

A Proposed Traveller's Rest Area
(Shipping Containers as An Alternative to Conventional
Building Materials in Housing Construction)

Rasheed Tolulope SHOTE
LCU/PG/002053

Being a MSc Thesis Submitted to The Department of Architecture,
Faculty of Environmental Design and Management,
Lead City University, Ibadan, Oyo State, Nigeria.

In Partial Fulfilment for The Requirements of The Award of
Master Degree (MSc) In Architecture

2022

Certification

This is to certify that Rasheed Tolulope SHOTE with matriculation number LG/PG/002053 carried out this research work titled “shipping containers as alternative to conventional building materials in housing construction” in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, for the award of Master Degree (M.Sc.) under the supervision of:

Arc. (Dr.) Funmilayo. M. Adedire
Department of Architecture
Faculty of Environmental Design and Management
Lead City University, Ibadan, Nigeria

Head of Department
Arc. (Dr.) Funmilayo. M. Adedire
Department of Architecture
Faculty of Environmental Design and Management
Lead City University, Ibadan, Nigeria

Dedication

This research is dedicated foremost to Almighty Allah for his favour, mercy and grace upon my life especially during the process of carrying out the research. I also dedicate this to all people that contributed and supported me to make the research a successful one. I appreciate you all.

DO NOT COPY. LEAD CITY UNIVERSITY, NIGERIA

Acknowledgement

I sincerely express my gratitude to the Governing council as well as the Academic and Administrative staff of Post Graduate College, Lead City University Ibadan, Oyo State for creating the platform on Architecture as an opportunity to allow me to pursue my academic career. I sincerely acknowledge my supervisor, Arc. (Dr.) Funmilayo M. Adedire for her immense support, practical advice, and ideas that have helped tremendously towards the completion of this thesis. Without her support and guidance, this project would not have been possible.

I also express my sincere thanks to all my studio Critics and lecturers in the department of Architecture namely: Arc. Ademola Adeola, Arc. (Dr.) Oluwatosin Ayanleke D, Arc. Oluwakemi Ajijola S, Arc. (Dr.) Adegoke, Arc. Jumoke Fasheun-Motesho, Arc. Martins Olaniyan, Arc. Jide Aseyan, Arc. David Oguntunde and Engr Samuel Oladeji from Civil Engineering Department. I appreciate the continuous efforts of all other lecturers of the department of Architecture for their mentorship, I am deeply indebted to them all, their professional assistance has helped me during my postgraduate journey at Lead City University.

I will also like to appreciate my fellow course mates for their support and contribution during the course of this research work, you are all important. I sincerely appreciate my dear wife, Margaret Fatima Shote, and the children for their great support and endurance during my study. Thank you all.

Even though the above-mentioned institutions and persons have assisted in the process of this research work, I alone stand responsible for the errors, if any, found in the work.

Abstract

ISO containers has been adopted as a cost-effective alternative building material across the world as it is a recyclable and reusable material. Therefore, this study is set to investigate the use of ISO containers as an alternative to conventional building materials in construction, towards proposing a design for a traveler's rest point to be located in Lokoja, Kogi State, Nigeria. The research design approach adopted is case study. This involved selection of four rest points to be understudied. Three case studies were international namely: Travelers Container Hostel Jinan China, Rest Area Niemenharju Lake Kolima Finland, Georgia Rest Stop, Lochini, Georgia, and one local (Dankade Rest Stop Area Rigachikun Kaduna Nigeria). The result of the case study revealed that container has been used in some of the facilities investigated and planning is an integral part of the design and construction of a rest area. Lessons from the case study were transferred into the proposed design by using containers to design the fire station and filling station. Also, lessons as regard planning were inculcated into the proposed design by adopting a drive-through site planning approach which enabled easy access for both pedestrian and vehicular movement. It is therefore recommended that stakeholders involved in the design and construction of housing can adopt the use of containers as it is a cost-effective and sustainable alternative building material.

Keywords: *Alternative Building Material, Conventional Building Material, ISO Container, Sustainable Building Construction and Travellers Rest Point.*

Table of Contents

Certification	ii
Dedication	iii
Acknowledgement	ii
Abstract	v
Table of Content	viv
List of Figures	x
List of Table	xiii
Chapter One	1
Introduction	1
Background to The Study	1
1.2. Statement of The Problem	2
1.3. Aim And Objectives Of The Study	3
1.4. Research Questions	4
1.5. Significance Of The Study	4
1.6. Scope of The Study	4
1.8. Limitation	5

1.9. Operational Definition of Terms	5
Chapter Two	7
Litrature Review	7
2.1. Conceptual Review	7
2.1.1. The Concept of Conventional And Alternative Materials	7
2.1.2. The Invention of The Shipping Container	9
2.1.3. Shipping Container Transformations	11
2.1.4. Structure of a Shipping Container	13
2.1.5. Shipping Container Structural Modification	14
2.1.6. Types of Containers And Specification	15
2.1.7. Insulation	27
2.1.8. Traveller Rest Point	33
2.2. Empirical Review	37
2.3.1. Shipping Containers as a Housing Solution	37
2.3.2. Advantage and Disadvantage of Shipping Container Homes.	40
Chapter Three	47
Methodology (Case Studies)	47
3.1. Case Study	47
3.2. Research Method	48
3.2. Case Study One: Travelers Container Hostel, Jinan China	49
3.2.1. The Design Concept	49
3.2.2. Appraisal	56

3.3. Case Study Two: Rest Area Niemenharju, Lake Kolima, Finland	56
3.3.2. Appraisal	60
3.4. Case Study Three: Georgia Rest Stop, Lochini, Georgia	61
3.4.1. The Brief	61
3.4.2: Analysis	64
3.5. Case Study Four: Dankade Rest Stop Area Rigachikun Kaduna Nigeria	64
3.5.1. The Brief	64
3.5.2. Analysis	67
Chapter Four	68
Site Analysis And Design Synthesis	68
4.1. Brief Analysis	68
4.1.1. Design Brief	68
4.1.2. Design Brief Development	68
4.2. Study Area	69
4.2.1. Site Location	69
4.2.2. Site Selection Criteria	69
4.2.3 Site Analysis	70
4.3. Project Analysis and Design Synthesis	75
4.3.1. Design Considerations	75
4.3.2 Conceptual Development	78
4.3.3 Functional Relationship	79
4.3.4 Space Allocation/Schedule Of Accommodation	80
4.3.5. Construction Methods and Materials	81

Chapter Five	82
Conclusion and Recommendation	82
5.1 Conclusion	82
5.2 Recommendation	83
References	84
Appendix	87
Drawing 1	88
Drawing 2	88
Drawing 3	88
Drawing 4	89
Drawing 5	89
Drawing 6	90
Drawing 7	90
Drawing 8	90
Drawing 9	91
Drawing 10	91
Drawing 11	92
Drawing 12	92
Drawing 13	93
Drawing 14	93

List of Figures

Figure	Title	Page
2.1	Shipping Container Home	12
2.2	Shipping Container Structural Feature	13
2.3	Highly modified shipping container home	15
2.4	Slightly modified shipping container home	15
2.5	Dimensions for Standard or General Containers	16
2.6	Pallet wide containers	17
2.7	Hard Top Container	18
2.8	Open top container	19
2.9	Flat Rack Container	20
2.10	Platforms (plats)	21
2.11	Ventilated container	22
2.15	Tank Container	26
3.1	showing the main entrance	49
3.2	showing the site lay-out	50
3.3	showing the aerial view	50
3.4	showing the floor plan	51
3.5	showing the floor plan	51
3.6	showing elevation	52
3.7	showing the elevation	52

3.8	showing the floor plan	53
3.9	showing the arrangement of the shipping containers	53
3.10	showing the typical type of container home	54
3.11	showing the stacking of shipping containers on each other	54
3.12	showing the court yard	55
3.13	showing the landscape of the travellers rest area	55
3.15	showing a perspective view	57
3.16	showing the conceptual development process	58
3.17	showing an interior view	58
3.18	showing the ground floor	59
3.19	showing a section	59
3.20	showing another section	59
3.21	showing another interior section	60
3.21	showing a front view	61
3.22	showing a perspective	62
3.23	showing the site plan	62
3.24	showing a façade detailing on the material used	63
3.25	showing the filling station on site	63
3.26	showing a location map	65
3.27	showing the parking area	65
3.29	showing the site plan/layout of the rest area	66
3.30	showing that most of the buildings are temporary structures	67
4.1	Site location map	69
4.2	Site analysis	72
4.3	Rainfall chart	73

4.4	Temperature chart	74
4.5	Sites should be chosen where both seclusion and views into the site from the road are available.	77
4.6	A natural transition from road to rest area should be possible.	77
4.7	Relationship to the road for safety and noise reduction.	78
4.8	Site concept	79
4.9	flow chart	80
4.10	Spacial analysis	80
4.11	Brief development	81

List of Table

Table	Title	Page
2.1	Batt Blanket and Matt Insulation	29
2.2	Loose Fill Insulation	31
2.3	Rigid Board Insulation	31
2.4	Spray Foam Insulations	33

DO NOT COPY. LEAD CITY UNIVERSITY, NIGERIA

Chapter One

Introduction

Background to The Study

Most of the country's cities are quickly urbanising, and they must respond to population growth by increasing densities, necessitating research into alternatives to the basic building materials often utilised in house construction. Alternative construction materials are typical building materials that have been adapted to reduce production. These materials are transformed so that they can fulfil current housing criteria. It is also defined as the strategic use of renewable resources and unconventional materials acquired from the waste stream (recycling or industrial end products), such as cans, tyres, and containers (Marut et al., 2020).

As a result, containers were created in order for goods to be transported. It is mostly walled off to provide a storage room, either totally or partly. The ergonomic design of this container makes it simple to transition from one mode of transportation to another (Chamber, 2012). Repurposing existing shipping containers is becoming more popular as a means of creating new retail spaces and improving people's living situations (Chamber, 2012).

ISO shipping containers have many characteristics that set them apart, including rigidity, modularity, malleability, affordability, and accessibility. These characteristics have enabled its use in regional shipping (Shipping Container Fundamentals, 2020). According to the available literature, shipping containers may be used to construct anything from storage structures to generator houses and even human residences. Because of a surplus of shipping containers in wealthy nations, the idea of employing containers for construction has surfaced. Because these containers are not recycled in the Western world, they wind up in landfills (Imbasa Educare, 2011 Shipping Container Fundamentals, 2020). For example, the New Jerusalem Children's Home was constructed from repurposed shipping containers since they

were inexpensive and provided imaginative space options (New Jerusalem Children's Home, 2014).

Even though shipping containers are a commonly accessible and low-cost alternative construction material in Nigeria, architects, developers, and builders do not employ them for several reasons. These include a lack of construction rules, a lack of pioneer projects, ISO shipping container size constraints, and a reluctance to vary from the standard.

On the other hand, ISO shipping containers are designed to withstand the severe weather conditions experienced during a sea trip and the stacking of many fully loaded containers, making them an acceptable structural component. Containers constitute an ideal modular unit because of their regular size; their inherent robustness, weatherproof nature, and quick availability make them good candidates for living projects. As a consequence, the goal of this study is to look at the possibility of reusing shipping containers as a way to fulfil the expanding demand.

1.2. Statement of The Problem

Construction causes environmental harm at each stage of a structure's life (Bhatia, 2018). These impacts are felt from the moment a structure is conceived until it is demolished (Bhatia, 2018). There are several threats to the environment, some of which are attributable to human activity. The production of cement and comparable materials results in the emission of greenhouse gases, which contributes to the depletion of natural resources (Bhatia, 2018).

For low-income families, it has always been challenging to design an economical and sustainable home that utilises renewable energy sources and other innovative strategies for energy saving and efficiency (Bhatia, 2018). Energy pricing, inefficient appliances, a large initial investment in energy efficiency, and a lack of comprehensive low-income programmes

are just a few of the barriers that currently stand in the way of widespread energy conservation (Bhatia, 2018).

Consequently, there is a need for energy-efficient housing targeting groups now more interested in cost-effective housing options. For many, the long-term financial and health advantages of sustainable housing are overshadowed by the high initial price of the presently available inventory of energy-efficient dwellings. Alternative construction materials must be used to address the need for low-cost housing (Truman 2016).

Consequently, energy efficiency and cost-effectiveness are the main drivers behind the rising trend of using containers as alternative construction materials. These buildings should be constructed using state-of-the-art renewable energy products and innovative methods for conservation and efficiency; they should also be modular, adaptable, and, most importantly, affordable for low-income populations or those desiring to live in rural areas with limited access to utilities (Ijigah et al., 2013).

Due to advances in material science and technology, as well as the declining costs of renewable energy products like solar PV and batteries, alternatives such as ISO containers may soon be attainable (Ofori & Corresponding, 2015). Although conventional techniques (brick, concrete, blocks, and mortar) have been prioritised throughout the years to tackle the housing problem in Kogi State, it may be time to investigate alternatives, such as the shipping container-based construction technology is already in use in Nigeria

Consequently, this study aims to investigate the viability of using ISO containers in the development of a Rest Area in Lokoja, Kogi State.

1.3. Aim and Objectives of The Study

The study aims to assess the adoption of ISO shipping containers as alternative building element for travellers' rest point in Lokoja, Kogi, Nigeria.

The following objectives are set in order to achieve the aim of the study:

1. to identify the inherent potentials in shipping containers as an alternative building material
2. to investigate existing medium of usage of shipping containers an alternative building material'
3. to examine the appropriateness of ISO shipping containers in the design of travellers' rest point.

1.4. Research Questions

1. What are the functional potentials in ISO as an alternative building material?
2. Are their existing cases and methodology in adopting ISO shipping as building material?
3. How functional is the use of ISO in design of a traveller's rest point?

1.5. Significance of The Study

Although container housing is by no means a new idea, it is gaining popularity in advanced countries of the world such as USA where their severe trade deficit which leaves an abundance of unused shipping containers, it is a viable system of quick cheap and safe housing which is yet to be adopted in Nigeria. Conducting this research will show the possibility of using shipping container as an alternative to conventional building especially in the construction of public buildings.

1.6. Scope of The Study

This study focuses on how shipping containers can be converted to housing units in Lokoja, Kogi state Nigeria, without compromising the essentials of a dwelling. Globally there is a growing trend of young couples choosing to downsize and live in tiny (toll-able) mobile homes and medium-sized motor vehicles (van), this trend demonstrates the limits

of what is a home and more importantly, what is the minimum square area tolerable for habitation. Van living and tiny home trend is made possible by advances in technology that allows all homely appliances to be run off of a solar recharged battery and so people can live in a van without sacrificing the comforts of a regular home. Having established that living in a van is not just possible but also practical, container housing might be perceived as a luxury as a result of its much bigger size. This study also breathes life to the potentials that can be achieved if shipping container living is properly planned and implemented in Kogi state. Many of such potential include its unarguable sustainability, low cost and efficiency of building supply over a short period of time as is needed in Kogi state with some urgency.

1.8. Limitation

This research focuses only on Lokoja, which is situated in the Nigerian state of Kogi. The paucity of knowledge on the issue of recycling shipping containers into dwelling quarters, particularly in Kogi State, Nigeria, was an early barrier to surmount. Few shipping container apartment complexes exist in the city, limiting the case study's potential outcomes. Inaccessibility to the tenants of the case study building prevented researchers from interviewing them and obtaining their perspectives on living in a container home.

1.9. Operational Definition of Terms

Shipping Container: Shipping containers are large reusable steel boxes used for intermodal shipments. A shipping container in this study refers to a building material derived from ISO shipping containers. Usually the 20m and 40m type.

Housing: is a living space usually meant for protection of human beings and properties. In this case housing construction refers to all facilities provided in a rest area.

Sustainable Building Material: these materials refer to those materials that are environmentally friendly, socially acceptable and cost effective. These materials could be conventional building materials. However, in this study sustainable building materials are those that are reusable and recyclable.

Rest Area/Point: this is an area designed to aid road travellers on long journeys have a place to rest, should in case of any delay or just for the purpose to ease and rest for a while.

It includes facilities such as a filling station, a motel, restaurants and relaxation spots etc.

DO NOT COPY. LEAD CITY UNIVERSITY, NIGERIA

Chapter Two

Literature Review

2.1. Conceptual Review

2.1.1. The concept of conventional and alternative materials

One of the core industrialization processes is construction. The development of a city, a nation, and its economy all depend on industrialization. Conventional building materials are those that have been employed in the construction of structures such as homes and buildings for a considerable amount of time, however they may not always have been sourced locally. Glass, cement, plaster, steel, and other materials fall into this category. Because individuals often utilize these materials the most, they are referred to as conventional (Designing Buildings, 2020).

Additionally, the definition of a standard building material takes into account its widespread use, industrialized processing, and low unit costs. Conventional materials are often employed without taking into account regional requirements throughout global supply networks. The usage of conventional materials is fuelled by a broad client base attained by leveraging global distribution and low production costs through mass manufacturing. To ensure consistency and high-quality output, conventional materials are treated. In order to reduce costs, new technologies are being developed to maximize production productivity. Common typical building materials include steel, concrete, and wood, with concrete being the most widely used one globally (Suffian et al., 2019).

However, one of the main issues that these traditional building materials have raised is that they are not environmentally friendly because the chemicals that are used to make them are components of waste and pollution. Additionally, the industrial process produces large amounts of chemical waste, which increases pollution in the environment. Now that times

have changed, environmental concerns are growing daily in both the building sector and the general public (Suffian et al., 2019 and Designing Buildings, 2020).

Studies have also shown that not all conventional materials are harmful to the environment, as some conventional materials, depending on the region, are also traditional building materials like mud and clay. Although cement has been used in construction since the Roman era, it wasn't widely used until roughly 200 years ago. Cement is one of the key ingredients of conventional building materials. In addition, glass has been a common building material since ancient times (Suffian et al., 2019; Designing Buildings, 2020).

Alternative construction materials typically fall under the non-conventional category. These unconventional materials come in a variety of shapes and sizes, including locally produced or vernacular materials, technologically produced materials, and sustainable materials. Alternative building materials are variously referred to as local building materials, unconventional building materials, alternative residential construction materials, sustainable building materials, indigenous building materials, vernacular building materials, green building materials, environmentally responsible building materials, eco-friendly building materials, quickly renewable or harvested building materials, recycled building materials, and others.

Alternative building materials can also be defined as conventional building materials that have undergone modifications to lower production costs or unconventional (traditional, local, indigenous, or vernacular) building materials that have undergone modifications to incorporate them into modern construction projects. Additionally, it is defined as the creative use of regional resources, including natural resources and unconventional ones like tires, cans, and containers that are offered by the waste stream (Marut et al., 2020). Alternative Building

Materials (ABM) are further defined as non-traditional building materials, as well as materials generated from recycling or industrial waste products (Marut et al., 2020).

