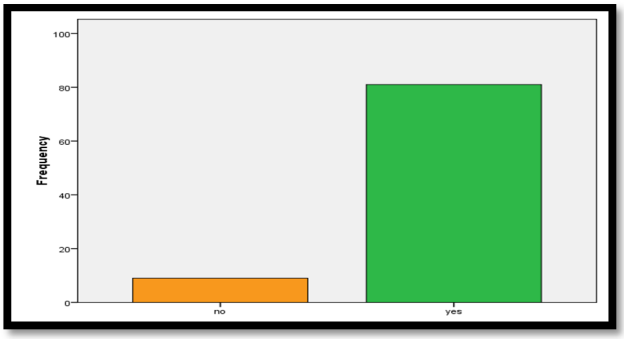

Figure 6: Nursery & Primary School Frequency
Source: Field Work 2012

3.1.7. Recreational Facilities

The survey carried out shown in figure 7 shows that 55.6% of the respondent's residential neighbourhoods have access to the civic centre, playgrounds and parks, while 44.4% of the respondent's residential neighbourhoods do not have access to the civic centre, playgrounds and parks.

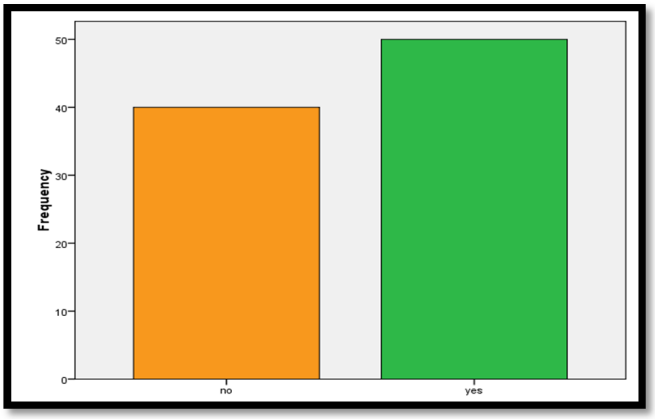

Figure 7: Recreational facility.
Source: Field Work 2012

3.1.8. Medical Facility

The survey shows that 46.7% of the residential neighbourhoods do not have access to the medical facility, while 53.3% have easy access to the clinic and primary health care within their residential area. This is shown in the figure 8.

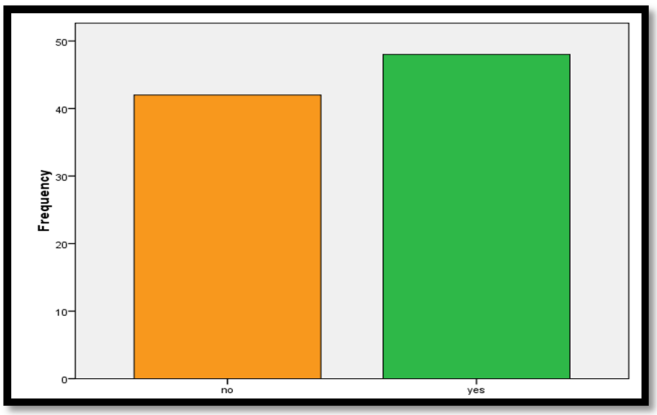

Figure 8: Medical Facility
Source: Field Work 2012

3.1.9. Security

According to the analysis shown in figure 9, security measures put in place include a community measure of 32.2% input, 47.8% individual measure and 20% police action.

