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Towards Sustainable Redesign of Academic Library Buildings in Nigeria: Case for Remodelling Higher Institution Library Buildings to Meet 21st Century Users' Expectations

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ABSTRACT

The rapid transition in technology, changing user needs, and altering educational procedures have forced the long-term redesign of academic library facilities all over the world. However, in Nigeria, most academic library buildings have not been updated to meet changing trends and user expectations. This has consequently affected the users' learning and educational experience. Many Nigerian higher education libraries still use antiquated designs that do not meet the expectations of digital-age users who demand more flexible, collaborative, and technology-integrated environments. This paper investigated the disparity between traditional library architecture and the needs of the 21st-century academic community. The objective was is to determine how to redesign current academic library buildings in Nigeria to fulfil 21st-century user expectations, with a focus on sustainability, flexibility, and technological integration. The study took a quantitative approach, surveying students and staff (n=484) at selected higher education institutions about their library usage patterns and expectations. The findings show that altering library designs can considerably improve user experience, accessibility, and collaborative learning in higher education. The paper proposed essential design concepts that connect with sustainability, user-centred space provision, and digital integration to prepare academic libraries for the future while also supporting environmental aims. It concluded that remodelling academic libraries in Nigeria can close the gap between current infrastructure and future user needs, particularly in terms of technology, flexibility, and sustainability.

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1. Introduction

University libraries around the world are constantly evolving to suit the changing demands of students, staff, and researchers. To comply with evolving higher education paradigms, the change involves building varied places and adopting modern technologies [1]. This transition is driven by users' rising expectations, which are influenced by the impact of technology on resources and services. Staff training, information technology utilisation, various learning environments, services, and equipment are all critical components in enhancing library innovation. Universities around the world recognise this value, which has led in the refurbishment, redesign, and enlargement of their library buildings. Notable examples include Tsinghua University Library in Beijing, China, which has successfully transitioned to modern library formats in response to global trends [2].

Academic library buildings are crucial to universities' intellectual life because they provide resources, study space, and technology access. These buildings have historically served as knowledge hubs, contributing significantly to the intellectual development and research activities of higher education institutions [3,4]. Academic library buildings are critical hubs for intellectual study, research, and information transmission in an ever-changing educational landscape [5]. However, the emergence of technology developments and advancements in the twenty-first century presents numerous obstacles, rendering physical library buildings underutilised and outdated. These libraries' difficulties necessitate a thorough investigation into the obsolescence and suitability of their physical infrastructure. Intellectual libraries have historically been the foundation of education, offering access to a variety of material required for intellectual endeavours [6]. However, the rapid advancement of technology has caused changes in the way information is accessed, shared, and used [4]. Nigeria, like other academic libraries throughout the world, is grappling with how to adapt to the changing nature of higher education.

In the twenty-first century, students and teachers want libraries to provide collaboration spaces, quiet study areas, and technology-equipped rooms. However, present traditional library layouts frequently fail to accommodate these varying requirements. Understanding and responding to the diverse and complex needs of modern library users is critical. Libraries in industrialised countries have expanded and restructured in the twenty-first century, utilising a variety of multimedia to provide a wide range of services to a diversified audience [7]. From the afore mentioned challenges facing Nigerian academic libraries, this study highlight the following research gaps identified in literature to be addressed in this paper as follows: (i) Lack of focus on user-oriented library design: While there have been studies on library service provision, marketing, and technology integration, there is a paucity of research addressing the integration of user needs into the architectural design and redesign of academic library buildings in Nigeria to meet 21st-century expectations. (ii) Lack of research on obsolescence in Nigerian academic libraries: Current research does not adequately examine the extent of obsolescence in Nigerian academic library buildings, particularly how ageing infrastructure, technological advancements, and changing user expectations contribute to declining utility and value. (iii) Insufficient study on improvement strategies for Nigerian university libraries, addressing difficulties such as technological obsolescence, space limits, and limited finances. (iv) Lack of user-centric insights: Comprehensive research on users' opinions of 21st-century university library facilities show the need of aligning library design with user demands to remain relevant and useful in the digital age. (v) Need for a comprehensive study: There is a lack of study on the opportunities and challenges of restructuring Nigerian university libraries to meet the needs of the 21st century users.