The primary distinction between conventional and alternative building materials is that alternative building materials are more environmentally friendly and utilise recycled items, whereas conventional building materials are largely unrecycled and destructive to the environment (Suffian et al., 2019). Alternative construction materials stand out because, in contrast to conventional building materials, they are sustainable and typically have lower embodied energy and toxicity levels. They require less processing and do less environmental harm (Marut et al., 2020).

The word "alternative building materials" refers to the fact that these materials have replaced the traditional ones that have been utilized for millennia as a building solution. As an illustration, employing straw-based walls rather of conventional brick walls or wood for flooring instead of concrete. In addition to being environmentally friendly, alternative materials also have the benefit of being a very cost-effective alternative to traditional materials. Additionally, they require less upkeep, which results in substantial long-term cost savings (Marut et al., 2020). Since these materials are created from finished goods, environmental pollution is reduced. They consist of substances including bamboo, ferro-cement, bituminous materials, soil conditioners, tempered glass, crumb rubber, fiber reinforced polymer, glass fiber reinforced polymers, and polyester fibers (Marut et al., 2020).

2.1.2. The Invention of The Shipping Container

Malcolm McLean created the shipping container in 1952. He had a trucking firm in the United States of America, and when he needed a simple way to move cargo from the truck to the ship, he bought a steamship company. The idea was that the storage container itself, not the contents, needed to be transportable (Sophie Koenig, 2016). After extensive testing, the

first ISO container was created, and the shipping containers were granted a patent in 1956. It was made of steel, stackable, and portable. The containers could be stacked without causing harm because to the reinforced corners. They were uniform in size, theft-proof, and easy to load. Buyers and sellers of goods quickly saw the potential of container shipping, and only after six years later in 1961, the international standards for container size for the first time were agreed – making way for container ships to use for transport goods between countries. In 1968, ISO 668 was introduced, which defined the dimensions uses today as:

ISO Standards (seven common lengths)

8 ft. (2.43 m)

9 ft. (2.99 m)

20 ft. (6.10 m)

40 ft. (12.19 m)

45 ft. (13.72 m)

48 ft. (14.63 m)

i. 53 ft. (16.15 m)

The most commonly used ones are 20 ft. (6.10 m) and 40 ft. (12.19 m) containers.

Over the past few years, shipping containers have been increasingly utilised as office buildings or dwelling units in a variety of locations across the world. Shipping containers can still be very valuable constructions for housing purposes in Egypt, even though they have occasionally been employed in projects owing to trends and sometimes without fully utilizing their qualities. The term "container" refers to a piece of transport machinery (such as a lift-van, movable tank, or other similar structure) that is fully or partially enclosed to constitute a

compartment intended for containing goods; it is made for easy handling, especially when being transferred from one mode of transportation to another; it is simple to fill or empty; it has accessories and equipment suitable for the use intended, provided that the accessories and equipment are capable of withstanding the intended use; it is designed for ready handling; and Containers are a very recent and undoubtedly distinctive kind of transportation (Chamber, 2012).

Reusing shipping containers in modern society is increasingly being used to provide better living circumstances for individuals and not just to provide commercial spaces (Chamber, 2012). As they are used to offer homes for those in need, shipping containers have evolved into a source of accessible and creative space solutions. One such example is the New Jerusalem Children's Home, which was built from shipping containers (New Jerusalem Children's Home, 2014). Additionally, they are employed to enhance the delivery of social services, such as the utilization of shipping containers for soup kitchens (Imbasa Educare, 2011).

2.1.3. Shipping Container Transformations

The most durable modular buildings in the world are ISO shipping containers. They are numerous, stackable, inexpensive, and simple to cut. Consequently, it can be utilized for purposes beyond from shipping. Storage sheds, generator housing, and even human dwellings are examples of this use. Due to the oversupply of shipping containers in western nations, using containers for construction became popular. In many western nations, including the US, imports vastly outnumber exports. The shipping container is not used to export products back out of the country when they are shipped there. In order to avoid creating waste, experiments were conducted using shipping containers for other purposes beyond from melting them, which led to their use as a building material (Shipping Container Fundamentals, 2020). According to published accounts, Phillip Clark used shipping containers for building

construction for the first time in 1987. He insisted that they made the ideal modular building material. He also proved that shipping containers could be recycled into building materials to build houses more cheaply. Filip Clark was not the first person to contemplate using shipping containers as building materials, despite the fact that he is recognized as the creator of shipping container homes. Shipping containers were utilized as building materials to erect many buildings on the filming set of the 1985 movie *Space Rage*. The idea of repurposing shipping containers and converting them into livable homes first came up in the 1970s in the university thesis of British architect Nicholas Lacey. With Urban Space Management, he has now built a number of similar shipping container buildings (Shipping Container Fundamentals, 2020).

In 2006, Peter De Maria, a Californian Architect, designed the first shipping container home in the US. Known as the Redondo Beach House, the home was approved under the national Uniform Building Code and completed in 2007. It was the first shipping container home (The Container House by Monica Michael Willis) (Shipping Container Fundamentals, 2020).



Figure 2.1: Shipping Container Home
Source: Shipping Container Fundamentals, 2020

2.1.4. Structure of A Shipping Container

These containers' sides are not consistent in shape, and each box has more than two faces. Cast feet on the corners permit stacking of up to seven boxes. There are two doors on each end, as well as twist-lock fasteners in each corner. The framework is comprised of a total of twelve columns. They provide the means for the walls to be sustained. (GDV, 2018).

In addition, the major load-bearing components of a shipping container are its four corner posts with castings, two bottom and two top side rails, two bottom cross members, a front top end rail, and a door header made from weathering steel. The side walls, end walls, and roof bear the least load, with the latter two depending on the material used for those sections (Ghada Mohammad Elrayies, 2017).

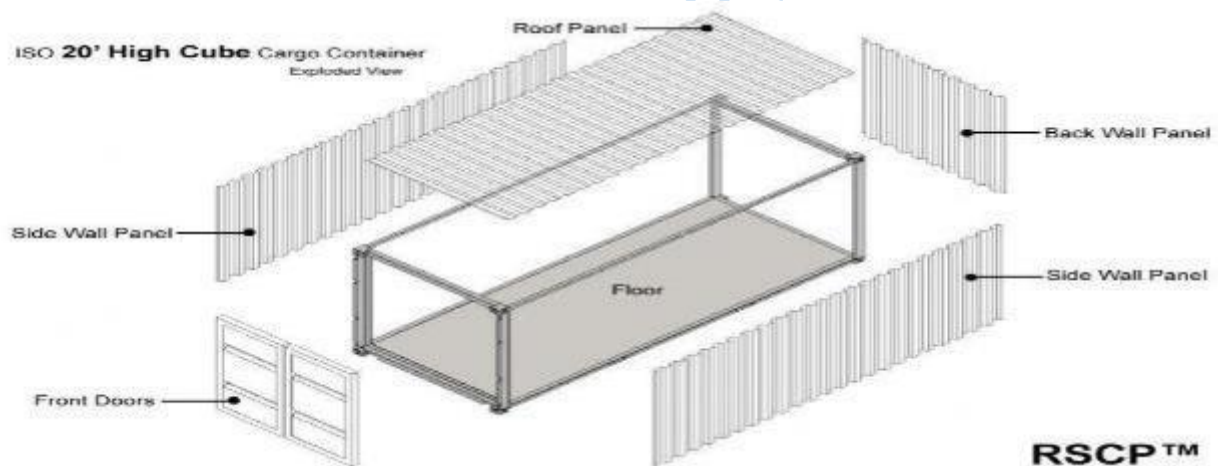


Figure 2.2: Shipping Container Structural Feature
Source: Ghada Mohammad Elrayies, 2017

According to research conducted by Ghad Mohammad Elrayies (2017), modified shipping containers need neither a foundation nor substantial assembly and may be installed almost anywhere. Almost all modes of transportation, including truck, aircraft, boat, and rail, are capable of expedited delivery and assembly. They may be despatched to ordinarily unreachable regions due to their mobility. In addition, since they are available in standard,

modular sizes, they may be combined in a variety of configurations that maximise available space while minimising their total footprint.

According to the article "The beneficial features of shipping containers" (STB, 2016), shipping containers are intended to withstand the corrosive elements of the open ocean. Because they are constructed to survive the rigours of moving huge goods over the ocean and being stacked on top of one another, shipping containers are resistant to the elements.

Planking or plywood is commonly used to construct the floors of shipping containers because it is dent-resistant, robust, and simple to repair if damaged. The panels are varnished as a prophylactic precaution to resist insects and other wood-destroying organisms. The precisely welded and sealed steel structure is impervious to both wind and water.

2.1.5. Shipping Container Structural Modification

Due to its purpose of holding and transporting goods, a shipping container has the form of a rigid box. As a structural component of a building, they must be modified to allow place for windows, doors, and insulation. The structural integrity of the shipping container will likely be affected due to these modifications, which will shift the container's centre of gravity and increase the modification's price. Priority one when constructing a container should be to keep it as simple as possible without jeopardising its structural integrity (Shipping Container Fundamentals, 2020).

As a result of their reinforced corners, containers can withstand being piled on top of other units and can be placed down quite easily on the majority of base types; this relates to the budget since, depending on the style of building, an inexpensive and simple basis may be selected. Office buildings, temporary military camps, shops, shopping centres, restaurants, residential units, and opulent suites are just some of the numerous container applications (Shipping Container Fundamentals, 2020). Figure 2.4 displays a housing constructed from a

significantly modified shipping container, whereas Figure 2.5 depicts a more lightly modified dwelling.



Figure 2.3: Highly modified shipping container home



Figure 2.4: Slightly modified shipping container home

2.1.6. Types of Containers and Specification

The different types of shipping containers and specification was discussed by Starmarine services ltd. In one of their documents for container building construction. These types are discussed below:

- i. Standard containers: General-purpose containers are another name for standard containers. They are closed containers, meaning that all sides are closed. Most of the

usual needs can be met by them. On land, by rail, and by sea, standard containers are built and designed for the transportation of general commodities. They can withstand temperatures as high as 70 °C without losing their strength or water-tightness. This ranges from -40 °C to 158 °C. All general stuff is shipped in standard containers (dry cargo). They are best suited for carrying light, bulky loads as well as over-height loads up to a maximum height of 2.70m.

The most common sizes of standard containers are 20' and 40'. Smaller-sized containers are relatively infrequently used. In fact, the tendency is moving toward greater dimensions, like 45'.



20' Dry Container

Dimensions*	Length	Width	Height
External	6096 mm	2362 mm	2590 mm
Internal	5944 mm	2337 mm	2388 mm
Door Openings		2337 mm	2286 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
24000 kg	2080 kg	21920 kg	33.9 cub.m



40' Dry Container

Dimensions*	Length	Width	Height
External	12192 mm	2438 mm	2591 mm
Internal	12014 mm	2286 mm	2388 mm
Door Openings		2337 mm	2286 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
30480 kg	3900 kg	26580 kg	67.7 cub.m



40' High Cube Container

Dimensions*	Length	Width	Height
External	12192 mm	2438 mm	2896 mm
Internal	11963 mm	2362 mm	2692 mm
Door Openings		2286 mm	2591 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
30480 kg	4150 kg	26330 kg	76.4 cub.m

Figure 2.5: Dimensions for Standard or General Containers
Source: Star marine services ltd.

- ii. Pallet wide containers: The domestic pallet wide containers used in Europe have slightly differing dimensions than the ISO boxes. To accommodate European pallets,

they are often wider (typically 2.5 meters in the case of dry vans). With the exception of width, pallet wide containers have the same properties as normal containers. Despite this, pallet wide containers are rarely employed in international service.



Pallet Wide Container

Size	Weights*			Capacity*	Dimensions*	Length	Width	Height
	Max. Gross	Tare	Max. Payload					
20' Pallet Wide Ctnr	30480 kg	2550 kg	27930 kg	39 cub.m	Internal	5903 mm	2434 mm	2686 mm
					Door Openings		2436 mm	2592 mm
40' Pallet Wide Ctnr	34000 kg	4200 kg	29800 kg	78.6 cub.m	Internal	12050 mm	2422 mm	2692 mm
					Door Openings		2390 mm	2260 mm
40' High Cube Pallet Wide Ctnr	38270 kg	4270 kg	34000 kg	79.2 cub.m	Internal	12100 mm	2442 mm	2680 mm
					Door Openings		2394 mm	2565 mm

Figure 2.6: Pallet wide containers
Source: Starmarine services ltd.

- iii. Hard top containers: Hard top containers often have two distinctive structural characteristics which are the detachable steel top roof and the door header. Some variations of this roof have points that can hold forklift trucks, allowing forklift trucks to lift the roof. The roof is about 450 kg in weight. Furthermore, the door header can be turned out. These two structural elements simplify the container's loading and unloading processes. When the roof is open and the door header is swivelled out, it is significantly simpler to load and unload a container using a crane or a crab. When transporting over height cargo, it is possible to leave the container roof open and

secure it to a side wall from the inside. Only about 13 cm of room is required on the roof to do this. 20' and 40' are the typical hard-top container sizes.

Containers with hard tops are used to convey general commodities of any sort (dry cargo). Their major role is to carry large or tall freight from above or through the doors using a crane or crab.



Hard Top Container

Size	Weights*			Capacity*	Dimensions*	Length	Width	Height
	Max. Gross	Tare	Max. Payload					
20' Hard Top Ctnr	67200 kg	2590 kg	27890 kg	32.8 cub.m	External	6096 mm	2362 mm	2590 mm
					Internal	5886 mm	2342 mm	2388 mm
					Door Openings		2336 mm	2276 mm
					Roof Openings	5590 mm	2208 mm	
40' Hard Top Ctnr	30480 kg	4700 kg	25780 kg	67.2 cub.m	External	12192 mm	2438 mm	2591 mm
					Internal	12020 mm	2342 mm	2388 mm
					Door Openings		2336 mm	2292 mm
					Roof Openings	11724 mm	2208 mm	
40' High Cube Hard Top Ctnr	30480 kg	4900 kg	25580 kg	75.8 cub.m	External	12192 mm	2438 mm	2896 mm
					Internal	12020 mm	2342 mm	2693 mm
					Door Openings		2336 mm	2597 mm
					Roof Openings	11724 mm	2208 mm	

Figure 2.7: Hard Top Container
Source: Starmarine services ltd.

- iv. Open top containers: Open top containers typically have the following distinctive structural characteristics: The roof is made up of detachable bows and a detachable tarp. The door header can rotate out. These two structural elements make packing and unpacking the container easier. In particular, when the roof is open and the door

header is swiveled out, it is very simple to pack and unpack the container from above or through the entrance by crane or crab.

However, it should be noted that an open-top container's roof bows serve a number of other functions in addition to supporting the tarpaulin, including enhancing container stability. The typical open-top container size ranges between 20' and 40'. Open-top containers are used for all types of general cargo (dry cargo). Their principal uses are packing and unpacking from above or through the door by crane or crab and tall cargo



Open Top Container

Size	Weights*			Capacity*	Dimensions*	Length	Width	Height
	Max. Gross	Tare	Max. Payload					
20' Open Top Ctnr	30480 kg	2350 kg	28130 kg	32.5 cub.m	External	6096 mm	2362 mm	2590 mm
					Internal	5888 mm	2345 mm	2365 mm
					Door Openings		2335 mm	2280 mm
					Roof Openings	5415 mm	2205 mm	
40' Open Top Ctnr	30480 kg	3850 kg	26630 kg	66.4 cub.m	External	12192 mm	2438 mm	2591 mm
					Internal	12029 mm	2342 mm	2376 mm
					Door Openings		2336 mm	2230 mm
					Roof Openings	11544 mm	2230 mm	

Figure 2.8: Open top container
Source: Starmarine services ltd.

- v. Flat rack containers: Flat racks are made up of two end walls that can either be fixed or collapsible, as well as a floor structure with a high weight capacity that is made up

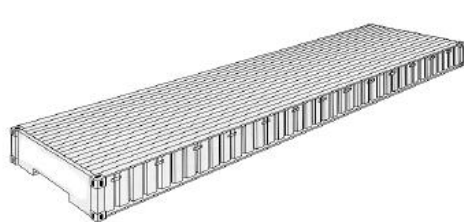
of a steel frame, a softwood floor, and two end walls. A number of flat racks can be piled on top of one another and cargo securing devices can be mounted to the end walls since they are stable enough to do so. Flat racks come in 20' and 40' lengths. The majority of the time, big lifts and over height or over width cargo are transported using flat racks.



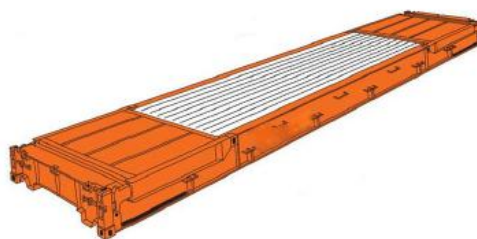
Size	Weights*			Internal Dimensions*		
	Max. Gross	Tare	Max. Payload	Length	Width	Height
20' Flat Rack Container	34000 kg	2740 kg	31260 kg	6038 mm	2438 mm	2213 mm
40' Flat Rack Container	30480 kg	4200 kg	26280 kg	12086 mm	2224 mm	1981 mm
40' High Cube Flat Rack Container	45000 kg	5700 kg	39300 kg	12060 mm	2365 mm	2245 mm

Figure 2.9: Flat Rack Container
Source: Starmarine services ltd.

vi. Platforms (plats): Platforms feature no side or end walls and only a floor structure with a very high loading capacity. It is feasible to concentrate huge weights on condensed areas thanks to its high loading capacity. A platform has a hardwood floor structure and a steel frame. Platforms come in 20' and 40' lengths. Platforms are typically utilized for exceptionally large and big payloads.



Platform



Platform, Converted From a Flat Rack Container

Size	Weights*			Dimensions*		
	Max. Gross	Tare	Max. Payload	Length	Width	Floor Height
20' Platform	30480 kg	2520 kg	27960 kg	6058 mm	2438 mm	370 mm
40' Platform	45000 kg	5700 kg	39300 kg	12192 mm	2245 mm	648 mm

Figure 2.10: Platforms (plats):
Source: Starmarine services ltd.

- vii. Ventilated containers: Coffee containers or passively (naturally) ventilated containers are other names for ventilated containers. The top and bottom side rails' ventilation openings allow for ventilation. To stop the cargo from deteriorating due to rain or spray, the opening does not allow for spray. Ventilated containers typically come in sizes of 20'. Particularly for cargo that needs to be ventilated while in transportation, vented containers are employed. Green coffee beans are one of the most important of these goods, hence the name coffee container.



