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# Universal Design Compliance in South-west Nigeria's Federal Universities' Faculty of Environmental Science Buildings

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**Abstract** Technological advancements in construction and architecture have led to the neglect of some users' needs in building designs, this study assessed the compliance of selected faculty of environmental science buildings with Universal Design (UD) principles in southwest Nigeria. The paper reviews the evolution of higher educational buildings, UD principles, and their significance in academic environments. Using a case study approach, buildings at the University of Lagos, Obafemi Awolowo University, and Federal University of Technology Akure were examined. Data was collected through direct observation and document analysis. Findings revealed significant deficiencies in accessibility features, including inadequate ramps, non-functional lifts, poor wayfinding systems, and insufficient parking for people with disabilities. The study highlighted a systemic lack of consideration for diverse user needs in educational facility planning and execution. It emphasizes the need for a paradigm shift in academic environment design, aligning with national disability rights legislation. Recommendations include retrofitting buildings with UD structures, retraining professionals on UD principles, updating building policies, and ensuring new buildings incorporate UD principles. This research provides empirical data on UD compliance in Nigerian universities, serving as a baseline for future improvements in inclusive educational design.

**Keywords** Universal Design, Academic Buildings, Disability Rights, People Living with Disability, Retrofitting, Faculty of Environmental Science Buildings

## 1. Introduction

From the past to present times, humans have continuously improved and modified their prevailing physical settings, to make them useful to meet the need for which they are developed. With the rising development of human made environments and growing intricacies of new technologies, this has resulted in discrimination and exclusion of a diversity of users [1]. This suggests that despite the advances being experienced in the built environment, a greater part of developments tends to isolate a significant percentage of projected consumers. This statement is factual with the physically challenged with respect to public buildings and their environments.

A study by [2] revealed that most public buildings in Nigeria are difficult to get into and used by people living with disabilities (PWD). The authors found this anomaly after they studied 257 of such buildings, out of which 27 were educational buildings. This limits access to quality learning environment for PWD, contrary to the requirements of inclusive education. This also deprives the

society from benefitting from the skills, creativity and talents of this user. To reverse this trend there is a need for the inclusion of the principles of Universal Design (UD) in the design and development of public building, particularly educational buildings.

The focal point of UD is the design and development of products, buildings and environment to be accessible and functional to every person on equal terms irrespective of their age, size or disability [3]. Developing educational facilities in line with UD principles requires that optimal utilization by individuals of any age and capacity should be the primary consideration when designing facilities of this nature [4,5].

The earlier Barrier-free concept is related to UD as both concepts seek to produce inclusive environments that are more usable for PWDs. However, UD goes beyond the idea of obstruction-free access or access for PWDs [6]. It is an approach that is positive when designing to attain an inclusive integral design that is not only accessible by the widest possible array of users in view of their capacities, but whose solutions would be useful to a larger portion of its targeted consumers [7]. When UD is implemented in educational facilities, it enhances the nature of the learning conditions while guaranteeing that every tangible or intangible obstruction to learning is removed [8]. The goal for quality education for all can be achieve with the removal of every barrier in an educational environment [9].

The study's contribution to knowledge is that it provides empirical data showing the level of compliance to the principles of UD of Faculty of Environmental Science academic buildings and facilities within the study area. It is necessary to educate policy makers, architects and designers on the important issues that must be taken into consideration when buildings as this are being designed and approved for construction. It will also be used as a way of comparing the current Faculty of Environmental buildings in this part of the country with others in other part of the country and beyond in terms of their compliance with UD principles. The paper is structured into four parts. The first part covers the review of existing literature on UD and academic buildings. The second part documents the methods used to carry out the research. The third part covers the presentation and analysis of findings, followed by discussions on these findings. While the last part is the conclusion and recommendations made.

## 2. Literature Review

### 2.1. Evolution of Higher Educational Buildings

The history of educational buildings generally is connected to the history of education itself. Originally education started in ancient times as adults prepare the young in the learning and abilities regarded as essential for the overall good of the society. In these societies, this was accomplished orally, through apprenticeship usually at the place of such activities without a definite structure or buildings for learning. As societies advanced beyond capacities that could be learned by apprenticeship, a formal way of impartation of knowledge and learning, a type of organisation referred to as schools began to evolve [10].

In Europe, it is generally recognised that the first institution of higher learning is that founded by Plato in Athens called "The Academy" [11]. This was then followed by the Library of Alexandria, built during the 3rd century BCE with the establishment of the city of Alexandria in Egypt as the new intellectual centre after Athens [12]. Between the fall of Rome and the establishment of the Catholic Church as the one and only preserver of education in Western Europe, Confucius (551-479 BCE) from the Liu a state located in China became the country's most influential ancient philosopher, he gathered disciples and taught them while searching in futility for a leader that would embrace his concept for good governance [13].

With the ascent of the Catholic Church, advance education in Europe was organised in schools located within the premises of cathedrals or monasteries with priests and occasionally nuns acting as instructors and teachers: The evidence of these schools dates as far back as the 6th century [14]. As far back as the early medieval period, pre-existing schools evolved to become universities, as such these schools became the primary sites of higher education [15].

Amid the early modern period (approximately late 15$^{th}$ century to 1800) the universities located in Europe would see an enormous measure of innovative research, development and productivity. Toward the closing stages of the middle ages, about 400 years after the first university was established, twenty-eight new universities were also established and eighteen more added from 1500 to 1625 [14]. Within these periods, universities were further divided internally with the creation of different colleges to carter for the needs of various professions [16].

The design on layout of most of these colleges was modelled after existing monasteries. Key functional spaces such as spaces for teaching, spaces for religious activities, administrative spaces and other important areas that were used for the daily activities of the colleges were usually arranged around an open space with the inclusion of covered passageways. Examples of these could be seen in the Magdalen College at Oxford (1492-1509) [17]. This arrangement was utilized for large educational buildings in Europe until the 17th Century. As educational training became more advanced, because of the sharing of ideas, knowledge, culture and scientific innovations between the Arab world, China, Europe and India, and the introduction of more courses and subjects, the number of specialised lecture spaces increased with most having an amphitheatre seating arrangement. These lecture spaces later evolved into present day classrooms [18].