To address these gaps, the study intends to investigate the levels of obsolescence in Nigerian university libraries and make practical, user-centred recommendations for long-term redesign in the light of current educational and technological advances.

1.1 The Significant of Study

Several studies have been undertaken in the field of library sciences, with certain studies [8-11] focusing primarily on library service provision and marketing. Others, studies such as [12-14] have discussed the usage of technologies in libraries in detail on several occasions, which is undoubtedly quite useful in providing the user's need in the shortest amount of time feasible. In recent years, only a few studies, such as [15] and [1] have concentrated on the needs of 21st century library users and academic library buildings. While many writers have concentrated on identifying the most recent demands of the library system, according to [16], it is clear from their future implications that identifying user needs must be integrated in library designs in order for them to be effective.

Academic library buildings in Nigeria are dealing with the consequences of technological obsolescence, space constraints, and insufficient resources caused by rapid technological development, changing educational patterns, and shifting user expectations [17,18]. Building obsolescence is defined as a reduction in building utility and value caused by a variety of causes such as ageing, technological advancements, and changing user needs [19]. This involves a study of the libraries' current physical infrastructure, as obsolescence is a major issue in architectural design, affecting sustainability and economic viability. Understanding the difficulties and opportunities is critical to ensure that academic libraries continue to play an important role in promoting research, learning, and innovation.

Many academic library structures in Nigeria are becoming obsolete, as they struggle to satisfy the changing demands and expectations of 21st-century users [17]. While several difficulties face libraries and library users in Nigeria, there is a significant shortage in detailed information about the amount of obsolescence in academic libraries within Nigerian universities [18]. Furthermore, there is a scarcity of research focusing on improvement techniques, particularly in addressing obstacles and grabbing opportunities to meet the expectations of 21st-century users [18]. Thus, under the current environment, a comprehensive study with special reference to Nigerian higher institution libraries was urgently required, with a primary focus on users' perceptions of 21st century university library facilities. This study focusses on the research gap, demonstrating a paucity of research on user-oriented growth tendencies in 21st-century university libraries in Nigeria in light of the continually changing infrastructure.

The key objective of this paper is to assess current academic library performance, obsolescence, and the suitability of physical infrastructure to meet user expectations. This aims to emphasise the major aspects influencing its architecture and to give some conceptual recommendations for academic library remodeling. To accomplish this, the following objectives were set to:

i. Assess library users' perceptions of the library's environmental condition
ii. Investigate the space requirements for 21st century library users;
iii. Assess the adequacy of the library design for the 21st century; and
iv. Determine the effect of available spaces and facilities on how frequently the respondent uses the library.

2. Literature Review

Library space is a very flexible subject of study in library research. Despite its adaptability, the research's theoretical and conceptual foundation is still very weak, and it is still regarded as a fairly peripheral topic in academia. Several studies have focused mostly on the early history of library structures in the twentieth century [20-23]. These studies combine elements from sociology, architectural history, and library history to evaluate library structures from a broader societal viewpoint. The studies, which offer important insights on the layout and social function of libraries as well as illustrations of deliberate decision-making, can be regarded as foundational study on the topic.

Mattern [24] examines the current debate over public library architecture in the US as an exception to the historical approach to library research. In the meantime, a thorough overview of the evolution of public library spaces in Finland was given by Aaltonen [25]. Interest in library space appears to have grown gradually since the mid-1990s. Without a doubt, the shift in library operations brought about by new information technology has contributed to this. These modifications have made it necessary to redesign current library spaces and create fresh ideas for brand-new library designs. The two main ideas for library space in the digital age, to summarise the earlier library research literature, are the library as a place and the library as a learning environment. Although the two are not mutually exclusive, the former focusses mostly on academic libraries and the latter frequently targets public libraries.