20' Ventilated Container

Dimensions*	Length	Width	Height
External	6068 mm	2438 mm	2591 mm
Internal	5888 mm	2325 mm	2392 mm
Door Openings		2334 mm	2290 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
30480 kg	2400 kg	28080 kg	33.0 cub.m

Figure 2.11: Ventilated container
Source: Starmarine services ltd.

- viii. On the market, there are essentially two sizes of refrigerated and insulated containers: 20 footers and 40 footers. There are two distinct structures that may be identified: Components of a Whole (Integral Reefer Containers, Integrated Units).

The temperature within this kind of refrigerated container is managed by an inbuilt refrigeration unit. Integral units need to be connected to the ship's power supply system before being transported. Most complete unit reregistration units for transportation by road and rail are powered by a generator set. It's possible that this will be a part of the refrigeration unit or connected to it.

Products that need to be transported at a consistent temperature above or below the freezing point are placed in refrigerated containers. In accordance with the required shipping temperature, these commodities are separated into chilled goods and frozen goods. They primarily consist of fruits, vegetables, meat, and dairy items like butter and cheese. In particular, bulky and light items use high-cube integral units (e.g fruits, flowers.) The majority of refrigerated commodities are now delivered in integrated units, which command a far larger market share than porthole containers.



40' High Cube Reefer Container

Dimensions*	Length	Width	Height
External	12192 mm	2438 mm	2895 mm
Internal	11560 mm	2286 mm	2500 mm
Door Openings		2286 mm	2478 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
30480 kg	4200 kg	26280 kg	60.2 cub.m



20' Reefer Container

Dimensions*	Length	Width	Height
External	6096 mm	2370 mm	2591 mm
Internal	5455 mm	2260 mm	2275 mm
Door Openings		2237 mm	2260 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
27000 kg	3050 kg	23950 kg	28.0 cub.m



40' Reefer Container

Dimensions*	Length	Width	Height
External	12192 mm	2438 mm	2591 mm
Internal	11555 mm	2286 mm	2280 mm
Door Openings		2285 mm	2245 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
30480 kg	4370 kg	26110 kg	60.2 cub.m

Figure 2.12: Refrigerated Container
Source: Starmarine services ltd.

- ix. Insulated Containers (Porthole Containers): As this sort of container lacks an internal refrigeration mechanism, it is frequently referred to as an insulated container rather than a refrigerated container. The central cooling system of the ship is used to provide cold air inside the container while it is at sea. Similar to integrated units, air circulates through the container. The "warm" air is expelled at the top while cold air is blown in from the bottom.



20' Insulated Container

Dimensions*		Length	Width	Height
External		6096 mm	2362 mm	2590 mm
Internal		5724 mm	2286 mm	2014 mm
Door Openings			2286 mm	2067 mm
Weights*			Capacity*	
Max. Gross	Tare	Max. Payload		
24000 kg	2550 kg	21450 mm	26.4 cub. m	



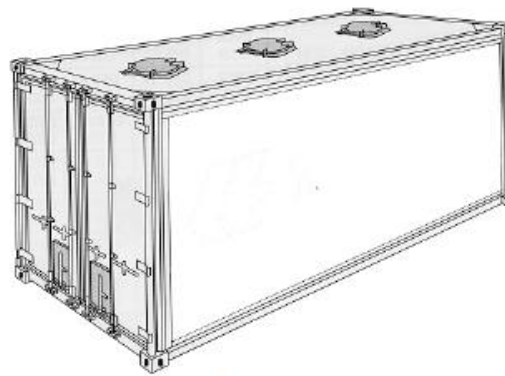
40' Insulated Container

Dimensions*		Length	Width	Height
External		12192 mm	2438 mm	2591 mm
Internal		11840 mm	2286 mm	2120 mm
Door Openings			2286 mm	2195 mm
Weights*			Capacity*	
Max. Gross	Tare	Max. Payload		
30480 kg	3850 kg	26630 kg	60.6 cub. m	

Figure 2.13: Insulated Containers
Source: Starmarine services ltd.

- x. Bulk containers: Three loading hatches with a diameter of roughly 455mm (13/4') each are located in the ceiling of bulk (or bulk cargo) containers. Center to center, there are 1.83 meters (6 feet) between the hatches. Two discharge hatches are located on the entry side and occasionally short discharge tubes are attached to them for guiding large cargo.

Alternatively, two unloading hatches for the containers could be put in the entrances. In particular, bulk goods like grains, feedstuffs, and spices is transported in bulk containers. They can, however, also be used to move common cargo.

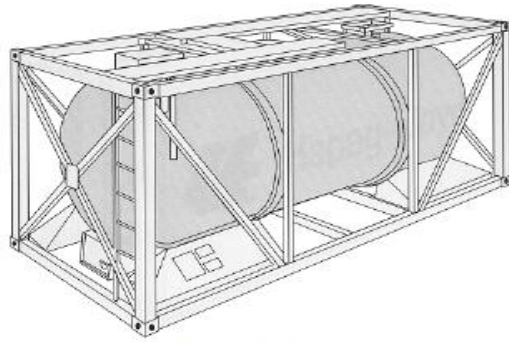


20' Bulk Container

Dimensions*	Length	Width	Height
External	6096 mm	2362 mm	2590 mm
Internal	5934 mm	2358 mm	2340 mm
Door Openings		2335 mm	2292 mm
Weights*			Capacity*
Max. Gross	Tare	Max. Payload	
24000 kg	2450 kg	21550 kg	32.9 cub.m

Figure 2.14: Bulk Container
Source: Starmarine services ltd.

- xi. **TANK CONTAINERS:** Tank containers are used for liquid cargoes such as foodstuffs such as fruits, juices, spirits, and sweet oils; chemicals such as fuels, dangerous compounds, and corrosive protective agents. Tank containers may be supplied with insulation or heating if the contents needs temperature-controlled transit.



20' Tank Container

External Dimensions To ISO*		
Length	Width	Height
6058 mm	2438 mm	2438 mm
Weights*		
Max. Gross	Tare	Max. Payload
30480 kg	4190 kg	26290 kg

Figure 2.15: Tank Container
Source: Starmarine services ltd.

DO NOT COPY. LEAD CLIP

RIA

2.1.6. Insulation

Insulation uses a substance or mixture of materials to minimise heat transmission into or out of a building (Thermal Insulation Association of South Africa [TIASA], 2010). Insulation allows a building to maintain a suitable temperature throughout the year (TIASA, 2010). In addition, it decreases the severity of the impacts of a fire or exposure to corrosive atmospheres, makes the crew safer and more comfortable by adjusting "surface temperatures for crew protection and comfort," and increases the heating and cooling systems' performance (Thermal Insulation Association of Canada [TIAC], 2013). Therefore, the purpose of insulation is to "increase a home's or a building's energy efficiency" (Tiasa, 2010: 23).

Insulation, according to the 2012 City of Cape Town Smart Structure Handbook, is one of the "most critical components of energy efficiency in any building" South Africa is one of the nations most afflicted by energy poverty; thus, buildings must use innovative and renewable energy sources to increase energy access and reduce energy costs (International Energy Agency, 2010). Insulation is one of the essential requirements for using shipping containers; thus, it is worth mentioning.

2.1.6.1. Factors to consider when choosing insulating material

The R-value to be utilised must be first considered when deciding the type of utilisation to use (Brodaski, Campanelli & Zabinski, 2010). R-value measures a substance's resistance to heat flow, with larger values indicating more resistance (Brodaski et al., 2010). The needed R-value should be determined by examining the room's needs and the heating/cooling equipment in place

Consideration must also be paid to how well the insulation resists fire and moisture and its overall durability (TIASA, 2010). Consideration must be given to the environmental effect of insulating materials, and the City of Cape Town Smart Building Handbook (2012) suggests utilising recycled and ozone-friendly goods.

2.1.6.2. Types and forms of insulation


Different forms of thermal insulation include bulk insulation, reflective foil laminate insulation (RFL), and composite bulk insulation (mixed bulk and reflective material) (TIASA, 2010).

- 1) Bulk Insulation: Most heat transmission is hindered by bulk insulation, trappers air between layers of insulating material (TIAC, 2013; TIASA, 2010). It contains polyisocyanurate, stag wool, polyurethane, rock fibre, polystyrene, cellulose, and glass fibre, among others (TIASA, 2010).
- 2) Reflective Foil Insulation Installation: Insulation built from aluminium foil laminates is known as reflective foil laminate insulation (RFL). RFL combined with air space in bulk insulation is advantageous because it functions as a heat flow buffer (TIASA, 2010). To limit the amount of radiant heat emitted and the amount of transferred heat, materials should be placed with their reflecting sides facing downward (TIASA, 2010). This material has exceptional thermal performance and resistance to water, dust, and ultraviolet light. However, defects like apertures, folds, and holes diminish its efficiency (TIASA, 2010). In the summer, these forms of insulation are more effective at preventing the sun's rays than blocking the heat (TIASA, 2010).
- 3) Additional types of insulation There are several types of insulation. Egg cartons, bubble wraps, blankets, duvets, and rags are some of the objects that may be utilised with stretch wire to create intriguing suspensions (Barnes, 2012). However, spray insulation is the most effective and often used kind of insulation available.

Additionally, the container or any goods stored inside it might be painted in vibrant hues (Chamber, 2014).

Table 2.1: Batt Blanket and Matt Insulation


<i>Material</i>	<i>Pictures</i>	<i>Characteristics</i>	<i>Challenges</i>
<p><u>Glass Fiber</u> (Glasswool) Made from molten glass and resin and formed into blankets, mats or rolls. Max opening temperature 350°C.</p>		<p>Light weight material that is suitable for standard tie beams and stud spaces. It easy to cut and set up. It will not slump if installed correctly.</p>	<p>Glass fiber can cause irritation to the, skin, respiratory system and eyes. Manufacturers manual to be followed strictly if done yourself. Performance affected by moisture</p>
<p><u>Mineral Wool</u> (Slag/Rock Wool/Stonewool) Made from molten industrial slag, limiting maximum operating temperature 850°C.</p>		<p>The appearance and texture of mineral wood is similar to that of glass fiber. It is heavier/thicker than glasswool and therefore has a higher R-Value per unit. The materials can resist high temperatures. (fire resistance)</p>	<p>These materials can cause irritation to the, skin, respiratory system and eyes. Manufacturers manual to be followed strictly if done personally. Rock wool is more costly than glasswool.</p>

<p><u>Polyester Fiber</u></p> <p>Fabricated using recycled polyester fibres (PET plastic bottles)</p> <p>150°C is the maximum permissible operating temperature.</p>		<p>It is easy to cut and set up</p>	<p>The materials melt and shrivel when exposed to fire.</p>
<p><u>Polyester Fiber batts</u></p> <p>Combination of polyester fiber and kenaf (renewable plant)</p>		<p>There are no documented health or physical adverse effects, and irritation is not one of them.</p> <p>It is available in batts weighing 24-100kg/m³ and boards weighing 50-300kg/m³.</p>	

Source: TIASA (2010)


Table 2.2: Loose Fill Insulation



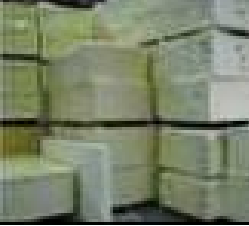

Material	Pictures	Characteristics	Challenges
----------	----------	-----------------	------------

<p><u>Cellulose Fiber</u></p> <p>Manufactured using recycled shredded paper</p>		<p>The material has been prepared to resist mould and fire.</p> <p>Insulation appropriate for providing consistency to irregularly shaped spaces and around obstacles (electrical wires and nails etc).</p>	<p>If the insulation is not blown to manufacturer's recommended density and thickness it can settle over time, and the intended R-Value will not be achieved and maintained.</p>
---	---	---	--

Source: TIASA (2010)


Table 2.3: Rigid Board Insulation

Material	Pictures	Characteristics	Challenges
<p><u>Vermiculite</u></p> <p>It is a close relative of mica and exists in two forms.</p>		<p>When treated vermiculite is coated with asphalt, it becomes water repellent and can be used in high moisture environments.</p> <p>The material does not irritate the skin.</p> <p>It has no odour and is not flammable.</p>	<p>Untreated vermiculite absorbs water in the opposite direction. The material dries out slowly.</p> <p>Despite its great density, it is rarely employed when looking for high R-values.</p>

<p><u>Expanded Polystyrene (EPS)</u></p> <ul style="list-style-type: none"> - derived from pentane gas <p>Surface operating temperature is limited to 100 C.</p>		<p>This plastic foam insulation is lightweight and easy to install.</p> <p>The material is recyclable, water resistant, and fireproof.</p> <p>It has outstanding thermal properties and is non-toxic.</p>	
<p><u>Extruded Polystyrene(XPS)</u></p> <ul style="list-style-type: none"> - constructed from polystyrene foam and available in two configurations <p>Maximum surface temperature of 100 °C</p>		<p>The high density material is appropriate for insulating high-temperature-exposed regions such as brick wall cavities and slab edges.</p>	<p>When exposed to intense sunshine, the material will degrade and lose its use.</p> <p>It must be safeguarded from chemicals that might cause its degradation.</p>
<p><u>Polyurethane and Polyisocyanurate</u></p> <ul style="list-style-type: none"> - constructed of polyalcohols and isocyanurates - constructed of polyalcohols and isocyanurates 		<p>When utilised within a building, the material should be covered by a fire-resistant substance such as dry wall.</p>	<p>The material should be shielded from excessive water and sunshine. It is used in confined locations that need high R-values due to its high cost.</p>
<p><u>Phenolic Foam</u></p> <ul style="list-style-type: none"> - composed of phenol formaldehyde resin and available in either open or closed cell forms 		<p>It is appropriate for wall sheathing and interior usage both above and below grade. Use is often restricted to regions that need a high R-Value yet have limited space.</p>	<p>The material should be shielded from excessive water and sunshine.</p>

Source: TIASA (2010)

Table 2.4: Spray Foam Insulations

Material	Pictures	Characteristics	Challenges
<p><u>Polyurethane Foam</u></p> <ul style="list-style-type: none"> - blended on-site for extensive application - also available in tiny cans for limited uses (doors, windows) 		<p>The foam works as a sound barrier but not a moisture barrier. When utilised in the inside of a building, it must be covered by fire-resistant materials, such as drywall.</p>	<p>The material should be shielded from excessive water and sunshine.</p>

Source: TIASA (2010)

2.1.7. Traveller Rest Point

One of the most typical types of roadside services with parking and rest areas is a travelers' rest area. Since they offer drivers a secure and comfortable location close to the mainline, they are regarded as essential elements in the roadway network. The purpose of this facility is to offer road users a variety of amenities, including places to eat, sleep, rest, use the restroom, check vehicles and cargo, and rest. In order to safely park their vehicles and recuperate before continuing their journey, drowsy and exhausted drivers frequent rest areas (Alkhatni et al., 2021).

Rest places also have unique qualities that are not present at other facilities, such the availability of parking spaces for large cars and the possibility to stroll and take in the surroundings while doing so, as well as elements that make them accessible to children and people with disabilities. Rest areas are situated in rural areas, between towns, along state boundaries, or in large metropolitan areas where there is a high demand for services from motorists. Generally speaking, rest area facilities contribute to increased traffic safety, comfort and convenience for travellers, and easy access to pertinent information for drivers (Alkhatni et al., 2021).

A traveller rest area is an off-road facility for motorists that is not mainly designed for commercial usage or camping. Under this definition, rest places may vary from a small pull off or layby to vast service areas with several amenities, including cafés. This document is a digital reproduction of a 1994 dissertation completed at Lincoln University. Rest facilities on restricted-access highways for long-distance truckers are often more pleasant and convenient than ordinary rest stops. It is not necessary for travellers to deviate from the main road to use the toilet or purchase food or fuel. To wit: (Alkhatni et al., 2021).

2.1.7.1. Benefits of Rest Areas

The rest area is an essential component of key road networks because it delivers various advantages to road users, stakeholders, and outside entities. In general, the rest stop is easily accessible from the major highway and includes basic facilities such as parking, bathrooms, food, picnic tables, and travel information. The existence of rest spaces on the mainline benefits three groups: road users, highway stakeholders and other authorities, and outside entities (e.g., the tourism industry, local commercial businesses, etc.). The following are some of the advantages of rest areas:

- i. enhanced safety in public transportation,
- ii. Shelter during hazardous or emergency conditions
- iii. Improved roadway convenience and comfort
- iv. reduction in unnecessary travel and diversion

A. Enhance Safety and Traffic Operation: In general, rest areas work to increase traffic safety and operation by lowering fatigue-related collision rates, resolving shoulder parking conflicts, and offering cover during emergencies and hazardous situations.

The main purpose of the rest area is to increase traffic safety by lowering the number of road crash events. Another important rest area system concept is to improve traffic flow by lowering the number of trucks parked on the shoulder or ramp of high-

velocity highways, hence creating safer conditions for users. Having enough parking at rest places is a major problem (Alkhatni et al., 2021).

B. A Shelter During Hazardous or Emergency Conditions: Road users may be compelled to quit the road for a number of reasons, including bad weather, poor visibility, road closures, or emergency situations. Driving under hazardous weather conditions raises the risk of suffering serious injuries in an accident. When a moving vehicle experiences a small technical issue on the road, the driver will keep going rather than stop in an unsafe place on the shoulder in search of a safe and secure location. Under the aforementioned circumstance, parking at an undesignated or risky location is preferred over a rest area, which is seen as a shelter (e.g., the shoulder or ramp). Highway authorities also employ rest area amenities as assembly sites in unforeseeable situations (such as weather, road conditions, current traffic, etc.) to deliver vital information that aids travelers in selecting safe and enjoyable routes. The advantages of rest spaces for safety in bad weather or emergency situations, however, have not been investigated or quantified in any studies. It can be said that rest spaces are crucial for reducing traffic accidents in emergency and dangerous situations (Alkhatni et al., 2021).

C. Comfort and Convenience Benefits: A rest area facility's ability to improve road users' comfort and convenience is one of its main advantages. There is a consensus that the advantages of rest spaces do not originate from the facility itself. Instead, these advantages result from the created effects on the roads. Drinking fountains, restrooms, vending machines, parking spaces for both heavy and light cars, accommodations, communication, entertainment, and the availability of additional amenities are just a few advantages that can reflect convenience and comfort connected with a rest area. There are a number of intangible and difficult to properly measure convenience and

comfort advantages provided by rest spaces. However, they can be assessed using a proxy financial value that gauges how much road users are prepared to pay to enjoy rest area amenities. The willingness to pay approach is frequently used to calculate the price of intangible advantages from rest places, however survey participants may overestimate the true worth of these benefits. Additionally, features may differ from one rest space to another. That variance in usage fees cannot be taken into account by the willingness to pay technique (Alkhatni et al., 2021).