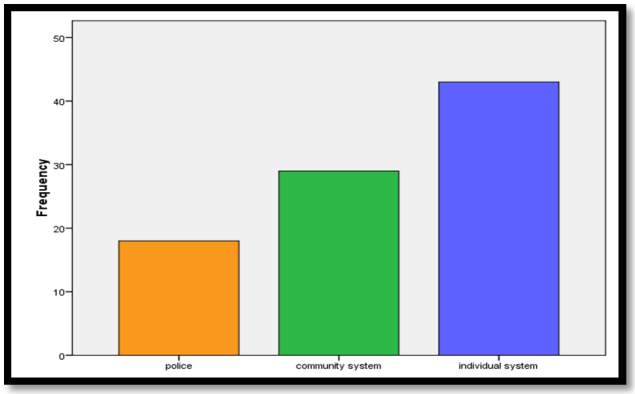

Figure 9: Security System
Source: Field Work 2012

4. Presentation of Findings and Planning Implications

4.1. Presentation of Findings

From the analysed data with respect to the aims and objectives of this study, it can be deduced that most of the facilities provided within the neighbourhood are not adequate, and most, when provided, are not fully utilized. Figures from 1 to 6 show the schools available in the selected neighbourhoods, figures 7 and 8 show the health care facilities in the neighbourhoods, figures from 9 to 11 show the recreational area and civic centre available, and figures from 12 to 16 show the building types available within the neighbourhoods respectively.

Figure 10: Showing Zarumai Model School Pupils,
Located at Type "B" Quarters (Zarumai Quarters)

Figure 11: Showing Cross Section Zarumai Model School,
Located at Type "B" Quarters (Zarumai Quarters)

Figure 12: Showing Fowman Islamic School, Located at Type "A" Quarters (Commissioner's Quarters)

Figure 13: Showing Approach View to Fowman Islamic School, Located at Type "A" Quarters

Figure 14: Showing 123 Primary School Minna, Niger State, Located at 123 Quarters

Figure 15: Showing a Cross Section of 123 Primary School Pupils on Break

Figure 16: Showing Umar Farouk Bahago Primary Health Care, Located at 123 Quarters

Figure 17: Showing the Newly Constructed Primary Health Care, Located at Type "A" Quarters

Figure 18: Showing Open Field Used for Recreational, Located at 123 Quarters

Figure 19: Showing Spectators Sitting Arena, Located at 123 Quarters

Figure 20: Showing the Civic Center, Located at 123 Quarters

Figure 21: Showing Prototype Design of Two Bedrooms Semi-Detach Houses, Located at 123 Quarters

Figure 22: Showing a Three Bedroom Prototype Design, Located at 123 Quarters

Figure 23: Showing a Duplex Prototype Design, Located at Type "A" Quarters (Commissioner's Quarters)

Figure 24: Showing a Duplex Prototype Design, Located at Type "A" Quarters (Commissioner's Quarters)

Figure 25: Showing Prototype Design, Located at Type "B" Quarters (Zarumai Quarters)

4.1.1. Planning Implications

The planning implication of using alternative building materials that are environmentally friendly is that much more affordable houses will be produced with very little or no carbon footprint. This will be a major contribution to the current global and national effort to reduce the generation of greenhouse gases, which are the major causes of the depletion of the ozone layer and a contributor to climate change.

4.1.2. Design Brief

The below sub-topics are the recommendations for the development of the neighbourhood.

4.1.2.1. Plot Size

The proposed neighbourhood shall have a total of one hundred and fifty plots, with seventy high-density plots, fifty medium plots, and thirty low-density plots, each occupying 20x30m, 25x30m, and 30x30m, respectively.

4.1.2.2. Population and House Types

- The estimated population for the entire site will be Nine hundred, i.e., six people per household.
- The neighbourhood will consist of two, three, and four bedrooms to accommodate the high, medium, and low densities, respectively. The type of houses shall include flats and duplexes for two, three, and four bedrooms, respectively.
- The two-bedroom flat and three-bedroom flat will have a sitting room, dining room, a visitor's convenience, kitchen, and bedrooms in a suite.
- The four-bedroom duplex will have a sitting room, dining room, a visitor's convenience, kitchen, and bedrooms in a suite.

4.1.2.3. Facilities and Services

The neighbourhood shall have the following facilities in common with each other:

- Nursery and primary school,
- A civic centre for social and cultural activities,
- A shopping centre or market,
- Retail shops located at strategic points in the neighbourhood for ready access to convenience goods,
- A neighbourhood rest park primarily for informal outdoor recreation,
- Pre-school children's playgrounds, place of worship,
- Health centre,
- Police post,
- Public utility system for water service reservoirs,
- Refuse depots,
- Service industrial area for solid waste recycling and liquid waste processing, and
- A solar-panelled plant.