2.1 The Concept of Library as a Space

The term "library as place" refers to a space where students can communicate intellectually, share information, and socialise in an academic setting [26]. Furthermore, libraries provide respite from a world dominated by entertainment, media sound bites, and ubiquitous commercial ideals. According to Buschman and Leckie [27] and Most [28], libraries are concrete spaces for a variety of social activities under the overall idea of the library as location. The idea of the library as a space is frequently only loosely related to the development of information technology, which contrasts with the idea of the library as a learning environment. The 1990s saw the rise in popularity of the Information Commons concept, which incorporates digital media, communal workspaces, technology, and access to librarians and technology specialists.

The concept of library as a space could be interpreted as a response and countermove against digitisation. Thus, if libraries are unable to compete with the Internet and new digital services, they can invest in the design of appealing library spaces and attempt to attract people by offering new types of activities, such as those claiming to foster various forms of social contact. Allowing discussion and food and drink in academic libraries has made them more appealing and hospitable to students. Academic libraries are now seen as welcoming venues that attract users through a combination of technology, comfortable work rooms, cafés, print and electronic collections, and knowledgeable information specialists. The emphasis is on praising the modern library space, particularly the Information Commons, which reflects these ideas, encourages learning, and revitalises the concept of the academic library.

The issue of space limits within academic library buildings poses a difficulty to the optimal operation of educational institutions in Nigeria. Margeton [29] explored the complications of space planning, concluding that libraries must be more adaptable than other types of academic facilities. This is especially relevant in Nigeria, where the growth of educational institutions increases the demand for study spaces, collaborative places, and resource storage. Olarongbe *et al.,* [30]

conducted a study in Nigeria to identify the key information demands of public library customers. The top six indicated demands were academic information, personal development, general knowledge, social amenities, government policies/programs, and agricultural information [30].

Technology has dramatically changed library operations and space planning. In contrast to the silent and antiseptic paradigm of mid- to late-20th-century academic libraries, today's mindset promotes a variety of activities such as group work, conversation, and access to technology, food, and beverages. The original "mausoleum library model" discouraged use, in sharp contrast to the present inclusive approach [31]. Alemna and Antwi [32] highlight the issues faced by library consortia in various African countries, emphasising the importance of strategic planning in addressing restricted space effectively. As academic libraries aim to build spaces that accommodate varied learning styles, spatial constraints necessitate creative solutions to suit the needs of 21st-century users [32].

Several authors [33-35] believe that the concept of the hybrid library, which combines the physical and digital dimensions of space and services, provides one possible strategy for libraries to function as multifaceted social institutions. However, there has been little genuine interest in exploring this idea further. Meanwhile, the primary motivation for this notion has been to investigate potential methods of connecting growing electronic resources to current library organisations. As a result, the physical part of this dual notion has been inadequately defined from the start, with the focus mostly on tangible collections. A more rigorous understanding of the significance of physical space in libraries may assist their overall development as institutions. Libraries are currently considered as multipurpose places that serve as welcome locations for information, social spaces, experimental spaces, and safe spaces in a variety of ways, rather than being limited to a single physical space [36].

Shonhe and Jain [37] used Survey Monkey to obtain both qualitative and quantitative data. Out of 82 online participants, 76% predicted 21st-century libraries to offer venues for community building. E-learning classrooms (79%), technological hubs (73%), group work stations, video conferencing (68%), and social areas (60%), were among the anticipated facilities. Desired services included online reference services (84%), Wi-Fi access (74%), personalised library services (69%), and online public access catalogues (OPAC) (61%). User problems included poor internet access (68%), insufficient online services (64%), and a lack of technological resources (63%).