### 2.2. Principle of Universal Design

Universal Design (UD) is an expression formed by the staff of the Centre for Accessible housing at North Carolina State University in the United States. The individual who coined the term Universal Design, with a specific emphasis on accessible housing, was Ron Mace. Mace actively advocated for accessible building codes and standards within the United States. His conceptualization and application of the term Universal Design reflect an inclusive philosophy, aiming to ensure that the design is accessible and user-friendly for people of all abilities [19]. The authors went further to differentiate UD from other concepts like “Barrier-free design and assistive technology” prevalent at that time by stating that UD broadly defines the user, declaring that UD is an issue driven from the user’s perspective and focuses on all people without recourse to their abilities or disabilities [20].

The basic aim of UD is to make daily activities of everyone easy and simple. The essential purpose of UD is that every individual has access to a product or environment and can utilise it without any form of obstructions [21]. This can be done by ensuring that the built environment, products and communications are easily accessible, used and understood as simply as possible. As stated by Ron Mace, UD is a user centred strategy to ensure the accommodation of the needs of all categorise of people and future change that will occur among intended users, like age, health and others [22]. This has made UD become an important part in the design, management and building of structures of which there are educational buildings [23].

UD is guided by seven principles and their associated guidelines to explain the concept in a detailed manner. These principles and their guideline are used to direct the design course of action and permit methodical evaluations of design proposals. They also aid in enlightening all users and product designers on the features of better design solutions [24]. Each of the seven principles is itemised and explained as follows:

1) Equitable Use: People with various classes of abilities should be able to utilize and share a product. This includes; providing single means of usage for all users; No user should be separated or stigmatized; all users should have equal provisions for privacy, security, and safety; and the design should be aesthetically pleasing to all users.
2) Flexibility in Use: Extensive variety of individual inclination and capabilities should be accommodated by the design. This includes: providing different options for usage; allowing for both right- or left-handed use or access, enhancing user accuracy and precision; and ensuring flexibility to the user's pace.
3) Simple and Intuitive Use: The utilization of designed product should be understood easily, regardless of the end user’s experience, language skills or current level of concentration. The guiding principles include; eliminating unnecessary complications or complexity, maintaining consistency with user’s intuition and expectations, catering to a wide range of literacy and language skills; organizing information to align with its significance, and offering effective prompting and feedback throughout and after task completion.
4) Perceptible Information: Vital information needs to be effectively conveyed to the user, irrespective of surrounding conditions or the user's sensory abilities. This involves employing various modes (such as pictorial, verbal, tactile) to repetitively present essential information, ensuring sufficient contrast between crucial information and its surroundings to maximize "legibility," differentiating elements in ways that can be easily described (facilitating clear instructions or directions), and ensuring compatibility with a range of techniques or devices used by individuals with sensory limitations.
5) Tolerance for Error: The design ought to mitigate risks and the undesirable consequences of unintentional or accidental actions. This involves organizing elements to minimize hazards and errors, prioritizing the placement of frequently used or easily accessible elements, removing, isolating, or shielding hazardous elements, issuing warnings for potential hazards and errors, and incorporating fail-safe features that discourage inadvertent actions in tasks requiring vigilance.
6) Low Physical Effort: Products should be designed in such a way that they can be used effectively and easily with least physical effort. This includes: allowing users to maintain positions they are comfortable with, using only necessary efforts while minimizing unnecessary activities that will cause unusual physical exertion.
7) Size and Space for Approach and Use: Ensuring suitable dimensions and room for approaching, reaching, manipulation, and utilization, regardless of the user's body size, posture, or mobility. This includes establishing a clear line of sight to essential elements for both seated and standing users, ensuring that all components are easily reachable for users in both seated and standing positions, adapting to variations in hand and grip size, and providing sufficient space for the use of assistive devices or personal assistance.

### 2.3. Significance of Universal Design in Academic Buildings

UD is often regarded as a design manual as well as a philosophy. It is a new perspective of reasoning that takes into consideration all aspects of what is referred to as “proper planning and sustainable development by Discrimination Against Persons with Disabilities (Prohibition) Act, 2018 [25]. This results in ensuring that

our academic and learning environment are accessible by all users and such users are also able to effectively utilize them. UD proposes a dynamic and innovative concept to deal with the need for universal access and utility of every part of every environment without any form of obstructions or barrier [26]. With the positive effect UD has on communities, its ideology can be said to have the following significance;

1) It assists us in delivering solutions that are truly sustainable to communities, while avoiding negative developments.
2) It encourages us to design environments that are impartial, all inclusive, participative and accessible to individuals with wide ranges of capacities and age.
3) It helps us to avoid inefficient and wasteful remodelling solutions, as adaptability and flexibility were considered during the design stages.
4) It ensures we integrate sustainable strategies for urban design, transportation, land use and the overall environment.
5) It produces better socio-economic models by creating greater efficiencies in investments for public infrastructure.
6) It creates an environment where people grow old and contribute to the society without losing their independence.

### 2.4. Influence of UD on Teaching and Learning

Designing academic buildings or environments that meet the principles of UD is a very challenging endeavour. It involves designing structures, physical learning environments, and education module, as well as recommending teaching methods and strategies to be used to ensure that every learning need resulting from the different needs of the general student population is accommodated. Additionally, UD compliant designs involve providing access to other auxiliary elements used in the environment to guarantee positive user experience in all aspects of schooling [27].

Various methods have been used to apply the principles of UD to teaching and learning; however, there has not been recorded a perfect application. This can be attributed to the fact that, like educational programs and curricula which were planned without PWDs in mind, UD principles, which were perfect for product and environmental designs, were not particularly created with learning in mind [28]. An analysis of recent studies and literature that relates to UD in the learning environment reveals an array of UD terminologies, which includes terms such as; Universal Design for Instruction (UDI), Universal Instructional Design (UID) and Universal Design for Learning (UDL). Among them UDL has become the most popular of all the terms since it depends on recent advancement in psychological neuroscience that is becoming generally acknowledged as a key perspective on how the human brain analyses information.