D. Benefits of Reduced Excess Travel and Diversion: Rest zones at both completely and partially controlled access roads have an impact on how drivers behave and possess certain qualities. Therefore, in addition to safeguarding the infrastructure of secondary roadways, rest areas offer significant benefits to road users by reducing unnecessary travel and diverted time that they might spend looking for desired services on the road (such as a restroom, communication, safe parking spot, etc.). The numerical difference between the real distance needed to drive (e.g., distance or time) to the closest commercial service centers (e.g., gas station, truck stop, small grocery, etc.) and the actual distance needed to enter a rest area is known as excess travel on limited-access roadways. Detours and excessive travel distances incur additional expenditures for operation and consumption of time (i.e., consuming fuel, depreciating vehicle, vehicle deterioration, and maintenance cost). Therefore, the extra travel time and operating vehicle expenditures resulting from leaving a limited-access roadway in search of the closest travelers rest stop can be used to calculate the beneficial reductions from excess travel and diversion.

2.2. Empirical Review

2.3.1. Shipping Containers as A Housing Solution

In situations when a temporary space is required, containers are frequently used as building modules. Most engineering construction sites will need one or two containers to serve as site offices. As a result of its usage as a transit space and their prompt availability when needed, containers are also fairly common (Slawik, et al. 2010). Containers can also be utilized for the construction of public structures, offices, residential housing, social/low budget architectural projects, commercial/corporate buildings, event/exhibition centers, art installations, etc., according to Slawik et al. (2010).

According to Cleveland Containers, shipping container homes are single- or multi-family dwellings made primarily of new or used shipping containers. According to a 2019 report on shipping container homes, the global market for container homes is expected to reach \$73 billion by 2025. Millions of shipping containers around the world are lying idle because they are often used for one-way purchases, making them ready for usage.

Modular construction techniques include the use of shipping containers for housing. The majority of the work may be completed off-site, and after that is done, shipping the containers to the installation site is all that is required. As a result, regions can be transformed totally in a short amount of time.

Around the world, several studies on shipping container homes have been done. According to research by Wong, Ling, and Tan (2018) on the viability of using ISO shipping containers to construct affordable housing in Malaysia, the creation of container homes in that country is only partially advised because 45% of Malaysians are open to the notion of residing in one. Future research should, according to the study's recommendations, look at how Malaysia's government perceives the viability of developing container homes there.

Using a case study methodology, Maphumulo (2016)'s study on the implications of using shipping containers to build affordable housing examined residents' perceptions of container homes in the Windsor East neighborhood, which is known for housing people with low to lower-middle incomes. The study's findings showed that locals saw the container development as providing appropriate accommodation and their individual apartments as places where they may generally express themselves, develop, and grow.

Balogun (2018) conducted another case study in Lagos, Nigeria, and found that if the same requirements are followed, the cost of a shipping container there is nearly identical to and slightly more than that of a conventional building. Because shipping container housing is quick to build but challenging to compete with and perhaps even replace traditional buildings, it is a feasible option. The study also showed that if a community chooses to rent or purchase a shipping container home, it will be acceptable. The results suggest that 84% of respondents will rent or buy such home while 16% will not, demonstrating that the community has at least some level of acceptance for the proposed solution.

Therefore, it is advised to gain vast knowledge and real-world experience to fully understand that when built, made economical, and ecologically friendly, shipping container homes are just as nice as any other home. According to Balogun (2018), additional research is required to create a viable subsidised program for the development of shipping container housing. Private landowners and developers will also gain additional knowledge from the program. The study also addressed ways to considerably lower the cost of shipping container homes compared to present pricing in and around Lagos by employing local materials. And how lower-middle-class individuals will be able to buy it for less than 30% of their take-home pay.

Additionally, Balogun (2018) proposed that employing shipping containers in conjunction with traditional housing techniques could be beneficial. As a result, appropriate housing must

be provided in Lagos, despite the fact that present construction techniques cannot produce the required number of homes each year and that Lagos' population is still growing.

2.3.1.1. Shipping container homes in developing countries

Shipping Container homes are a new sector in developing nations, and little research have been done on the comments received so far. There is a significant backlog of families waiting for homes in most nations, especially the developing ones, according to several surveys. As a result, many businesses are now offering affordable housing options, and container homes were one of the greatest brainchild ideas.

On an article titled “How much do shipping container homes cost in South Africa?” (Johannes van Graan, 2019). The article demonstrated that the cost of shipping container homes is far lower than the cost of a conventionally constructed home.

Another study of 13 South African homes made of used shipping containers revealed that the practice is currently gaining acceptance in South Africa. They are discovering more and more inventive and imaginative ways to construct sustainable homes in contemporary architecture and design. One of the methods this nation ensures is by contacting a container home shipping company that can not only ship the structure but also build it. A4AC Architects and Big Box Containers are two businesses that have completed numerous projects in Africa.

Balogun (2018) found in a Nigerian study on shipping containers as an alternative housing solution that the demand for decent, affordable housing has surged recently. There are a number of factors contributing to Lagos' growing housing shortage, but the primary one appears to be the fast urbanization that goes hand in hand with the country's ongoing population growth.

2.3.2. Advantage and Disadvantage of Shipping Container Homes.

According to a 2016 article by Justin-Anley, the advantages and downsides of shipping container homes are outlined below.

2.3..1. Advantages (Justin-Anley, 2016):

- i. Shipping containers are an excellent alternative for building. There has been a current recycling trend toward these containers because of their use in the construction industry owing to their lifespan, adaptability, lightweight, cheap cost, and ease of stacking.
- ii. They can be constructed into housing facilities easily.
- iii. They can be insulated and made into a comfortable year-round residence, regardless of the season.
- iv. The containers' primary use as means of transportation makes them portable.
- v. Made to withstand extreme conditions (extreme weather and salt corrosion), to be piled in columns, and to support massive weights.
- vi. They are sturdy and can endure storms, tornadoes, and earthquakes (vi). A single ISO container can withstand winds of up to 100 miles per hour if placed on its own. It can withstand gusts of up to 175 mph if properly secured. They are the most secure forms of storm shelter construction and will never collapse in the event of an earthquake.
- vii. Steel shipping containers lose their value as cargo carriers after just five years, and they often sit abandoned at shipyards for years, so they may be purchased for a low price since they are considered a waste product. The goal is to encourage people to live a more eco-friendly and sustainable existence by encouraging them to reuse these containers.
- viii. It is a low-priced building material that gets the job done.
- ix. Rapid construction

2.3.2.2. Empirical Discuss of Shipping Containers When Used in Design of Homes

Sustainable designs have been made possible by the usage of shipping containers; some of these design successes are covered in this section. Cost-effectiveness of the product is one of these accomplishments. Used shipping containers can drastically minimize the overall expenses of a residential housing project because they are typically less expensive than new ones. Even with the additional costs for design, delivery, permits, site preparation, infill, and customisation, shipping container homes are often less expensive per square foot than similarly sized traditionally built homes. A typical design for a simple one-story residence built with shipping containers can be had for as little as \$15,000. Although transportation, site preparation, and furnishings are not included, there is still a sizable cost savings as compared to typical building (Berbesz & Szefer, 2018).

Another accomplishment is that shipping container design is so reasonably priced in the home market because of the ISO standardization that makes containers so useful in the transportation business. Standardization makes prefabrication possible for architects and designers. This benefit decreases the amount of time required to excessively tailor architectural and mechanical plans, which reduces the amount of time needed for design, on-site building, and additional expenditures. A few building supplies can also be prefabricated and delivered directly to the construction site for quick installation. This kind of technology, according to SG Blocks, a pioneer in the container environment sector, can cut prices by up to 70% and building time by up to 40%. (Berbesz & Szefer, 2018).

The use of shipping container design to cut down on building costs and construction time has evident financial benefits. Globally, we use raw resources for construction purposes, which has a severe negative influence on the environment. Millions of acres of forest are cut down for building materials, which are then manufactured in factories and carried in polluting vessels. According to the U.S. Green Building Council, building construction uses 39% of the

country's primary energy, 70% of its resources, 12.2% of all drinkable water, or 15 trillion gallons yearly, and 40% of the world's raw materials (3 billion tons annually) (USGBC, Senate Statement, 2007). Container building often uses less cement depending on the site. Some construction sites don't even need to use cement. Given that the cement industry is infamous for being one of the main generators of carbon emissions, this is in favor of a more ecologically friendly approach to construction.

According to Drewry Maritime Research, nearly 30 million containers have been kept in docks worldwide since 2012. (Moore, Yildirim, & Baur, 2015). Reusing and upcycling containers not only saves money because shipping empty containers back to their original ports is not cost-effective, but it also gives builders the chance to repurpose resources that would otherwise go to waste in the world. The areas where construction is permitted has decreased due to the overall risk of wildfires brought on by climate change. Strict legal restrictions that limit the amount of available land, limit the number of development opportunities, and raise costs add to this problem.

Depending on the application, the versatility of container construction enables it to accommodate a greater number of homes while having a less environmental impact. Resources must be used during the container conversion process to create a living area. Prior to installation, sand blasting and the removal of some waterproofing and insecticide chemicals are required. Additionally, windows and door apertures need to be built. More sustainable than hardwood, bamboo flooring is used in the construction of newer containers. An energy consumption of 500 kWh or less is typical for a shipping container's conversion to habitation. Nearly 8,000 kWh of energy are normally needed for the disposal of an empty container (Berbesz & Szefer, 2018).

It is simple to observe which design has a smaller environmental impact when comparing the difference in carbon emissions between building a two-story single family home using conventional architecture methods (about equal to 88 tons) and doing so utilizing two 40' shipping containers (Berbesz & Szefer, 2018).

All throughout the world, including Southern California, people are feeling the effects of climate change. The majority of California is at a high danger of wildfires due to strong winds and extended droughts. Additionally, earthquakes frequently occur in this region of the nation. In this kind of climate, shipping containers have shown to be effective housing options. When utilized as intended, shipping containers are built to carry huge loads and priceless cargo through adverse weather (Radwan, 2015). Their steel structure makes them fireproof, and when correctly erected and secured, they are seismically sound and can endure hurricane-force winds (Dugal et al., 2016). As a result of the acceptability and popularity of shipping container architecture, governing bodies, engineers, designers, and other key figures in the sector are beginning to collaborate to develop rules and licenses that will guarantee its sustained and improved safety.

Disadvantages (Justin-Anley, 2016):

- Construction permits and building regulations are still required (same as usual residential)
- It may be tough to locate contractors with expertise.
- It is a fixed structural unit
- Conductivity of steel at high temperatures
- Condensation caused by excessive levels of moisture in uninsulated containers
- Demand for specialised labour for major container alterations (factory-based)
- Requires a significant amount of travel and cranes for lifting and placing operations

- Presence of solvents and hazardous pollutants (such as lead chromate in the primer paint)
- Containers that are severely damaged cannot be restored
- International steel price fluctuations and a rise in demand for containers might negatively impact costs.

2.3.2.4. Empirical Discuss of Design Challenges in The Use of Shipping Containers for Housing Construction.

Despite all of its benefits, shipping container architecture is not without its difficulties and detractors. While the majority of architects and industry experts agree that container architecture can be the best option in the right circumstances, some think the disadvantages simply outweigh the benefits in the majority of cases (Dugal et al., 2016).

The increased acceptability of sustainable building practices and awareness of carbon footprints are responses to the environment's unpredictable and volatile response to climate change. The ability to reuse used containers reduces the amount of waste materials across the world, which is one of the sustainable appeals of shipping container design. Chemicals like chromate, phosphorous, arsenic, and chromium, which are typically employed as pesticides, must be removed prior to building because shipping containers are not meant to be used as homes. Because lead-based paints are frequently used to construct containers, they must be removed during the sandblasting procedure (Dugal et al., 2016).

Containers are made with a 10-year life expectancy in mind. Typically, used containers have dents and scrapes from use and transportation. The dents and scratches need to be repaired in order to prolong their lifespan and prevent rust and future deterioration. Regular painting on refurbished containers can increase their lifespan by more than 20 years (Dugal et al., 2016).

A container is prepared for installation once the entire abatement procedure has been completed.

Due to the use of steel in container construction, which quickly absorbs heat and cold and makes it challenging to control internal temperatures, new problems have arisen. While this problem is manageable, insulation requires room, which limits the interior dimensions and, depending on the type employed, may also be harmful to the environment. Eight feet is the usual width for containers. After insulation is placed, the internal dimension is less, resulting in a small living area (Dugal et al., 2016).

According to International Residential Code R304.1, livable rooms (usually used for sleeping and living) must be at least 70 square feet (6.5 m²) in size, with a minimum length and width of seven feet (International Residential Code, 2018). Furthermore, utilities present difficulties for container architecture. Electrical, plumbing, and other mechanical services can be hidden behind walls, ceilings, and floors in traditional architecture. Polyvinyl chloride (PVC) pipe and heating, ventilation, and air conditioning (HVAC) ducts are not as forgiving as electrical wiring, which can typically fit behind finished walls inside the container. Due to a lack of available space for HVAC ducts, standard central air conditioning is typically unable to be installed in locations where hot weather is a concern, such as Southern California (Discover Containers, 2016).

Building regulators frequently struggle to understand the complicated requirements of shipping container architecture. It happens frequently that the rules change depending on whether the installation is completed entirely on-site or whether some components are prefabricated and built off-site. Dealing with officials makes it difficult to interpret laws and building rules. People who aren't familiar with this type of construction are frequently perplexed and judge conformity using their own interpretation. State rules, zoning regulations,

and ambiguous building codes are frequently the source of disputes and occasionally required design changes (Discover Containers, 2016).

Architects, builders, interior designers, and urban planners from all around the world have worked together to recognize and use shipping container architecture. The modular design of containers has proven to be an effective solution for many multi-unit residences and may be utilized as a base to address several global housing concerns. Case studies of these applications can offer qualitative investigation to compare and better comprehend the ideas and reasoning underlying the solutions (Dugal et al., 2016).

DO NOT COPY. LEAD CITY UNIVERSITY, NIGERIA

Chapter Three

Methodology (Case Studies)

3.1. Case Study

A case study is a meticulously recorded and systematic investigation of a project's decision-making, process, and outcomes that is conducted to influence future practise, policy, theory, and/or education (Francis, 1999).

The case study method is differentiated by the purposeful selection of the case to investigate and triangulation, which often involves the use of several data collection methodologies. In the interest of theory or other situations, generalisations are drawn from a particular instance. A competent method of study design seeks to offer answers to the predetermined research questions. The case study research method was used to assess critically the values, limits, ethical and practical challenges that might arise in architectural research and conclusions as a consequence of the aforementioned factors (Adewumi et al., 2020).

Therefore, a critical evaluation of the values, constraints, ethical, and practical difficulties that may arise when using the case study approach to analyze the architect's duties at each step (pre-construction, construction, and post-construction) of the building delivery process is necessary (Adewumi et al., 2020). Research in architecture frequently uses the case study methodology. This second generation of case studies, which is inclusive and pragmatic, combines these two traditions (Adewumi et al., 2020).

The work of a designer is built on comparisons between actual design situations and well-known cases from their repertory (Schön, 1991). An artefact might be the situation in the realm of architecture. Knowing the historical context of an artifact's design is frequently necessary for understanding it, as well as its modern surroundings (Adewumi et al., 2020).

As a result, historical case studies are common in architecture. The design process and occasionally even the researcher's own creative endeavors itself could be the case. As a result, it is essential to go beyond the limitations of what is typically thought of as a method of conducting research (Adewumi et al., 2020).

When attempting to get a comprehensive understanding of a subject, event, or phenomenon within the context of real-world experience, the case study technique is very useful. Case studies are a powerful tool for conducting investigations into relevant current building typology for further analysis and deductions in order to obtain a significant architectural services delivery (Adewumi et al., 2020).

3.2. Research Method

In this study, a case study methodology was used, and four facilities were chosen for investigation. The outcome will be presented in a descriptive manner utilizing images and photos. The four case studies were conducted on existing shipping containers that were being utilised as an alternative building material at three foreign and one Nigerian travelers' rest areas. The purpose of the carried out case study is to serve as an actual example or as a guide towards achieving a realistic design as well as to learn through their analysis, the merits and demerits of their design in order for the proposed design to imbibe some of their merits and then improve on the demerits, especially in attaining a unique designed form that will provide easy accessibility to travelers.

The case studies are however carried out on the following travellers rest point

1. Travelers Container Hostel Jinan China
2. Rest Area Niemenharju Lake Kolima Finland
3. Georgia Rest Stop, Lochini, Georgia
4. Dankade Rest Stop Area Rigachikun Kaduna Nigeria

3.2. Case Study One: Travellers Container Hostel, Jinan China

3.2.1. The Design Concept

The "Animal Home" theme camp will soon be open to tourists in Jinan's Wild World. This theme camp's structures resemble scattered boxes in the woods, and the whole location is designed for visitors to explore and learn about nature. The theme camp has a total area of 4 hectares.

It is situated on the banks of the picturesque Wangyun Lake, west of Wild World Jinan. This project's two themed container camps (the open event spaces and the speciality eateries) make it an ideal place for summer camping and s'mores parties.



