Application of Passive and Adaptive Energy Design Principles in the Design of a Vocational Study Center

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Certification

This is to certify that, Abolaji Mutiu SHITTU with matriculation number LCU/PG/004071 carried out this research work titled 'Application of Passive and Adaptive Energy Design Principles in the Design of a Vocational Study Center' in the department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, for the award of Master Degree (MSc) in Architecture. The thesis is an outcome of an independent and original work. I have duly acknowledged all the sources from which the ideas and the extracts have been taken. The project is free from any plagiarism and has not been previously submitted to any other institution.

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Dedication

This thesis is dedicated to my family and God, for supporting me in all my endeavors.

Acknowledgement

I am grateful to the management of Lead city university for giving me the opportunity to carry out this research and providing an enabling environment to learn. I want to sincerely thank God for the success of this thesis. It has been a rigorous experience, but I am grateful to my supervisor, Arc. Babajide Aseyan, for his mentorship and support in ensuring the successful completion of this program. I am grateful to my wife and family for supporting my aspirations. I also thank the members of the Department of Architecture, particularly the Head of Department, Dr. Oludare Obaleye, and all of my lecturers, for their contributions to my program.

Abstract

Energy needs in buildings are in continuous demand and rising carbon emissions, and dependence on non-renewable resources contribute to an increase in health, environmental, and economic risks. In the modern society of architecture today, building designs rely heavily on mechanical systems to solve, adjust, optimize and regulate heating, cooling and lighting effects in a building interior. In order to reduce air pollution levels and greenhouse gasses, there should be a focus on the design and construction of more passive buildings, thus contributing to a more sustainable environment. This research investigated the necessary design strategies essential for the design of a sustainable building through a study of literature and case studies. A vocational center was designed using energy efficiency principles and elements to enhance human activity and promote energy efficiency. The study concludes that energy efficiency should be prioritized in design and construction.

Keywords: Passive Design, Passive Design Principles, Sustainability, Vocational Center

Word Count: 142 words

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Chapter One

Introduction

1.1 Background to the Study

The demand for energy in buildings is constant and increasing carbon emissions, as well as reliance on non-renewable resources, lead to greater health, environmental, and economic risks (Elaouzy, & El Fadar, 2022). According to Liu et al, (2020), The use of architectural products accounts for 16–50% of the overall energy demand, highlighting the importance of incorporating passive energy management into building design. This underscores the need for architects and policy-makers to prioritize appropriate design from the beginning (Mahar, Verbeeck, Reiter & Attia, 2020).

In recent years, the application of passive and adaptive energy design principles has become crucial in constructing energy-efficient and sustainable buildings, particularly in vocational centers where long-term operational costs and environmental impact are key concerns. Passive energy design strategies aim to optimize natural energy sources, such as sunlight and ventilation, to create a comfortable environment while reducing dependency on mechanical systems (Liu et al, 2020). For vocational centers, where activities may require diverse energy uses throughout the day, integrating these principles supports both functionality and sustainability by lowering energy consumption.

In order to decrease the use of non-renewable energy sources, scientists have explored the idea of passive design. Passive design methods are used as a cost-efficient approach to lower building energy consumption while minimizing the reliance on active mechanical systems, which are highly unsustainable. The goal is to achieve thermal comfort by maximizing heat retention in the winter, reducing heat absorption in the summer, and utilizing light effectively, taking into account natural elements and adapting to the local climate. Therefore, it can be concluded that the necessity for cooling or heating and the overall thermal efficiency of a building significantly relies on its location.

Furthermore, all energy-saving and eco-system friendly techniques make use of the local climate and building characteristics to enhance indoor environment while lowering energy consumption are generally referred to as passive design strategies (Elaouzy & El Fadar, 2022). More researchers have further made propositions on diverse passive methods to achieve the unimaginable thermal comfort under varying environmental weather conditions, while taking into account their effectiveness from the perspectives of energy, economy, and environment (the three E's).

Passive design involves utilizing natural energy movements to regulate thermal comfort. This includes selecting the right building orientation, materials, and landscaping. Proper building orientation and specified building envelope materials are essential to reduce or prevent heat gain.

Shading also should be provided to minimize solar radiation (Ozarisoy., 2022). So many techniques can be applied such as using technology (active or passive) to regulate indoor environment for optimal conditions also to improve the health and well-built environment. Passive technologies refer to systems that utilize natural resources to provide comfort without the need for artificial energy. The selection of passive design methods is largely influenced by the specific climate of the project's location. These methods are sustainable and predominantly rely on natural resources. Incorporating such techniques can convert building envelopes into living organic structures that support human life.

The focus on adaptive energy design using responsive architectural elements that adjust to varying climatic conditions further enhances the resilience and efficiency of buildings in tropical climates, where energy demands for cooling can be high. Adaptive design also emphasizes user comfort, essential for educational and vocational environments, by ensuring stable indoor air quality and temperature without excessive energy use. Practical examples of this approach, such as the integration of passive cooling techniques and strategic building orientation, highlight the potential for significant energy savings (Megahed & Ghoneim, 2021).

In vocational centers, the emphasis on renewable energy sources, daylight optimization, and natural ventilation aligns with sustainable site and indoor environmental quality principles. These strategies not only support a lower ecological footprint but also foster learning environments that prioritize occupant health and comfort, facilitating an ideal setting for vocational training activities (Abouleish, 2021). Thus, a well-rounded, passive-adaptive design approach is instrumental in ensuring both functional sustainability and energy efficiency in the design of vocational study centers.

1.2 Statement of the Problem

The escalating global demand for energy, coupled with the environmental impact of conventional energy sources, underscores the need for sustainable architectural practices in educational facilities. Vocational study centers, which require efficient lighting, ventilation, and climate control for prolonged periods, contribute significantly to energy consumption within the educational sector. Yet, many vocational centers lack optimized design principles to reduce energy demand while maintaining a conducive learning environment (Abouleish., 2021). In recent years, passive and adaptive design strategies have demonstrated substantial benefits in reducing energy costs, enhancing indoor environmental quality, and mitigating the carbon footprint of buildings (Saboor et al., 2021). However, the application of these principles in vocational centers remains limited, often due to the perception that passive design is more suitable for larger-scale, commercial structures or complex architectural projects (Park et al., 2020).

Given the potential for energy conservation, occupant comfort, and cost-effectiveness, there is a critical need to investigate how passive and adaptive energy design principles can be applied effectively within vocational study centers. Addressing this gap is vital for promoting sustainable architecture across all educational facilities, particularly those in energy-intensive vocational training fields (Megahed & Ghoneim, 2021). This study aims to explore and evaluate how adaptive energy design strategies can meet the unique spatial and functional demands of vocational study centers, ultimately contributing to a sustainable built environment and the broader goals of energy efficiency in educational institutions (Rodríguez-Urrego & Rodríguez-Urrego, 2020). A well-constructed passive building reduces the emission of air pollutants and greenhouse gases, making a valuable contribution to a sustainable environment. Passive buildings not only save energy but also have additional hidden environmental advantages.

1.3 Aim and Objectives of the Study

The aim of this study is to identify Passive Design Strategies essential for the design of a vocational study center in Nigeria. The objectives are as follows:

1. To investigate necessary design strategies in the design and building of previous vocational study buildings.
2. To identify passive design strategies essential for the design of a sustainable building.
3. To incorporate passive design strategies for sustainable buildings in the design of a Vocational center.

1.4 Research Questions

In order to achieve the aim of this study the following questions will be answered:

1. What design strategies are best for the design of a vocational study center?
2. What passive design strategies are essential for sustainable building design?
3. How can a vocational center be designed incorporating passive design strategies?

1.5 Significance of the Study

The application of passive and adaptive energy design principles in designing a vocational study center is a pivotal approach to reducing energy demand and promoting sustainable architecture. Passive design focuses on maximizing the use of natural energy sources, such as sunlight and airflow, to reduce dependency on mechanical systems, while adaptive design accommodates changes in environmental conditions. Together, these principles foster an energy-efficient and comfortable environment conducive to learning and skill acquisition.

Passive design principles often include strategic building orientation, natural ventilation, and optimized daylighting. Research shows that effective building orientation significantly impacts energy savings by allowing natural light to reduce artificial lighting needs and by using materials that enhance thermal insulation, thus minimizing cooling and heating loads (Abouleish, 2021). Furthermore, natural ventilation can substantially reduce HVAC dependency in vocational centers located in temperate regions, maintaining indoor comfort levels while lowering energy use (López-Pérez, Flores-Prieto & Ríos-Rojas, 2019). Additionally, daylighting strategies, such as well-placed windows and light shelves, harness sunlight to enhance indoor lighting quality without excessive heat gain, contributing to better learner productivity and concentration (Abouleish, 2021).

Adaptive design strategies also play a crucial role in managing environmental fluctuations, ensuring that the structure can respond dynamically to changes in temperature, humidity, and lighting needs. For instance, adaptive facades, which adjust shading and insulation levels based on real-time climate data, can help optimize indoor conditions and energy use. Park et al. (2020) discuss how adaptive building envelopes can integrate photovoltaic systems to produce renewable energy, significantly offsetting operational energy demands. This adaptability is particularly beneficial in vocational study centers, where multiple rooms and functions often require varying energy loads and comfort levels (Megahed & Ghoneim, 2021).

Together, passive and adaptive energy design principles create a synergistic approach to designing vocational study centers that not only reduce operational costs but also foster a more sustainable, environmentally conscious educational environment. As more educational institutions aim for sustainable practices, integrating these energy principles will be essential in vocational centers to encourage eco-friendly learning spaces and set a standard for future architectural designs.

This study will be a reference material for architects, builders, policy makers and other built environment professionals to make informed decisions, incorporating passive design strategies in their designs.

1.6 Scope of Study

The scope of the study will be defined in terms of geographical borders and the specific subjects of study. The study is focused on Nigeria. A look at the passive designs' strategies for a vocational study center in Nigeria. This study was also limited the passive design strategies for only vocational center and does not include other building types or infrastructures.

1.7 Definition of Terms

i. **Energy:** Power obtained from the use of physical or chemical resources, particularly for generating light and heat or operating machinery.

ii. **Energy Efficiency:** The action of decreasing the amount of energy needed to produce goods and services. For instance, by insulating a building, it can use less energy for heating and cooling while still maintaining a comfortable temperature.

iii. **Energy Efficiency Principles:** Giving the highest consideration to cost-effective measures for energy efficiency when forming energy policies and making investment decisions.

iv. **Greenhouse gases:** These are gases that trap and release radiant energy in the thermal infrared range.

v. **Sustainable architecture:** Architecture that aims to minimize the adverse environmental impact of buildings.

vi. **Ventilation:** The movement of fresh air around a closed space, or the system.

vii. **Vocation:** a particular occupation, business, or profession.

viii. **Vocational Study Center:** a facility for the instruction of specific skills, which meets the state and/or federal requirements to be accredited.

Chapter Two

Literature Review

2.1 Conceptual Review

This chapter provides an in-depth review of a vocational center, highlighting its definitions, history, classification, types, characteristics, and other relevant information regarding passive design and strategies. It also examines previous studies by many other researchers in this area of study and analyzes some of the existing literature to determine how the studies were conducted conceptually and theoretically.

2.1.1 Passive Design

Passive design refers to the practice of designing buildings to maintain comfortable indoor temperatures without relying heavily on mechanical heating and cooling systems. This architectural approach utilizes natural energy flows, local climate conditions, and building orientation to enhance occupant comfort and reduce energy consumption. By strategically considering factors such as sunlight, wind patterns, thermal mass, and insulation, architects and builders can create structures that optimize energy efficiency and sustainability.

One of the key principles of passive design is the maximization of natural light. Well-placed windows and skylights can provide ample daylight, reducing the need for artificial lighting and enhancing the occupants' mood and productivity (Fereidani, Rodrigues & Gaspar, 2021).

Moreover, using high-performance glazing can help control solar heat gain and glare while still allowing natural light to penetrate deep into the building. Another essential aspect of passive design is thermal comfort, which is achieved through careful building orientation and the strategic placement of thermal mass materials. For instance, a building designed to face south in the Northern Hemisphere can capture sunlight during the winter while minimizing exposure during the summer months. Thermal mass, such as concrete or brick, can absorb heat during the day and release it at night, helping to stabilize indoor temperatures (Mohamed, Klingmann & Samir, 2019). Ventilation is also a critical component of passive design. Natural ventilation strategies can include cross-ventilation and stack ventilation, which rely on wind pressure and buoyancy-driven airflow, respectively. These methods not only improve indoor air quality but also reduce reliance on mechanical cooling systems. Properly designed ventilation systems can significantly enhance comfort, especially in temperate climates (Izadpanahi, Mahmoudi & Nikpey, 2021).

