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DESIGN SOLUTIONS CREATING BARRIERS TO ACHIEVING UNIVERSAL DESIGN COMPLIANCE OF ACADEMIC BUILDINGS IN UNIVERSITIES IN NIGERIA

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ABSTRACT

The concept of universal design is a design ideology that targets accommodating the accessibility and usability needs of everyone regardless of their ability or disability. It is however observed that in Nigeria, some educational facilities and environments are to some extent inaccessible to the mobility impaired. This is as a result of avoidable design solutions that are inadequate to meet the needs of all potential users. Where educational facilities are inaccessible or difficult to reach for any user group, such situation is capable of depriving those affected, the opportunity of acquiring the education needed to advance in life. To this end, this study investigated design and construction solutions that constitute barriers to achieving universal design compliance of academic buildings in universities in Nigeria, with a view to finding ways of improving accessibility to such buildings and their facilities for users, regardless of their mobility status. The study was a multiple case study research that adopted qualitative research approaches to collect, analyze and present data. The result showed that the areas that constitute barriers to achieving universal design in the academic buildings range from lack of equitable accessibility provisions, inappropriate access provisions, nonflexible usability provisions among others. This indicates that for the academic buildings to be able to adequately meet the accessibility and usability needs of all category of users, there is a need to eliminate the identified designed barriers preventing universal design compliance in them by retrofitting the structures with inclusive design features. To this end, some recommendations which includes, carrying out a phased renovation of the existing academic buildings, as well advising the management of universities in Nigeria to ascertain that subsequent routine and periodic maintenance works in their institutions comply with UD parameters before implementation, were made.

Keyword words: Universal Design, Accessibility, Usability, Academic Building, Inclusive Education, University and Nigeria.

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1. INTRODUCTION

The quest for education is considered a right rather than a privilege in many countries. Therefore, making educational facilities and environments accessible and usable for all user groups should also be a right rather than a privilege. However, in the past, few institutions made serious efforts to make their buildings accessible until some legislation began to demand non-discrimination on the basis of disability (Burgstahler, 1992) [1]. The milestone decision in 1954 by the United States (US) Supreme Court in the case of Brown vs. Board of Education that "separate is not equal", established the starting point of a design approach that respects every user and sets a precedence of equal opportunity in education (Ostroff, 2007) [2]. This landmark decision has placed a duty on all public authorities, including that of institutions of learning, to promote equality of opportunity for individuals living with disabilities in the provision of public services, facilities and environments. With regards to education, the idea of inclusive education which involves making education available to all is being promoted in many countries, including Nigeria. Making provisions that will enable all users to access and use facilities in academic buildings and their environments, is fundamental to achieving inclusive education. According to United Nations Children's Funds (2000) [3], when all barriers are removed, the goal of quality education for all can be attainable.

With regards to academic environments, it is important that their facilities, services as well as their design and construction satisfy the needs and expectations of every user group without any form of segregation or discrimination against any group. To this end, the concept of universal design (UD) has gained global recognition as a design ideology that accommodates the needs and expectation of every potential user. The UD concept is a strategy for developing products and environments that are accessible and usable to the highest extent possible by all individuals, regardless of their age, ability or disability status (Institute for Human Centred Design, 2016 and Centre for Universal Design, 2008) [4] and [5]. UD shares the same ideology with the concept of inclusive education, which according to the United Nation Educational, Scientific and Cultural Organization (UNESCO), entails the teaching of all children together in regular schools and not just children with disabilities alone. Both ideas have gained global recognition as ideologies for promoting social inclusion of all user groups in the main stream of the society, particularly with regards to education.

It is however observed that in some societies, many public buildings and their facilities are still to some extent inaccessible and not usable for the physically challenged contrary to the expectations of UD. In Nigeria, some researchers have found that accessibility and usability provisions made for people with disabilities (PWDs) in several public buildings are inadequate, unlike those provided for abled-bodied persons that are considered adequate (Sholanke, Adeboye, Alagbe and Ugah, 2018; Ibem, Oni, Umoren and Ejiga, 2017; Sholanke, Adeboye, Alagbe and Oluwatayo, 2016; Soyingbe, Ogundairo and Adenuga, 2016; and Maclean, 2014) [6], [7], [8], [9] and [10]. With regards to educational buildings, Soyingbe *et al.* (2016) [9] found that 257 public buildings investigated in Nigeria, out of which 27 are academic buildings, are inaccessible to PWDs. Sholanke *et al.* (2016) [8] also revealed that suitable access provisions were not provided for the physically challenged to gain access at the main entrances of five key public buildings studied in an academic environment in Nigeria. The inaccessibility

of institutions of learning to PWDs is an obstacle to achieving social inclusion in learning environments and constitute a hinderance to realizing the goal of inclusive education. But in many nations, the issue of disability is understood to be a human rights issue. On the global stage, segregating or discriminating against anyone on the basis of disability is not regarded simply as a physical and psychological disadvantage, but viewed as a loss of civic and human right. This is why several countries, including Nigeria, have enacted disability laws and planning regulations aimed at integrating PWDs back into the main stream of the society (Sholanke *et al.*, 2016) [8]. Despite these legal measures, Ibem *et al.* (2016) [7] noted that there is still a poor response to achieving basic accessibility requirements in public buildings in Nigeria after studying three museums in southwestern part of the country.

The World Health Organization (2015) [11] report on disability, puts the estimate of persons living with some form of disability worldwide at over a billion. This corresponds to about 15% of the world's population. According to Amusat (2009) [12], the World Health Organization (WHO) estimated that in Nigeria about 19 million people are living with disabilities, which is approximately 20% of the country's population (Lang and Upah, 2008) [13]. With such a sizable percentage of the population living with disabilities, Okoli (2010) [14] posited that there is a need to harness the potential of PWDs by eliminating barriers in buildings to allow this population contribute their quota to national development. Consequently, there is a need to investigate specific designed areas and elements capable of limiting accessibility and usability in public buildings, including academic buildings and their environments. This is with a view, to finding ways of improving access for mobility impaired persons, towards achieving their social inclusion in the main stream of the society.