2.2 The Concept of Libraries as Learning Environments

Since the mid-1990s, one of the most influential ideas in academic library architecture has been the usage of the notion of information commons, often known as an information centre or learning commons. These theories were explored in library research, particularly by [38-41]. Information commons is a comprehensive strategic and spatial concept that encompasses the various uses of library facilities, services, and equipment, particularly the usage of information technologies. The notion is frequently used to encourage novel learning approaches, including interactivity, co-learning, and situational learning. Beagle [38] was one of the first to take a systematic approach to the topic, establishing three major goals for the construction of information commons. He defined these goals as renewing library services by emphasising the use of electronic resources, creating new learning spaces that allow for both individual and collective forms of study, and initiating collaborative projects among various actors in the university community. Beagle [39] gives a detailed and practical approach to information commons design.

Bennett [40] compares the notions of information commons and learning commons, arguing that the latter should be used as a future paradigm for library spaces. By learning commons, he meant a

space that should help students learn more deeply by incorporating research evidence into the design and function of these spaces. According to the author, students should be more involved in the design and operation of learning commons. Bennett [41] splits the history of academic libraries into three periods: reader-centered, book-centered, and learning-centered. According to [41], the present challenge for academic libraries is a paradigm change from book-centered to learning-centered environments. This transformation process is far from complete, and a more rigorous definition of the concept and purposes of the learning commons should be developed.

According to Closet-Crane [42], the concept of information commons has been employed uncritically in some library information science work. The author stated that the theoretical conceptualisation of library space should be expanded in order to do additional research on the impact of affective and architectural elements of library space. Meanwhile, Gayton [43] distinguishes between the communal and the social, arguing that the new types of social activities taking place in information commons may undermine the academic library's traditional role as a communal space supporting and manifesting students' and faculty members' solitary and contemplative scholarly work. Similarly, Caniano [44] takes a critical position towards information commons, claiming that the architecture of such libraries does not meet users' expectations of what academic libraries should look like. The author also stated that such space configurations encourage unstructured social contact, which may not benefit students' learning processes.

2.3 The Theory of Obsolescence for Academic Libraries

The theoretical framework for building obsolescence provides a structured method to analysing the elements that lead to the decrease in usefulness and value of buildings over time. This framework combines theories and concepts from urban planning, real estate, architecture, and sustainability to provide a thorough examination of the problem. This study addressed a major theory to provide varied viewpoints on the obsolescence of Nigerian library buildings. Building obsolescence is characterised as a reduction in building utility and value caused by ageing, technology advancements, and changing user needs [45]. This is a major issue in urban planning, real estate, and architectural design, influencing both sustainability and economic viability.

2.4 Functional Obsolescence Theory

Functional obsolescence theory explains the reasons that make buildings less desirable or efficient over time, affecting their utility and value. Functional obsolescence happens when a structure can no longer perform the functions for which it was originally constructed owing to technological advancements, human needs, or standards. The literature presents several perspectives on the application of functional obsolescence theory to buildings and construction projects. For example, Thomsen and Van der Flier [46] described functional obsolescence as a decrease in a building's utility or desirability as a result of technological advancements, design choices, or human needs. This distinguished physical obsolescence (related to the building's physical condition) from functional obsolescence (related to its functionality or design) [47].

Pourebrahimi *et al.,* [48] and Mellal [49] divided functional obsolescence into three categories: technological obsolescence (e.g., outdated building systems), design obsolescence (e.g., inefficient layout or floor plan), and locational obsolescence (e.g., changes in surrounding land use or accessibility). To analyse and mitigate building functional obsolescence, Мищенко & Горлин [50] presented approaches such as surveys, interviews, and market data analysis. They emphasised the importance of considering both physical and functional considerations when determining a building's

obsolescence. The National Research Council's Division on Engineering, Physical Sciences, Commission on Engineering, Technical Systems, Building Research Board, and Committee on Facility Design to Minimise Premature Obsolescence [51] investigated strategies for reducing functional obsolescence in buildings, including adaptive reuse, renovation, and redevelopment. They emphasised the importance of inventive design and flexible zoning restrictions in revitalising outmoded buildings and increasing their worth.