The integration of passive solar design elements further enhances a building's energy performance. Passive solar design involves capturing and storing solar energy to provide heating and lighting. Techniques such as overhangs, sunshades, and strategic landscaping can help control solar gain, ensuring that buildings remain cool in the summer and warm in the winter (Mohamed, Klingmann & Samir, 2019). Moreover, passive design contributes to environmental sustainability by minimizing the carbon footprint of buildings. By reducing energy demand, passive buildings can decrease greenhouse gas emissions associated with energy production. As the construction industry increasingly faces pressures to address climate change, passive design principles are becoming more prevalent in sustainable architecture (Fereidani, Rodrigues & Gaspar, 2021).

In conclusion, passive design represents a holistic approach to building that prioritizes energy efficiency and occupant comfort. By utilizing natural resources and local climate conditions, architects can create spaces that are not only sustainable but also enhance the well-being of their occupants. As the world continues to grapple with the challenges of climate change and resource scarcity, the adoption of passive design strategies will be essential in shaping a sustainable built environment.

2.1.2 Strategies of Passive Energy Design

Passive energy design refers to architectural strategies that harness natural energy sources for heating, cooling, and lighting, thereby reducing reliance on active mechanical systems. These strategies emphasize the integration of design elements that respond to the local climate and environmental conditions, creating sustainable and energy-efficient buildings.

The orientation of a building significantly impacts its energy performance. Buildings should be positioned to maximize solar gain in winter and minimize it in summer. For instance, orienting a building along an east-west axis can optimize sunlight exposure, allowing for passive solar heating during cold months while using overhangs or awnings to block harsh summer sun. According to Pajek & Košir (2021), strategic site planning enhances the building's ability to harness natural light and wind, thereby reducing energy consumption.

Incorporating thermal mass materials such as concrete, brick, or stone can help stabilize indoor temperatures by absorbing heat during the day and releasing it at night. This approach is particularly effective in climates with significant temperature fluctuations. Insulation, on the other hand, plays a crucial role in minimizing heat transfer, ensuring that indoor spaces remain comfortable with less energy input. As noted by Mousavi et al. (2022), effective insulation strategies can lead to a 30-40% reduction in energy consumption for heating and cooling.

Natural ventilation utilizes wind and thermal buoyancy to facilitate air movement within a building, reducing the need for mechanical cooling systems. Designing operable windows, vents, and atriums allows for cross-ventilation and stack ventilation, enhancing indoor air quality while minimizing energy use. According to Avezova et al. (2024), buildings designed with adequate ventilation strategies can significantly decrease reliance on air conditioning systems, thus lowering overall energy costs.

Daylighting strategies involve maximizing the use of natural light to illuminate indoor spaces, thereby reducing the need for artificial lighting. This can be achieved through careful placement of windows, skylights, and light tubes. Using reflective surfaces and appropriate glazing techniques can further enhance daylight penetration while minimizing glare and heat gain. Research by Mousavi et al. (2022) indicates that incorporating effective daylighting strategies can reduce energy use for lighting by up to 50% in commercial buildings.

Landscaping plays a vital role in passive energy design by providing shade and reducing heat island effects in urban areas. Trees and shrubs can be strategically planted to block direct sunlight from hitting the building's exterior, lowering cooling loads in the summer. Additionally, green roofs can insulate buildings, reduce storm water runoff, and enhance biodiversity. According to Mousavi et al. (2022), green roofs can reduce energy consumption for heating and cooling by up to 25%, making them an effective strategy for sustainable building design.

Passive energy design strategies are essential for creating sustainable, energy-efficient buildings that respond effectively to their environmental context. By focusing on site orientation, thermal mass, natural ventilation, daylighting, and landscaping, architects can design buildings that not only reduce energy consumption but also enhance occupant comfort and well-being. As the urgency for sustainable practices continues to grow, the implementation of passive energy design will play a critical role in the future of architecture and urban planning.

2.1.2.1 Understanding the Local Climate (Micro-Climate)

In the design of a passive building, it is essential to utilize the local climate (micro-climate) to its fullest advantage. Understanding climate characteristics and their classification can aid in identifying appropriate approaches from the initial stages of site planning and analysis. When undertaking the design of a new building or renovation, a comprehensive understanding of the local climate is imperative. In today's era, abundant data offers a comprehensive knowledge of the local climate's operational dynamics in any region. The concept of microclimate refers to the localized climate conditions that differ from the broader regional climate. Understanding and utilizing microclimates is essential in the realm of passive energy design, which seeks to enhance building efficiency through natural environmental elements without relying heavily on mechanical systems.

When planning a climate-sensitive city, the focus should be on incorporating environmentally responsive design that integrates bioclimatic elements into outdoor spaces. The term "bioclimatic" pertains to the interaction between climate and life, especially how climate affects living organisms.

Microclimates are shaped by various factors, including topography, vegetation, water bodies, and human-made structures (Mousavi et al., 2022). They can influence temperature, humidity, wind patterns, and solar radiation levels in localized areas, leading to variations that can be exploited in architectural design. Recognizing the interplay between a building and its immediate microclimate enables architects and designers to enhance energy efficiency, thermal comfort, and overall sustainability.

The function of plants in microclimatic design approaches is diverse and can be utilized at different scales such as individual buildings, streets, or urban and semi-urban areas (Canducci, Figliola, Calcagni, Calenzo, Battisti, 2024). By controlling evapotranspiration processes and physical traits, trees, whether singular or in clusters, function as an effective method for cooling urban environments. As a significant climatic moderator, the use of vegetation can provide numerous thermal benefits, including creating shade, reducing ground and air temperatures, minimizing solar infiltration, facilitating ventilation, and mitigating glare from reflections (Pajek & Košir, 2021).

Several recent studies highlight the successful integration of microclimate strategies in passive energy design. For instance, the "Living Building Challenge" projects have showcased how designers can create net-zero energy buildings by carefully analyzing their microclimatic conditions. These buildings leverage local solar, wind, and vegetation patterns to minimize energy consumption (Anisa, Jundullah Afgani & Lissimia, 2024). Moreover, a study conducted in a hot, arid climate demonstrated that buildings designed with a deep understanding of local microclimates achieved up to 30% energy savings compared to conventional designs (Mousavi et al., 2022). By utilizing shade from nearby trees, optimizing window placement based on wind patterns, and incorporating thermal mass, these buildings maintained comfortable indoor environments while significantly reducing energy usage.

2.1.2.2 Solar Geometry

Architects and builders must carefully consider the sun's position when designing a building. Because of the Earth's orbit, the sun's location in the sky changes with the seasons. To take advantage of this, designers incorporate features such as southern fenestration and longer overhangs. These elements optimize the sun's warmth during the winter months, while providing shade and preventing overheating in the summer. By implementing these techniques on the southern side of the building, maximum heat gain can be achieved in the winter, while ensuring effective shading during the summer(Mousavi et al., 2022). Solar geometry is the study of the position of the sun in relation to the Earth, crucial for understanding solar radiation's interaction with buildings, landscapes, and other surfaces. It provides essential insights for architects, urban planners, and environmentalists aiming to optimize energy efficiency and reduce the environmental impact of structures.

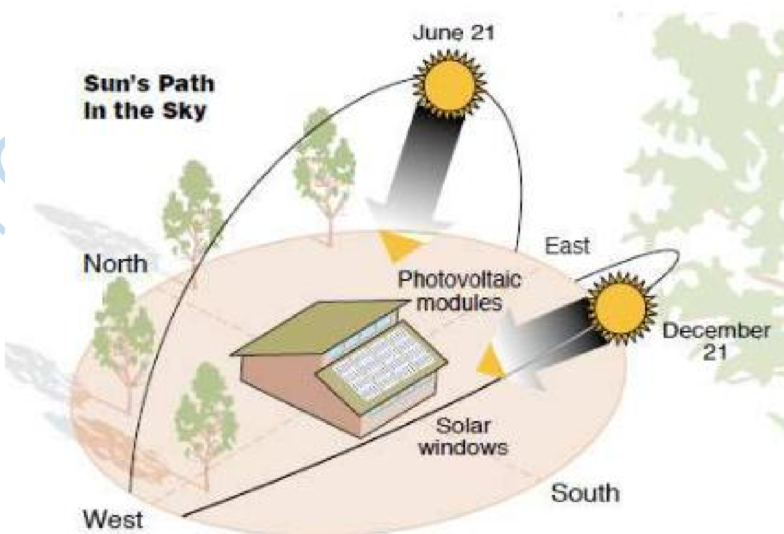

Fig 2.1: Showing Passive Cooling Techniques in Buildings

Source: (Mousavi et al., 2022).

At the core of solar geometry is the concept of solar angles, which includes the solar altitude angle, solar azimuth angle, and the concept of solar noon. The solar altitude angle refers to the height of the sun above the horizon, while the solar azimuth angle indicates the compass direction from which the sunlight is coming at any specific point on Earth. Understanding these angles helps in determining the intensity and duration of sunlight received at various times of the day throughout the year (Mousavi et al., 2022). The Earth's axial tilt (approximately 23.5 degrees) and its elliptical orbit around the sun contribute to the variation in solar angles, resulting in seasonal changes. This variation plays a significant role in climate and weather patterns, influencing agricultural practices and energy production strategies (Mousavi et al., 2022).

The applications of solar geometry are extensive, especially in building design and renewable energy. For architects, understanding solar geometry aids in creating designs that maximize natural light, optimize heating and cooling, and enhance occupant comfort (Anisa, Jundullah Afgani & Lissimia, 2024). The orientation and shape of a building can significantly affect its energy consumption; for instance, buildings oriented to capture more sunlight can reduce heating costs in colder climates. In renewable energy, solar geometry is vital for the design and placement of solar panels. The angle at which panels are installed can significantly impact their efficiency in capturing solar energy. Various studies have highlighted the importance of adjusting the tilt angle of solar panels based on seasonal variations to maximize energy generation (Anisa, Jundullah Afgani & Lissimia, 2024). Advanced software tools now integrate solar geometry data to assist in the optimal placement and design of solar energy systems.

Recent advancements in technology have improved the ability to calculate solar geometry accurately. Geographic Information Systems (GIS) and solar modeling software enable users to simulate and analyze solar exposure and shading effects on buildings and landscapes. These tools are particularly beneficial for urban planning, where they assist in evaluating the solar potential of different sites (Anisa, Jundullah Afgani & Lissimia, 2024). Furthermore, ongoing research is focusing on developing new materials and technologies that enhance the effectiveness of solar energy systems. For example, studies have explored the use of bifacial solar panels, which can capture sunlight from both sides, potentially increasing overall energy output by leveraging reflected sunlight from surrounding surfaces (Pajek & Košir, 2021).

Solar geometry is an essential field of study that underpins many aspects of architecture, urban planning, and renewable energy. Its principles guide the design of energy-efficient buildings and solar energy systems, contributing to a sustainable future. With continuous advancements in technology and ongoing research, the understanding and application of solar geometry will only become more sophisticated, allowing for more effective utilization of solar energy in various contexts.

2.1.2.3 Building Orientation

An effective passive design strategy involves orienting the building to capture solar heat. By aligning the building with the sun's movement, this orientation ensures that the heat entering through windows in winter doesn't compromise comfort in the summer (Liu & Ren, 2020).

Consider the following: A well-designed building should be strategically positioned to optimize natural light and airflow, thereby minimizing the reliance on artificial systems. A rectangular floor plan is most effective for passive solar design, with the long axis of the building (east-west) oriented within 10 degrees of true south. Simple building designs typically require less energy compared to those with more complex geometries.(Pajek & Košir, 2021).

Natural light is essential in educational settings, influencing students' mood, productivity, and overall well-being (Liu & Ren, 2020). By strategically orienting a vocational center, architects can maximize the penetration of daylight into classrooms, workshops, and communal areas. For instance, positioning the building with its longer facades facing south in temperate climates allows for optimal solar gain in winter while minimizing glare and overheating during summer months (Pajek & Košir, 2021). This approach not only reduces reliance on artificial lighting, thereby lowering energy costs, but also creates a more pleasant and engaging learning environment.

Building orientation also plays a pivotal role in promoting natural ventilation. Properly positioned windows and openings can harness prevailing winds, facilitating air movement and reducing the need for mechanical cooling systems (Pajek & Košir, 2021). In vocational centers, where workshops may generate heat from equipment and activities, effective cross-ventilation is vital for maintaining comfortable indoor temperatures. Research has shown that buildings oriented to capture prevailing breezes can significantly enhance indoor air quality and thermal comfort, fostering an atmosphere conducive to learning (Pajek & Košir, 2021).