Consequently, the study investigated designed barriers to achieving UD compliance of academic buildings in selected universities in Nigeria based on three UD assessment approach criteria; of approachability, accessibility and usability. With a view to findings ways to improving access to use such buildings by students, regardless of their mobility status, towards achieving social inclusion in educational environments. The scope of the study is limited to selected universities in Ogun State in the southwestern part of the country (See research methods section for selection procedure). Ogun State was preferable as the study area for the research, because the State has Federal, State and private universities located in it, as well as having the highest number of universities in the country (National University Commission, 2018) [15]. The key research question addressed by the study is; what are the designed solutions used in academic buildings of universities in the study area that constitute barriers that can hinder the physically challenged from using spaces, facilities and services of the buildings?

The study investigation was limited to academic buildings used on a regular basis by all categories of students for academic purposes. The academic building types are, colleges/faculties, main libraries and main lecture theatres. Because the study focus is on finding ways of improving access to use academic environments for the physically challenged, the investigation was limited to areas capable of impacting on accessibility to use spaces, facilities and services in the buildings. To this end, the study was restricted to areas used by students on a daily basis in the course of their academic pursuit in each building type. These areas include, general circulation routes around and inside the academic buildings, general movement routes and maneuvering areas of classrooms, main library reading rooms, main lecture theatre halls, toilets as well as reaching heights and usability provisions of electrical and sanitary facilities.

The study contributes to knowledge by providing empirical evidence of designed solutions capable of limiting access for the physically challenged and creating barriers to achieving universal design in the academic buildings investigated in the study area. This is considered

important for updating and informing design professionals, planners and construction experts of the building industry, on designed areas of academic buildings that require improvement towards achieving solutions that are inclusive in nature and meets the requirements of the UD principles. In addition, architects and architecture students will find the study a useful reference material to work with, in the course of designing barrier-free environments. The study will also be useful for benchmarking academic buildings in the study area with their counterparts in other parts of the world, including other areas of Nigeria, with regards to the existence of designed solutions that constitute barriers to achieving UD in academic buildings in universities. The following part of this paper is structured into five sections. The first is a review of literature found relevant to the subject matter. The second is a description of the research methods employed. The third is the results, analysis and discussion of findings, while the fifth is conclusion and recommendations made.

2. LITERATURE REVIEW

2.1 Development of Academic Buildings and their Role in the Society

Education plays an important role in the development of every society and has been adjudged to be the bedrock of every development in any society and in all human endeavours (Archibong, 2010) [16]. Historically, towards the emergence of modern advancement, at the dawning of the 19th century, there was a need for mass education, which brought about the development of large buildings within urban communities for educating students (Dudek, 2015) [17]. Initially, education started in ancient times by the way of adults preparing the young ones in learning and skills considered important for the general benefit of the society. This was achieved verbally, through apprenticeship that usually takes place at the place of the training, without a definite building or structure for learning. As a result of societies advancing beyond capacities that could be taught in this manner, a formal setting of learning and impartation of knowledge, known as schools began to develop (Assmann, 2003) [18]. As far back as the early medieval period, the pre-existing schools developed to become universities. These pre-schools became the primary sites of higher education.

In recent times, higher education, particularly university education, is being sought after due to its ability to increasingly provide social and economic developments driven by application of knowledge and advancement. A university is an organised research environment for knowledge development and impartation (Jekiayinfa, Yusuf, Yahaya and Yusuf, 2010) [19]. Universities usually consist of colleges which are semi-autonomous and could also have residential and feeding facilities for users. The colleges consist of teaching spaces, while facilities that are not peculiar to any specific college, but needed by every college, are mutually administered and used (Adler, 2005) [20]. Some of these facilities include, libraries, lecture theatres, workshops and laboratories. These academic facilities are located in buildings commonly referred to as educational or academic buildings. The buildings also include spaces for recreation, administration and other social amenities.

Based on the abovementioned background information on the development, components and importance of academic buildings in a university environment, it is clear that the main responsibility of such buildings is to provide educational facilities required for research, knowledge development and impartation. This implies that academic buildings are public buildings. Therefore, one of their design considerations will be how to plan and construct them to be inclusive in nature. Their facilities, spaces and services should be equitably accessible and usable by all users in conformity with the UD principles; and by so doing adds value towards promoting inclusive education.

2.2. Universal Design Framework

The quest for sustainable processes in all spheres of public life has become a priority that is attracting substantial global interest. The issue of focus at the world stage has shifted from how developments and environments contradict one another to how to achieve sustainability (Sharachachandra, 1991) [21]. Throughout history people have continuously adapted and improved their physical environments to make them produce more functionally (Froyen, 2013) [22]. Hence, approaches to design have changed from narrow code compliance that often meets the specialized needs of a few, to more inclusive design strategies that accommodate the needs of everyone (Ostroff, 2011) [23]. In this light, several design models targeted at producing inclusive environments have been developed. Notably among such models is UD, a design concept which according to McGuire, Scott and Shaw (2006) [24] originated from the field of Architecture. The UD concept centres around producing products and environments that are accessible and usable by all individuals on equal terms without resulting to adaptation or a special form of design (Centre for Universal Design, 2008) [5].