Other authors, such as Rodi *et al.,* [52], focused on the impact of functional obsolescence on property valuation, emphasising the importance of appraisers considering both physical and functional elements when establishing the value of a structure. They talked about value methodologies that account for obsolescence, like the income approach and the cost approach. Olajide and Ijagbemi [53] explored the link between functional obsolescence and real estate investment decisions, demonstrating how perceptions of obsolescence might influence property market dynamics and investment returns. They proposed that proactive management of obsolescence risks might improve property performance and investor trust. Along with these issues is the dilemma of insufficient space, which results from initial designs that frequently fail to handle rising student populations and the demand for various, adaptable learning areas.

For a twenty-first-century library building, utilitarian design should take precedence over majestic grandeur. Functionality, extensibility, environmental suitability, flexibility, adaptability, safety and security, suitability for information technology, accessibility, efficiency, variety, interactivity, ambiance, conducive environment, and provision of areas for documents, staff, library equipment, and service areas are all important considerations [54,55]. It might be argued that functional obsolescence theory provides useful insights into the aspects that affect a building's functioning and worth over time. This hypothesis is critical for determining when structures should be updated or repurposed to suit modern requirements. The implications of functional obsolescence theory for academic library buildings in Nigeria emphasise the importance of proactive, strategic management to keep these institutions relevant and successful. This comprises regular assessments, user-centred design, technological integration, financial planning, and regulatory compliance. By resolving these issues, academic libraries can overcome functional obsolescence and improve their ability to meet modern educational needs.

Ensuring that library buildings are adaptable, sustainable, and prepared to meet current demands is critical for creating a lively, effective learning environment in Nigerian universities. As a result, the purpose of this study is to assess the level of obsolescence of academic library buildings in Nigeria, first by identifying the challenges posed by outdated structures by investigating aspects such as user perception, space requirements, and the impact of environmental conditions on library usage, and then by conducting a quantitative investigation of users' perceptions of the current state of academic libraries and their relevance to meeting their 21st century user expectations.

3. Material and Methods

3.1 Study Location

The study was carried out in Niger state and Abuja, Nigeria. Niger State is located in the North Central region at 10°00’N 6°00’E. The state's climate is exceptionally warm, with an annual average temperature of 34^{o} C. The climate is warm or hot throughout the year, with only a few months being truly tropical. Abuja, Nigeria's Federal Capital Territory (FCT), is located at 9°4’N 7°29’E and has a population of 776,298 people [56]. Abuja was picked since it is the country's federal capital territory and is home to an increasing number of universities in North Central Nigeria.

3.2 Research Design and Instrument and Pilot Testing

To address the study's objectives and questions, a mixed method research design consisting of quantitative and qualitative research methods was used. Although the data acquired was both quantitative and qualitative, the research was mostly quantitative. The quantitative approach was widely used in the study because it allows for statistical analysis to quantify and generalise data [57]. The researchers' well-designed questionnaire was used as the major method of data collection since it could immediately reach a wide range of study participants [58]. Thus, employing a survey approach, the study concentrated on academic libraries in state, private, and government-owned tertiary educational institutions. The author's personal observations, concerns from students, particularly from Niger State, Nigeria, and a pilot survey of students on campuses all inspired the decision to pursue the current study on library buildings. A questionnaire containing open and closed-ended questions was developed and used as a data collection tool (research instrument) in the quantitative research method. It was a rapid and easy way to gather data [59-61].