### 2.5. Structures of Universal Design in Academic Built Environment

Structures of UD in academic built environment are accepted practices and design procedures used to help designers and end users in achieving UD in an academic built environment. They include the following;

1) Access Strategy: This involves strategic planning for accessibility that holds significant potential for designing spaces that cater to a diverse range of users. However, achieving an accessible environment usually requires a heightened sensitivity to the needs of various user groups. Planning for access does not mean mere regulatory compliance, as meeting minimum standards may not be enough to achieve comprehensive accessibility. It demands a deliberate effort to identify multiple accessible routes and ensure inclusivity for different user categories, which include elderly people, PWDs, as well as those who are physically fit and without any physical disabilities. Beyond access requirements, attention must be given to means of escape (MOE), particularly as certain groups depend on assisted evacuation.
2) Walkways and Ramps: These include accessible walking surfaces, gradient of walkways and ramps, width of walkways and ramps, safety measures in form of buffer planters, railings, safety barriers or warning to be provided if walkways pass through any pool, stream or water features. Others include walkway and ramps being clear of obstruction, covered walkway where it links two buildings and frequent access is required, surface and level changes, drainage of walkway, Braille and tactile guide and edge protection.
3) Car Parking: Enhancing the accessibility of public transportation, organizing parking spaces, and incorporating laybys significantly enhance mobility and give varied opportunities for PWDs, the aged, and adults having young children. It is crucial to consider incorporating covered passenger drop-off areas, as well as designated spaces for taxis and buses. Consideration should be given to accessible parking spaces designed for wheelchair users, the provision of designated parking bays, and the establishment of secure passenger drop-off areas that will cater for aged individuals and PWDs near the primary entrance of parking facilities that cannot be situated in close proximity to the lift lobby or entrance.
4) External Areas: This includes entrances, gratings, and landscaped areas. The pathways leading to a building and the surrounding outdoor spaces constitute a vital component in the overall travel infrastructure. Therefore, the approach to an accessible entrance should feature a paved walkway or ramp with slip-resistant surfaces, ensuring an uninterrupted path devoid of steps. When grates are situated on walkable surfaces, efforts should be made to minimize the size

of openings to prevent the trapping of wheelchairs or walking aids. Additionally, entrances leading to landscaped areas should be designed for universal use, accommodating PWDs, the elderly and children. Networks of clear pathways should directly connect all entrances, exits, and major activity centres, ensuring stability, smoothness, and slip resistance. Adequate and easily noticeable wayfinding cues and signage should be in place.

5) Internal Areas: To ensure the incorporation of the UD principle pertaining to equitable use, it is crucial to guarantee the presence of at least one accessible route connecting the entrances of accessible buildings or facilities, along with all accessible elements and spaces situated on the same site and within the building. This accessible route should, to the greatest extent possible, align with the route designated for the general public. It is essential to consider colour and luminance contrast between walls and ceilings, as well as between walls and floors. The width of walkways, corridors, passageways, aisles, or any other circulation spaces should not fall below 2 meters. Additional considerations include the implementation of entry systems incorporating new technologies, enhancements in design and placement, and the installation of handrails on all ramps, staircases, and steps.
6) Lift: Minimum dimensions for passenger lifts, platform lifts and internal lifts should be used where applicable with adequate entrance space for wheel chair users. Materials for Wall and Ceiling finish should be non-reflective and floor finish should be slip resistance. Proper signage indicating floor levels should be provided.
7) Step, Staircase, Escalators and Travellators: When considering vertical circulation, ramps and/or lifts should be prioritized over steps, staircases, escalators, and travellators where feasible. The predominant use of stairs, escalators, and travellators for vertical movement is discouraged when alternative means, such as ramps or lifts, are viable. This precaution arises from the limitations posed by staircases, which are inaccessible to wheelchair users and may present challenges for ambulant disabled individuals, pregnant women, young children, and the elderly. In instances where staircases are provided, it is essential to have an alternative accessible route through ramps or lifts in close proximity. While escalators are effective for circulation, they lack barrier-free access routes. Therefore, alternative paths such as lifts and ramps, accompanied by appropriate signage, should be made available to guide users with specific needs. Travellators are to be treated similarly to escalators and staircases in this context.
8) Way finding and Signage: These should include information related to various aspects, including services and facilities, direction to these services and facilities, directions to utility spaces, reception areas, exits, and other essential locations. Additionally, the inclusion of room signs and numbers, identification of facilities and equipment, stairs and floor signs and numbers, and safety notices and instructions that covers warnings, possible hazards, fire exits, refuse chutes, and prohibitions is imperative.
9) Tactile Surfaces: These are surfaces that are utilised for showing directions to spaces, warnings to vertical or horizontal openings and edges for those users having visual impairment and they include directional tile, positional tile and warning tile. Materials used for such surfaces must be firm and not slippery, and they should be designed in colours that are brilliant and have great contrast to other adjourning surfaces, either dark-on-light or light-on-dark. The material utilised as a tactile surface should be a connected part of the general floor finish.

# 3. Materials and Methods

This study aimed to assess the compliance of selected faculty of environmental science buildings with the principles of Universal Design (UD). The case study research approach was adopted for this research, as it allows for the exploration and understanding of complex issues [29]. Notable studies [30-32] also made use of case study method. The case study method was defined as a method used to observe data at a fundamental level. Previous research defined the case study research approach as an investigation of a current situation within its present physical setting, particularly suitable when the boundaries between the occurrence and the environment are not easily distinguishable [33,34]. According to the author, research using the case study approach copes with distinct situations that are technical and possesses multiple variables of interest as one outcome. It also relies on different sources of evidence, with the data gathered brought together in a triangulating manner, thus benefiting from existing applications to guide future decisions.

The study area was southwest Nigeria, comprising six states: Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti. This region was chosen due to its high concentration of educational institutions, including several federal universities. Southwest Nigeria is known for its rich cultural heritage, with a diverse population and a blend of traditional and modern influences. The region has a tropical climate and is home to several major cities, including Lagos, which is the most populous city in Nigeria and a commercial hub. The southwest is also known for its vibrant arts and crafts scene, as well as its contributions to literature and music.

This study used multiple data sources, focusing on direct detailed observation and content analysis of documents. Multiple cases of faculty of environmental science buildings were selected in the study area, including the

Faculty of Environmental Science buildings of Obafemi Awolowo University, Ile Ife, Osun State, the University of Lagos, Akoka, Lagos State, and the Federal University of Technology, Akure. These buildings were selected based on the functions expected of the Faculty of Environmental Science in these universities. Among the six federal universities existing in the southwest of Nigeria, only four have a Faculty of Environmental Science, out of which these three were randomly selected as the sample size. Table 1 shows the selected federal universities in south-west Nigeria which were derived from the sampling frame of all federal universities in south-west Nigeria in Table 2.