The thermal performance of a building is heavily influenced by its orientation. A well-oriented vocational center can reduce heating and cooling demands by strategically utilizing the sun's path throughout the year. For example, incorporating overhangs, shading devices, and thermal mass on the southern facade can mitigate heat gain during the summer while allowing passive solar heating in winter months (Liu & Ren, 2020). This not only enhances occupant comfort but also contributes to the building's overall energy efficiency. A study by Ren, Wang, Liu & Liu, (2021) demonstrated that passive design strategies, including proper orientation, can lead to significant reductions in energy consumption in educational buildings.

Effective building orientation should also consider the surrounding landscape and site context. Landscaping elements such as trees, shrubs, and water bodies can provide additional shading and cooling effects, further enhancing the benefits of orientation (Liu & Ren, 2021). For vocational centers, integrating outdoor learning spaces and shaded areas can facilitate hands-on training and workshops while promoting interaction with the natural environment. By thoughtfully planning the building's orientation in relation to site features, architects can create an integrated educational experience that extends beyond the classroom walls.

Building orientation is a fundamental passive design strategy that offers numerous benefits in the design of vocational centers. By maximizing natural light, enhancing ventilation, improving thermal performance, and considering the surrounding landscape, architects can create spaces that not only foster effective learning but also promote sustainability and environmental stewardship. As the demand for energy-efficient and environmentally friendly buildings continues to grow, the importance of integrating passive design strategies such as building orientation will only become more critical in the development of educational facilities.

2.1.3 Elements of Passive Solar

Passive solar systems involve the collection, storage, and distribution of solar energy without the use of fans, pumps, or complex controllers found in active systems. This approach relies on an understanding of local climate, building geometry, and solar orientation. In addition to orientation, there are other key elements of passive solar design to consider when developing passive design strategies. The design of a vocational center that incorporates passive solar principles is pivotal in maximizing energy efficiency, promoting sustainability, and enhancing the learning environment. Passive solar design refers to architectural strategies that utilize natural energy flows, primarily solar energy, to regulate indoor temperature and light without the reliance on mechanical systems. This approach not only conserves energy but also creates a comfortable and productive atmosphere for students and staff (Ren, Wang, Liu & Liu, 2021).

One of the fundamental elements of passive solar design is the orientation of the building. In a vocational center, positioning the structure to optimize solar gain is critical. Ideally, the building should be oriented with its longest side facing south (or the equator), allowing for maximum exposure to sunlight throughout the day (Pajek & Košir, 2021). This orientation enables the collection of solar energy during winter months while minimizing heat gain during summer. Proper site selection and layout also consider shading from nearby trees or buildings, which can influence solar access (Mohamed, Klingmann & Samir, 2019).

The use of thermal mass is another crucial component of passive solar design. Materials with high thermal mass, such as concrete, brick, or stone, can absorb and store heat during the day, releasing it slowly at night (Amirhajloo & Saghae, 2021). In a vocational center, these materials can be incorporated into walls, floors, and other structural elements to stabilize indoor temperatures. Additionally, effective insulation plays a significant role in minimizing heat loss during colder months and reducing heat gain in warmer months. Insulation materials should be carefully chosen based on their R-values, which indicate their effectiveness in resisting heat flow (Amirhajloo & Saghae, 2021).

Windows are a critical aspect of passive solar design, allowing natural light to penetrate the interior while also facilitating solar heat gain. In a vocational center, window design should incorporate high-performance glazing that minimizes heat loss and glare while maximizing daylighting (Pajek & Košir, 2021). The placement and size of windows should be strategically planned; south-facing windows can provide ample sunlight in winter, while overhangs or shading devices can block excessive summer sun. The concept of daylighting, which involves using natural light to illuminate spaces, can reduce reliance on artificial lighting, further enhancing energy efficiency (Pajek & Košir, 2021).

Effective natural ventilation is another critical component of passive solar design. A well-designed vocational center should facilitate cross-ventilation, allowing cool air to flow through the building and warm air to escape (Pajek & Košir, 2021). This can be achieved through strategically placed windows, vents, and other openings. The integration of operable windows allows occupants to control airflow, creating a comfortable learning environment. Additionally, the use of thermal chimneys can enhance stack ventilation, drawing warm air upwards and facilitating the movement of cooler air from lower levels (Amirhajloo & Saghae, 2021).

Landscaping plays an essential role in passive solar design by enhancing the building's thermal performance. Planting deciduous trees on the south and west sides of the vocational center can provide shade during the summer while allowing sunlight to penetrate in winter when the leaves fall (Liu & Ren, 2021). Moreover, the incorporation of reflective surfaces, such as light-colored pavements and water features, can enhance solar gain and reduce heat absorption in the vicinity of the building. Careful consideration of the surrounding landscape can contribute significantly to energy efficiency and occupant comfort**.**

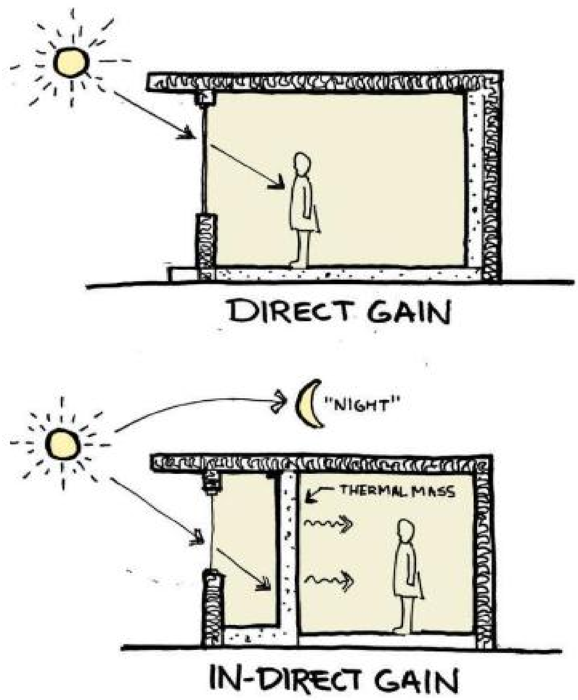

Fig 2.2: Showing Passive Cooling Techniques in Buildings

Source: (Liu & Ren, 2021).

2.1.4 Passive Control Methods

Fenestration: Effective use of glazing entails capturing heat and daylight while also providing insulation when sunlight is not required, such as on hot days or at night. This can be achieved through the use of drapes with thermal liners, awnings or overhangs, low emissivity coatings, and high-performance double or triple pane windows. Fenestration includes windows, doors, and other openings that manage light, heat, and airflow, making it essential in passive solar control. The design, placement, and type of glazing in windows influence a building's energy efficiency. Recent studies highlight that high-performance glazing reduces heat gain, and orienting windows based on solar angles enhances daylighting while minimizing overheating (Liu & Ren, 2021). Dynamic fenestration elements, such as shading systems, are effective at lowering cooling demands by about half, while internal shading only reduces cooling by one-third (Yang, Fu, He., He & Liu, 2019). Using reflective glass further supports thermal control by minimizing direct sunlight absorption, especially when positioned on east- and west-facing facades.

Roof Overhang: Roof overhangs are structural projections that shade windows and walls from direct sunlight, preventing excessive indoor heat during summer while allowing sunlight during winter. Their effectiveness is largely tied to orientation; horizontal overhangs work well for south-facing facades, while vertical shading devices are better for east and west orientations (Liu & Ren, 2021). Studies show that carefully calculated overhang angles based on solar paths can reduce cooling loads significantly by creating a balance between shading and daylight access (Yang, Fu, He., He & Liu, 2019). The use of louvers and external blinds can further enhance the performance of roof overhangs, particularly in climates with intense seasonal sunlight.

Roof overhang are a great passive design strategy at blocking the direct overhead rays of the summer sun all while allowing the direct rays of the winter sun. Appropriately sized overhangs will depend on your latitude on the Earth and can be accessed online. Overhangs can alternatively be a balcony, reflective mirror or a design aspect that shields the summer light from entering the building.

Thermosiphoning: The convective loop system is a passive strategy that uses the natural movement of warm air to heat a space. It works by transferring warm air from a collector to a storage or room, and then circulating the now cooler air back to the collector to be reheated. This process relies on the principles of thermodynamics to efficiently move warm air where it's needed. The collector area is positioned at a lower elevation than the main room, which can be a drawback depending on site constraints. While this concept has been developed into an active design strategy, its fundamental nature remains as a passive system due to the way convective loops naturally move warm air.

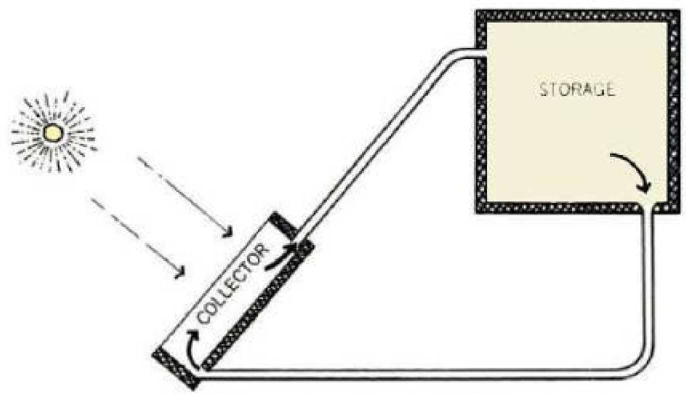

Fig 2.3: Showing Passive Cooling Techniques in Buildings

Source: (Yang, Fu, He., He & Liu, 2019).

Thermosiphoning, or thermal siphoning, leverages the natural rise of warm air to facilitate cooling. It typically involves creating a solar chimney or vertical channel that directs heated air upwards and out of the building, drawing cooler air in from lower points. Recent developments in thermosiphoning systems have optimized designs, particularly in hot climates, by incorporating solar chimneys that draw out warm air, reducing the need for mechanical cooling systems (Yang, Fu, He., He & Liu, 2019). Thermosiphoning also works in tandem with natural ventilation techniques, where strategic openings maximize airflow across the structure, enhancing the overall indoor thermal comfort (Yang, Fu, He., He & Liu, 2019).

Landscaping: Using trees and vegetation as a passive design strategy is a great way to effectively shade a space from sun or wind. Deciduous trees can be used when shading is needed in the summer. Some of the factors to consider when deciding on which trees work best is to look at branch and twig density and winter sun filtration. An arrangement of evergreen shrubs and trees should be used along the north and windiest sides of the building (look at the site's historic data) to protect it from colder winter winds.

Landscaping is increasingly recognized as a critical passive cooling technique. Trees and plants not only shade buildings but also cool the surrounding microclimate through evapotranspiration. When placed around a building, vegetation can reduce temperatures by creating shaded zones and minimizing heat absorption from surrounding surfaces. Green roofs and walls offer additional benefits by acting as insulators, reducing urban heat islands and managing stormwater (Yang, Fu, He., He & Liu, 2019). Studies confirm that green facades and roofs can lower energy costs and enhance occupant comfort, particularly when integrated with other passive strategies like shading devices and optimized ventilation.

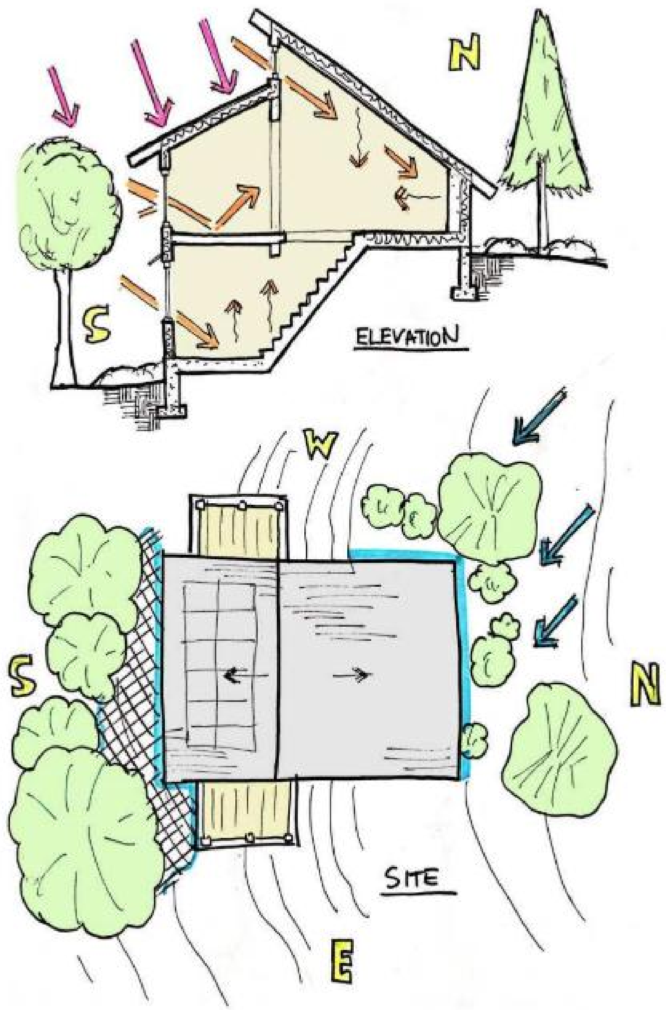

Fig 2.4: Showing Passive Cooling Techniques in Buildings

Source: (Yang, Fu, He., He & Liu, 2019).