Figure 3.1: showing the main entrance
Source: Researchers fieldwork



Figure 3.2: showing the site lay-out
Source: Researchers fieldwork



Figure 3.3: showing the aerial view
Source: Researchers fieldwork

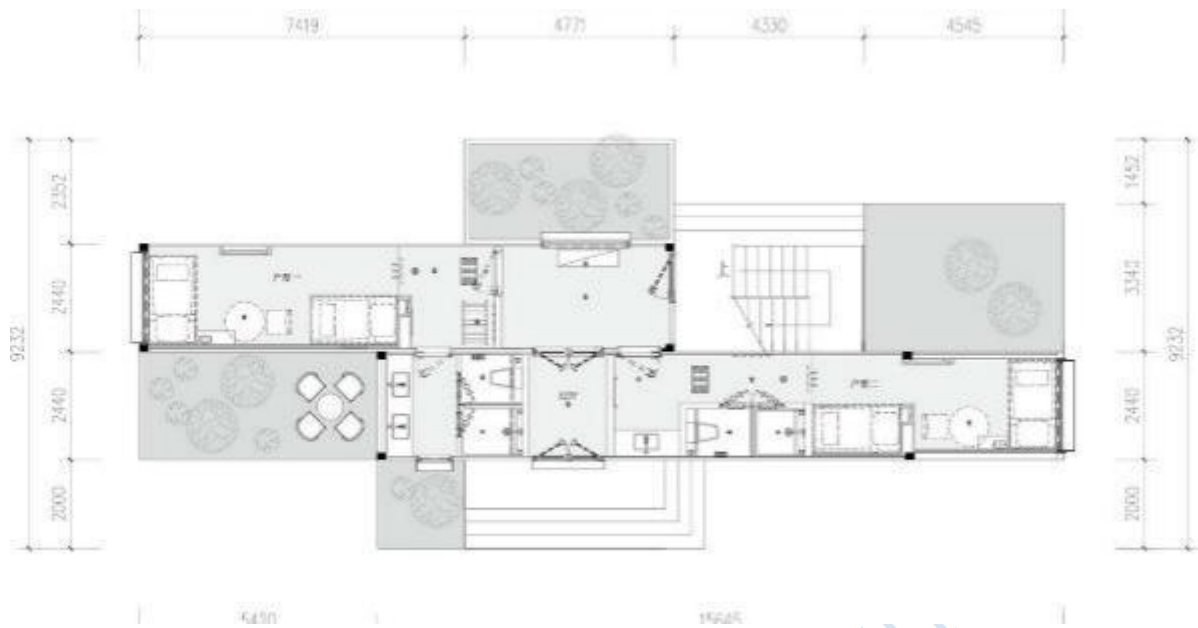


Figure 3.4: showing the floor plan
Source: Researchers fieldwork



Figure 3.5: showing the floor plan
Source: Researchers fieldwork

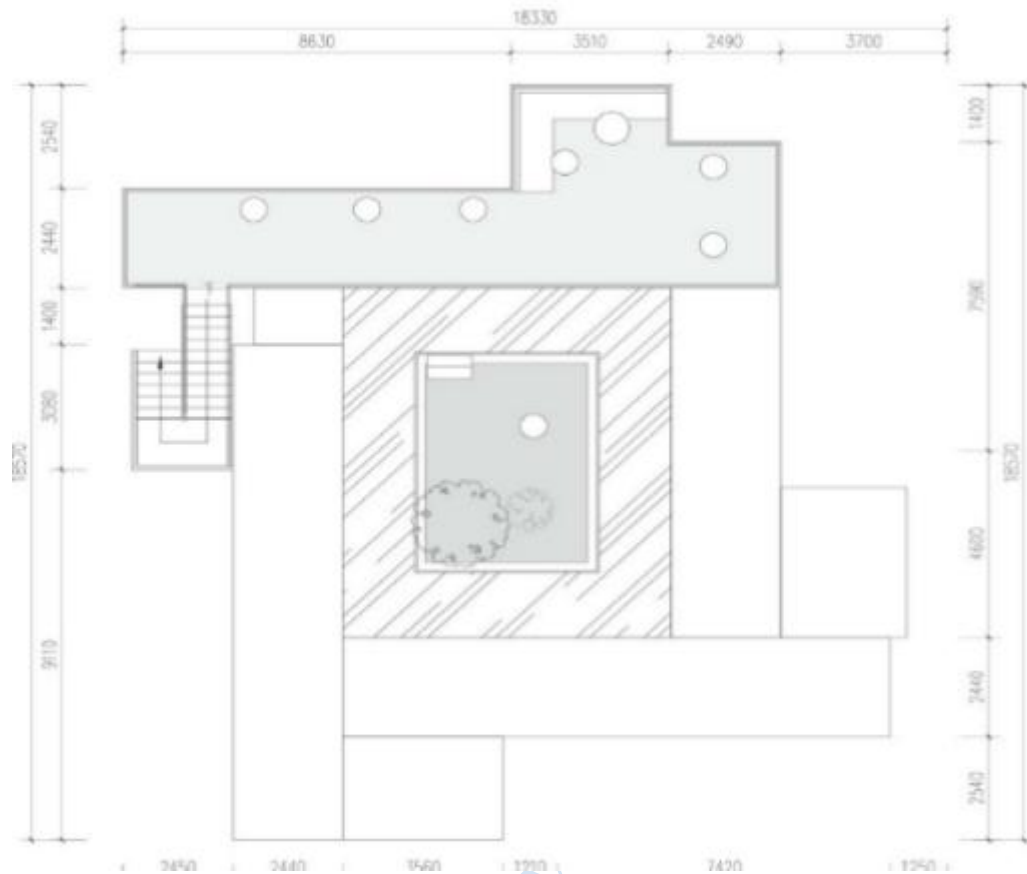


Figure 3.8: showing the floor plan
Source: Researchers fieldwork



Figure 3.9: showing the arrangement of the shipping containers
Source: Researchers fieldwork



Figure 3.10: showing the typical type of container home
Source: Researchers fieldwork



Figure 3.11: showing the stacking of shipping containers on each other
Source: Researchers fieldwork



Figure 3.12: showing the court yard
Source: Researchers fieldwork



Figure 3.13: showing the landscape of the travellers rest area
Source: Researchers fieldwork

3.2.2. Appraisal

3.2.2.1 Merit

In the design concept of natural ecology, the designer strives to create a wonderful dialogue between "small buildings" and "great nature" and try to make a new experience of "coming from nature and going to ecology". Therefore, they want to bring all users a unique accommodation experience.

3.2.2.2. Demerit

The camp lacks some facilities with can make it more convenience for the user. Such facilities are fuel station. Canteen, rest point for traveler non-lounging etc.

3.3. Case Study Two: Rest Area Niemenharju, Lake Kolima, Finland

This rest stop was created with the surrounding natural beauty in mind. In addition to offering a nice break from the monotony of driving, the region offers breathtaking, unobstructed views of the lake. 24 tree-like columns are arranged in an 8m × 8m grid around the Main Building to serve as a barrier between the road and the forest. As visitors wander amid the columns, they will believe they are in a verdant forest. They are carrying a big canopy that arches high toward the roadway in an attempt to attract the attention of passing motorists. The canopy protects all users from the weather by enveloping the structure's fueling area and pedestrian path. All auxiliary activities are concealed in black cubes under and above the canopy, blending them into the murky backdrop of the forest.



Fig

Figure 3.14: showing the design concept
Source: Researchers fieldwork



Figure 3.15: showing a perspective view
Source: Researchers fieldwork

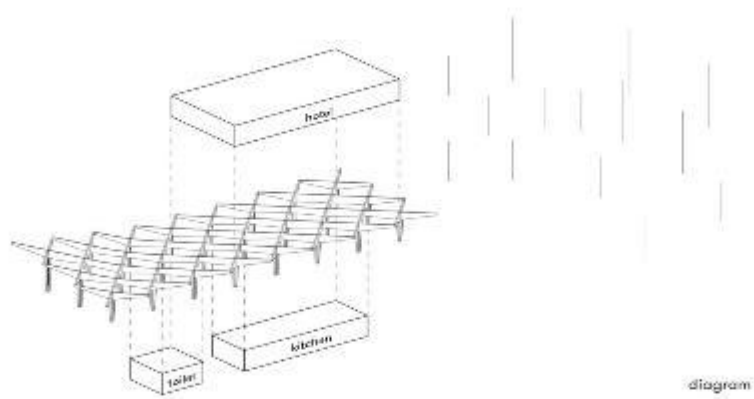
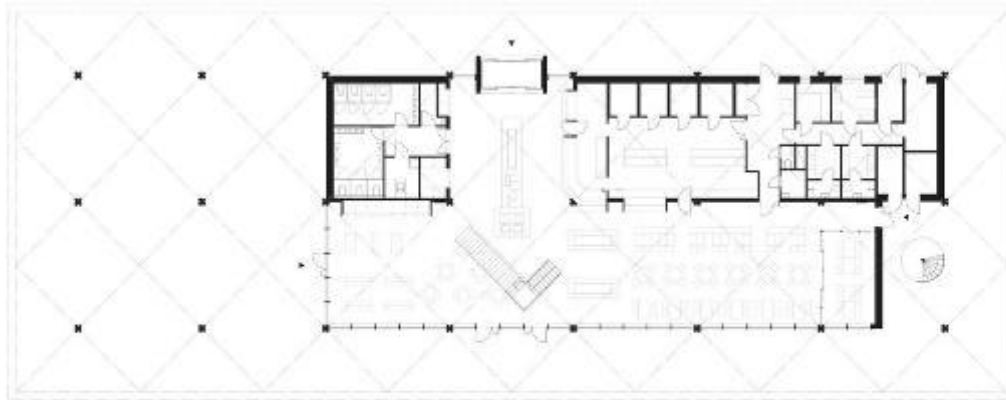


Figure 3.16: showing the conceptual development process
Source: Researchers fieldwork



Figure 3.17: showing an interior view
Source: Researchers fieldwork



ground floor

Figure 3.18: showing the ground floor
Source: Researchers fieldwork

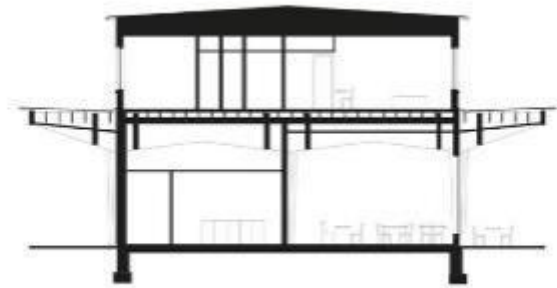


Figure 3.19: showing a section
Source: Researchers fieldwork

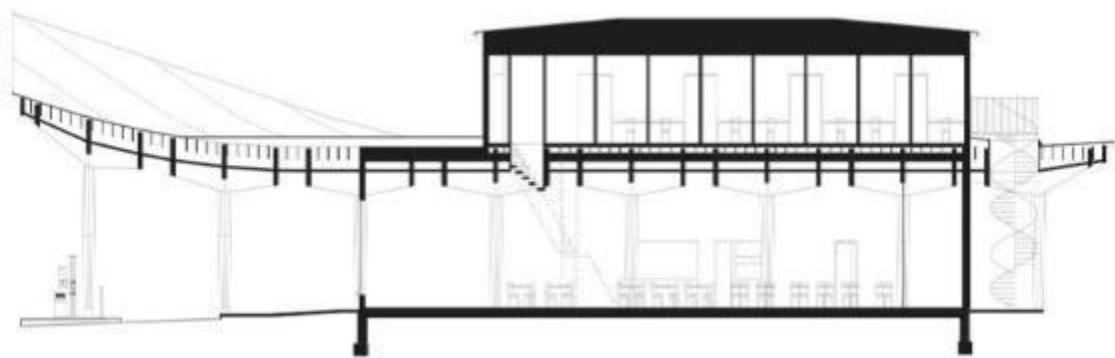


Figure 3.20: showing another section
Source: Researchers fieldwork



Figure 3.21: showing another interior section
Source: Researchers fieldwork

3.3.2. Appraisal

3.3.2.1. Merit

Existing vernacular structures on the campground served as models for the new structures' design. Stained black, the new structures disappear into their natural surroundings. Also, this aids in highlighting the historic structures. A Place to Take a Break When it comes to gas stations, Niemenharju is definitely not the norm. It is a quiet place to get away from the hustle and bustle of the city and relax, dine, and sleep. All of this is made possible by eco-friendly, forward-thinking, and conventionally unconventional timber building.

3.2.2.1. Demerit.

The rest area lack facility like vehicle maintenance point. The vehicular movement is not define away from the pedestrian, the vehicle parking is not define.

3.4. Case Study Three: Georgia Rest Stop, Lochini, Georgia

3.4.1. The Brief

The projected highway would traverse Georgia and link the Republics of Azerbaijan and Turkey; in 2009, the director of Georgia's Roads Department commissioned J. Mayer H. to construct twenty rest stations along the route. Two rest stops have been completed, while a third is under development.



Figure 3.21: showing a front view
Source: Researchers fieldwork



Figure 3.22: showing a perspective
Source: Researchers fieldwork

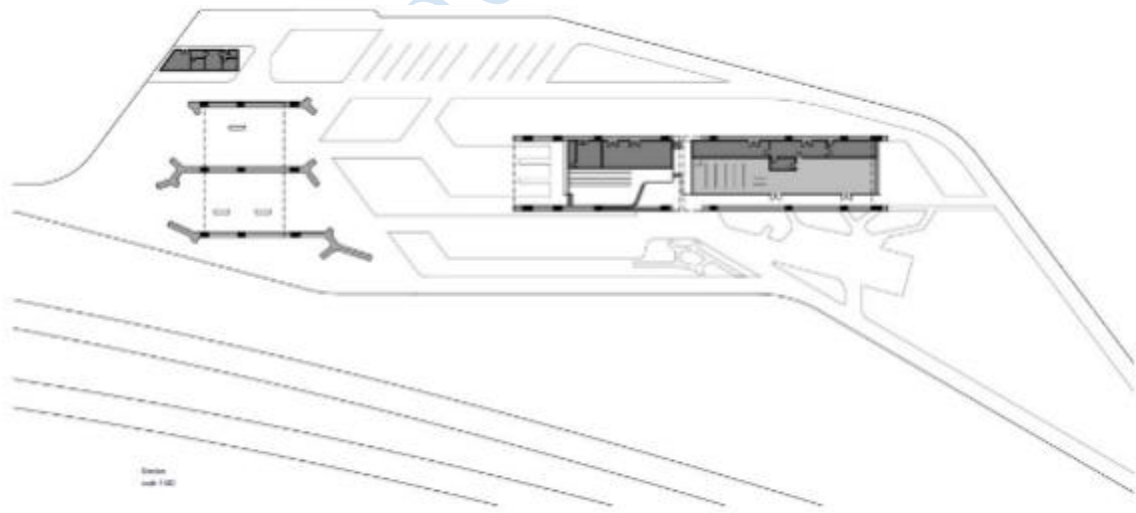


Figure 3.23: showing the site plan
Source: Researchers fieldwork



Figure 3.24: showing a façade detailing on the material used
Source: Researchers fieldwork



Figure 3.25: showing the filling station on site
Source: Researchers fieldwork

3.4.2: Analysis

3.4.2.1. Merit.

The rest stop is located on selected scenic viewpoints along the route and serve as activators for their area and neighboring cities, including not only nearby a gas stations and supermarket, but also a farmers' market and a cultural space for local arts and crafts

3.4.2.2. Demerit.

The rest stop did not control the vehicular movement among the trucks, cars and pedestrians.

3.5. Case Study Four: Dankade Rest Stop Area Rigachikun Kaduna Nigeria

3.5.1. The Brief

The Dankande rest stop is located twenty kilometers outside of Kaduna town on the Kaduna–Zaria–Kano dual highway. It sits outside the Kaduna urban area's planned radius of 12 miles (19.3 km). According to the 1967 Kaduna Capital Development Plan, the rest region is an undeveloped tract of land on the city's outskirts. In the leisure zone, there are options for structuring lifestyles and producing money. The construction of the rest stop is a creative response to an urgent community need.



Figure 3.26: showing a location map
Source: Google map



Figure 3.27: showing the parking area
Source: Researchers fieldwork



Figure 3.28: showing shanty buildings and walkways
 Source: Researchers fieldwork

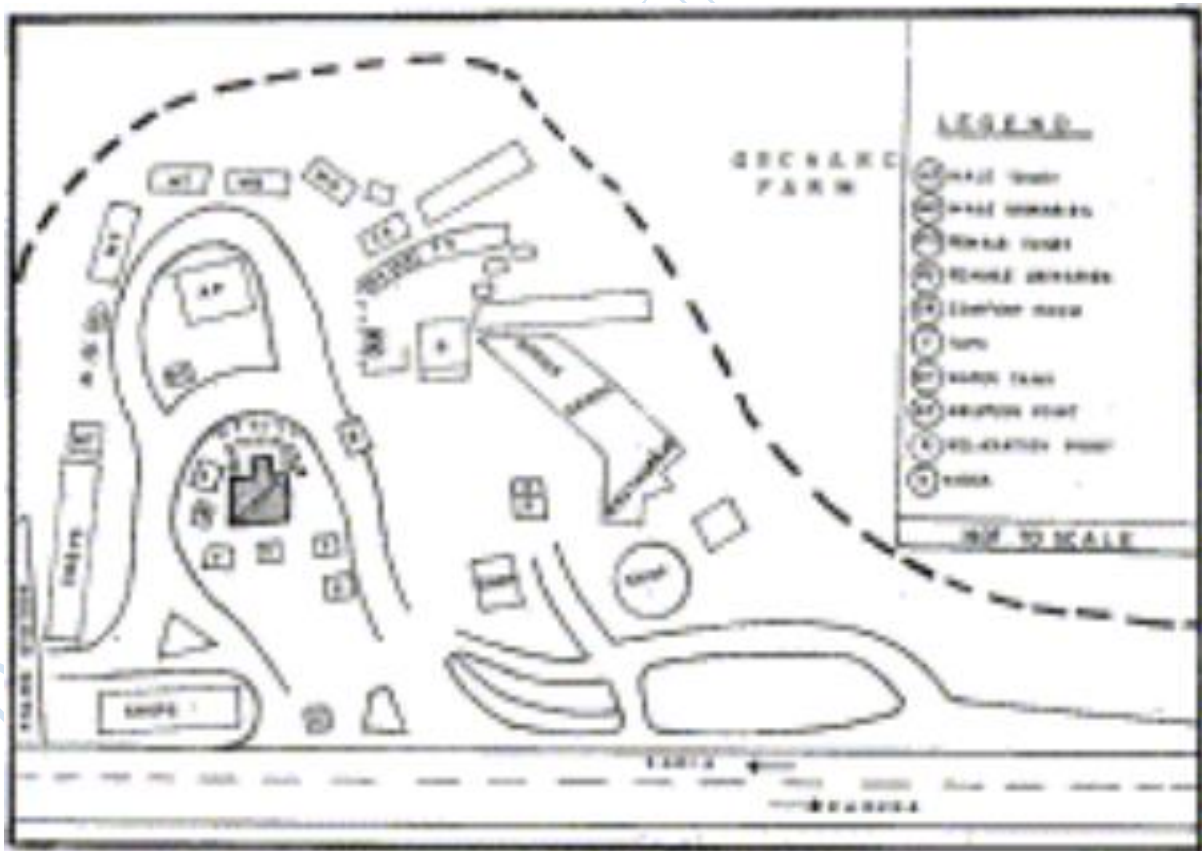


Figure 3.29: showing the site plan/layout of the rest area
 Source: Google

3.5.2. Analysis

3.5.2.1. Merit

The rest stop has easy access to every shop space i.e car can easily drive through the space.

The development of the rest area has attracted jointly exploit an opportunity similar to urban renewal situations.

3.5.2.1. Demerit

The rest stop did not create parking for trucks and also not control the movement pedestrians away from vehicular movement. Most of the shop are temporary structures as shown in Plate

3.3.



Figure 3.30: showing that most of the buildings are temporary structures

Source: Researchers fieldwork

Chapter Four

Site Analysis and Design Synthesis

4.1. Brief Analysis

4.1.1. Design Brief

Due to the nature of bad roads in the Nigeria and some road eventualities such as traffic, accidents etc., motorist could be faced with the challenges of delay, consequently leading to the need to rest and refresh themselves shortly or overnight before continuing their journey which bring about the need for a public facility called “TRAVELLER’S REST AREA”.