The Government of Ireland (2005) [25] defined UD as an approach to design and construction that targets making products and the built environment accessible and usable for everybody, particularly PWDs. According to the Institute for Human Centred Design (2016) [4], UD is a framework for designing places, things, information, communication and policy to be usable by the broadest range of persons functioning in the broadest range of conditions without the need for special or separate design. The implementation of UD in the field of architecture enables PWDs to use buildings alongside others without the need for retrofitting (Al-Azawei, Serenelli and Lundqvist, 2016) [26]. The simple basic message of UD is that the needs of all potential users are considered from the planning and design stage. Going by these descriptive narratives of what UD is about, it is clear that when UD is given consideration as a design requirement and applied at the design and planning stage, everyone, particularly the physically challenged, benefit when such design is implemented. The fundamental targets of UD can be summarised as accessibility, usability and widening the users range to accommodate everybody or as many persons as possible, instead of designing to satisfy an average user, which many advocates of the concept believe do not exist. Its key operational concepts are equal status, equal treatment and equal merit (Sholanke *et al.*, 2016) [8].

The emergence of UD in design fields did not occur in isolation. According to Dion (2004) [27], UD emerged from the earlier barrier-free concepts, the broader accessibility movement, adaptive and assistive technology and also seeks to fuse aesthetics into these key considerations. Ostroff (2007) [2] identified two main distinctive threads that can be traced to the emergence of the UD as legislative measures with provisions that accommodate PWDs and the nonregulated market-driven responses to an aging population, mostly involving products. The Centre for Universal Design (2008) and Story, Muller and Mace (1998) [5] and [28] traced the origin of UD to changing demographics, federal legislations, barrier-free movements, rehabilitation engineering, assistive technology and economic and social changes among older adults and people living with disabilities throughout the 20th century.

Generally, the UD ideology is understood to be against disability discrimination, which is an act of treating a person with disability less favourably than an individual without a disability. Its philosophy is against every form of unnecessary segregating, discriminating and stigmatizing specialized solutions, regardless of whether they are meant for PWDs or any other user group. The idea of UD is simple in theory, but complex in practice. Thus, merely defining the term is considered inadequate. In this regard, promoters of UD usually make use of two

methods to present the approach. The first is citing good examples of aspects of its application, such as the use of remote controls to adjust devices from a distance. The second strategy is offering time-proven tests to show how UD is used, for example, determining if a device can be utilized while standing or seating. However, no decisive criteria cover all aspects of any design (Story *et al.*, 1998) [28].

Though UD concept targets making provisions that will meet the needs of everyone, advocates of the concept generally seem to agree that such goal is usually not achievable. Trost (2005) [29] argued that the believe that UD can dissolve all boundaries is absurd and maintained that life experience and market realities contradict such belief. His view is shared by McGuire *et al.* (2006) [24]. The authors supported their position with the believe of Ronald Mace who is widely acknowledged as the pioneer of the UD concept as promoted in the last few decades. Mace was quoted to have admitted that the use of the term "universal" is unfortunate, because nothing indeed can be entirely universal. He advanced that there will always be persons who will not be able to make use an item no matter how considerately planned or designed. Nevertheless, Mace canvassed that things can continuously be improved upon to make them more generally usable. This infers that in theory, the UD concept targets everyone, but realistically makes provisions for as many people as possible. To this end, National Disability Authority (2014) [30] noted that UD is a process and not an outcome. Hence, the assumption that a fully universal solution is realisable for any given design should be discarded, rather UD should be a guideline for designers to continually strive to achieve a more usable solution.

2.3. Universal Design Principles

The definition of UD developed by the Centre for Universal Design (CUD) is accompanied by a set of seven principles. The principles are copyrighted to the CUD located in the School of Design in North Carolina State University at Raleigh, USA (Sholanke *et al*., 2016 and Story *et al.*, 1998) [8] and [28]. The seven principles are globally acknowledged as the principles of UD. Each of the principle is accompanied by a set of four or five guidelines. The principles and their guidelines are as follows:

Principle One – *Equitable Use:* The design should not disadvantage or stigmatize any user group. Its first guideline is that the same means of use should be provided for all users; identical where possible and equivalent where not. The second specifies that segregating or stigmatizing any user should be avoided. The third requires that provisions for privacy, security and safety should be made equally available to every user, while the fourth guideline specifies that the design should be made to be appealing to every user.

Principle Two – *Flexibility in Use:* The design should accommodate varieties of individual preferences and abilities. Its first guideline requires that choice in means of use should be provided, while the second one entails that right- or left-handed access and use should be accommodated. The third guideline stipulates that user's accuracy and precision should be facilitated, while the fourth one entails that adaptability to the user's space should be provided.

Principle Three – *Simple and Intuitive Use:* The design should be easy to use and understand, irrespective of the experience, knowledge, language skills or current concentration level of the user. Its first guideline requires that unnecessary complexity should be eliminated in a design, while its second guideline stipulates that designs should be consistent with the expectations and intuition of users. The third specifies that a broad range of literacy and language skills should be accommodated, while the fourth requires that information should be arrange to be consistent with its importance. The fifth guideline of the third principle stipulates that effective prompting and feedback during and after task completion should be provided.

Principle Four – *Perceptible Information:* The design should communicate needed information effectively to users, irrespective of ambient conditions or sensory abilities of the users. The first guideline stipulates that different modes such as pictorial, verbal and tactile should be used for redundant presentation of essential information, while the second requires that legibility of essential information should be maximised. The third entails that elements should be differentiated in manners that can be described, that is, making it easy to provide instructions or directives, while the fourth requires that compatibility with various techniques or devices used by persons with sensory limitations should be provided.

Principle Five – *Tolerance for Error:* The design should minimize risks and the adverse effects of accidental or unintentional actions. Its first guideline entails that elements in designs should be arranged to minimize hazards and mistakes: most utilised elements, most accessible; unsafe elements should be removed, isolated or safeguarded. The second requires that cautions of hazards and errors should be provided, while the third states that fail-safe features should be made available. The fourth guideline stipulates that unconscious action in tasks that necessitate vigilance should be discouraged.