2.1.5 Passive Cooling

It is our ethical responsibility to preserve historical architecture, along with traditional passive cooling methods, not only for their artistic significance but also to ensure that regional characteristics endure for future generations. Passive cooling technologies are eco-friendly methods that help effectively lower indoor temperatures with minimal or no reliance on electrical power. The incorporation of traditional passive cooling techniques can play a significant role in designing modern buildings in hot, arid regions.

Passive cooling techniques are broadly categorized under three sections: heat prevention/reduction, thermal moderation and heat dissipation. However, this classification can be simplified and divided into two types either through releasing heat from the building or by blocking the thermal flow into the building. Although the passive cooling system has varied technologies, the ideal objective is thermal resistance of heat entering from the outside alongside the release of heat accumulated in indoor spaces (Yang, Fu, He., He & Liu, 2019).

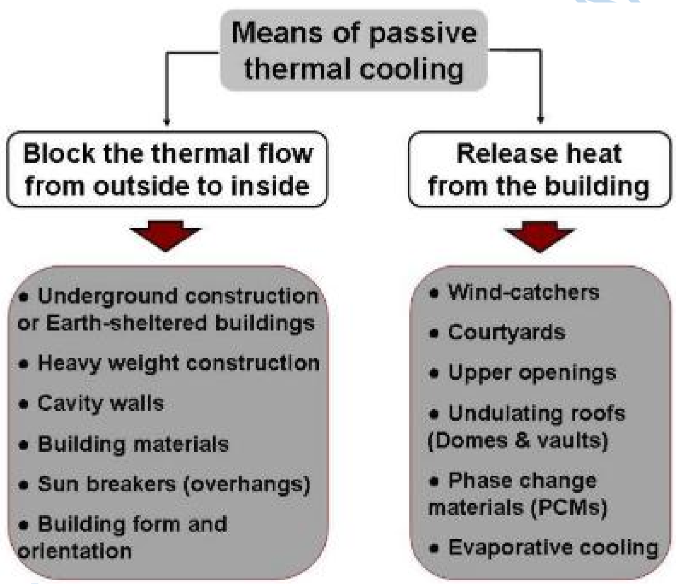

Fig 2.5 Showing Passive Cooling Techniques in Buildings
Source:(Yang, Fu, He., He & Liu, 2019).

2.1.6 Classification of Passive Energy Design

There are diverse classifications of passive design techniques. Norbert Amirhajloo & Saghae, (2021) categorized green techniques into three tiers of basic building design, passive system, and mechanical equipment use according to the design process. Accordingly, tiers 1 and 2, which are associated with passive design techniques, are divided into heating, cooling, and lighting methods. Heating methods involve techniques such as solar radiation penetration, efficient energy control through surface to volume ratio, trombe wall, and sunspace. Cooling methods include shading from solar radiation or using shading and ventilation to bring in ambient air. Lighting methods involve natural lighting techniques that use windows, skylights, and light shelves.

2.1.7 Passive Design Techniques

According to Amirhajloo & Saghae, (2021), the environmental control area of passive design techniques includes the light environment, air environment, and thermal environment.

Light environment: Passive design techniques for controlling the light environment include utilizing a south-facing building orientation, arranging the major axis in the east-west direction, facing a stepped or sloped mass towards the south, incorporating open spaces such as atriums and courtyards, arranging openings appropriately (skylights and clerestory), and using light induction devices like light shelves and daylight ceilings. There are also techniques for shielding direct sunlight for buildings facing the east and west and producing equal indoor illumination to create a more pleasant indoor environment on the south side. These techniques involve sun shading using a building form technique that adds a translucent skin to the curtain wall, as well as controlling sunlight using louvers, canopies, and sunscreens.

Air environment: Passive design methods for regulating the air environment begin with the goal of improving natural ventilation's efficiency. This concept covers the Venturi effect, stack effect, cross ventilation, and techniques involving terrain and geographical features. The Venturi effect facilitates natural ventilation by capitalizing on variations in air speed. This effect serves as a clear illustration of creating a ventilation pathway by altering the width of the spaces between buildings. The stack effect arises from pressure discrepancies caused by differing heights. This approach is employed to boost ventilation by utilizing a skylight, clerestory, or atrium.

Thermal environment: The passive design strategy for optimal natural ventilation manages both the air and temperature environments. The design strategy includes building ventilation channels or installing open areas, as well as properly arranging apertures or ventilation induction equipment. These produce a composite effect for air environment control by leveraging natural ventilation while mitigating the warming issue caused by the introduction of external air.

Table 2.1: Showing Environmental Effect of Passive Design Techniques

Design Area	Passive Design Techniques	Environmental control Area		
		Light Environment	Air Environment	Thermal Environment
Building Orientatio n & Shape	South orientation	natural lighting	-	solar radiation penetration
	Sun shading form	daylight shading	-	solar radiation shading
	Ventilation path	-	natural ventilation	air intake
	Raised roof	-	-	Efficient control of sunlight
	Volume to surface ratio	-	-	efficient control of sunlight
Open Spaces	Atrium	natural lighting	natural ventilation	solar radiation penetration /air intake
	Court yard, light well	natural lighting	natural ventilation	solar radiation penetration /air intake
Opening & Device	Skylight, monitor roof	natural lighting	natural ventilation	solar radiation penetration /air intake
	Clerestory	natural lighting	natural ventilation	solar radiation penetration /air intake
	Daylight duct	natural lighting	-	-
	Light shelves, daylight ceiling	natural lighting	-	-
	Ventilation duct, ventilation tower	-	natural ventilation	air intake
Building Skin	Double skin	-	-	efficient control of sunlight
	Translucent skin	daylight shading	-	solar radiation shading
	Louver, sun screen	daylight shading	-	solar radiation shading
	Closed facade	-	-	efficient control of sunlight
Building Planting	Green roof, landscaped ramp	-	-	soil insulation
	Green wall	-	-	soil insulation
	Water space	-	-	heat exchange

Source: (Amirhajloo & Saghae, 2021)

Chapter Three

Methodology: Case Study

3.1 Introduction

This study focused on the incorporation of passive design principles in the creation of a vocational center for residents of Moniya in Ibadan, that promotes an effective learning process and performs all its functions. A review of the literature on passive design techniques and how they may be used in design was conducted via the use of journals, papers, books, and other materials. Already existing vocational centers of various locations were also investigated and assessed to have a better understanding of the design requirements and techniques that may inform the design of a proposed vocational center.

3.2 Case Study Selection Criteria

The case studies were chosen with care based on the following criteria:

1. Vocational centers designed with passive design principles.
2. Vocational centers that incorporated passive design principles in their architecture.
3. The project's scope (national/international).

3.3 Aspects of Case Study Analysis

Following selection, the case studies were evaluated on four criteria:

1. Overview/general information
2. Design concept and building materials
3. Building's architectural description/features
4. Study observations and conclusions

3.4 Case Studies

3.4.1 Case Study 1: Lagos State Vocational Training and Skill Acquisition Centre

Name: Lagos State Vocational Training and Skill Acquisition Centre

Location: Surulere, Lagos.

Project year: 2015

3.4.1.1 Overview

The vocational training program offers nothing less than professional vocational trainings. The Center is a government initiative setup to train young Nigerians in different skill acquisition, like computer studies, barbing, hat/bead/craft making, textile design, photography, catering and hotel management, hairdressing and cosmetology, fashion design and dressmaking and many more.

Plate 3.1 Showing The Faculty Entrance
Source: Author's survey

3.4.1.2 Design Concept and Building Materials

The lecture rooms, which are arranged along the building's façade is precise having a straightforward and logical design in contrast to the vibrant atrium. In addition to producing a striking visual effect, the varied pattern of windows generously admits light into the structure and provides a breath-taking perspective of the river.

The design made use of various building materials like hollow blocks, reinforced concrete, mass concrete, glass, combination of wooden and steel roof truss, aluminum roofing sheet, wooden frames and doors, metal doors.

Plate 3.2 Building Interior Showing Poor Lighting Conditions

Source: Author's survey

Plate 3.3 Bead Making Section
Source: Author's Survey

Plate 3.4 Fashion Design School Section

Source: Author's Survey

3.4.1.3 Description and Features

Lagos State Vocational Training and Skill Acquisition Centre is a composite structure. The structure was constructed with structural steel framework with concrete slabs and columns are cast-in-situ.

3.4.1.4 Observations

- There is good natural ventilation to exterior facing offices.
- There is good natural lighten to exterior facing offices.
- It is easily accessible
- There is proper space allocation for users
- There is proper shading element in the building
- Emergency escape doors is not enough
- There is no proper shading element in the building
- The design was beautiful but in a state of disrepair.
- There is no proper drainage which can lead to erosion as time goes on.
- Corridors, staircases and lobbies are dark.
- There is no enough parking space for the office building area.
- There is no functional water and electricity supply to the building. Alternative means are sourced.

3.4.2 Case Study 2: Home Science Association Vocational Institute

Name: Home Science Association Vocational Institute

Location: Ebute Metta, Lagos

Project year: 1961

3.4.2.1 Overview

Home Science Association was formed over 54 years ago (1961) by some visionary women Home Economist in furtherance of their passion for nation building.

Plate 3.5: Picture Showing the Exterior of Home Science Association Vocational Institute

Source: Author's Fieldwork

3.4.2.2 Design Concept and Building Materials

The structure consists of hollow blocks and features reinforced concrete, mass concrete, and glass elements. The roof truss is a combination of wood and steel, with aluminum roofing sheets. The building also includes wooden frames and doors, as well as metal doors.

Plate 3.6 Cross Section of Lecture Session in Fashion designing

Source: Author's Fieldwork

Plate 3.7 Picture Showing Spacious Lecture Room

Source: Author's Fieldwork

3.4.2.3 Description and Features

The construction method utilized a structural framework, with concrete slabs and columns being cast-in-situ.

3.4.2.4 Observations

- There is good natural ventilation to exterior facing offices.
- There is good natural lighten to exterior facing offices.
- It is easily accessible
- There is proper space allocation for users
- There is proper shading element in the building.
- There is enough parking space for the office building.
- Emergency escape doors is not enough
- There is no proper shading element in the building
- The design was beautiful but in a state of disrepair.
- There is no proper drainage which can lead to erosion as time goes on.
- Corridors, staircases and lobbies are dark.
- There is no functional water and electricity supply to the building. Alternative means are sourced.
- Office space inadequate due to expansion and creation of more departments.

3.4.3 Case Study 3: Ecove Centre of Vocational Empowerment

Name: Ecove Centre of Vocational Empowerment

Architect: SEZA Architects & Interior Designers

Location: Aurangabad, India

Year: 2022

3.4.3.1 Overview

In rural areas lacking adequate public infrastructure, community gathering places represent more than just architectural structures; they embody social progress, offering a sense of human dignity, potential, and communal space. Our goal for the Vocational Training Institute in Aurangabad is to provide young villagers with the opportunity to gain a skill that will enable them to support a modest lifestyle on their own. Aurangabad, situated in the state of Maharashtra in India, is renowned for the Ajanta Ellora caves, a UNESCO world heritage site. These caves form one of the largest Hindu rock-cut cave complexes globally, featuring panels depicting stories from the two principal Hindu epics. Additionally, the caves showcase sculptures and carvings representing three different faiths: Brahmanism, Jainism, and Buddhism, promoting the values of tolerance and optimism.