**Table 1.** The selected federal universities in south-west Nigeria

| SN | Federal Universities | Location |
|---|---|---|
| 1 | Obafemi Awolowo University (OAU) | Ile-Ife, Osun State, Nigeria |
| 2 | University of Lagos (UNILAG) | Akoka, Lagos State, Nigeria |
| 3 | Federal University of Technology, Akure (FUTA) | Akure, Ondo State, Nigeria |

**Table 2.** The sampling frame of all federal universities in south-west Nigeria with and without a faculty of environmental science

| SN | Federal Universities | Location | Present |
|---|---|---|---|
| 1 | University of Ibadan (UI) | Ibadan, Oyo State, Nigeria | |
| 2 | Obafemi Awolowo University (OAU) | Ile-Ife, Osun State, Nigeria | |
| 3 | University of Lagos (UNILAG) | Akoka, Lagos State, Nigeria | |
| 4 | Federal University of Agriculture, Abeokuta (FUNAAB) | Alabata Road, Abeokuta, Ogun State, Nigeria | — |
| 5 | Federal University of Technology, Akure (FUTA) | Akure, Ondo State, Nigeria | |
| 6 | Federal University, Oye-Ekiti (FUOYE) | Akure, Ondo State, Nigeria | — |

The data were derived primarily from primary sources, complemented by data obtained from secondary sources. The secondary sources included websites of the selected schools and documented records on such buildings. Other documents studied included the National Building Code and literature documenting guides for the principles and structures of UD gotten from databases such as science direct and Google scholar. For the primary sources, on-site assessments from observations of the structures and photographic materials obtained during visits to the buildings were used to collect data.

Primary data collection was conducted between September 2023 and December 2023, during visits to the three case studies. The data collected were primarily related to the structures of UD within and around the various facilities, including access strategies, walkways and ramps, car parking, external areas, internal areas, lifts, presence of steps, staircases, escalators and travellators, wayfinding/signage, tactile surfaces, and assistive listening systems. The collected data were qualitative in nature and were analyzed using content analysis. This assisted the researchers in comparing the existing components and structures of UD in the buildings with the established standards of UD found in practical and theoretical literature. The study employed a descriptive approach, utilizing photographs to convey its findings.

# 4. Findings and Analysis

## 4.1. Case Study 1: Faculty of Environmental Science, University of Lagos (Unilag), Akoka, Lagos, Nigeria

The University of Lagos (Unilag) is a research university owned by the Nigerian Federal Government. Under the authority of the University of Lagos Act of 1962, it was set up on the 22 of October 1962.Currently the university has 3 campuses, two of the campuses are located in Yaba (the main campus located in Akoka, and a new campus is located in the now defunct school of radiography) while the third one is the College of Medicine that is located in Idi Araba, in Surulere. The total plot size of its main campus in Akoka is measured at 802 acres located at the North-Eastern part of Yaba, in Lagos State, south-western Nigeria [35].

The Faculty of Environmental Science has its roots in the School of Environmental Design which was set up within the already existing Faculty of engineering in 1970. The School was separated from the Faculty of engineering and designated the faculty of Environmental design during the 1973/74 session. With the Faculty originally providing training in architecture it underwent some restructuring in 1980 with the separation of the programme into 3 interdependent departments of City and Regional Planning, Building Technology and Architecture. With this restructuring came the introduction of a six-year continuous professional degree for the 3 departments to replace the previously offered two-tiered BES and MED programs. These six year programs consist of a four-year undergraduate training and a two-year post graduate training.

Further reorganization happened in 1986 when the university underwent rationalization of its programmes and units and the re-designation for the Faculty as The Faculty of Environmental Sciences and the following departments: Architecture and Design, Estate Management, Building and Geography and Planning. In 1997, there was another restructuring which involved the movement of the department of Geography from the Faculty of Environmental Science to the Faculty of Social Sciences occurred making the departments in the Faculty of Environmental Science reduce to 5 departments.

The main faculty building is a 3-floor structure consisting of a ground floor, first floor and second floor. It also has a basement level where printing and photocopying are done. The functions are arranged round an open courtyard system at the centre bounded by the 2 sides. At the front side of the building is the entrance to the faculty. On entering the building, there is a reception area which flows easily into the office complex where the offices and other facilities are located.

After evaluating the Faculty of Environmental Science building at the University of Lagos, a detailed analysis of its accessibility features was performed. Table 3 below summarizes the current accessibility conditions in key areas of the building.

**Table 3.** Summary of accessibility features in the Faculty of Environmental Science building at the University of Lagos

| Structures of Universal Design in Academic Built Environment | Level of Implementation | Notes |
|---|---|---|
| Access Strategy | Partially Implemented | Clear visual connection exists, but lacks level threshold, automatic doors, and ramps |
| Walkways and Ramps | Not Implemented | Absence of ramps, handrails, and tactile surfaces |
| Car Parking | Not Implemented | Lack of markings, designated accessible bays, and ramps |
| External Areas | Not Implemented | Unfinished areas, lack of ramps and accessible walkways |
| Internal Areas | Partially Implemented | Well-ventilated and naturally lit, but inaccessible to wheelchair users |
| Lifts | Not Implemented | Complete absence of lifts throughout the building |
| Stairs and Steps | Partially Implemented | Stairs present, but lack proper safety features and accessibility enhancements |
| Wayfinding and Signage | Not Implemented | Lack of color variation, textures, and proper signage |
| Tactile Surfaces | Not Implemented | Total absence of tactile surfaces around the building |

### 4.1.1. Analysis of Accessibility Features

The Faculty of Environmental Science building at the University of Lagos presents significant challenges in terms of accessibility and inclusive design. The main entrance area (Plate 1) exemplifies many of these issues, being primarily designed for able-bodied users. While there's a clear visual connection between the reception, entrance area, and external approach, the building lacks essential accessibility features such as level thresholds, automatic doors, and wheelchair ramps. These deficiencies extend throughout the structure, affecting both external and internal areas.

**Plate 1.** Main Entrance Area of Faculty Building

Moving from the entrance to the surrounding areas, the walkways and parking facilities (Plates 2 and 3) further highlight the lack of accessibility considerations. External walkways and staircases are finished with rough concrete, while internal courtyards have terrazzo flooring. However, there's a conspicuous absence of ramps and other assistive components for navigating-level changes. The parking areas are poorly maintained, lacking proper markings and designated accessible spaces. Often, parked cars obstruct the main entrance, compounding access difficulties.

**Plate 2.** Walkways and steps for change in levels in the external pathways and the internal courtyards

**Plate 3.** Areas left for car park around faculty buildings

Inside the building, while internal circulation spaces are well-ventilated and naturally lit, they remain inaccessible to wheelchair users due to the presence of steps (Plate 4). This issue is exacerbated by the complete absence of lifts throughout the building, with vertical circulation relying solely on stairs (Plate 5). These design choices significantly limit the building's usability for individuals with mobility impairments.