Therefore, the Kogi state government have commissioned me to provide a design proposal for a traveler’s rest area within Lokoja. Features should include restaurant, motel, gas station, conveniences etc.

4.1.2. Design Brief Development

After analysis of case studies, the brief was developed to include facilities such as

1. Gas station.
2. Food and refreshment facilities
3. Internet café
4. Public conveniences
5. Parking space vehicles
6. Security post
7. Fire station
8. Accommodation (motel)
9. Supermarket

10. Bookshop

11. Car wash.

4.2. Study Area

4.2.1. Site Location

The site of the proposed traveller's rest area will be located in Lokoja, the capital of Kogi State.

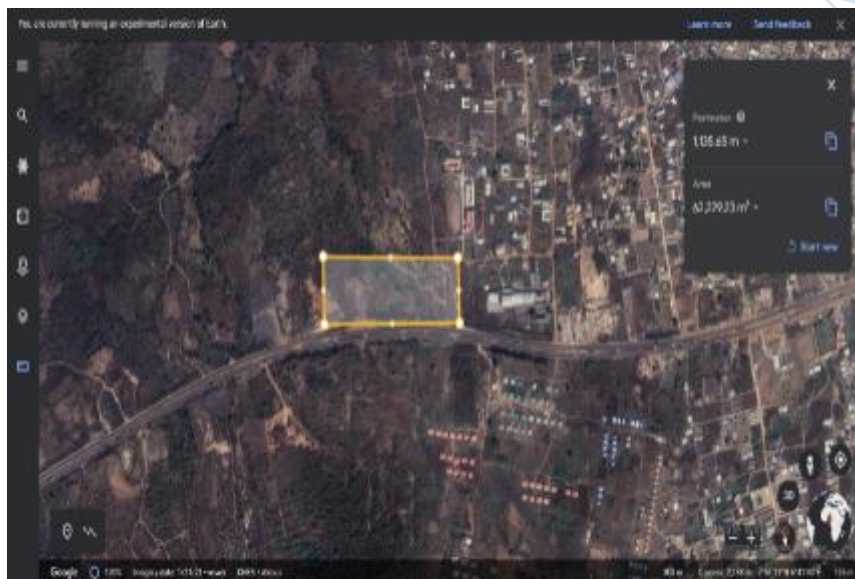


Figure 4.1: Site location map
Source: Google map

4.2.2. Site Selection Criteria

Site analysis is important in the design process because the information gathering during the site inventory needs to be analysed to address all issues that may affect the proposed design of the rest area. The existing features on the site and the adjoining properties must be properly investigated for effective site planning. Good site planning reflects the research on the physical inventory and covers the following.

Before the selection of any site for traveller's rest area, some qualities and conditions need to be taken into consideration. These are:

1. The site should be large enough to accommodate the rest area facilities.
2. The site should be easily accessible from the highway.
3. The site should not be in a populated area so that traffic can be controlled.
4. The location of the site should have some social amenities such as electricity, access road etc.

4.2.3 Site Analysis

Climatic and physical features

The site inventory reveals the existence of the following features.

1. Favorable climatic condition
2. Soil condition
3. Vegetation (trees, shrubs etc.)
4. Existing structures around
5. Electricity, water, sewer telephone
6. Road network and drainage
7. General pleasant environment (pollution)

Natural features

Topography: The proposed site is sloped toward the south region of the site.

Geology: The site soil bearing capacity is stable which can accommodate the type of foundation which to be used for the development.

Size and shape: the proposed site is rectangular in shape, wide enough and have easy access from the high way.

Physical features

Drainage pattern: The site slope determines the drainage pattern. it drains from north to the south.

Vegetation: The vegetation of the site is dense; tree shrubs and grass are found to litter the land mass in uneven proportion. Some of the trees would be cut off while some would be retained, so as not to totally destroy the habitat of the site and to serve as wind breakers.

Structures

The site is adjuring with school behind it and also at the other side of the high way there is housing estate opposite to the site.

Utilities services

These include services which are used by the public, such as electricity, gas supply, water supply, and other useful services but not present on site.

1. Electricity: the site has electricity power supply which pass through it which make easy access for connection to electricity power supply
2. Water: Water supply will be provided on site.
3. Sewer: Cesspool, soak away, septic tank and other sewage system will be provided on site.
4. Telecommunication: This service is part of facility need at the site.



Figure 4.2 Site analysis
Source: Researcher's fieldwork

Climate Features

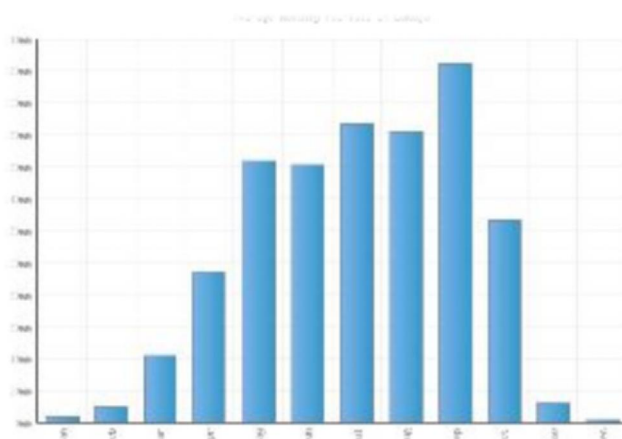
This is the general weather conditions usually found in a particular place. It is the average weather condition experienced at a particular place over a period of time. The major element of climate and weather to be considered for effectiveness of the project are rainfall, temperature variation, wind, relative humidity and sunshine.

Rainfall

During the rainy season, between February 23 and November 16, lokoja receives an average of at least 1.3 millimeters of precipitation every 31 days. Lokoja receives an average of 7.5 inches of precipitation in September.

The end of the rainy season occurs between November 16 and February 23. December is the driest

average



month in Lokoja, with an average of 0.1 inches of precipitation.

Figure 4.3 rainfall chart
Source: weather2visit.com

Temperature

From January 28 to April 19, Lokoja has its warm season, with average daily highs over 93 degrees Fahrenheit. March is the hottest month on average in Lokoja, with highs of 95 degrees Fahrenheit and lows of 76.

During the four months between June 22 and October 22, the average daily high temperature is less than 87 degrees Fahrenheit, making this season chilly. In December, the coldest month of the year, the average temperature in Lokoja drops to 67 degrees Fahrenheit and rises to 90 degrees Fahrenheit on average.

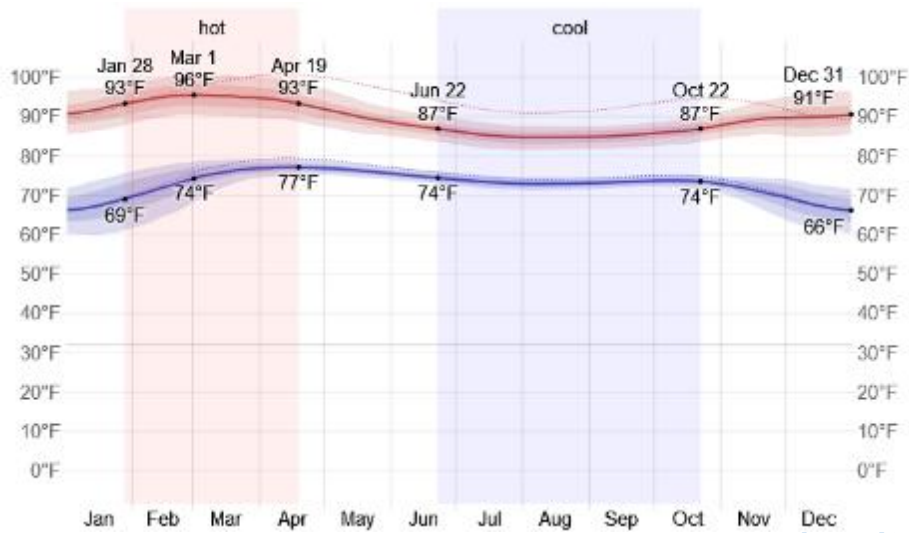


Figure 4.4 Temperature chart
Source: weatherspark.com

Sun Pattern

The summertime sunrise in Lokoja starts on June 1 at 6:14 AM and finishes on August 13 at 6:26 AM, 12 minutes later. On July 15, sunset will occur at 6:55 PM, while on August 31, it will occur at 6:41 PM, a 14-minute difference.

Wind direction

The seasons have a significant influence on the average hourly wind speed in Lokoja throughout the year. The average wind speed is more than 5.8 miles per hour for 6.7 months, from around the 15th of February to the 6th of September, when the winds diminish. April is the windiest month of the year in Lokoja with an average hourly wind speed of 7.2 miles per hour.

4.3. Project Analysis and Design Synthesis

4.3.1. Design Considerations

1. Landscape

In order to enhance or maintain the aesthetic features of a site, its surrounding area, and its natural environment, landscapers treat the land (rather than the buildings) on which it is situated. Landscaping involves natural aspects, terrain and water systems, and manmade components, such as pavement, fences, and playground equipment. It also includes "soft landscape," trees, shrubs, and other vegetation types. (National Building Code for 2021)

The landscape is an important element of our natural environment. Landscape, which includes topography, vegetation, soil, water bodies, and the spatial arrangement of these aspects, is one of the humans' most basic visual needs. As a result of the favourable psychological and physiological impacts of a beautiful landscape, they suggest that human-nature interactions induce individuals to have varied views of their local surroundings. Making and implementing housing laws may be difficult by people's varying viewpoints and preferences on the environments in which they reside. The objective of every competent landscape designer is to maximise a piece of land's potential for human occupancy and enjoyment. Therefore, landscape architecture of high calibre may considerably contribute to the health of a community. The discipline of landscape architecture integrates aesthetic expression with the environmental, physical, and biological sciences, all of which emphasise the outdoors. A properly defined landscape environment may increase the quality of life in settings tailored to individual preferences. The attractiveness of a landscape is not limited to flora alone.

Additionally, the hardscape features that complement the plants are considered. Smart landscape planning is required to increase the quality of a residential neighbourhood and

make it more pleasant to live in. This landscaping strategy can increase the property's market value and resale value. Elements of the landscape, such as softscape, hardscape, and water features, must collaborate to create harmony in outdoor spaces. According to previous research (Areas et al., 2014), it is also essential to consider the area's ability to accommodate rest stops. This is significant not only from a physical perspective but also in terms of whether or not obvious roadside development is appropriate, and if so, at what scale, in the given terrain. Some ecologically fragile landscapes should either not be developed to discourage people from doing so or should only be developed within specific boundaries to prevent irreversible damage.

2. Visibility

Privacy / Visibility Alongside a Road Whenever feasible, choose a site visible from the road. A sample of the site's offerings is one technique to assist visitors in deciding whether to visit. Despite this, it is typical to want some isolation from the bustling street. Consequently, a site should be chosen that permits both of these alternatives.

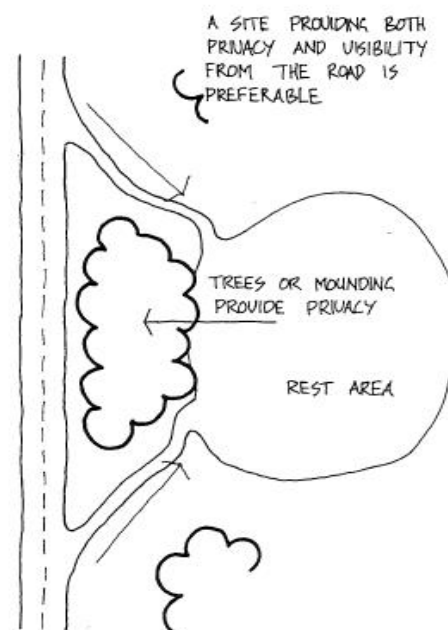


Figure 4.5: Sites should be chosen where both seclusion and views into the site from the road are available.

3. Rest Area Transition

The property's closeness to the freeway is also significant. The transition from driving to unwinding should be as smooth as possible. In this sense, sites with a moderate inclination off the road are perfect.

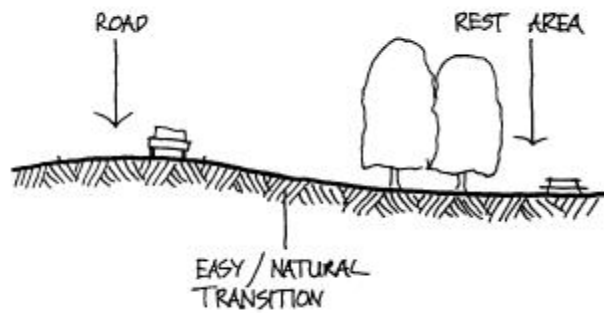


Figure 4.6: A natural transition from road to rest area should be possible.

4. Pedestrian Safety & Comfort

Consideration should also be paid to pedestrian safety during rest stations. Keep the location away from major roads as much as possible. If significant traffic noise is expected to interfere with visitors' comfort, a location with strong physical barriers between it and the road, such as an embankment, might be acceptable.

Due to the fact that interventions such as planting have a limited influence on noise levels, recognising this at the site selection stage is critical. If the visitor cannot determine where the noise is coming from, it might benefit their mental health.

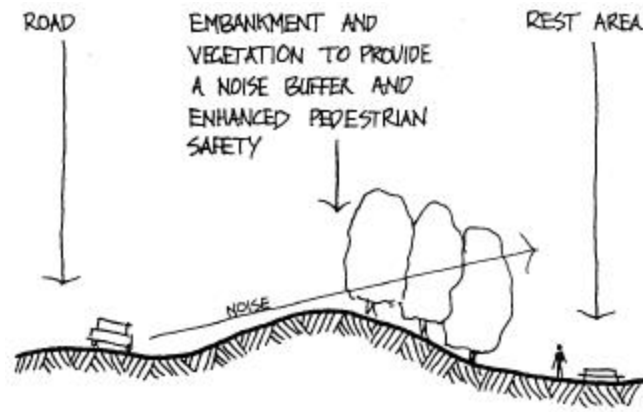


Figure 4.7: Relationship to the road for safety and noise reduction.

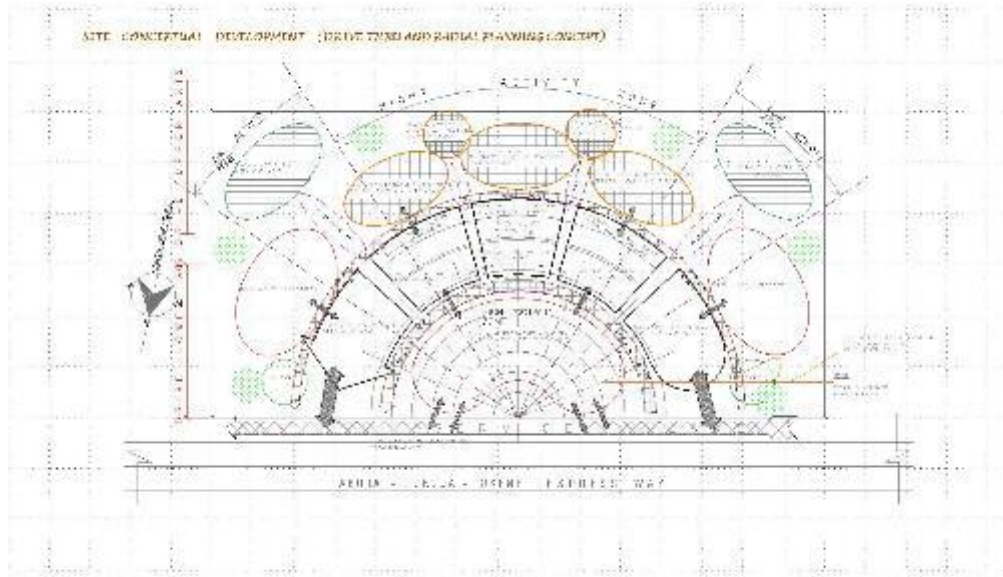
4.3.2 Conceptual Development

The concept ideas derived from specific instance, from one of the five main concept of architecture which can be identify as Pragmatic; looking at the function. The other concept is

- i. Analogous i.e. looking at other things
- ii. Metaphor i.e. looking at abstraction
- iii. Essence i.e. looking beyond function
- iv. Ideal i.e. solving architectural problems

Site concept: the site concept deals with the idea behind the initial and overall planning of site activities in relation to the site existing physical features which is to be taking advantage of, a

pragmatic approach was taken toward the site planning and arrangement of facilities



provide

Figure 4.8: Site concept

4.3.3 Functional Relationship

The functional relationship chart shows the relationship among the various activities in the facility. These aid the planning process of activities and functionality of the design. General principle of functional relationship principle taken into consideration include;

1. separation of the various traffic from one another i.e. control of vehicular away from pedestrian.
2. Orientation of building to create maximum thermal comfort for the users.
3. Functionality, orderliness, aesthetics unity.
4. Landscaping hard and soft
5. Parking space

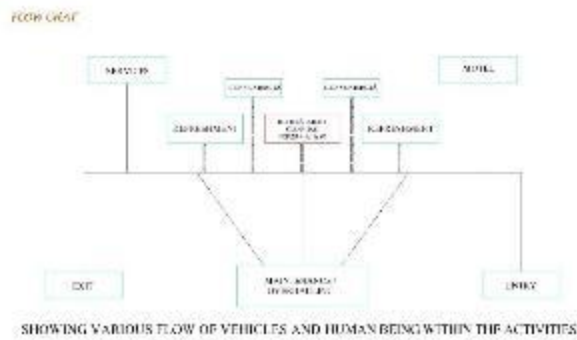


Figure 4.9 flow chart

4.3.4 Space Allocation/Schedule of Accommodation

SPACIAL ANALYSIS AND REQUIREMENT		
S/N	FUNCTIONAL SPACE	AREA REQUIRE (PERSON/CAR/ BUS)
1	RESTAURANT (PERSON)	1.4 - 1.8
2	ROOM (PERSON)	1.5 - 2.5
3	MAINTENANCE OFFICE (PERSON)	1.6
4	PARKING (PRIVATE CAR)	17.75
5	PARKING (LUXURY BUS)	45.0 - 46
6	PARKING (MINI BUS)	15.06 - 17