Plate 3.8: Front View of Ecove Centre of Vocational Empowerment

Source: Author's Fieldwork

3.4.3.2 Design Concept and Building Materials

The facility combines modern elements with a nod to the historical context of its surroundings. It is well-suited to the local area and draws inspiration from the nearby cave complex to convey a message of hope to the villagers. The design reimagines the traditional courtyard layout, with the administrative area opening up to a series of corridors leading to classrooms, technical rooms, a canteen, and an auditorium, all situated around the central courtyard. The center provides training in sewing, computers, dye making, electrical courses, and basic English language skills. By separating the different activities into distinct sections connected by small courtyards and transitional pathways, we have created a vibrant combination of indoor and outdoor community spaces.

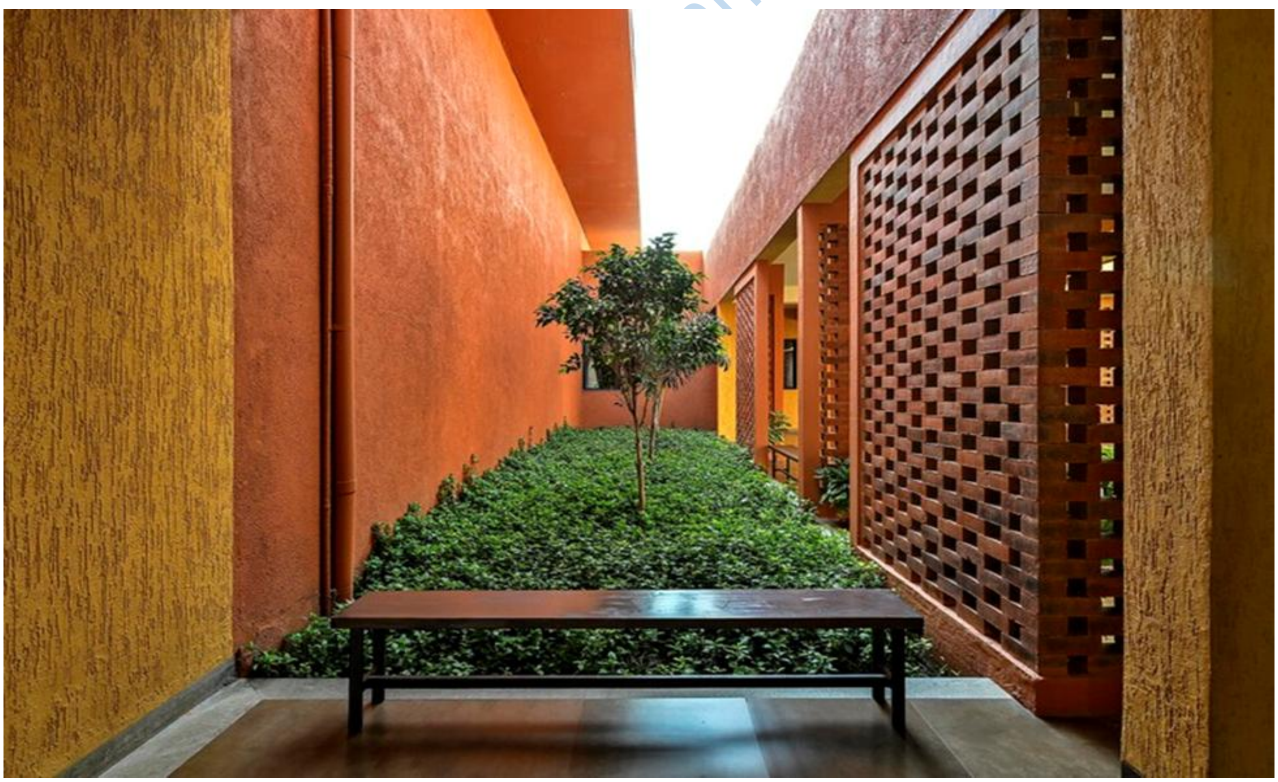

Plate 3.9: Interior view of Ecove Centre of Vocational Empowerment
Source: Author's fieldwork

Plate 3.10: Interior view of Ecove Centre of Vocational Empowerment
Source: Source: Author's fieldwor

3.4.3.3 Description and Features

Our goal was to design a space with a strong connection to nature, using natural materials, sunlight, and greenery to create a pleasant learning environment for the villagers. Instead of air conditioning, the classrooms rely on natural ventilation to stay cool. The use of passive ventilation and daylighting systems promotes a learning environment that harmonizes with the surrounding natural landscape. The corridors feature angular brick screens that help reduce intense heat, making them more comfortable to be in. In this region, summer temperatures can reach as high as 40-45 degrees. Staggering the classrooms created additional social interaction spaces beside the multiple courtyards.

3.4.3.4 Observations

- There is good natural ventilation to exterior facing offices.
- There is good natural lighten to exterior facing offices.
- It is easily accessible
- There is proper space allocation for users
- There is proper shading element in the building using anodized glass.
- There is enough parking space for the office building.

3.4.4 Case Study 4: MBO Nimeto

Name: MBO Nimeto

Architect: Maarten van Kesteren Architecten

Location: Utrecht, Netherlands

Year: 2023

3.4.4.1 Overview

MBO Nimeto provides education for individuals interested in creative space design, including painting, restoration, styling & presentation, sign making, and similar fields. The school's premises consist of two specially designed vocational schools constructed around 1970. One was originally intended for the National Painters School, while the other was for the Netherlands Butchers School. These buildings were later joined together, although they are separated by a street. Over the course of fifty years, numerous modifications have been made to the building, resulting in an unbalanced layout that does not fully align with

Nimeto's educational principles. Additionally, the increasing student population and new insights have made a comprehensive transformation necessary.

Plate 3.11 Front View of MBO Nimeto
Source: Author's fieldwork

3.4.4.2 Design Concept and Building Materials

The plan utilizes the unique characteristics of the original buildings, such as their spaciousness and adaptable nature, to revitalize the 1970's architecture as a foundation for the school of the future. Van Kesteren has modified the original design by implementing four significant architectural changes. In three locations, he has established multi-level open areas by removing sections of the concrete floor. These empty spaces enable natural light to penetrate deep into the building, while also establishing links, points of reference, and communal areas.

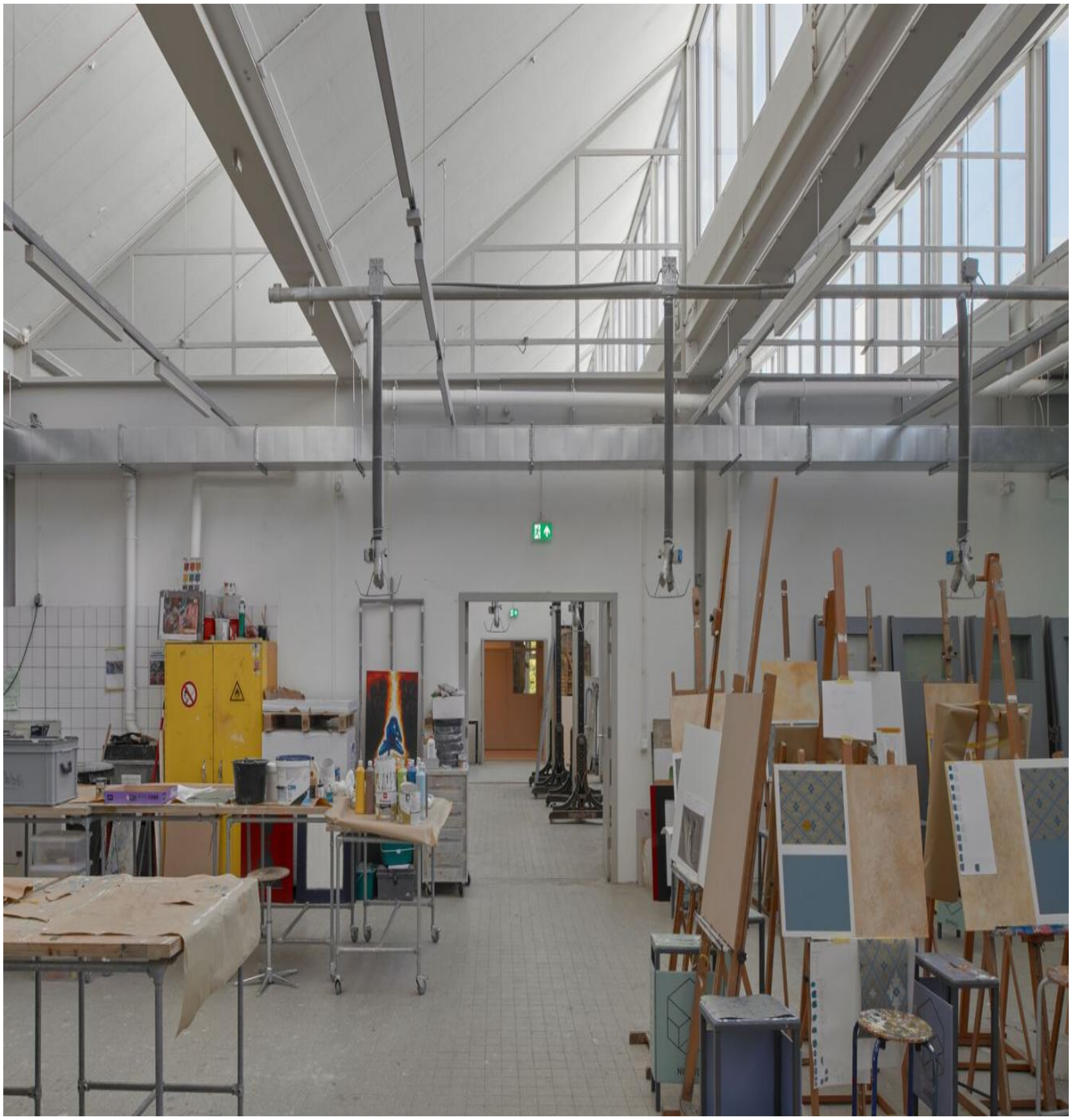

Plate 3.12 View of Demonstration Room of MBO Nimeto
Source: Author’s fieldwo

Plate3.13 View of Courtyard Area of MBO Nimeto
Source: Author's fieldwork

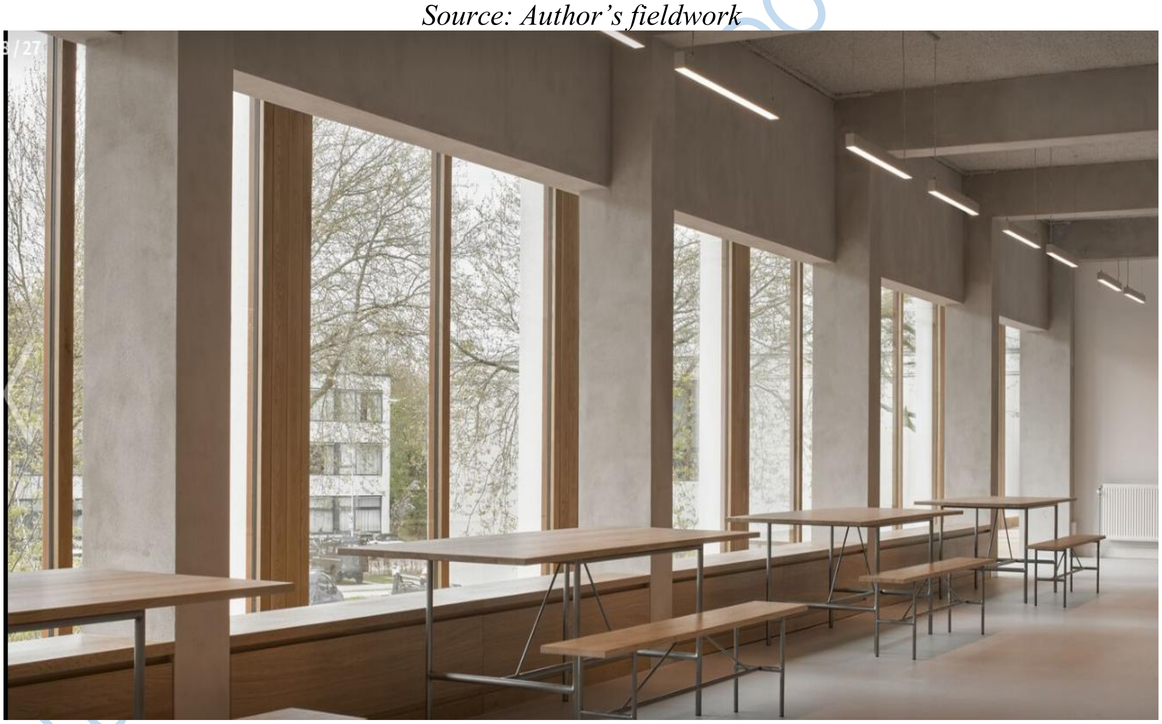

Plate 3.14 View of Demonstration Room of MBO Nimeto
Source: Author's fieldwork

3.4.4.3 Description and Features

Nimeto made a decision to go against the common practice in the Netherlands, which involves regularly tearing down educational buildings that are more than forty years old and replacing them with new ones. The school acknowledged and appreciated the strengths of the existing building and understood that current budget constraints would result in new schools with less space and often constructed using a modular system that offers minimal architectural or spatial quality. In his design for Nimeto, Maarten van Kesteren aimed to simplify and open up the fifty-year-old building and transform it into a more harmonious whole

3.4.4.4 Observations

- There is good natural ventilation to exterior facing offices.
- There is good natural lighten to exterior facing offices.
- It is easily accessible
- There is proper space allocation for users
- There is proper shading element in the building using anodized glass.
- There is enough parking space for the office building.