**Plate 4.** Internal Veranda with steps for change in levels

**Plate 5.** Stairs connecting different floor levels in building

### 4.2. Case Study 2: Faculty of Environmental Design and Management, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

Obafemi Awolowo University (OAU) was founded in 1961 as a comprehensive educational public institution by the regional government of the then western Nigeria that was led by Chief Samuel Ladoke Akintola, classes however started in October 1962. In 1987 the University was renamed Obafemi Awolowo University after the demise of the first premier of the western region of Nigeria, Chief Obafemi Awolowo (1909-1987). Currently the institution is owned and operated by the Federal Government of Nigeria. The University is located in Ile-Ife, Osun State in the Southwest Area of Nigeria situated on an extensive stretch of land measured at 11.86 hectares [36].

The Faculty of Environmental Design and Management established in 1982, located within the university, is one of the prestigious faculties within the school which was formerly part of the faculty of technology in which the Department of Estate Management was situated. The department grew to include Architecture, Building Technology, Quantity Surveying and Urban and Regional Planning. These units eventually became individual departments when the faculty was established. The department of Fine and Applied Art was added to the faculty in 1990.

After an extensive review of the Faculty of Environmental Design and Management building at Obafemi Awolowo University, a detailed examination of its accessibility features was undertaken. Table 4 below outlines the current accessibility status across various essential areas of the building.

**Table 4.** Summary of accessibility features in the Faculty of Environmental Design and Management, Obafemi Awolowo University

| Structures of Universal Design in Academic Built Environment | Level of Implementation | Notes |
|---|---|---|
| Access Strategy | Partially Implemented | Long flight of stairs for pedestrian access, lacks clear definition and centralization |
| Walkways and Ramps | Partially Implemented | Concrete walkways present, some ramps available but not universally |
| Car Parking | Not Implemented | Lack of markings, designated accessible bays, and ramps |
| External Areas | Partially Implemented | Some walkways present, but interrupted by stairs; limited ramps |
| Internal Areas | Partially Implemented | Long corridors present, but poor lighting and ventilation |
| Lifts | Not Implemented | Lifts present but non-functional due to poor maintenance |
| Stairs and Steps | Fully Implemented | Stairs present at building ends, accessing all levels |
| Wayfinding and Signage | Not Implemented | Lack of color variation, textures, and proper signage |
| Tactile Surfaces | Not Implemented | Total absence of tactile surfaces around the building |

#### 4.2.1. Analysis of Accessibility Features

The Faculty of Environmental Design and Management building at Obafemi Awolowo University presents a mixed picture in terms of accessibility and inclusive design. The main pedestrian access from the road, as shown in Plate 6, immediately highlights a significant barrier: a long flight of stairs. This design choice caters primarily to able-bodied users, neglecting the needs of elderly individuals, people with disabilities (PWDs), and those with temporary mobility impairments.

**Plate 6.** Pedestrian Access Route from Main Access Road

Moving beyond the entrance, the walkways and ramps (Plates 7, 8, and 9) show some consideration for accessibility, but implementation is inconsistent. While the walkway gradients are suitable for proper drainage and some ramps are present with gradients less than 5 degrees (ideal for wheelchair users), the provision of handrails is limited. The topography of the site further complicates access, with the main access point to these ramps located on the right side of the site, leading from a side road to the car park behind.

The car parking area (Plate 10) and its connection to the building entrances (Plates 11 and 12) reveal further accessibility challenges. The parking surfaces are finished with asphalt and gravel, but markings have worn off, and there are no designated accessible parking bays. The absence of ramps from the parking area to the building entrances creates additional barriers for wheelchair users and those with mobility impairments.

**Plate 7.** Pedestrian Access Route from Main Access Road

**Plate 8.** Ramps provided for the Right and Left Wing of the Building Blocks Respectively

**Plate 9.** Main Access point to Main walkway servicing all the building blocks that makes up the Faculty of Environmental Science Building

**Plate 10.** Carpark area

**Plate 11.** Stairs leading to rear entrance of building blocks

**Plate 12.** External Areas showing absence of walkway and ramps

Inside the building, the internal corridors (Plate 13) present their own set of challenges. While spacious, they suffer from poor natural lighting and ventilation. The adaptation of corridor spaces for storage and exhibition due to space constraints further complicates navigation, especially for visually impaired users who may encounter

unexpected obstacles.

The presence of lifts in the building (Plate 14) could have been a significant asset for accessibility. However, due to poor maintenance, these lifts are non-functional, effectively negating their potential benefit and relegating vertical circulation to staircases alone.

Staircases (Plate 15), while present and providing access to all levels of the building, lack essential safety features such as contrasting handrails and visually distinct step nosings, which are crucial for users with visual impairments.

**Plate 13.** Internal Corridors flanked on both side by offices


**Plate 14.** Internal Corridors flanked on both side by offices

**Plate 15.** Stairs connecting different floor levels in building.

### 4.3. Case Study 3: School of Environmental Technology (SET), Federal University of Technology, Akure (FUTA), Ondo State, Nigeria

In line with the Federal Government of Nigeria's commitment to establish institutions dedicated to providing students with both practical and theoretical knowledge in technology, the Federal University of Technology Akure (commonly referred to as FUT Akure or simply FUTA) was founded in 1981. Situated in Akure, the state capital of Ondo State in southwest Nigeria, the university strives to fulfil this vision [37].

Founded in 1989 during the tenure of the inaugural Dean, Professor (Arc) E.A. Adeyemi, a distinguished member of the Nigerian Institute of Architects and the first Professor of Architecture in Sub-Saharan Africa, the School of Environmental Technology (SET) initially comprised four academic departments: Architecture, Estate Management, Quantity Surveying, and Urban and Regional Planning. The current departments within the faculty include Architecture, Building Technology, Estate Management, Industrial Design Development, Urban and Regional Planning, Survey and Informatics, and Quantity Surveying [34].

Following an in-depth assessment of the School of Environmental Technology building at the Federal University of Technology, Akure, a comprehensive evaluation of its accessibility features was carried out. Table 5 below presents a summary of the current state of accessibility in key areas of the building.