These facilities serve both the people living within and around the neighbourhood.

4.1.2.4. Elements of Sustainability

- Solar Panel: The solar panel will require inverter batteries of 12v to build a system voltage of 48v with a capacity of three thousand amps/hour, i.e. (3000AmpHours).
- Bio-Gas Plant: A bio-gas plant breaks down organic matter (dead plant, animal feces and materials, kitchen waste) converted into gaseous fuel (either electrical fuel or gaseous fuel) in the absence of oxygen. This will be located at the sloppy end part of the neighbourhood to make the collection of waste easy due to the influence of gravity and this will be used to cover the need for cooking gas.
- Rainwater Harvesting: Rainwater harvesting is the accumulation and storing of rainwater for reuse before it reaches the underground layer of water-bearing permeable rock or unconsolidated materials such as gravels, sand or silt. This will be used for irrigation and feeding of livestock and as a source of drinking water. It will be collected from the roofs of houses and then treated by each individual house for drinking. This will serve as an alternative to water supply. The industrial layout will also cover the treatment and distribution of water collected. The water will be stored in an overhead tank after treatment.
- Compressed Earth Blocks: The introduction of compressed earth blocks (a type of manufactured construction material formed in a mechanical press that forms an appropriate mix of dirt, non-expensive clay and an aggregate into a compressed block) as an alternative to concrete building material.

4.1.2.5. Land Budgeting

In view of the standards that a standard neighbourhood must occupy, the following are the bases for land development and allocation of space for facilities.

4.1.2.5.1. Site and Access Standards for Neighbourhood Facilities and Services

Neighbourhood Facilities and Service	Site Area (hectares)
Nursery primary school	1.6 – 3.2
Civic Centre	0.8 – 1.6
Shopping Centre or market	1.6 – 4.0
Retail shops	0.05 – 0.1
Neighbourhood playgrounds	1.6 – 2.4
Neighbourhood park	0.8 – 2.4
Children’s playground	0.2 – 0.5
Health Centre	0.4 – 0.6
Place of worship	0.3 – 0.4
Postal agency	0.1 – 0.2
Police post	0.2 – 0.4
Commercial bank	0.3 – 0.4
Refuse site (depot)	0.2 – 0.4
Service industrial area	2.0 – 3.0

Table 1: Site and Access Standards for Neighbourhood Facilities and Services
Source: Land Subdivision basics. Oluremi. I. Obateru

4.1.2.6. Land Allocation in Residential Neighbourhoods

Land Use	Percentage
Residential	50 – 60
Road and streets	15 – 25
Commercial	3 – 5
Service industries	2 – 3
Outdoor recreational	6 – 8
Utilities, facilities and services	10 – 15

Table 2: Land Allocation in Residential Neighbourhoods
Source: Land Subdivision Basics. Oluremi. I. Obateru

5. Recommendations and Summary of Findings

5.1. Summary of Findings

From the survey conducted, it is thus concluded that the following elements are necessary design parameters for the sustainability of the proposed housing project:

- Solar Panel: The solar panel will require inverter batteries of 12v to build a system voltage of 48v with a capacity of three thousand amps/hour, i.e. (3000AmpHours).
- Bio-Gas Plant: A bio-gas plant to break down organic matter and this will be used to cover the need for cooking gas.
- Rain Water Harvesting: This will be used for irrigation and feeding of livestock and as a source of drinking water. It will be collected from the roofs of houses and then treated by each individual house for drinking. This will serve as an alternative to water supply.
- Compressed Earth Blocks: Compressed earth blocks have been introduced as an alternative to concrete building materials.

5.2. Planning Proposal (Application of Design Parameters)

5.2.1. Modern Facilities

Below are some of the modern facilities that are found within any residential neighbourhood that are less expensive and environmentally friendly. These include:

5.2.1.1. Solar Energy

The power generated from the sun is a viable and responsible source of energy. The energy can be captured in two different ways:

- The first way is passive solar power, which directly allows the sunlight to heat, cool and light a structure.
- The second way is active solar power. Active solar power uses a solar collector that will store and distribute energy throughout the structure.