3.4.5 Case Study 5: Herningsholm Vocational School

Name: Herningsholm Vocational School

Architect C.F. Møller

Location: Herning, Denmark

Year: 2014

3.4.5.1 Overview

The new Herningsholm Vocational School presents itself as a separate structure within a preexisting cluster of educational buildings on the campus. The school has been planned with a strong emphasis on cultivating ideal learning and study settings, both internally and externally. This includes creating inviting urban areas that offer opportunities for outdoor learning and teaching, taking into account the surrounding context.

Fig 3.1 Typical Floor Plan of Herningsholm Vocational School

Source: C.F. Møller Architects Amirhajloo & Saghae, (2021),

3.4.5.2 Design Concept and Building Materials

The structure has an angled design that unites three building sections under a sloping roof, which adjusts its height to the surroundings by decreasing from three floors in the southernmost area to two floors in the northernmost part. The angled structure forms three new outdoor urban and educational areas in collaboration with the adjacent buildings: The Plaza, the study garden, and a front garden. The building is intended for general use, and the educational spaces are planned to ensure that the physical environment complements and aligns with diverse, adaptable, and modern learning principles. Integrated seating/study nooks in the facade enhance the quality of the spaces and encourage alternative, more unconventional uses. Movable furniture can rapidly modify the educational space for different teaching scenarios. The structure consists of hollow block walls, reinforced concrete columns and beams, and mass concrete foundations. The building features glass windows, a roof made of a combination of wooden and steel trusses covered with aluminum roofing sheets. The interior includes wooden frames and doors, as well as metal doors.

Plate 3.15 Exterior View of Herningsholm Vocational School
Source: Author's Fieldwork

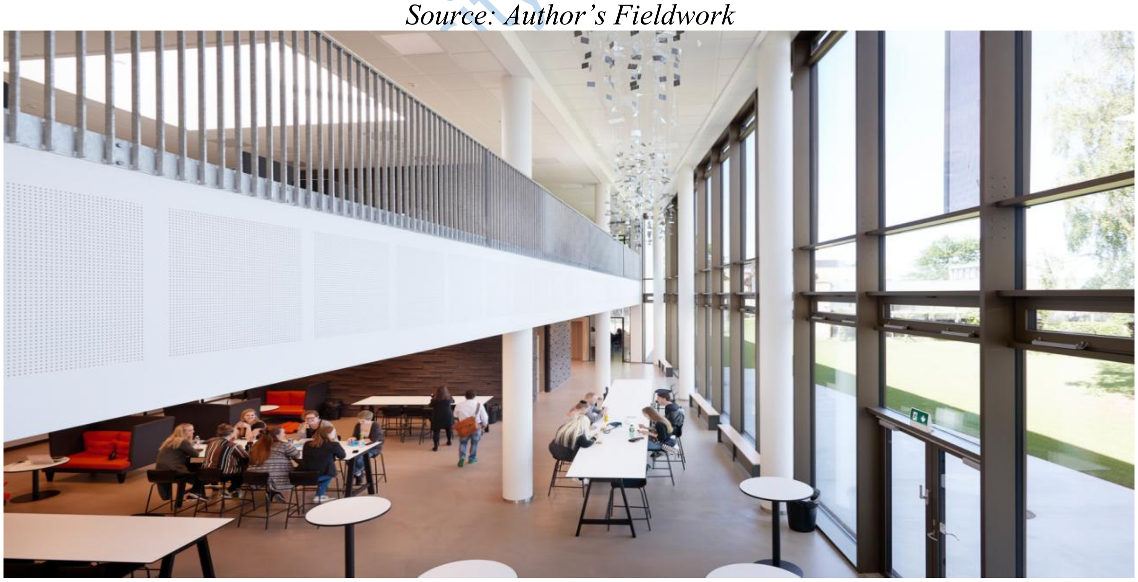

Plate 3.16 Exterior View of Herningsholm Vocational School
Source: Author's Fieldwork

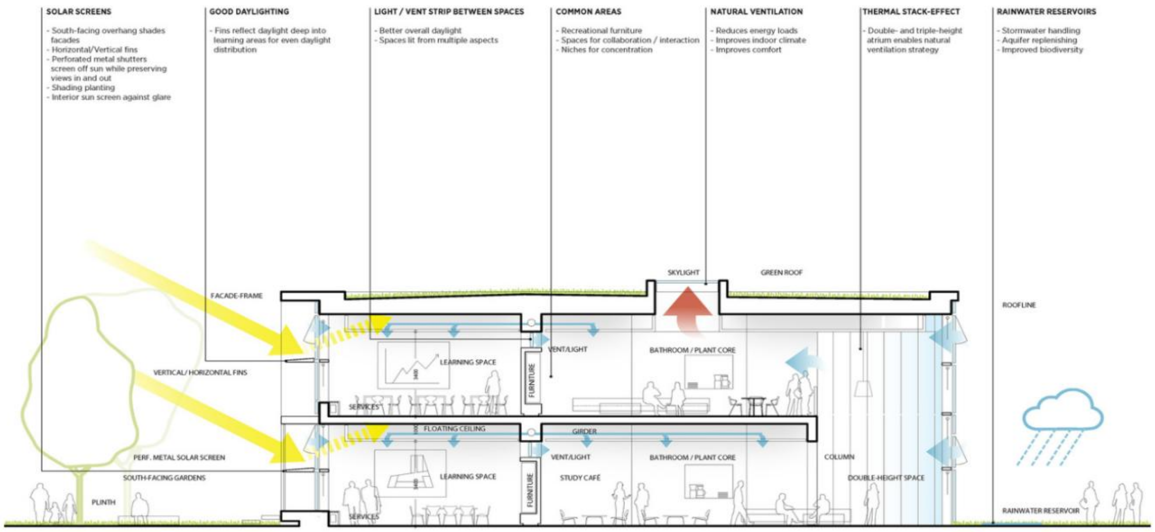

Fig 3.2 Typical Sections of Herningsholm Vocational School

Source: Martín Schubert Amirhajloo & Saghae, (2021),

3.4.5.3 Description and Features

The construction acknowledges that our actions and thoughts are influenced by the physical surroundings we inhabit. The design of the learning environment and the architecture has a profound impact on the daily learning processes of students and is therefore created based on modern and democratic principles. The foundational learning spaces of the building are arranged around a central common area that also functions as a flexible learning space. These learning spaces are paired together to ensure direct access to the common area from all parts of the school. The common study areas provide a range of physical environments for various types of work, from the double-height rooms overlooking the garden, suitable for workshop-style activities, to a student café space for informal student gatherings, to quiet and intimate dedicated study corners. Each learning space is designed to accommodate numerous layouts and uses.

3.4.5.4 Observations

- There is good natural ventilation to exterior facing offices.
- There is good natural lighten to exterior facing offices.
- It is easily accessible
- There is proper space allocation for users
- There is proper shading element in the building using anodized glass.
- There is enough parking space for the office building.
- Such facility is too elegant for a university office.
- Maintenance would be very high.
- Servicing and running cost would be unsustainable.

Chapter Four

Site, Project Analysis and Design Synthesis

4.1 Study Area

This section discusses the preliminary design proposal and the design decisions taken to arrive at the proposed vocational center. The proposed design is based on the spatial requirements, case studies, and the application of integrated lighting to ensure user comfort.

4.1.1 Site Location and Description

The proposed vocation center is ideally situated in Moniya, Ibadan, Oyo State, Nigeria, occupying a prime position directly opposite the prestigious International Institute of Tropical Agriculture (IITA). Its proximity to the University of Ibadan's Distance Learning Center further enhances its strategic location, establishing it as a central hub for educational and vocational pursuits within the area. The surrounding environment is both academic and professional, fostering an atmosphere of learning, innovation, and skill acquisition.

This prime placement not only offers easy accessibility for students and professionals but also aligns the vocation center within a community dedicated to growth, agriculture, and knowledge exchange, making it a valuable addition to the landscape of Moniya. The site has a total square area of 30,950.43 and total perimeter of 687.13m. Moreover, its accessibility is enhanced, as it is bordered by roads on both the front and side, ensuring convenient entry and exit points.

Fig 4.1: Map of University of Ibadan Distance Learning with Proposed Site Highlighted
Source; Google Map (Satellite)

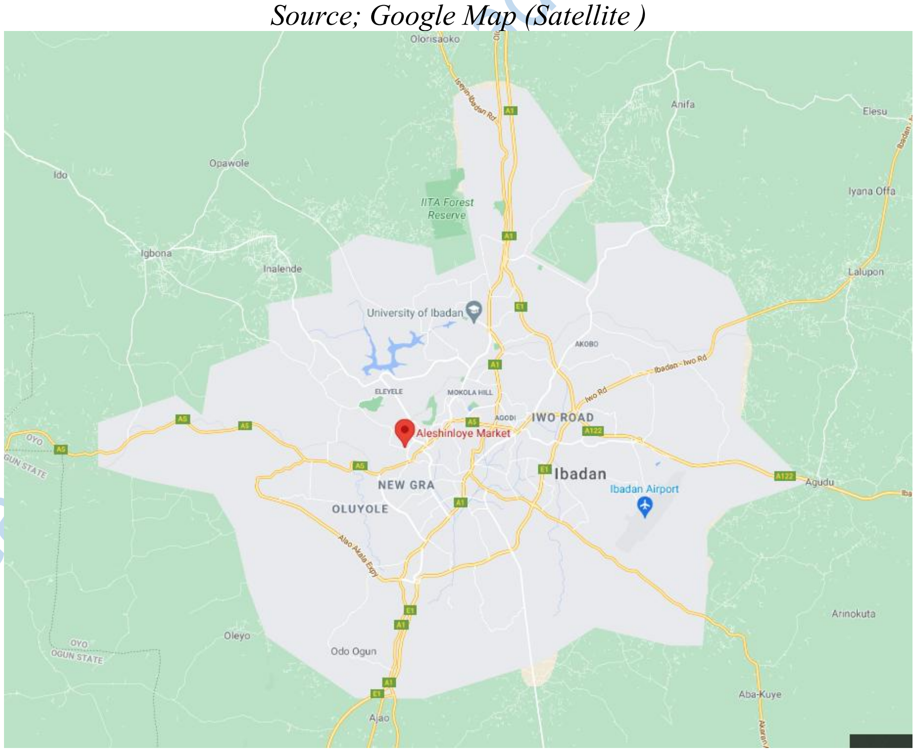

Fig 4.2: Site Map Location.
Source: Google Map (Satellite)

4.1.2 Site Selection Criteria

Choosing an optimal site is a pivotal decision-making process for businesses, governments, and organizations, impacting operational success, sustainability, and overall cost-effectiveness. Site selection involves a thorough analysis of multiple factors, from economic conditions to environmental impact. An appropriate site selection strategy requires balancing diverse criteria to ensure that the selected location aligns with the organization's goals.

These criteria help ensure that the selected site for a Vocational School Building meets the functional, regulatory, and environmental requirements necessary for the success of the facility:

4.1.2.1 Accessibility

Proximity to Transportation: Ensure the site is easily accessible by public transportation and has good connectivity to roads and highways. Accessibility affects how easily users, including those with disabilities, can reach and navigate the center, directly impacting the center's success and inclusivity. Universal design principles underscore the importance of creating spaces that accommodate a diverse population, which is especially critical in vocational training contexts, as such facilities serve people with varied abilities and educational backgrounds.

Site Access and Proximity to Public Transport: A vocational center should be accessible by public transportation to facilitate access for users who may not have private vehicles. Locating near major transportation routes reduces commuting challenges and makes the facility more inclusive. This approach also aligns with sustainable transportation practices, reducing the environmental impact associated with commuting (Wu, Li, Wargocki, Peng, Li & Cui, 2019).