**Table 5.** Summary of accessibility features in the School of Environmental Technology (SET), Federal University of Technology, Akure (FUTA)

| Structures of Universal Design in Academic Built Environment | Level of Implementation | Notes |
|---|---|---|
| Access Strategy | Partially Implemented | Long flight of stairs for pedestrian access, lacks clear definition and centralization |
| Walkways and Ramps | Partially Implemented | Concrete walkways present, some ramps available but not universally |
| Car Parking | Partially Implemented | Lack of markings, designated accessible bays, and ramps |
| External Areas | Partially Implemented | Some walkways present, but interrupted by stairs; limited ramps |
| Internal Areas | Partially Implemented | Long corridors present, but poor lighting and ventilation |
| Lifts | Not Implemented | Lifts present but non-functional due to poor maintenance |
| Stairs and Steps | Fully Implemented | Stairs present at building ends, accessing all levels |
| Wayfinding and Signage | Not Implemented | Lack of color variation, textures, and proper signage |
| Tactile Surfaces | Not Implemented | Total absence of tactile surfaces around the building |

4.3.1. Analysis of Accessibility Features

The School of Environmental Technology (SET) building at the Federal University of Technology, Akure, presents a mixed picture in terms of accessibility and inclusive design. The access strategy, as shown in Plate 16, reveals a design primarily catering to able-bodied users, with pedestrian access from an adjoining visitor' carpark and a staff' carpark located directly in front of the drop-off zone.

**Plate 16.** Pedestrian Access Route from External area

The approach view of the faculty building (Plate 17) showcases its architectural presence but also highlights the challenges faced by users with diverse mobility needs.

**Plate 17.** Approach view of Faculty Building

Moving to the walkways and ramps, the external walkway (Plate 18) alternates between concrete rough finish and interlocking tiles, providing sufficient gradient for proper drainage. However, ramps are limited to the main entrance porch (Plate 19) and lack essential handrails, compromising their effectiveness for users with mobility impairments.

The car parking areas (Plates 20 and 21) are well-positioned but lack crucial elements for accessibility. While finished with asphalt and interlocking tiles, there are no designated accessible parking bays, and the main entrance point's use for parking obstructs pathways and access routes to entrance doors.

**Plate 18.** External Walkway

**Plate 19.** Ramps provided for main building

**Plate 20.** Carpark provided in front of building for staff uses

**Plate 21.** Visitors Car park located beside the faculty building

The external areas (Plate 22) showcase well-landscaped green spaces, carparks, and walkways. However, the site's topography necessitates steps within the walkways, with no ramps provided, rendering these areas inaccessible to wheelchair users.

**Plate 22.** External Areas showing presence of walkway

Internally, the building benefits from verandas around courtyards that provide natural lighting and ventilation (Plate 23). However, the terrain's influence is evident in the presence of steps in certain parts of the veranda, creating barriers for wheelchair users.

**Plate 23.** Internal veranda showing change in levels and steps used to navigate them

**Plate 24.** Stairs connecting different floor levels in building

The building's vertical circulation relies entirely on stairs (Plate 24), as there is a complete absence of lifts throughout the structure. While the stairs provide access to all levels, including the roof, this sole reliance on steps significantly limits accessibility for users with mobility impairments.

### 4.4. Proposed Areas for Improvement Across Case Studies

The assessment of the three institutions - the Faculty of Environmental Science at the University of Lagos, the Faculty of Environmental Design and Management at Obafemi Awolowo University, and the School of Environmental Technology at the Federal University of Technology, Akure - reveals several common areas for improvement in terms of accessibility and inclusive design.

At the University of Lagos, the primary concern is the lack of basic accessibility features at the main entrance. The clear visual connection from the reception to the external approach is commendable, but the absence of level thresholds, automatic doors, and wheelchair ramps significantly hinders access for individuals with mobility impairments. This issue extends to the Obafemi Awolowo University, where the main pedestrian access consists of a long flight of stairs, creating a substantial barrier for elderly individuals and people with disabilities. Similarly, at the Federal University of Technology, Akure, while the architectural presence of the building is notable, the approach fails to accommodate users with diverse mobility needs.

To address these entrance issues, all three institutions would benefit from installing ramps alongside existing stairs, implementing automatic doors, and ensuring level thresholds. Additionally, creating covered drop-off zones with clear signage would greatly enhance accessibility, particularly at the Federal University of Technology, Akure.

Moving beyond the entrances, the external areas of all three institutions present similar challenges. At the University of Lagos, walkways and parking facilities lack essential accessibility features such as ramps and designated accessible spaces. Obafemi Awolowo University shows some improvement with the presence of concrete walkways and some ramps, but implementation is inconsistent. The Federal University of Technology, Akure has well-landscaped external areas, but the site's topography necessitates steps within walkways without accompanying ramps.

To improve these external areas, all three institutions should implement a consistent system of ramps with handrails throughout, ensure proper gradients for wheelchair users, and use appropriate surface materials for easy navigation. Parking areas should be redesigned with clear markings and designated accessible bays, providing direct, ramped access to building entrances.

Internal circulation presents another common area for improvement across all three institutions. At the University of Lagos, while internal spaces are well-ventilated and naturally lit, they remain inaccessible to wheelchair users

due to the presence of steps. Obafemi Awolowo University faces similar issues, with the additional challenge of poor lighting and ventilation in corridors. The Federal University of Technology, Akure benefits from verandas around courtyards providing natural lighting and ventilation, but steps in certain parts of the veranda create barriers for wheelchair users.

To enhance internal accessibility, all three institutions should focus on providing alternative routes or mechanical aids where steps currently impede wheelchair access. Improving natural lighting and ventilation in corridors, creating clear visual distinctions between floors and walls, and using contrasting colors for doors and frames would benefit all users, particularly those with visual impairments.

Vertical circulation is a critical issue across all three case studies. The University of Lagos and Obafemi Awolowo University completely lack functional lifts, while the Federal University of Technology, Akure relies entirely on stairs for vertical movement. This significant barrier to accessibility could be addressed by installing and maintaining functional lifts in all buildings, providing access to all levels. Additionally, enhancing existing staircases with contrasting handrails and visually distinct step nosings would improve safety and usability for all users.

Wayfinding and signage represent another area requiring a significant enhancement across all three institutions. The current lack of effective wayfinding systems, proper signage, and tactile surfaces makes navigation challenging, particularly for individuals with visual impairments or cognitive disabilities. Implementing a comprehensive wayfinding strategy using different colors for building sections, varied textures in floor coverings, contrasting handrails, and clear signage with raised letters, symbols, and Braille would markedly improve the user experience in all three institutions.

Finally, all three institutions present opportunities for enhancing overall sustainability and user comfort. While the University of Lagos and the Federal University of Technology, Akure benefit from some degree of natural lighting and ventilation, these aspects could be further optimized across all three campuses. Implementing more energy-efficient lighting systems, improving window designs for better air circulation, and incorporating shading devices could enhance both comfort and energy performance. The external areas of all three institutions also present opportunities for more sustainable landscaping, including the introduction of native plants, creation of water-efficient green spaces, and implementation of rainwater harvesting systems.