Figure 4.10 spacial analysis

BRIEF DEVELOPMENT		
S/N	FUNCTIONAL SPACE	AREA (sqm)
1	SALE PROMOTION SECTION	
A.	Director's office	17.8sqm
B.	Business meeting	30.4sqm
C.	Manager's office	5.8sqm
E.	Client's room	5.7sqm
A.	Store	2.8sqm
E.	Receptionist's office	31.6sqm
B1.	Wait	5.4sqm
F.	Reception desk	2.8sqm
L.	Local charging room	5.0sqm
A.	Receptionist's office	11.8sqm
2	FOOD AND BEVERAGE FACILITIES	
A.	2 No. SUPER MARKET	
	• Store	25.0 sqm
	• Store and freezer	20.0 sqm
	• Kitchen	20.5 sqm
	• Charging room	11.8 sqm
	• Concessions stand	17.0 sqm
	• Dining hall	278.0 sqm
B.	5 No. CAFETERIA (Breakroom/Reception)	
	• Kitchen	28.5 sqm
	• Cold and dry store	20.0 sqm
	• Charging room	11.0 sqm
	• Concessions	17.4 sqm
	• Dining hall and server	243.5 sqm
C.	2 No. SUPER MARKET	
	• Store	12.1 sqm
	• Supermarket office	12.0 sqm
	• Waiting entrance	7.7 sqm
	• Check-out stand and	8.4 sqm
	• Truck's hall	117.8 sqm
D.	1 No. Dining hall	
	• Dining hall	127.0 sqm
	• Store	12.1 sqm
	• Maintenance office	17.0 sqm
3	INTERNET CAFE	
	• Servers and Ticketing Booth	10.4 sqm
	• Servers' office	10.2 sqm
4	PUBLIC CONVENIENCE	
	• Charging room	5.4sqm
	• Showers	2.0sqm
	• Water closet	2.0sqm
5	PARKING SPACE FOR LUXURY BUSES	
	• Luxury bus parking space per car	45.0 sqm
	• Maintenance space	11.0 sqm
6	WARRANTY ROOM	
	• 12 charging room	7.2 sqm
	• Concessions and	5.24 sqm
	• Waiting lounge	11.2 sqm
7	PROSTATION	
	• Application box	14.0 sqm
	• Car's parking (on per car)	11.75 sqm
	• Reception	15.5 sqm
	• Ergonomics	3.0 sqm
	• Furniture	12.0 sqm
	• Maintenance	25.0 sqm
	• Store	4.0 sqm
	• Cell room	-
	• Fire maintenance	1.70 sqm
	• Office	12.0 sqm
8	CAR WASH CENTER	
	• Washing space for private car per car	14.75 sqm

Figure 4.11 Brief development

4.3.5. Construction Methods and Materials

The choice of materials for construction is very important to the construction method that would be employed. There are some basic factors to be consider during the selection of construction materials, which are as follows:

- i. Availability of the materials
- ii. Durability
- iii. Climatic condition of the material
- iv. Aesthetics /economical value
- v. Choice of client
- vi. Regulation and by law governing the material
- vii. Application of the materials
- viii. Functionality of the material with space

Construction materials

1. Substructure: reinforcement concrete, hollow block wall
2. Floors: in-situ concrete slab, vertify tiles. steel floor

3. Walls: fixed glass in aluminium panel, cutting wall, dry wall with insulation material hollow block wall floating, laminated board
4. Window: pvc casement window
5. Doors: steel panel coated finish, glass in aluminium frame
6. Ceiling: dry wall material, p.o.p.
7. Roof: steel truss, hard wood truss, long span roofing sheet
8. External walls: paint wall finish
9. External works: lawn, asphalt road, trees kerbs, precast slab e. t .c

Building Services.

All electrical and mechanical services to be installed are to pass through duct provided and some should be conduit and some to be surface

The building must have a fire muster point, fire appliance must be placed at strategic point for easy access in case of fire outbreak

The flow of the mechanical pipe should be laid to slope in order to flow waste properly

Chapter Five

Conclusion and Recommendation

5.1 Conclusion

This study investigated the use of ISO shipping container as alternative to conventional building material in housing construction. Literature revealed that it has been used as a sustainable and cost-effective building material across different countries. It is discovered

that the shipping container can be recycled after use for other purposes such as it can serve as a material for housing construction.

The case study analysis further showed how ISO containers were used in the construction of Rest Areas both internationally and locally. Also, lesson learnt from the case studies includes the need for proper planning of the environment such that pedestrian and vehicular movements are properly defined.

These lessons were transferred into the design of a proposed Travellers Rest Area located in Lokoja, Kogi State, Nigeria. The site was selected because it is in a major traveller hub, such that it is accessible from different part of the country. Furthermore, the proposal included the design of facilities such as filling station, motel, food and refreshment station etc. majorly, the Motel, filling station and the public conveniences explored the use of ISO containers for the design.

In conclusion, the study was able to established the fact that ISO container can be used as an alternative to conventional building materials which is the main objective of this study.

5.2 Recommendation

Since, this study was able to show that ISO containers can be used as an alternative to conventional materials for housing construction in Nigeria. Stakeholders (Client, Architects, Contactors, Suppliers and Engineers) could be sensitized towards its advantages and thus encourage the use in achieving sustainable and cost-effective building construction in Nigeria.

In addition, the government can also create policies that will encourage the use of alternative building materials such as ISO shipping containers as this will help them align themselves towards achievement of SDGs goal 7, 9, 11,12 and 13.

References

Adewumi, M. B., Zakari, K., & Madu, A. (2020). *Architectural Case Study as a Research Method- A Review*. 18(4), 393–403.

Alkhatni, F., Ishak, S. Z., & Milad, A. (2021). *Characteristics and Potential Impacts of Rest Areas Proximate to Roadways : A Abstract : 260–271*.
<https://doi.org/10.2174/1874447802115010260>

Areas, U., Shahli, F. M., Ramzi, M., Hussain, M., & Tukiman, I. (2014). *The Importance Aspects of Landscape Design on Housing Development in Urban Areas*. December.
<https://doi.org/10.1016/j.apcbee.2014.10.058>

Bhatia, N. (2018). *Design of a Cost-effective , Modular and Energy-efficient Home*. 1–24.

Francis, M. (1999). *A Case Study Method For Landscape Architecture*. 1–19.

Ijigah, E. A., Jimoh, R. A., Aruleba, B. O., & Ade, A. B. (2013). *An Assessment of Environmental Impacts of Building Construction Projects. 2006*, 93–105.

Lincoln University Digital Dissertation. (1994).

Marut, J. J., & Daniel, M. M. (2020). *Alternative Building Materials (ABM): Towards Adoption of Common Terminology and Definitions*. 12(11), 2014–2021. <https://doi.org/10.7176/CER/12-11-03>

National Design Guide. (n.d.).

Ofori, S., & Corresponding, A. (2015). *Impacts of Construction Activities on the Environment : The Case of Ghana*. 5(3), 18–27.

STP, Posted April 27 2016 , shipping containers favorable features, In Shipping Container Features, Shipping containers, Storage Solutions, Texas Transportation.

Shipping containers fundamentals, December 29, 2020, Shipping Container History: Boxes to Buildings

Sophie Koenig , August 22nd, 2016, a brief history of shipping containers, Tough strong solutions, Willbox

Ghada Mohammad Elrayies, 2017, Thermal Performance Assessment of Shipping Container Architecture in Hot and Humid Climates, International Journal on Advance science Engineering information technology, Vol.7

GDV. (2018). container-explanation of terminologies. (G. d. Versicherungswirtschaft, Producer) Retrieved 2 5, 2018, from containerhandbuch.de: http://www.containerhandbuch.de/chb_e/stra/index.html

New Jerusalem Children's home. (2014). Championing the rights of children. Retrieved July 5 from <http://newjerusalemchildrenshome.org/>

Imbasa Educare. (2011). Container Kitchen. [Video file]. Retrieved March 2, 2014, from <https://www.youtube.com/watch?v=AR0xR9sY-1A>

Chamber, P. (2014). Shipping container house. [Video file]. Retrieved from July 3, 2014, from <https://www.youtube.com/watch?v=wJSNH9Svjmg#t=12>

Thermal Insulation Association of South Africa. (2010). The Guide to Energy Efficient Thermal Insulation in Buildings. Retrieved from <http://www.aaamsa.co.za/images/Technical%20Publications/TIASA/TIASA%20GUIDE%202010%20Low%20Res.pdf>

International Energy Agency. (2010). How to make modern energy access universal. Special early excerpt of the World Energy Outlook 2010 for the Un General Assembly on the Millennium Development Goals. Retrieved from http://www.se4all.org/wpcontent/uploads/2013/09/Special_Excerpt_of_WEO_2010.pdf

Lukmon Abiodun Balogun, May 2018, shipping container as an alternative housing solution, Bachelor's thesis Degree Program in Environmental Engineering, Case Study Lagos, Nigeria.

Minenhle Maphumulo, November 2016, Implications for using shipping containers to provide affordable housing, a research report submitted to the faculty of Engineering and built Environment, University of Witwatersrand, Johannesburg.

Radwan, Ahmed Hosney. 2015. "Containers Architecture Reusing Shipping Containers in Making Creative Architectural Spaces." International Journal of Scientific and Engineering Research 6 (11): 1562–77. <https://doi.org/10.14299/ijser.2015.11.012>. [ref type : journal]

Edric King Hui Wong, Cher Siang Tan and Philip Chie Hui Ling, (2018). Feasibility of using ISO shipping container to Build Low Cost House in Malaysia, International Journal of Engineering & Technology.

Shipping Container Zoning, Permits, and Building Codes. (2019, August 27). Retrieved from <https://www.discovercontainers.com/shipping-container-zoning-permits-andbuilding-codes-which-states-allow-them/>.

Discover Containers, 2019. [discovercontainers.com](https://www.discovercontainers.com). [Online] Available at: <https://www.discovercontainers.com/fundamentals/>.

Discover Containers, 2020. 23 Stunning Shipping Container Homes (With Owner Interviews). [Online] Available at: <https://www.discovercontainers.com/what-i-wish-id-known-before-building-my-shipping-container-home/>.

Discover Containers, 2020. How Are Shipping Containers Made. [Online] Available at: <https://www.discovercontainers.com/how-are-shipping-containers-made/>.

Discover Containers, 2020. Shipping Container Home Cost Calculator. [Online] Available at: <https://www.discovercontainers.com/cost-calculator/#descriptions>

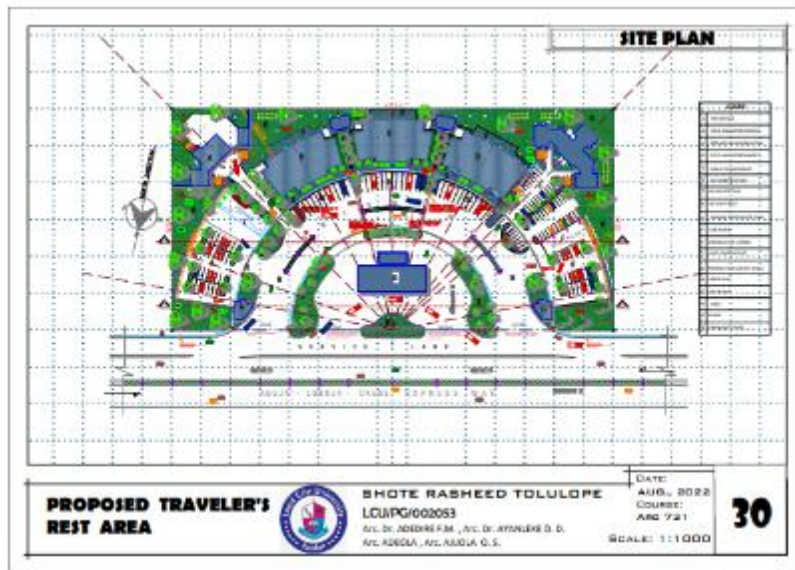
H. Slawik, J. B. M. B., 2010. Container Atlas. 1st ed. Berlin: Gestalten Verlag.

Slawik, H., Bergmann, J., Buchmeier, M. & Tinney, S., 2010. Container Atlas - A Practical Guide to Container Architecture. 2nd ed. Berlin: Gestalten.

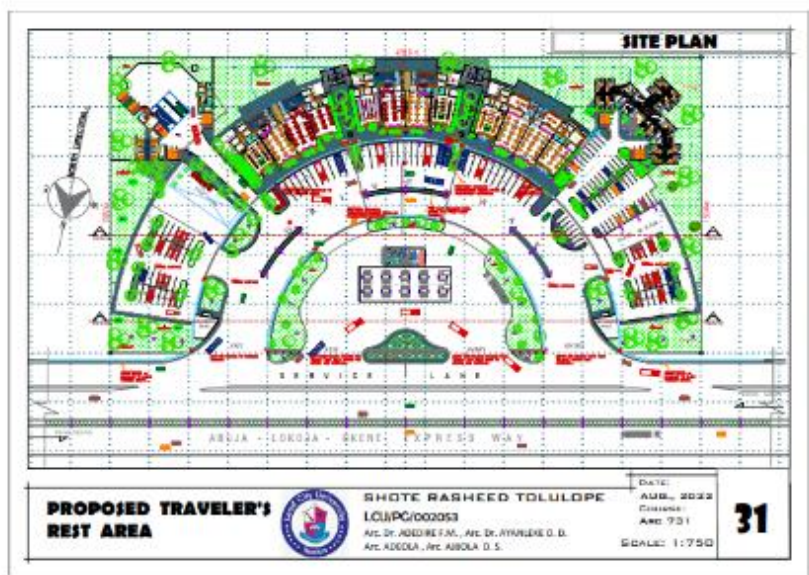
https://www.designingbuildings.co.uk/wiki/Traditional_materials#:~:text=In%20construction%2C%20traditional%20materials%20are,a%20locality%2C%20region%20or%20nation.

<https://askanydifference.com/difference-between-conventional-and-alternative-building-materials/>