Physical Accessibility Features: According to universal design principles, the facility's entrance and interior should be accessible to individuals with disabilities, including those with mobility impairments. Ramps, elevators, wide corridors, and accessible parking are essential features that enhance usability for all users (Du, Li, Yu, Liu &Yao, 2019). Ensuring that pathways, entrances, and exits meet ADA or similar standards helps in achieving accessibility for individuals who rely on mobility aids.

Interior Layout and Spatial Design: Vocational centers need flexible spaces that support hands-on learning while accommodating diverse needs. Workshops, labs, and classrooms should be spacious and allow for easy movement. Additionally, layouts that reduce noise and provide adaptable seating arrangements enhance the learning environment for individuals with sensory or cognitive needs. For instance, an automotive or woodworking workshop might require specific floor designs that mitigate hazards related to heavy equipment or hazardous materials (Ichinose, Lei & Lin, 2017).

Supporting Technology and Resources: Vocational centers benefit from technology-enhanced classrooms and specialized tools, such as computer labs for technical training or carpentry labs for manual skill-building. Ensuring these areas are accessible to people with visual or hearing impairments, such as through auditory-visual aids and touch-based resources, helps foster inclusivity. These accommodations ensure that vocational training remains accessible to all, aligning with best practices in educational facility design (Zhang, Qi, Zhang & Zhou, 2024).

Community and Social Connectivity: The location should be strategically chosen to encourage community engagement and partnerships. A site within reach of related industries or community support systems can enable vocational centers to form partnerships that benefit learners, especially through on-site collaborations or community-based projects. Such accessibility enhances the center's role within the broader community and provides learners with realistic, hands-on experience.

In summary, prioritizing accessibility in the location choice for vocational centers fosters an inclusive environment that supports skill acquisition for individuals of all backgrounds and abilities. This focus on universal design not only aids individuals but also strengthens the community's socio-economic fabric by equipping diverse groups with practical, employable skills (Chen, Zheng, Yang & Yoon, 2021).

4.1.2.2 Location and Surroundings Facilities

Proximity to other institutional facilities for collaboration Resources: Choose a location that is close to libraries, laboratories, and other academic facilities to enhance collaboration and resource-sharing. In designing a vocational center, considering the location and surrounding facilities is vital to optimize its functionality and accessibility. The surrounding infrastructure, amenities, and related facilities directly impact the vocational center's ability to fulfill its educational and community service roles effectively. Key factors include the center's accessibility to public transportation, proximity to relevant industries, and integration with other community facilities such as libraries, retail areas, and recreational spaces.

Locating a vocational center near transportation hubs can significantly enhance attendance, particularly for centers serving diverse communities, as it improves the convenience for students, faculty, and visitors. Moreover, close proximity to industries related to vocational programs encourages practical, hands-on learning experiences through partnerships, internships, and site visits, essential for career and technical education programs (Guo, Kong, Chow, Li, Zhu, Qiu, Li, Wang, & Riffat, 2020).

4.1.2.3 Infrastructure and Utilities

Availability of Utilities: Ensure the availability of essential utilities such as water, electricity, gas, and sewage to support the academic building's operations. Beyond industrial connections, nearby facilities such as retail centers and social services improve the center's appeal and function as a community hub. Spaces like cafeterias, recreational parks, and communal work areas foster a collaborative and creative environment, transforming the vocational center into a multi-use facility rather than merely an educational institution. Such community-centered designs allow for more flexible use of space, where workshops, exhibitions, and other public activities can take place, contributing to local economic growth and fostering an inclusive environment (Wang, Uddin, Ji, Yu & Wang, 2021).

4.1.2.4 Future Expansion Potential

Growth and Development: Consider the potential for future expansion or development on the site to accommodate the changing needs of the academic institution. This concept underscores the importance of selecting a site that accommodates the expected growth of the facility in terms of physical space, technological advancements, and service demands over time. Proper attention to expansion potential ensures that the center can adapt to changing community needs, evolving vocational programs, and an increasing number of students or trainees. This adaptability is especially vital for a vocational center that may expand its services, introducing new skill sets in response to job market trends and industrial advancements.

Physical space is one of the first considerations in ensuring expansion potential. According to Zune, Rodrigues & Gillott (2020), **site selection should prioritize locations with ample land** or nearby areas that the center can acquire later if needed. By doing so, the design accommodates the future addition of training facilities, classrooms, or workshops as demands grow. Many centers in developing regions face limitations in this regard due to high land costs or densely packed urban locations. However, proper planning around this limitation such as **integrating modular or flexible building designs** can mitigate some of the challenges (Peters & Halleran, 2021).

A site selected for a vocational center should also support flexible facility design to accommodate future technological needs. Peters & Halleran (2021) highlight that **vocational centers must be capable of integrating new technologies and infrastructures** into their systems to keep pace with changes in the vocational landscape. For example, vocational programs in computer technology, renewable energy, and robotics are expected to expand rapidly, and centers need to be equipped with space and design flexibility to accommodate these. Buildings designed with modular components and adaptable electrical and network infrastructure are better suited to this need (Peters & Halleran, 2021).

The accessibility and infrastructure surrounding the chosen site also play a significant role in expansion potential. Moghtadernejad, Chouinard & Mirza (2020) argue that **vocational centers should be located in areas with reliable transportation networks, power, and internet connectivity** that can support increased usage over time. Centers that are located in areas with expanding infrastructure are well-positioned for future growth, allowing them to serve a larger catchment area as roads and public transport options increase.

Another key aspect of future expansion potential is aligning the location with **community and market growth projections.** A site chosen based on current population data without considering future growth can quickly become inadequate. Peters & Halleran (2021) recommend using demographic and economic forecasts to determine areas that will see significant growth, ensuring that the vocational center remains relevant and accessible to the evolving population. For instance, regions experiencing industrial development or new housing projects could present promising locations for vocational centers due to the likely increase in local demand for vocational skills.

Lastly, environmental factors and sustainability are increasingly significant in selecting sites for future expansion. As climate resilience becomes essential in construction, choosing a location that minimizes environmental risks while offering expansion space aligns with sustainability goals (Leng, Wang & Liu, 2020). Designing green spaces and energy-efficient structures within a vocational center can contribute to long-term sustainability, ensuring the facility's relevance and usability even as environmental regulations evolve.

In conclusion, future expansion potential as a location criterion in vocational center design includes considering physical space availability, flexibility in building design, accessibility to robust infrastructure, alignment with community growth, and environmental sustainability. These factors enable vocational centers to evolve and remain effective in fulfilling community needs and responding to technological advancements. Selecting a site that meets these criteria ensures that the center can fulfill its role as a dynamic and resilient institution well into the future.

4.2. Project Analysis and Design Synthesis

4.2.1 Brief Analysis

A vocational school, also known as a trade school or career school, is an educational institution that focuses on providing practical skills and training for specific trades, crafts, or professions. Unlike traditional four-year colleges or universities, vocational schools typically offer programs that are shorter in duration and more hands on in nature.

The aim of this school is to stay current with industry trends and developments to ensure that their programs are relevant and responsive to the needs of employers.

4.2.2 Brief Development

After conducting a thorough examination of five case studies that encompassed several learning centers, it became evident that there were notable similarities in their spatial functionalities. These studies aimed to determine the necessary planning standards and the distinct roles these spaces fulfil within a vocational school.

- Classrooms
- Workshops/Laboratories
- Specialized Facilities
- Administrative Offices
- Student Services
- Common Area
- Storage and Maintenance

4.2.3. Design Criteria

Vocational schools offer training programs in various fields such as automotive technology, cosmetology, culinary arts, electrical work, plumbing, nursing, graphic design, welding, and many others. These programs are designed to equip students with the specific skills and knowledge needed to enter the workforce directly after graduation. These criteria help ensure that the Vocational school building meets the functional, regulatory, and environmental requirements necessary for the success of the facility:

1. Ventilation: To create a comfortable learning environment, vocational schools need efficient ventilation systems that allow for good air circulation and reduce unpleasant odors in classrooms and office areas. This will be accomplished via the use passive (natural) or active (artificial) ventilation methods. Both methods are essential in ensuring a comfortable space and a pleasant experience for those inside the building.
2. Lighting: Our goal is to ensure that the building has sufficient and suitable lighting to create a welcoming and conducive learning environment for students. This will enhance the mood, ambience and visibility of students and teachers.
3. Accessibility: The school is carefully designed with accessibility in mind, making it easily accessible for people with disabilities, and ensuring smooth circulation throughout the building.
4. Aesthetics: To make the school visually appealing and inviting to students, we will incorporate various structural forms, fins, a well-designed roof, thoughtful color selection, and creative planning. Our goal is to enhance their overall learning experience.
5. Safety: To guarantee the safety of students and teachers and protect the property, we will incorporate various safety measures in the design. These measures will consist of fire exits, fire suppression systems, emergency lighting, and strict safety protocols. By making safety a top priority, we aim to always create a secure environment for occupants of the building, ensuring confidence and peace of mind.

6. Structural Stability: The design of the vocational school will prioritize structural efficiency to allow for various activities and to withstand dead, live, and seismic loads. This will be accomplished by carefully selecting materials and implementing sturdy construction methods. These measures will ensure the building's durability and ability to endure the test of time. By prioritizing structural stability, the vocational school will offer a secure and dependable environment for those who use it.
7. Site and Landscape: The site and landscape of the vocational school building will be carefully considered in the design process. The building's location, parking areas, green spaces, and outdoor event areas will be planned per building regulations to ensure optimal functionality and aesthetic appeal. Landscaping features will be incorporated to complement the architecture and create an inviting and harmonious atmosphere.

4.2.4. Construction Methods and Materials

In designing this project, we gave top priority to sustainability by using eco-friendly materials and construction methods. We carefully considered various factors when choosing these materials, including aesthetics, durability, climate, availability, functionality, and compliance with regulations, bylaws, and building standards. the selection of construction methods and materials is crucial to ensure structural integrity, functionality, and sustainability. Recent advancements in construction technology over the last five years offer multiple innovative options.

Substructure: Foundations for multi-story buildings are typically reinforced with concrete or steel piles, especially for soil with low load-bearing capacity. The use of precast concrete piles has become popular, as they minimize on-site labor and ensure quality control through factory production (Ardavani & Doulos Zerefos, 2020). Alternatively, steel piles are a viable choice due to their strength and adaptability to varying soil conditions (Dikou & Kourniatis, 2022).

For a vocational center, soil testing should precede foundation laying to determine the best approach. The recent development of ground improvement techniques, such as vibro-compaction and soil mixing, has improved foundation stability for multi-story buildings, especially in challenging soil conditions (Dikou & Kourniatis, 2022). The reinforced concrete used in constructing the substructure of the learning center and publishing space ensures a robust and stable foundation.

Landscape: To enhance the appeal of the outdoor space and promote eco-friendliness, the landscape design effectively incorporated precast concrete interlocking stones and concrete curbs.

Shading Device: Using aluminum composite panel boards to cover steel substrates effectively reduces heat gain and enhances energy efficiency by providing shade.

Walls: The school building incorporates concrete blocks, columns, and glazed curtain wall systems. Glass is also used in internal partitions to allow natural light to flow and create a sense of openness. For wall construction, lightweight concrete blocks or autoclaved aerated concrete (AAC) blocks have gained traction. These materials are lightweight yet durable and provide excellent thermal insulation, which is essential for a vocational center that may require varied interior temperatures across workshops (Dikou & Kourniatis, 2022). Exterior insulation is essential for energy efficiency, especially with current emphasis on sustainable building practices. Insulating concrete formwork (ICF) has been adopted to enhance both insulation and structural integrity. ICF panels are made from polystyrene blocks filled with concrete, offering robust insulation without adding much weight to the structure (Dikou & Kourniatis, 2022).

Wall finishes: To ensure a truly healthy indoor environment, it's important to apply Airlite paint to the walls inside. This high-quality paint doesn't just improve appearance but also delivers vital protection against mold, microbes, and germs, greatly boosting the overall health of everyone in the area.

Window: Large casement windows were used in learning areas to provide adequate internal daylight illumination and ventilation. Louver windows were integrated into the upper and lower panels of the glass curtain walls to facilitate ventilation through stack effect.

Stairs: Within the school building, timber and steel stairs were used to access the different floor sections. Additionally, a glazed panoramic lift was installed to assist elderly individuals and people with disabilities in moving from the ground floor to the first floor.