By addressing these common areas of improvement - from basic accessibility features to advanced sustainability measures - all three institutions could transform their built environments into models of inclusive and environmentally conscious design. Such improvements would not only benefit current users but also align the physical environments with each institution's mission of environmental stewardship and inclusive education, setting a standard for future developments in Nigerian universities and beyond.

# 5. Discussion

The present study aimed to assess the compliance of selected faculty of environmental science buildings with the principles of Universal Design (UD) in southwest Nigeria. The findings and analysis across the three case studies (University of Lagos, Obafemi Awolowo University, and Federal University of Technology, Akure) revealed several areas where the implementation of UD principles falls short, as well as opportunities for improvement.

The observed deficiencies in accessibility features across all three institutions underscore a broader issue in the design and development of academic buildings in Nigeria. These findings align with observations made by [2], who reported that most public buildings in Nigeria are difficult to access and utilize by people living with disabilities (PWDs). This suggests a systemic lack of consideration for diverse user needs in the planning and execution of educational facilities.

While section 4.4 detailed specific areas for improvement, it's crucial to consider the underlying factors contributing to these shortcomings. The consistent lack of accessible features across all three institutions points to a gap in awareness, policy implementation, and design practices in the Nigerian higher education sector. This aligns with the literature emphasizing the importance of considering UD principles from the initial stages of planning and design to avoid inefficient and wasteful remodeling solutions [26].

The study's findings highlight the critical need for a paradigm shift in approaching the design of academic environments. The principles of UD extend beyond mere regulatory compliance or meeting minimum standards. As emphasized by [4] and [5], developing educational facilities in line with UD principles requires considering optimal utilization by individuals of any age and capacity as the primary consideration during the design process. This holistic approach is currently lacking in the examined institutions.

The importance of UD in academic buildings, as highlighted in the literature review, is further reinforced by this study's findings. By embracing UD principles, academic institutions can create inclusive learning environments that remove tangible and intangible barriers to education [8,9]. The observed deficiencies in areas such as wayfinding, signage, and tactile surfaces underscore the need for designs that ensure access to auxiliary elements, guaranteeing positive user experiences in all aspects of schooling [27].

Moreover, the integration of UD principles in academic buildings aligns with the principles and objectives outlined

in the Discrimination Against Persons with Disabilities (Prohibition) Act of 2018 [25]. The gap between this legislation and the current state of accessibility in these institutions suggests a need for stronger enforcement mechanisms and perhaps more detailed guidelines for implementation in the education sector.

This study contributes to the existing body of knowledge by providing empirical data on the level of compliance with UD principles in faculty of environmental science academic buildings within the study area. This data can serve as a baseline for comparison with other academic institutions, both within Nigeria and beyond, facilitating a nuanced understanding of the broader impact of UD implementation in educational settings.

Furthermore, the study highlights the need for increased awareness and education among policymakers, architects, and designers regarding the critical issues that must be considered when designing and approving the construction of academic buildings. The consistent shortcomings across all three institutions suggest that this is not an isolated issue but a systemic one that requires attention at multiple levels - from policy formulation to architectural education and professional practice.

In conclusion, while section 4.4 outlined specific areas for improvement, this discussion emphasizes the broader implications of these findings. The study underscores the need for a holistic and comprehensive approach to implementing UD principles in academic buildings. By addressing the observed deficiencies and embracing the principles of UD from the initial stages of planning and design, academic institutions can create environments that are truly inclusive, accessible, and conducive to learning for all individuals, regardless of their abilities or disabilities. This not only aligns with national legislation but also positions these institutions as leaders in promoting equality and inclusivity in higher education.

## 6. Conclusions and Recommendation

Based on the findings, the following conclusion was made. All the buildings studied showed that aside the provision of ramps to the main entrance of some of the buildings, there is a marked absence of all the structures of universal design in an academic built environment as have been stated before. These structures help to ensure that the buildings where they are used meet with the principles of UD. There is also an observation that the buildings are designed with little or no consideration for the usability of the disabled, the elderly and small people. These observations indicate that with the absence of these structure, a building becomes inaccessible to a broad range of users, thus making these structures inaccessible for the provision of education for all as stated by the United Nations. In view of these the following recommendations are made.

The first recommendation is the immediate retrofitting of these buildings with these structures to ensure these buildings meet the principles of UD, thus addressing the observed and documented inadequacies. The second recommendation is that architects, designers and professionals in the built industry must be retrained to understand the principles and ideals of UD and ensure that these ideals and principles be used in academic buildings in particular and buildings in general. The third recommendation is that building policies should be updated to include that the principles and ideals of UD. The last recommendation is that every new building be designed and built to ensure that the principles and ideals of UD be included in it, thus ensuring the accessibility and usability of these building for all users.

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## REFERENCES

[1] Basnak M., Tauke B., Weidemann S., "Universal design in architectural education: who is doing It? How is it being done?," Proceedings of the Future of Architectural Research The Architectural Research Centers Consortium (ARCC), Chicago, Illinois, 2015.

[2] Soyingbe A., Ogundairo A. M., Adenuga A. O., "A Study of Facilities for Physically Disabled People in Public Buildings in Nigeria," International Household Survey Network, 2016. http://catalog.ihsn.org/index.php/citations/60291 (accessed Nov. 15, 2017).

[3] Centre for Excellence in Universal Design (CEUD), National Disability Authority (NDA), Junior Achievement Ireland (JAI), "Universal Design in the Power of Design; Project Report 2022-2023," Ireland, 2023. https://universaldesign.ie/uploads/publications/Universal-Design-in-the-Power-of-Design_Project-Report-2022_2023.pdf

[4] Aslaksen F., Bergh S., Bringa O. R., Heggem E. K., "Universal Design: Planning and Design for All," Cornell University ILR School DigitalCollections@ILR, 1997. https://hdl.handle.net/1813/76583 (accessed May 14, 2024).

[5] Alhusban A. A., Almshaqbeh S. N., "Delivering an inclusive built environment for physically disabled people in public universities (Jordan as a case study)," Journal of Engineering, Design and Technology, vol. ahead-of-print, no. ahead-of-print, 2023. DOI:10.1108/JEDT-06-2022-0281

[6] Ibem E., Oni O., "An Appraisal of Universal Design Compliance of Museum Buildings in Southwest Nigeria," International Journal of Applied Engineering Research, vol. 13, no. 16, pp. 13731-13741, 2017.

[7] Prestamburgo S., Sgroi F., Venudo A., Zanin C., "Universal Design as resilient urban space plan strategy. New scenarios," AIMS Environmental Science, vol. 8, no. 4, pp. 321-340, 2021.