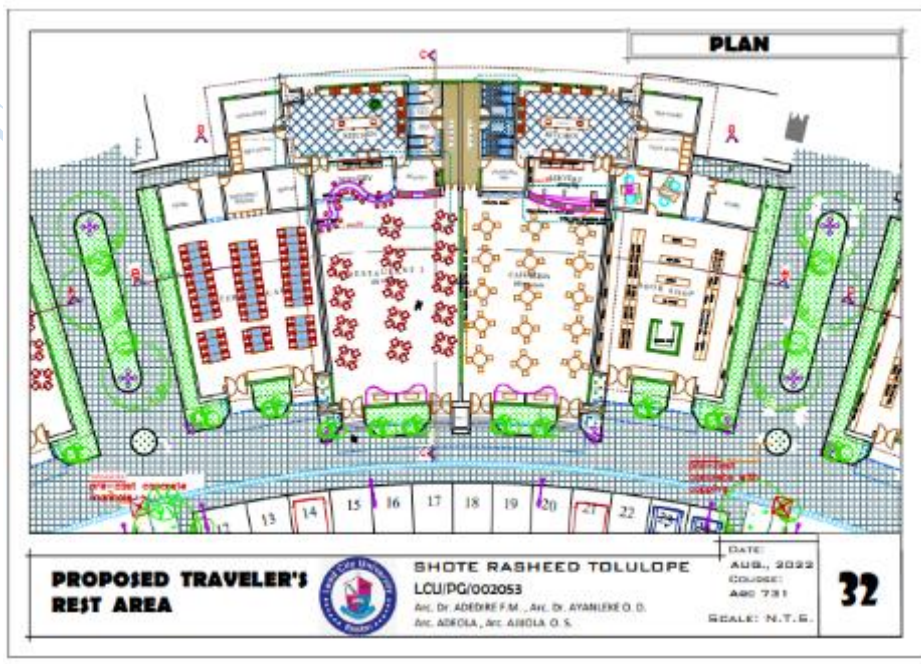
APPENDIX



Drawing 1



Drawing 2



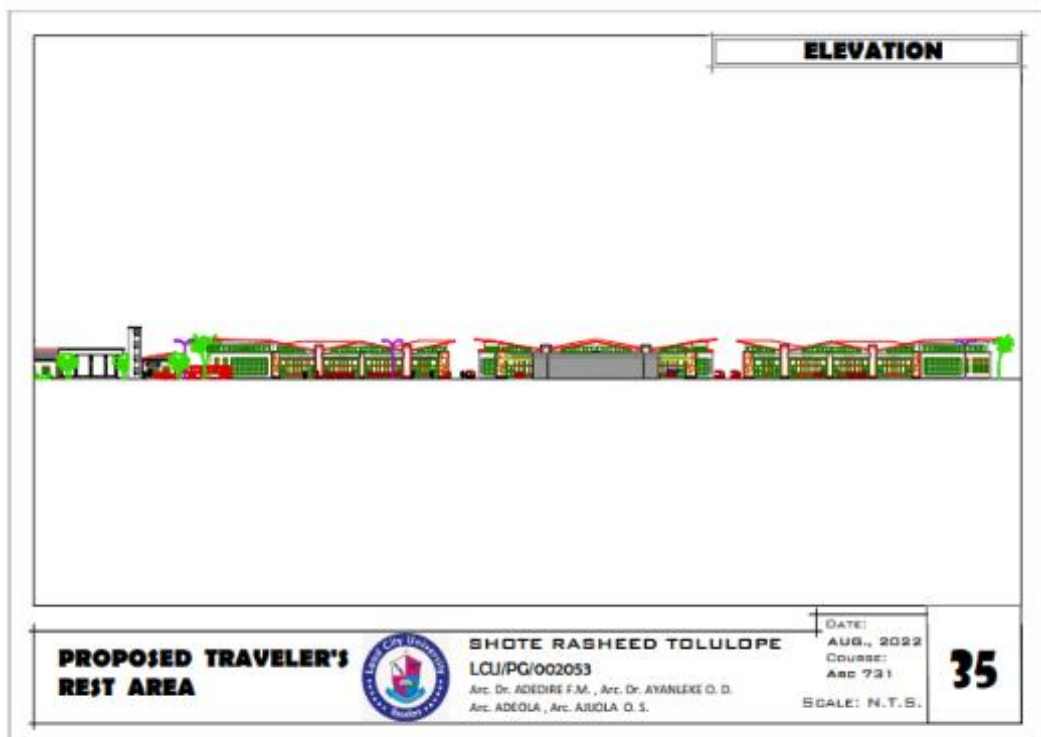
Drawing 3



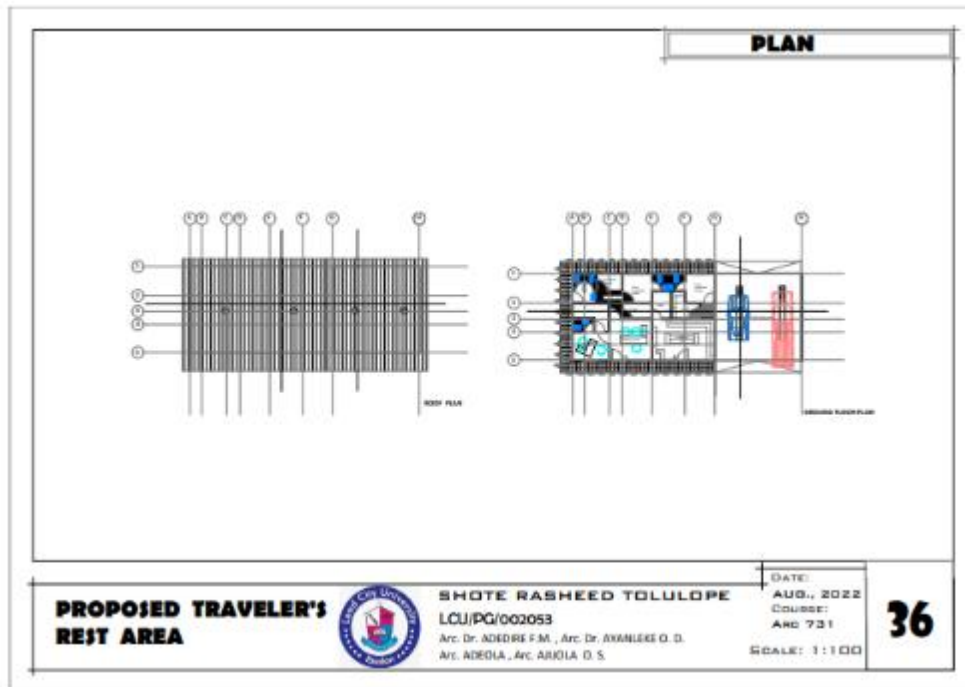
Drawing 4



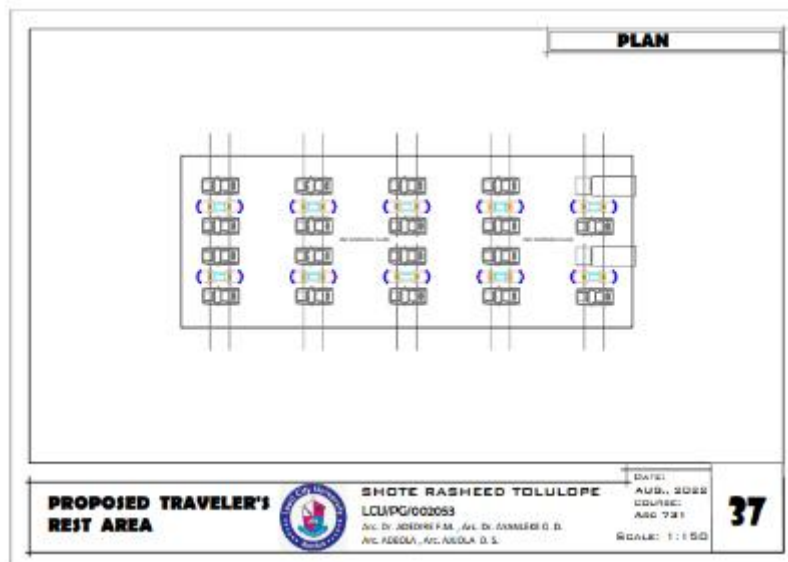
Drawing 5



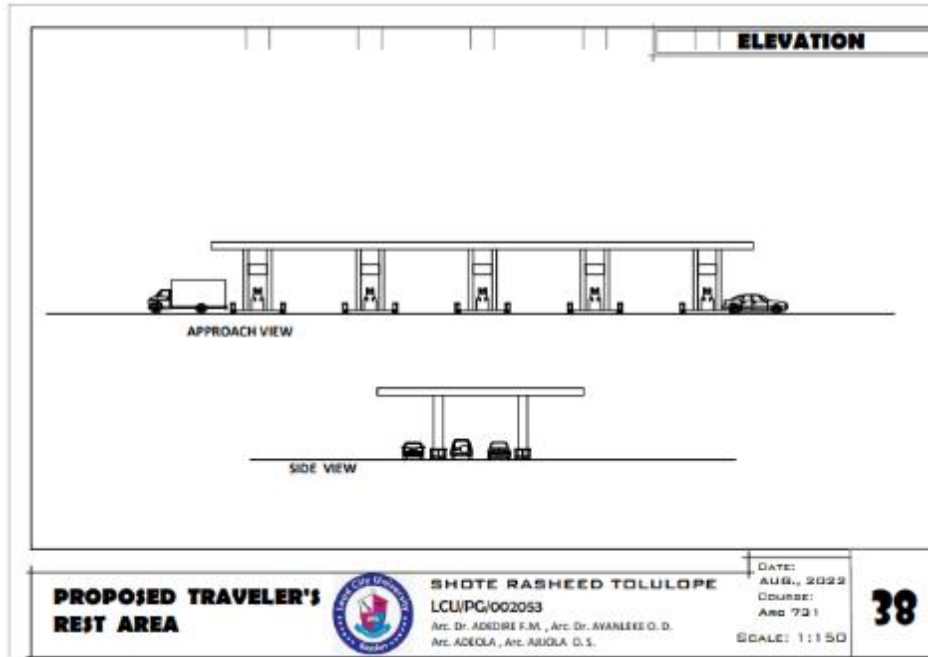
Drawing 6



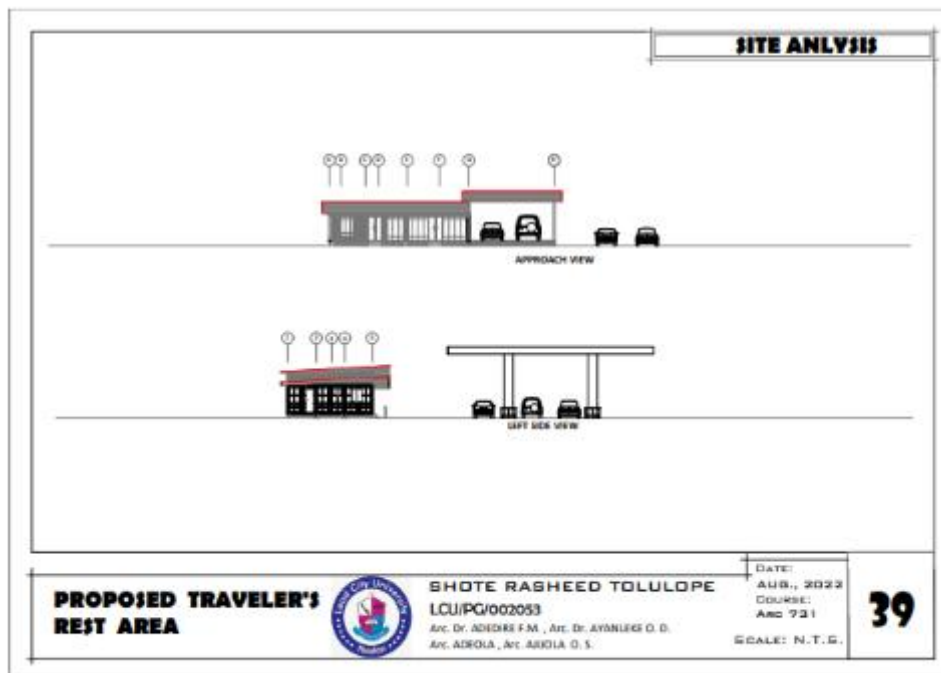
Drawing 7



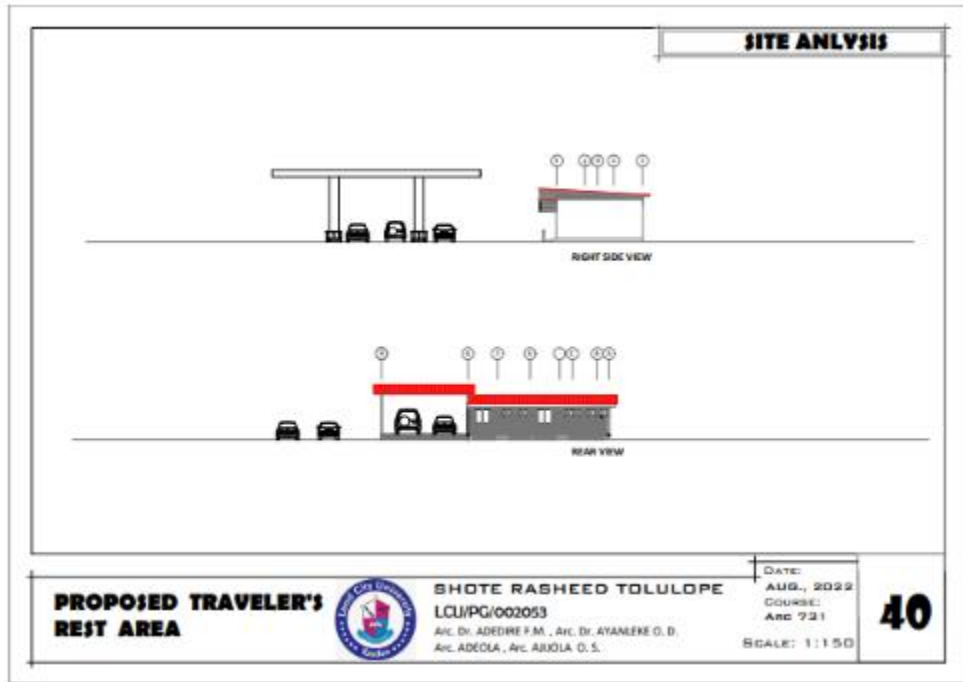
Drawing 8



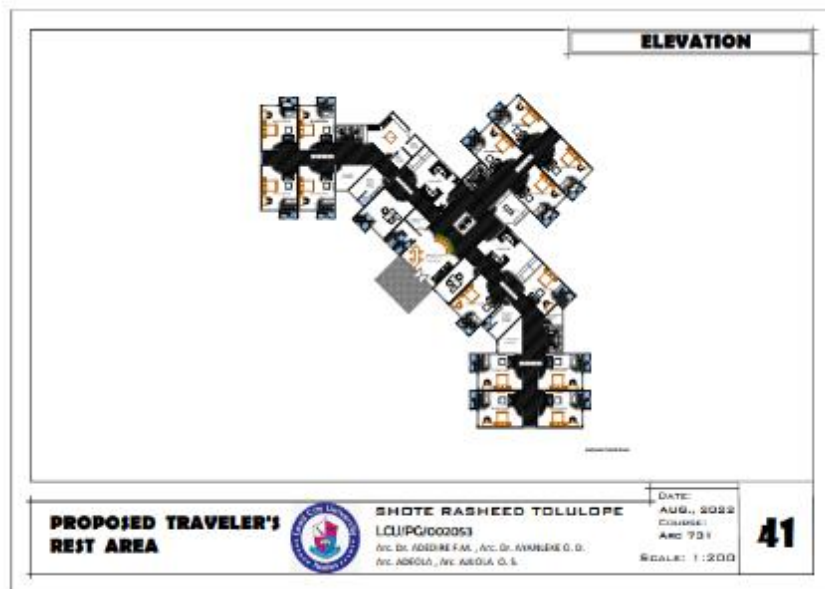
Drawing 9



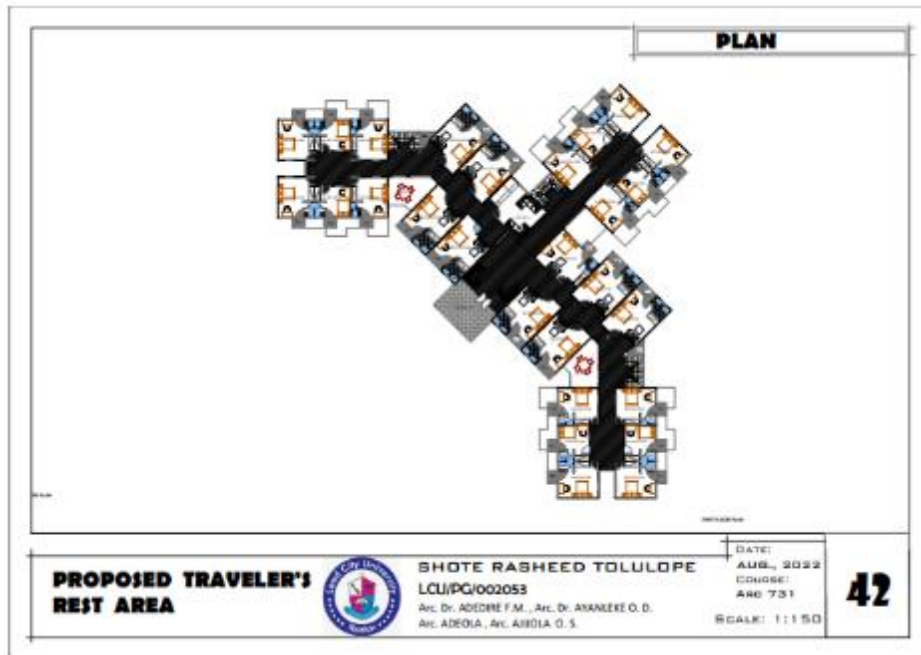
Drawing 10



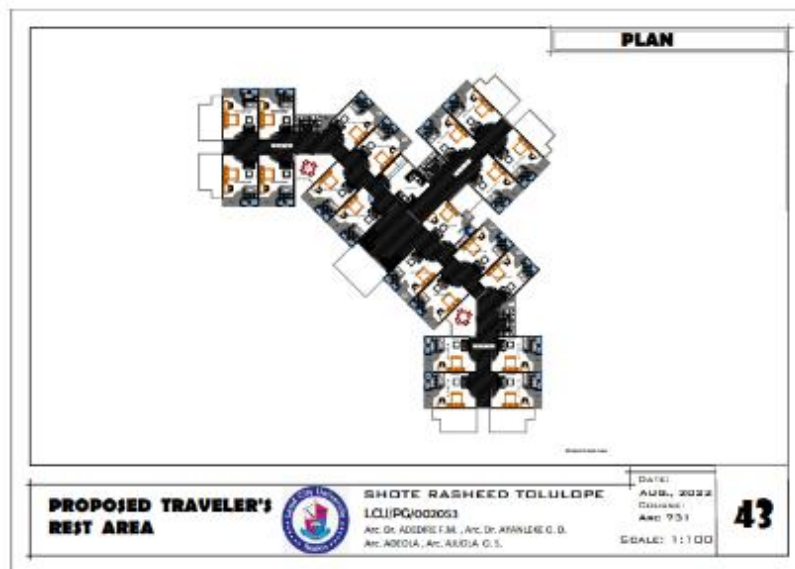
Drawing 11



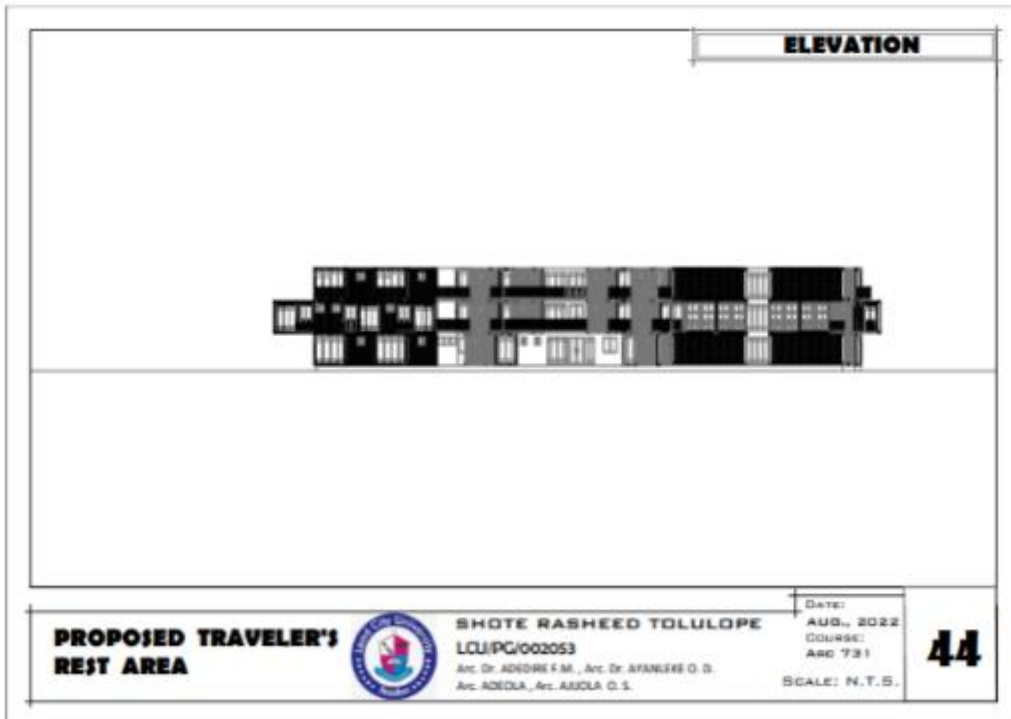
Drawing 12



Drawing 13



Drawing 14



Drawing 15

DO NOT COPY. LEAD CITY UNIV.

Biodata

A. Personal data:

1. Name: Rasheed Tolulope SHOTE
Permanent Home Address: No 189c Akarigbo Road sabo Sagamu, Ogun State,
Nigeria.
Contact Address: Lead City University, Ibadan, Nigeria.
Email Address: shote_lovely@yahoo.com
Phone Number: 08034539914
2. Date of Birth: 1st April, 1982
Place of Birth: Lagos State
3. Nationality: Nigerian
4. Next of Kin Name: Margaret E. Shote
Address: No 189c Akarigbo Road sabo Sagamu, Ogun State,
Nigeria.

B. Education background with date

- i. Institutions attended with dates
- | | |
|---|-------------|
| Lead City University, Ibadan, Oyo State. | 2020 - 2022 |
| Bells University of Technology Ota, Ogun State. | 2017 - 2020 |
| Remo Divisional High School Sagamu. | 1994 - 1999 |
- ii. Qualifications with dates
- | | |
|---------------------------|------|
| BSc Architecture (Bells): | 2020 |
| WASSCE: | 1999 |

C. Working experience with date

- Project Architect, Kanat Global Concept Nig. Ltd. 2017 till date
Project Architect, Monguno Engineering Nig. Ltd. 2010 - 2017

D. Professional affiliation

- Graduate member, ARCON.

E. Referees

Arc. (Dr.) Funmilayo Adedire

Department of Architecture

Faculty of Environmental Design and Management

Lead City University, Ibadan, Nigeria

Funmidire@gmail.com

+234 816 926 3162

Arc. (Dr.) Tosin Babalola

Department of Architecture

Faculty of Environmental Design and Management

Lead City University, Ibadan, Nigeria

Babalola.oluwatosin@lcu.edu.ng

+234 703 822 0942

DO NOT COPY. LEAD CITY UNIVERSITY, NIGERIA

University Compliance Form

This is to certify that this thesis by Rasheed Tolulope SHOTE with matriculation number LCU/PG/002053 in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan is in full compliance with the approval of the University's format and style.

Signature

Date

DO NOT COPY. LEAD CITY UNIVERSITY, NIGERIA