Floor Structural System: due to the massive span of the building floor area, a waffle slab system was adopted due to its effectiveness in such situations. The structural framework of a four-floor building often incorporates steel or reinforced concrete. Steel frameworks have become increasingly popular for their flexibility and strength, which support quicker construction times (Satola et al., 2022). A steel-reinforced concrete frame provides robustness and resistance to both environmental stressors and the high foot traffic expected in a vocational center (Hosseini, Mohammadi, Schröder & Guerra-Santin, 2020). Innovations in prefabricated structural components have also allowed for faster and more efficient on-site assembly, reducing labor costs and time. Prefabricated beams and columns, combined with hybrid systems that use both steel and concrete, are also energy efficient and cost-effective (Satola et al., 2022).

Floor Finishes: When selecting flooring materials for the store area, sustainability was an essential factor. The chosen options were PVC tiles, and polished concrete. These materials were carefully chosen for their durability, low maintenance requirements, and visually appealing appearance. Interior flooring and finishes in a vocational center should prioritize durability, aesthetics, and easy maintenance. Epoxy and polished concrete floors are increasingly popular for their resistance to high foot traffic, scratches, and stains (Satola et al., 2022). These floors require minimal upkeep, an advantage in high-traffic buildings like vocational centers. Additionally, terrazzo floors are an excellent choice, as they are durable and allow for a variety of aesthetic customizations. Other materials like vinyl flooring or rubber tiles may also be considered in workshop areas due to their resilience and ability to absorb impacts, ensuring both functionality and worker safety (Satola et al., 2022).

Door: The design of the vocational center incorporates various types of doors, including aluminum and glass doors, wooden panel doors, and fire-rated exit doors. These doors were deliberately selected to ensure optimal safety, security, and convenient accessibility throughout the building.

Ceiling: Within the vocational center, different ceiling materials were used. The offices have POP false ceilings, while 600mm x 600mm gypsum boards were applied in the large display area.

Electrical, Plumbing, and HVAC Systems. With recent technological advancements, buildings are now increasingly integrated with smart systems for efficient energy management. Vocational centers benefit from smart HVAC systems, which regulate indoor climate efficiently, reducing energy consumption. Modern HVAC systems can be integrated with IoT-enabled sensors to monitor and optimize air quality and temperature, providing an optimal learning environment (Satola et al., 2022). For plumbing, the use of high-quality PVC or PEX piping is advised for durability. Recent advancements in low-flow plumbing fixtures and automatic shut-off systems reduce water usage, making plumbing systems more sustainable (Satola et al., 2022).

Sustainable Materials and Green Building Technologies: The use of sustainable and recycled materials has become increasingly emphasized in recent years. Materials such as recycled steel and wood substitutes are now commonly used in urban construction, driven by environmental considerations and policies favoring green building (Satola et al., 2022). In a vocational center, sustainable materials not only reduce environmental impact but also contribute to a healthier learning environment for occupants. Green building technologies such as solar panels, rainwater harvesting systems, and energy-efficient lighting further enhance the building's sustainability. These additions align with global sustainability goals and can significantly reduce operational costs over time (Hosseini, Mohammadi, Schröder & Guerra-Santin, 2020).

Roofing Systems and Waterproofing: A vocational center roof should be durable and capable of withstanding environmental elements. Metal roofing systems, particularly those with aluminum or galvanized steel, offer high durability, while green roofing techniques, such as vegetation-covered roofs, provide insulation and contribute to environmental sustainability (Hosseini, Mohammadi, Schröder & Guerra-Santin, 2020). Moreover, membrane roofing, a modern roofing technology, has been adopted for its durability and waterproofing benefits (Philokyprou & Michael, 2020). Additionally, waterproofing at the roofing and foundation levels is essential. Modern waterproofing materials like thermoplastic polyolefin (TPO) membranes and spray-applied membranes ensure effective moisture control and prevent leakages, thus extending the building's longevity (Philokyprou & Michael, 2020).

The construction of this vocational center incorporates advanced methods and materials developed over the past five years, balancing sustainability, durability, and cost-effectiveness. By selecting appropriate foundation, structural, insulation, and finishing materials, along with integrating green technologies, the building can meet modern standards for functionality and environmental responsibility.

4.2.5. Building Services

The design of the vocational center will include mechanical, electrical, and plumbing services that prioritize functionality, efficiency, and safety. These services will be customized to meet the diverse needs of visitors, staff, and to protect valuable assets such as books and electronics. Each floor will have Electrical Panel Rooms that house essential components for seamless power distribution and easy maintenance.

The building will receive power from the existing university IBEDC connection, supplemented by solar-powered inverters. A 900mm ceiling duct will be incorporated to ensure optimal space utilization and simplify maintenance procedures for various services. In addition, a discreet 1200mm duct will conceal water supply, sewage pipes, and inspection chambers. The building will also feature a panoramic lift with adjacent doors to ensure accessibility for all individuals.

In the design, natural lighting is a top priority. Carefully selected artificial lighting fixtures will be installed on the false ceiling soffits, suspended floor slab soffits, and in external areas to create a harmonious ambiance both within and outside the bookshop (Zhu, Liu, Sang & Cui, 2024)

The fire suppression system will use the FM-200 (HFC-227ea), capable of extinguishing Class A, B, and C fires without leaving any residue or water behind, thus safeguarding valuable assets and promoting sustainable practices. Additionally, fire hydrants are provided at recommended distances in the car park area to cater for external fire accidents (Rane, Choudhary& Rane, 2024).

Chapter Five

Conclusion

5.1 Project Appraisal

This thesis focused on designing a vocational center that prioritizes sustainability through the use of passive energy design principles. Through the literature reviewed, effective principles and strategies were identified that were efficiently incorporated into the design.

The use of curtain walls, courtyards, natural lighting, energy saving lighting tools, building orientation, and shading devices, as well as the use of plants and natural materials were all found to be highly effective in the design of the vocational center.

5.2 Conclusion

In conclusion, the integration of passive energy design strategies and innovative lighting systems can greatly enhance spatial comfort in various settings. Mimicking natural elements and utilizing natural light can have a positive impact on the well-being of individuals and create a more enjoyable and relaxing atmosphere. As demonstrated by the success of these strategies in other vocational centers, it is clear that incorporating these elements in design can greatly benefit the overall comfort and satisfaction of individuals in various environments.

5.3 Recommendations

Passive and adaptive energy design plays a crucial role when it comes to creating a comfortable and human-centered environment in spaces. The following recommendations are proffered to stakeholders in the design industry:

- Consider the role of technology: As technology continues to advance, there are more opportunities for innovative energy saving and sustainable solutions such as programmable lighting and smart controls and therefore further research should be carried out on these areas.

- Lighting can enhance the overall experience of users in any space, so it should always be prioritized in design.
- Buildings should always be designed with passive energy principles in mind, this will create buildings that are energy saving and responsive to the environment.

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Appendix 1

3D1: Approach Perspective View

3D2: Approach Perspective View

3D3: Approach Perspective View

4: Approach Perspective View

5: Side Perspective View

3D6: Side Perspective View

D7: Side Perspective View

3D8: Side Perspective View

3D9: Side Perspective View

3D10: Bird Eye View

3D11: Approach Perspective View

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Educational Institutions Attended with Dates

A. Primary Education

Nursery & Primary School, Oni & Sons, Oluyole, Ibadan 1983 - 1989

B. Secondary Education

The Smart School, Ojoo-UI road, Ibadan 1989 - 1994

C. Higher Education

1. Lead City University 2021 – 2022
2. Federal University of Technology, Minna, Niger State 2015 – 2018
3. Federal University of Technology, Akure, Ondo State 2012 – 2014
4. Ladoke Akintola University of Technology, Ogbomoso, Oyo State 1997 - 2002

5. Federal Polytechnic, Nasarawa 2007 – 2010
6. The Polytechnic of Ibadan 1995 – 1998

D. Academic and Professional Qualifications with Dates

1. Bachelor of Science (B.Sc) Architecture 2022

2. M.Tech Urban and Regional Planning (Housing & Urban Renewal) 2014

3. Post Graduate Diploma in Architecture 2014
4. B.Tech (Hons) Urban & Regional Planning 2002
5. HND Architecture 2010
6. OND Architecture 1998
7. West Africa School Certificate 1994

8. Primary School Leaving Certificate 1989

E. **Work Experience with Dates**

I. **Federal Capital Territory Administration** 2011 – 2014
Department of Development Control
Senior Town Planning Officer

Monitoring, supervision, report on all physical development within Central Area (AOO), Kukuwaba (BOO) and Institutional ResearchCOO.
Vetting of the of all building plan proposal within my district.

II. **Principal Town Planning Officer** 2014 – 2016

Member of a planning team that vett and approve institutional building plans.

Collection, evaluation and analysis of physical and social economic data for the purpose of taking planning decisions.

Site analysis report of proposed development in line with the provision of master plan and prevailing land use.

III. **Assistant Chief Town Planning Officer** 2016 – 2017

Work in the process in the process of granting official permit for all forms of physical developments (Public & Private) & monitoring same to ensure sustainability of completed development

Planning & installations of street furniture e.g. Billboards, signage, telecom mast & others amenities

Monitoring & Enforcement of physical development in line with the provision of master plans & other developments control guideline

Offering advice & counseling to prospective developers

IV. **Chief Town Planning Officer** 2020 – 2024

1. Engage in counseling and consultation for stakeholder's interest groups, professionals and Junior Staffs on city designs and development plans.

2. Manage physical development growth with Wuse I and Wuse II district of the city.

3. Integrate sustainable practice into building plan approval process.

4. Review and approval of development proposal making sure it complies with master plan and development control manual.

5. Access and process development application.

6. Collect and collate data on population growth city development, housing issues and other factors that affect urban development.

7. Ensure regulatory compliance that all proposed development comply with local and national planning regulation and laws.

8. Ensure collaboration with other government agencies and Department.

9. Advise developers, architects and property owners on regulatory requirements and development control process to facilitate compliant development.

10. Initiate project with clear project objectives deliverable.

11. Coordinate a team of multidisciplinary professionals including Architects, Engineers, Environmentalist and legal advisers on built environment issues.

12. Develop mitigation strategies on identified risks.

13. Maintain records and reporting accordingly to the management.

V. **City Planners and Managers, Abuja** 2004-2011

Urban and regional planning, Architecture& Estate Development

1. Monitoring of clients' developments/construction in FCT.
2. Provide guidance and advice on land developments.
3. Project development and management operations
4. Urban design and renewal, site acquisition, monitoring submission for development approval.
5. Visiting of site to identify developmental challenges.
6. Advice developers on approval or developments requirements.
7. Monitoring and enforcement on all illegal developments, land encroachments up to the demolition level.
8. Consultants for communication companies on mast location and approval.

VI. **Professional Bodies**

a) Member Nigeria Institute of Town Planners (MNIT) 3213

b) Town Planning Registration Council TOPREC (RTP) 2606

c) Member International Society of Charted Planners (ISOCARP)

d) Graduate Member, Nigerian Institute of Architect (2022)

e) Nigerian Environmental Society (2022)

VII. **Training and Development**

1. American Planning Association, 2024 (Minneapolis, USA)
2. Sustainable and Smart Cities, (Singapore) – March 2024

3. Comprehensive city planning Sept 9- Oct 2014 (Tokyo, Japan)
4. American planning association April (2015) Seattle U.S.A.
5. World urban forum, Naples, Italy 2012.
6. Town and Country Planning Association (TCPA) United Kingdom 24 -27 June 2014.
7. NITP (MCPDP) 2014, 2015, 2016,2017,2018,201
8. Project Management Institute (Feb. 2023)

VIII. Personal Qualities, Strength & Skills

1. Project Management Skills
2. Hard working and ability to face challenges
3. Ability to work under pleasure and with minimum supervision, result oriented
4. Excellent Organizational Skills
5. A demonstrated track record of meeting deadlines and achieving key objectives, critical and lateral thinking.
6. Good oral, written and presentation skills.
7. Ability to find new and innovative solutions to problem.
8. Highly Analytical, Planning and implementing skills, enthusiastic &commitment to work.
9. Many years of experience working effectively across with different cultures

IX. References

1. **Prof. Adedire Funmilayo**
Dean, Faculty of Environmental Sciences Bowen University Iwo, Osun State.

2. **TPL, (Dr.) Razak Sherriff**
   Department of Development Control,
   AMMC, FCTA Sector Monitor.

3. **Dr. Madayese Samuel**
   Senior Lecturer,
   Department of Urban and Regional Planning
   Federal University of Technology, Minna, Niger State.

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Date   Signature

The University Compliance Certificate

This is to certify that the thesis by Abolaji Mutiu SHITTU with matriculation number LCU/PG/004071 in the department of the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, Nigeria, is in full compliance with the University format and style of thesis.

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Signature   Date