Principle Six – *Low Physical Effort:* The design can be used comfortably, and effectively, as well as and with a minimal fatigue. Its first guideline stipulates that users should be allowed to maintain neutral body position, while the second entails that reasonable operational force should be used. The third stipulates that repetitive actions should be minimize, while the fourth guideline entails that sustained physical effort should be minimised.

Principle Seven – *Size and Space for Approach and Use:* The principle requires that appropriate size and space should be provided for approach, reach, operation and usage irrespective of the body size, position or mobility of users. Its first guideline entails that an unobstructed line of sight should be provided to important elements for all users in seated or standing position. The second requires that reach to every component should be made comfortable for all users in seated or standing position, while the third provides that differences in hand and grip size should be accommodated. The fourth stipulates that adequate space should be provided for the use of assistive devices or personal assistance.

The UD principles are a blueprint that clearly explains the characteristics of UD. The principles are generally used globally. Sometimes they are modified, such as categorising two principles together (Institute of Human Centered Design, 2016) [4]. The principles are useful for guiding and influencing the design process to accommodate everyone as well as for evaluating existing products and environments. They are also useful for educating designers and consumers about the characteristics of more usable designs (Aslakse, Bergh, Bring and Haggem, 1997) [31]. Nevertheless, the principles do not include all criteria for good design, but only for universally usable designs. Other important factors, some of which include: aesthetics, cost, social considerations, environmental impact, cultural appropriateness and other sustainability criteria should also be considered in addition to the principles. In addition to the UD principles, accessible design standards also exist. The standards are guidelines developed towards achieving accessible environments. Some of these standards include the ones provided in The Building Regulations (2015) [32] used in the United Kingdom (UK) and Wales, Inclusive Mobility (2012) [33], Neufert Architects' Data by Neufert and Neufert (2012) [34] and ADA Standards for Accessible Design by Department of Justice (2010) [35] used in America.

Apart from UD, some other concepts such as universal accessibility, inclusive design, barrier-free design and usability have all been developed towards providing easy access for PWDs in the development of the built environment. However, UD stands out among these other concepts in its category, as its focus goes beyond making things more accessible for the

physically challenged. Its target is achieving both accessibility and usability for not only PWDs, but all individuals, regardless of their ability or inability. This is why UD principles has found relevance and penetrated markets in several industries, such as architecture, urban design, product design, information technology and education. Its principles and guidelines can be applied to designs processes in any sphere of life for the benefit of every user.

2.4. UNIVERSAL DESIGN ENVIRONMENT BASICS

Everyone, irrespective of ability or disability should be able to move around freely and unassisted within accessible buildings and their environments to use spaces, facilities and services (Neufert and Neufert, 2012) [35]. This key requirement of an accessible environment is the main idea behind a universal designed environment. This means the basic design strategies for achieving accessible environments is also useful for achieving a UD environment that can be used by all users regardless of their mobility status. In such environment, accessible passage ways should allow for safe, independent use by every user. Where changes in level occur, users should be provided with the option of choice by incorporating both steps and ramp as connecting access features, to ensure that the same route can be used by everyone. Steps cannot be used by wheelchair users, but some mobility impaired persons find it easier to use steps than a ramp, hence the need to provide both. Travel routes should be adequately wide to allow each user to manoeuvre comfortably alongside others, including mobility aid users like wheelchair users or individuals using crutches. In an existing environment, it is important to ensure that users with disabilities can use the same access points as others (National Disability Authority, 2014) [30]. With regards to public buildings, The Building Regulations (2015) [32] stipulated that reasonable provisions should be made for everyone to reach the main entrance and other entrances to the building from the site boundary, parking spaces within the site and from other buildings on the same site, regardless of disability or age. The regulation requires that provisions should be made for at least one parking bay designated for PWDs on firm and level ground close to the main entrance of public buildings.

The design and construction of new constructions or alterations of any facility or part of a facility to be provided for the use of the public, are expected to also be designed and constructed in such a way that the facility or its part is readily accessible and usable by PWDs. In cases of alterations, path of travel to the altered areas and restrooms serving the altered sections are also required to be readily accessible and usable for PWDs, including wheelchair users. Any alteration that decreases the accessibility of a building or facility below the requirements stipulated for new construction at the time of the alteration is prohibited (Department of Justice, 2010) [36]. Generally, mobility impaired persons such as walking stick, walking frame or wheelchair users, the blind and visually impaired persons, should be largely independent of outside help when using accessible environments and their facilities. This requirement also pertains to those with other disabilities or conditions that impair movement, such as the aged, pregnant women, children and people who are exceptionally short, tall or fat in nature.

3. RESEARCH METHODS

As earlier stated, the study was designed to investigate designed solutions employed in academic buildings of universities in the study area that constitute barriers that can hinder the physically challenged from using spaces, facilities and services of the buildings. According to the Centre for Innovation in Research and Teaching (2018) [36], qualitative research methods are used when the aim of a research problem centres around examining, understanding and describing a phenomenon. As the study was aimed at examining, unfolding and describing an existing situation, qualitative research methods was considered suitable and adopted.

According to Yin (2009) [37], a case study research can be exploratory, explanatory or descriptive and are preferred to answer the "how" and "why" questions, where the researcher has little control of the events and the study focus is on the present rather than on historical issues. A case study can be single or multiple sites, allowing researchers to explore and discover issues under investigation and how to address them (Stewart, 2013) [38].