[8] Special Parent Information Network: Hawaii, "Inclusion in Education and Community," https://spinhawaii.org/inclusion-in-education-community/ (accessed May 6, 2024).

[9] Saini M., Sengupta E., Singh M., Singh H., Singh J., "Sustainable Development Goal for Quality Education (SDG 4): A study on SDG 4 to extract the pattern of association among the indicators of SDG 4 employing a genetic algorithm," Education and Information Technologies, vol. 27, pp. 2031-2069, 2022.

[10] Bentley J., Ziegler H., Salter S. H., Traditions and Encounters: A Global Perspective on the Past (ISE HED HISTORY), 6th ed. McGaw-Hill Education, 2020.

[11] Meinwald C. C., "Plato," Encyclopaedia Britannica, https://www.britannica.com/biography/Plato/Late-dialogues (accessed May 6, 2024).

[12] Blainey G., A Very Short History of the World. Penguin Group, 2007.

[13] Shaoan M. M., Akash M., Musengamana I., Okoye M. C., "An Investigation about Education as Envisioned by Confucius and Its Implications for Contemporary Moral Education," International Journal of Multidisciplinary, vol. 4, no. 12, pp. 4182–4191, Dec. 2023. DOI: 10.11594/ijmaber.04.12.03

[14] Pierre R., Education and Culture in the Barbarian West: From the Sixth through the Eighth Century. University of South Carolina Press, 1978.

[15] Lynch S. B., "Marking Time, Making Community in Medieval Schools," History of Education Quarterly, vol. 61, no. 2, pp. 158-180, 2021. DOI: 10.1017/heq.2021.7

[16] Koterski W. J., Begley B. R., "Medieval Education". Fordham University Press, 2005. 32–216. https://www.fordhampress.com/9780823224258/medieval-education/ (accessed June 12, 2024).

[17] Gardiner R., "The Story of Magdalen College Oxford" in Blandford Forum. Workshop Press, 1991. https://openlibrary.org/books/OL15199039M/The_story_of_Magdalen_College_Oxford. (accessed June 12, 2024).

[18] Jackson V., "The Evolution of the Classroom," The Hoban Visor, https://hobanvisor.news/the-evolution-of-the-classroom/ (accessed May 6, 2024).

[19] Centre for Excellence in Universal Design, "Definition and Overview of Universal Design," https://universaldesign.ie/about-universal-design/definition-and-overview (accessed May 6, 2024).

[20] Null R., Universal Design: Principles and Models. CRC Press, 2013. DOI: 10.1201/b15580

[21] Hubbard P., "Bridging the gap between theory and practice: Technology and teacher education." In The Routledge handbook of second language acquisition and technology, pp. 21-35. Routledge, 2022.

[22] Adewale B. A., Fasae O. A., "Users' Perception of Need for Universal Design Accessibility and Circulation Provisions in Selected Old Peoples' Home in Lagos State, Nigeria," IOP Conference Series: Materials Science and Engineering, vol. 640, no. 1, 012033, 2019.

[23] Centre for Excellence in Universal Design, "History of Universal Design," https://universaldesign.ie/about-universal-design/history-of-universal-design (accessed May 6, 2024).

[24] Null R., ed. Universal design: Principles and models. CRC Press, 2013. https://books.google.com.ng/books?hl=en&lr=&id=kcenAAAAQBAJ&oi=fnd&pg=PP1&dq=Universal+Design+Handbook.+McGraw+Hill,+2011.&ots=n23ulHG5Iv&sig=AgNysegeTfoEuCO2fyeR2xDPFP8&redir_esc=y#v=onepage&q=Universal%20Design%20Handbook.%20McGraw%20Hill%2C%202011.&f=false (accessed July 19, 2024).

[25] National Assembly of the Federal Republic of Nigeria, "Discrimination Against Persons with Disabilities (Prohibition) Act, 2018," https://laws.lawnigeria.com/2019/04/02/discrimination-against-persons-with-disabilities-prohibition-act-2019/ (accessed May 28, 2024).

[26] Babalola D. O. et al., "Appraisal of Ferry Terminals Design Compliance to Guidelines for Universal Accessibility in Lagos State Nigeria," International Journal of Recent Technology and Engineering, vol. 8, no. 5, pp. 2153-2167, 2020.

[27] Opoko P. A. et al., "Assessment of Applications of Universal Design Principles in Educational Facilities for Challenged Children in Lagos State, Nigeria," 11th International Technology, Education and Development Conference, Valencia, Spain, 2017, pp. 3012-3020. DOI: 10.21125/inted.2017.0796

[28] Pagliara S. M., Utge S. M., Bonavolonta G., Mura A., "Analysing Italian Inclusive Education Practice in Relation to Universal Design for Learning Principles," in Assistive Technology: Shaping a Sustainable and Inclusive World, Amsterdam, 2023, pp. 511-516.

[29] Sena B., The Case Study in Social Research: History, Methods and Applications. Taylor & Francis, 2023.

[30] Adewale B. A. and Ene V. O., "An assessment of the implementation of green design strategies in selected museums in Abuja, Nigeria," Civil Engineering and Architecture, vol. 12, no. 3A, pp. 2461–2481, 2024. DOI: 10.13189/cea.2024.121337.

[31] Sholanke A. B. and Oyeyipo F. J., "Appraisal of lighting Strategies for achieving environmental Sustainability in selected art museums and galleries in Nigeria," Civil Engineering and Architecture, vol. 11, no. 6, pp. 3811–3825, 2023. DOI: 10.13189/cea.2023.110641.

[32] Ezema I. C., Ajanaku P. A., Fulani O. A., Johnson O. P., and Eyo M. U., "Use of Passive Cooling Strategies in Selected Mega-Churches within Lagos-Ogun Megacity, Nigeria," Civil Engineering and Architecture, vol. 11, no. 6, pp. 3789–3810, 2023. DOI: 10.13189/cea.2023.110640.

[33] Yin R. K., Case study research: Design and methods. Vol. 5. sage, 2009.

[34] Rowley J., "Using Case Studies in Research," Management research news, vol. 25, no. 1, pp. 16-27, 2002.

[35] University of Lagos, "Home Page," https://unilag.edu.ng (accessed May 6, 2024).

[36] Obafemi Awolowo University, "About OAU," https://oauife.edu.ng/about-oauife/ (accessed May 6, 2024).

[37] The Federal University of Technology Akure, "Home Page," https://futa.edu.ng/ (accessed May 6, 2024).