5.2.1.2. Wind Energy

Wind power is harnessed through turbines set on tall towers (typically 20' or 6m with 10'or 3m diameter blades for an individual household's needs) that power a generator that creates electricity. They typically require an average wind speed of 9 km/hr. (14 km/hr.) to be worth their investment (as prescribed by the US Department of Energy) and are capable of paying for themselves within their lifetimes. Wind turbines in urban areas usually need to be mounted at least 30' (10m) in the air to receive enough wind and to be void of nearby obstructions (such as neighbouring buildings).

5.2.1.3. Biogas

This is produced by the anaerobic digestion or fermentation of biodegradable materials. It comprises methane, carbon dioxide and a small amount of hydrogen sulphide moisture and siloxanes. The gases such as methane, hydrogen, and carbon monoxide can be combusted or oxidized with oxygen. The energy released allows biogas to be used as fuel for either cooking or heating.

Figure 26: An Ongoing Construction Using Compressed Earth Bricks
Source: Wikipedia.com

Figure 27: Showing Outlined Solar Panels on a Building Roof
Source: Wikipedia.com

Figure 28: A Biogas Plant with Its Pipe Distribution
Source: Wikipedia.com

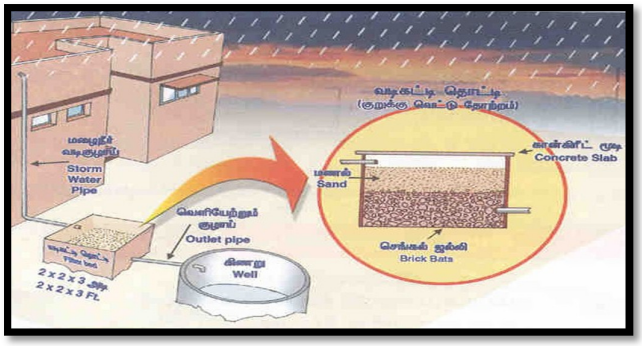

Figure 29: A Typical Rain Water Harvest Process
Source: Wikipedia.com

6. Conclusion

With new technologies and reasonable pricing, many facilities are now investing in sustainable housing. The reason for that is obvious: they believe that they are actually saving money in the long run, also to show care about the environment and its projection. Below are the advantages of sustainable housing delivery:

6.1. High Investments and Solid Returns

It is true that almost all forms of sustainable housing require a substantial investment at the beginning. For example, solar panels are expensive, and new modern building facilities and subsidies have little effect on delivery, but the eventual results are quite good and compensative.

The initial example of solar panels will bring and reduce the bills on electricity as they remain active throughout the entire year, even with minimum maintenance, which saves the user a decent amount of money. Most of these developed and discovered technologies last for a long time without additional costs, which also increases their effectiveness and efficiencies, which is a long-term investor's profits from, thanks to the computer age and technological advancement.

6.2. Better Living Condition

Sustainable housing provides better living conditions as the buildings are built in suburban areas; this increases the quality of the environment and its user-friendliness.

For the concept of neighbourhood to be achieved, the following must be ensured and promoted:

6.2.1. Promotion of Partnership with Countries Having These Technologies

Countries like China, the United States of America, and any other related technologically advanced company should be given the opportunity to come to Nigeria and invest in the development of these neighbourhoods, inculcating into the development all modern elements of sustainability.

6.2.2. Acquire Expertise in Construction and Management of Elements of Sustainability

Encouragement must be made to send people to these developed countries to acquire more knowledge on the production and maintenance of these basic amenities and facilities.

6.2.3. Partnership Packaging

The partnership can further be advanced with time by encouraging the developers to come into the country and manufacture these elements. These will aim at reducing the amount to be spent on importing the materials into the country; it can give room for research to take place, leading to the discovery of alternatives to the materials used for the construction and development of these elements.

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