Consequently, the study adopted a multiple sites case study research approach. This allowed for a wide range of academic buildings to be investigated and enabled data retrieved to be robust and comprehensive. To select the universities for the study, the universities in the study area were first divided into their various strata of Federal, State and private to allow each group to be represented in the research. Thereafter, one university was selected from each stratum by simple random sampling. Three academic building types were investigated in each of the three universities as earlier stated in the scope of the research. The three building types are college/faculty, main library and main lecture theatre. Where more than one of the building types existed in a university, simple random sampling method was used to select the one used for the study. Table 1 shows the selected universities and their corresponding academic buildings that were investigated.

Table 1: Universities and Academic Buildings Sample Size

S/N	Selected Universities	University Ownership Status	Academic Building Type	Selected Academic Buildings
1.	Federal University of Agriculture, Abeokuta (FUNAAB)	Federal	College	1. College of Management Sciences
			Main Lecture Theatre	2. 1000 Capacity Tertiary Education Trust Fund Lecture Theatre
			Main Library	3. Nimbe Adedipe Library
2.	Olabisi Onabanjo University, (OOU) Ago-Iwoye	State	Faculty	4. Faculty of Sciences Complex
			Main Lecture Theatre	5. Otunba Gbenga Daniel Lecture Theatre
			Main Library	6. Main University Library
3.	Covenant University (CU), Ota	Private	College	7. College of Science and Technology
			Main Lecture Theatre	8. Main Lecture Theatre
			Main Library	9. Centre for Learning Resources

Source: Author's Fieldwork (2018)

The data derived from the study were basically from primary sources. To gather data for the research, observation was used to identify designed solutions that do not conform with UD parameters (UD principles and accessible design requirements). The designed solutions considered as barriers to achieving UD were noted and documented with photographs. The data was gathered between January and March 2018 when the three universities were visited. The data gathered were basically qualitative data, hence content analysis was used to analyse them. In analysing the data, the areas documented were first grouped according to what was found in each academic building and university, after which themes were identified and the data grouped according to the themes. The result was presented in themes rather than based on what was found in each academic building. This is because the barriers found, cut across all the academic

buildings investigated. Consequently, it was necessary to present the result in themes to avoid repetitive presentation of data retrieved. In addition, the focus of the research was to identify designed solutions that constitute barriers within the study context of universities in the study area, rather than in individual academic buildings. Therefore, retrieving data from the academic buildings is considered a means to achieving the end, rather than the end itself. The themes were presented using descriptive approach with photographs.

4. RESULT AND DISCUSSION

The design solutions identified as barriers to achieving UD in the study area cut across all the nine academic buildings investigated as earlier noted. The barriers are presented as follows:

4.1 Absence of Dropped Kerbs along External Walkways

External walkways leading to the academic buildings are generally not provided with dropped kerbs for the use of mobility impaired persons such as wheelchair users or workers pushing trolleys as shown in Figures 1, 2 and 3. The walkways are a step higher than road levels. This implies that everyone using the walkways will have to step up to use them or step down to get off them. Also, the height of many of the walkways exceed 170 mm, which is the maximum riser height specified in Inclusive Mobility (2012) [33]. A single step is not usually a problem for abled-bodied persons, but is an obstacle that can limit access for mobility impaired users. This situation contravenes the first principle of UD (equitable use) that requires that a design should not disadvantage or stigmatise any user group and the second principle (flexibility in use) which stipulates that designs should accommodate diverse individual preferences and abilities. Level or flushed access is important for most wheelchair users. Where this is not possible, Inclusive Mobility (2012) [34] recommended that such access should be provided by dropped kerbs.

Figure 1

Figure 2

Figure 3

Figures 1, 2 and 3 Absence of Dropped Kerbs along External Walkways

Figures 1, 2 and 3 were taken in FUNAAB, OOU and CU respectively.

4.2. Open Drainage along Walkways

Many external walkways in all the universities have open drainage along their sides without any safety barriers to them as shown in Plates 2 and 11. Such situations are not safe for users, because any user can accidentally slip and fall into such drainages. This contravenes the fifth principle of UD (tolerance for error) which entails that risks and adverse effects of accidental or unintentional actions should be minimized. Unsafe elements are expected to be avoided or safeguarded in conformity with the requirement of the first guideline of the fifth principle.

4.3. Absence of Accessible Carparks

In all the academic buildings investigated accessible design carparks were not provided in compliance with accessible design standard requirement. This also contravenes that first and second principle of UD as explained earlier. The Building Regulations (2015) [33] stipulated that at least one designated carpark for PWDs should be provided close to the main entrance of public buildings on firm and level ground. This implies that PWDs are marginalised with regards to carpark provision in the universities, contrary to UD requirement. Most of the carparks were also not marked in conformity with standard requirement of carparks. In addition, provision of covered drop-off points was also absent at the main entrance of all the buildings, which further makes accessing the buildings more challenging for individuals with mobility impairment who arrive the buildings in vehicles. Figures 3, 4 and 5 show carpark areas provided without any accessible parking space for PWDs.

Figure 4

Figure 5

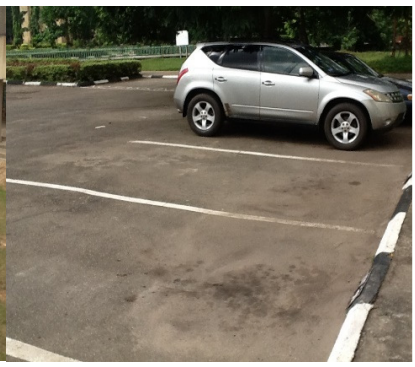

Figure 6

Figures 4, 5 and 6 Absence of Accessible Carparks

Figures 4, 5 and 6 were taken in FUNAAB, OOU and CU respectively.

4.4. Absence of Ramps along Access Routes where there is a Change in Level

In all the buildings investigated, only steps without ramps were provided where there are changes in level along most of the access routes, as shown in Figures 7, 8 and 9. This also contravenes the first and second principles of UD as well as the sixth principle (low physical effort). Aside from the fact that equitable usage and flexibility in use are not provided for at such locations, many physically challenged persons will need to use more physical effort to climb the steps compared to what they will need if ramps were available as alternatives for them to use. This scenario limits accessibility for the physically challenged at such points and constitutes a barrier to achieving UD in the academic buildings.

Figure 7

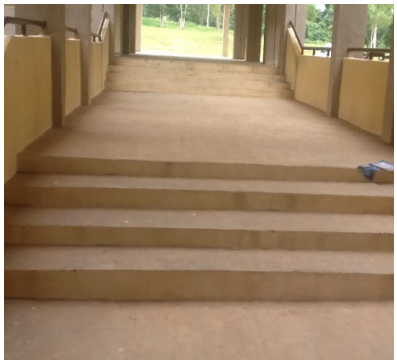

Figure 8

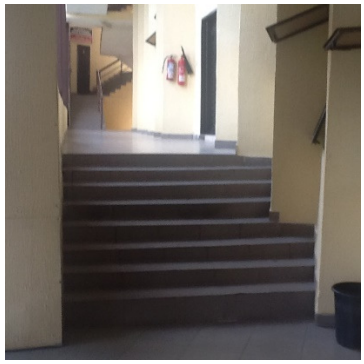

Figure 9

Figures 7, 8 and 9 Absence of Ramps along Access Routes where there is a Change in Level

Figures 7, 8 and 9 were taken in FUNAAB, OOU and CU respectively.

4.5. Physical Obstructions across Access Routes

Physical obstructions such as, open drains (Figures 10 and 11), kerbs (Figure 11) and concrete cover used to protect service pipes (Figure 12) were found across access routes in the universities. This might not be a problem for most abled-bodied persons to pass over, but will hinder free flow access for many PWDs, particularly wheelchair users. This is in addition to such areas not being completely safe to use contrary to UD requirement.

Figure 10

Figure 11

Figure 12

Figures 10, 11 and 12 Absence of Ramps along Access Routes where there is a Change in Level

Figures 10, 11 and 12 were taken in FUNAAB, OOU and CU respectively.

4.6. Inappropriate Door Provisions

Doors with inadequate levelled ground before or after them, inadequate widths and high thresholds were found in all the academic buildings investigated. These scenarios can limit accessibility for the physically challenged, especially those who use mobility aids such as wheelchair, walking frame or crutches. Many doors, particularly toilet doors, have clear passage way of less than 815 mm to 900 mm wide (Figure 14), which is the minimum allowable door width range for accessible doors (Department of Justice, 2010) [35]. Several door thresholds were also higher than 10 mm, the maximum threshold height allowable for accessible doors. The high thresholds are also not bevelled, hence constitute a barrier for independent use for wheelchair users in conformity with UD requirement (Figure 15). Absolute minimum clear space of at least 1500 mm is specified before and after doors to allow

wheelchair users to manoeuvre freely (Inclusive Mobility, 2012) [33]. Such space is also absent before or after many of the doors (Figure 13). These situations contravene UD principle one and six as earlier explained and constitute barriers to achieving UD at several door locations across the universities.

Figure 13

Figure 14

Figure 15

Figures 13, 14 and 15 Inappropriate Door Provisions

Figures 13, 14 and 15 were taken in FUNAAB, OOU and CU respectively.

4.7. Inappropriate Steps/Stairs Provisions

High and inconsistent step risers, inconsistence threads, extremely low handrail and absence of handrails along some steps were observed in most of the academic buildings as shown in Figures 16, 17 and 18. Many of the steps have risers higher than the maximum allowable height of 170 mm and threads with depth outside the minimum allowable depth of 250 mm specified in Inclusive Mobility (2012) [33]. Several of the stairs risers and threads are not consistent in conformity with safety requirements (Figure 16). Some stairs have low handrails which are lower than the minimum acceptable handrail height of 850 mm (Figure 18), while some are not provided with handrails at all in conformity with accessible design requirement for stairs (Figure 16). Generally, handrails at a lower level to the main handrails along stairways are absent across the universities. Such handrails are necessary requirements in public buildings for the convenient use of children or people with short stature. Some stairs were observed to have open risers which the Department of Justice (2010) [35] noted can be dangerous for some users as their feet can mistakenly slip through such points (Figure 17). All the highlighted step/stairs anomalies limit accessibility for users, especially the physically challenged, in addition to contravening the safety guideline of UD principle six (tolerance for error).

Figure 16

Figure 17

Figure 18

Figures 16, 17 and 18: Inappropriate Steps/Stairs Provisions

Figures 16, 17 and 18 were taken in FUNAAB, OOU and CU respectively.

4.8. Inappropriate Ramps Provisions

Steep ramp gradients and absence of handrails along ramps limit access for people who are mobility impaired as shown in Figures 19, 20 and 21. Many others such as pregnant women, the aged and some children will also find such ramps challenging to climb or descend from. The general preferable gradient of ramps is 1^{o} to 5^{o} (Inclusive Mobility, 2012) [33]. Majority of the ramps found in the academic buildings across the universities have gradients far above the maximum acceptable limit of 8^{o} specified in (Inclusive Mobility, 2012) [33] and considered dangerous to use, especially where such ramps are not provided with handrails on both sides as specified in accessible design standards of The Building Regulation (2015), Inclusive Mobility (2012) and Department of Justice (2010) [32], [33] and [34].

Figure 19

Figure 20

Figure 21

Figures 19, 20 and 21 Inappropriate Ramps Provisions

Figures 19, 20 and 21 were taken in FUNAAB, OOU and CU respectively.

4.9. Narrow Access Routes and Inadequate Manoeuvring Spaces

Generally, classrooms, library reading rooms and most of the lecture theatre hall access routes and manoeuvring spaces are narrow and inadequate. Most of the access routes are not up to 900 mm which is the minimum width of access routes specified in accessible design standards generally. Many of the areas in these spaces, including toilet cubicles generally, do not have adequate manoeuvring space of at least 1500 mm stipulated by Neufert and Neufert (2012) [35] as the minimum turning space to be provided in every room for wheelchair users to turn around. This implies that wheelchair users, people with mobility impairments and individuals who are exceptionally fat will not be able to conveniently pass through most of the access routes in classrooms (Figure 22), library reading rooms (Figure 23), lecture theatre halls (Figure 24) and toilet cubicles (Figure 28) to use facilities, contrary to UD requirements. This contravenes the seventh principle of UD which requires that appropriate size and space should be provided for approach, reach, operation and usage, regardless of body size, position or mobility status of users.

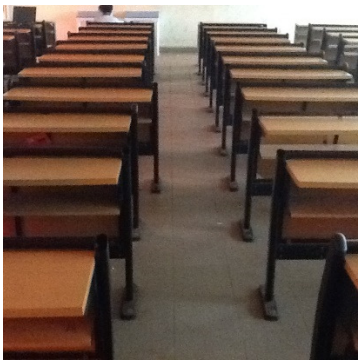

Figure 22

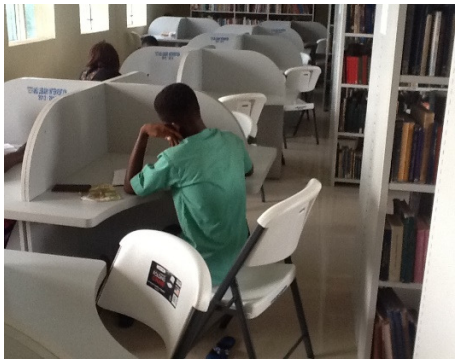

Figure 23

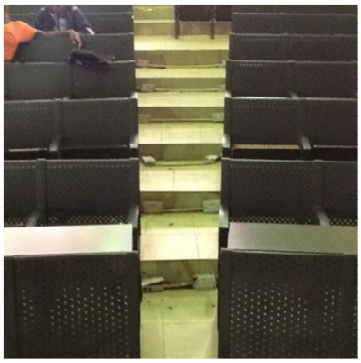

Figure 24

Figures 22, 23 and 24 Narrow Access Routes and Inadequate Manoeuvring Spaces

Figures 22, 23 and 24 were taken in FUNAAB, OOU and CU respectively.

4.10. Absence of Equitable Vertical Access Provisions Between Floors

Aside from one of the academic buildings, all the others investigated are storey buildings of between two to four floors. But only in one of the storey buildings was ramps and stairways provided as access mediums between floors. Only stairways were provided in others (Figures 25 and 26). Some of the stairways design configuration and accessibility provisions can only allow for just one abled-bodied user to pass through at a time (Figure 25). The use of such stairways during rush hours or chaotic situations can be time wasting as only one person can pass through at a time. It can also lead to unintentional situations that could be injuries to users, particularly in chaotic situations. In none of the academic buildings was a lift provided. A lift shaft was observed in one of the buildings, but a lift was not installed. The shaft access points on each floor were however covered up with plywood as a safety precaution (Figure 27). This means that people with mobility difficulty like the physically challenged, the aged or workers pushing or pulling trolleys will find it challenging to travel between floors in most of the buildings without assistance. Wheelchair users will practically have to be fully assisted in order to be able to travel from one floor to the other, contrary to the ideal of UD. Absence of vertical access movement features for travelling between floors in majority of the buildings, negates the requirements of UD principles one (equitable use), two (flexibility in use), five (tolerance for error) and six (low physical effort).

Figure 25

Figure 26

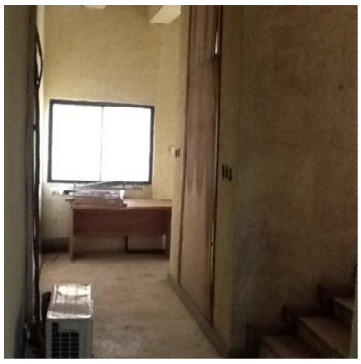

Figure 27

Figures 25, 26 and 27 Narrow Access Routes and Inadequate Manoeuvring Spaces

Figures 25, 26 and 27 were taken in FUNAAB, OOU and CU respectively.

4.11. Facilities Outside Accessible Height and Location

Several facilities such as window opening handles, fan regulators, light switches (Figure 28) and sanitary facilities are outside the allowable reach height of 1200 mm generally specified for accessible buildings. Though electrical sockets are mostly located at reachable heights of between 400 mm and 550 mm, majority of them are not easily accessible to every potential user. This is because access to reach several of them are either too narrow or blocked by furniture (Figure 30). Generally, accessible toilet provisions are not made in any of the academic buildings for people with mobility challenges in conformity with UD requirements. Toilet cubicles are generally inaccessible for wheelchair users and difficult to manoeuvre in for mobility impaired users generally, due to their tight spaces (Figure 29). Neufert and Neufert (2012) [35] stipulated that at least one toilet of seat height 480 mm should be provided for wheelchair users in all sanitary facilities which was absent across the universities. The toilet is expected to be equipped with vertical and horizontal grab bars for support and wash hands basin close to the WC so users can reach them in seated position on the WC. Such toilet cubicle door should open outwards and not less than 900 mm wide when open. In addition, flushing handles are mostly located on the right of WCs. This does not give left handed people the opportunity to use them with their preferred hand. The situations described in this section generally contravene UD principle one (equitable use), two (flexibility in use) and seven (adequate size and space for approach and use).

Figure 28

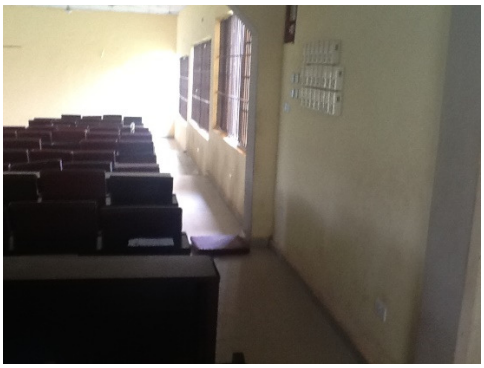

Figure 29

Figure 30

Figures 28, 29 and 30 Narrow Access Routes and Inadequate Manoeuvring Spaces

Figures 28, 29 and 30 were taken in FUNAAB, OOU and CU respectively.

4.12. Absence of Tactile Surfaces and Audio Directional Guide

Provisions to facilitate free flow movement and independent use of the academic buildings and their facilities for the blind or cane users such as, tactile surfaces and audio directional guide were absent across the universities. This means that this user group cannot navigate through the academic buildings to use facilities and services unassisted in compliance with UD requirement. This situation contradicts the provisions of UD principle one (equitable use) and five (tolerance for error).

4.13. Discussion

As a result of some design solutions constituting barriers for some user group from being able to freely and independently use spaces, facilities and services in public buildings contrary to UD requirements, the study investigated nine academic buildings across three universities in Ogun State in southwest Nigeria, to identify such design inadequacies. The findings clearly show that PWDs such as those who are mobility or visually impaired are generally

marginalised as a result of accessibility and usability provisions not suited for their use in several areas of all the buildings. Right from the approach of the buildings to the interior spaces, horizontal and vertical movement access provisions are mostly designed to suit the accessibility and usability needs of able-bodied persons. Even with that, some of the provisions do not comply with UD parameters (UD principles and accessible design requirements). Some stairs have open riser ends that are not well protected, some have handrails whose heights are too low and considered dangerous to use, while several others have inconsistent risers and thread dimensions. In none of the academic buildings was a second handrail located at a lower level to the mail handrail for the use of children or people of short stature. Where provisions were made for the physically challenged, many of such provisions fall short of UD requirements. For instance, ramp gradients are too steep in addition to many of them not provided with handrails for the use of the aged or mobility impaired persons to support themselves.

Generally, only stairways are provided as vertical movement provisions between floors in most of the buildings. This means mobility impaired users, particularly those who use mobility aid such as, wheelchair, crutches or walking frame cannot conveniently and independently travel from one floor to the other without outside help. Many doors variables such as, their clear opening widths, threshold heights and clear level ground before or after the them, do not conform with UD requirements. Facilities that form integral part of the buildings such as windows, electrical and toilet facilities were also mostly designed to suit the accessibility and usability needs of average abled-bodied users. Operating handles or devices of many of the facilities are outside accessible design height range, reach or location. Most of the WC's flushing handles are located on the right-side only, while some stairways are provided with handrails on just one side. This means that many users are not provided with the opportunity to use their preferred hand when using these facilities in the academic buildings. This scenario contravenes the second principle of UD (flexibility in use).

In general, the outcome of the research agrees with the result of previous researchers who found that enough provisions were not made in some public buildings in Nigeria for the convenient use of PWDs, as provided for abled-bodied persons (Sholanke *et al.*, 2018; Ibem *et al.*, 2017; Sholanke *et al.*, 2016; Soyingbe *et al.*, 2016; and Maclean, 2014) [8], [9], [10], [11] and [12]. This study has however gone further to identify specific designed solutions creating barriers to achieving UD compliance in academic environments with a view to finding possible ways of developing inclusive design solutions beneficial to all user groups, towards promoting inclusive education.

5. CONCLUSION AND RECOMMENDATIONS

Generally, the design solutions found to constitute barriers to achieving UD in the nine academic buildings investigated in the study area in Nigeria, are solutions that do not take the accessibility and usability needs of the mobility and visually impaired into consideration. The general implication of the result is that the academic buildings as presently configured are not suitable for encouraging the promotion of the concept of inclusive education in Nigeria. This implies that architects and construction experts need to pay more attention to the special needs of the physically challenged in the development academic environments in Nigeria to be able to design and produce buildings that are inclusive in nature. Base on the result of the research, the following recommendations are made:

Architects usually design to comply with a set of building code. It is not clear if the codes used in Nigeria have enough provisions to facilitate the design and development of inclusive learning environments. In this light, there is therefore a need for further studies to be carried out to ascertain the compliance level of building development regulations in Nigeria with UD

parameters, particularly in the study area, Ogun State. This is considered the first step to take towards facilitating the design and development of fully inclusive educational environments in the country.

Secondly, it is observed that overcrowding of academic spaces with furniture to exceed their designed capacity accounted for most of the access routes and manoeuvring spaces of classrooms, library reading rooms and lecture theatre halls to have movement routes to fall short of UD requirement. To this end, it is recommended that arbitrarily increasing the designed capacities of academic environments by adding more furniture to accommodate more than the capacity originally designed for, should be avoided by the institutions.

The third recommendation is that the university authorities should carry out a phased renovation of their buildings to correct the anomalies identified. Such renovation will involve retrofitting the buildings with accessibility and usability provisions that are inclusive in nature, where they are lacking or inappropriately designed, as well as reducing the furniture in academic spaces that are overcrowded to achieve accessible routes and manoeuvring spaces.

Lastly, the management of the universities are further advised to ascertain that future repairs, routine and periodic maintenance works in their institutions are assessed and ascertained that they comply with UD parameters before they are executed.

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