The research instrument was developed after reviewing the literature [62] and conducting a semi-focal group interview with students regarding the subject. Respondents were asked to indicate their opinion by ticking any of the five points on a Likert scale ranging from strongly agree to strongly disagree, equivalent to points 1 to 5. The Likert scale was chosen due to its high reliability coefficients and greater likelihood of eliciting responses that adequately reflect the subject matter. The questionnaire was organised into four sections. The first section gathered background information from respondents, while the second section gathered geographical evaluation data for the library. The third section was an environmental assessment of the library, with questions centred on indoor environmental data (temperature, humidity, and so on). Meanwhile, the fourth component discussed expanded library facilities and places.

Given the significance of the pilot study and its impact on the validation and effectiveness of a research tool, a pilot study is typically conducted with a small sample of the intended population. Thus, in this study, a subject procedure was carried out before presenting the final questionnaire to the responder. The prototype questionnaire was distributed to a small group, known as the pilot study group, to elicit input and comments on the research tool, as well as to allow for any necessary adjustments. The pilot group consisted of students from numerous universities. The subject pilot group's results showed that the questionnaire's questions were straightforward and unambiguous. The questions were engaging, accurate, and simple to understand. However, any questions that were vague, imprecise, or unclear were redesigned to fit the criteria.

According to Adu Gyamfi *et al.,* [63] a pilot survey can help researchers better understand or improve research themes, select the most successful approach, and estimate the time and resources required to perform the more in-depth study version. Following pilot testing, a reliability coefficient (Cronbach's alpha) with an overall average of 0.873 (Table 1) was calculated to evaluate and verify the data is reliable and suitable for judging the study purpose. The achieved value exceeded the minimum necessary threshold value of 0.70 to 0.95 for reliable variable performance, as reported by Tavakol and Dennick ([64].

Table 1
Reliability statistics of the research instrument

Section	Cases	Reliability	Interpretation
Section 2	6	0.753	Highly reliable
Section 3	15	0.817	Highly reliable
Section 4	13	0.888	Highly reliable
Overall	34	0.873	Highly reliable

3.3 Population, Sample and Response Rate

Nigeria now has 304 academic libraries; however, this study population only includes university libraries in the study region. According to Sukindar *et al.,* [65] Before conducting a survey to collect public responses, a sample size is essential to determine the exact number of replies required for validation. A sample is defined as a subset of the target population or group of persons. The sample population of users comprises of respondents who utilise university libraries, which account for the total number of participants that completed the questionnaire. These universities comprise the University of Abuja (150 questionnaires), the Federal University of Technology Minna (300 questionnaires), Newgate University Minna (120 questionnaires), and Ibrahim Badamasi University, Lapai (20 questionnaires), for a total sample size of 590. The rationale for the sample size chosen by the researcher was based on the following factors:

i. The population size with which the researchers are dealing and the amount of error that the researchers are willing to tolerate;
ii. The researchers' desire to collect sufficient data and have an estimate with a desired level of accuracy; and
iii. The study's limited available resources and the research question. Out of 590 questionnaires distributed, 484 were retrieved, accounting for 82% of the total. These institutions were carefully selected to reflect the three senatorial districts as well as the diverse types of higher education in the state.

3.4 Data Collection and Data Analysis

For the quantitative aspect of the study, the data was acquired by distributing questionnaires to library users at four Nigerian universities. Data collection includes data on library user satisfaction to ensure the current status of university libraries' resources, services, and facilities; to investigate technological advancements implemented in Nigeria state's university libraries; and to identify user perceptions of 21st century university libraries in terms of resources, services, and facilities. The questionnaires were distributed both in paper and digitally (using Google Forms). Both means of communication were used to get the greatest replies from the participants. The criterion mean was used to calculate the level of acceptability of an item, and statistical means in ascending order of magnitude were utilised to determine the most preferred procedures identified in the data collection instrument. The factors in the questionnaire were evaluated and ranked using Mean Response Analysis (MRA) statistics based on participant replies.

The mean score was derived on a five-point Likert scale. The MRA formula goes as follows: Mean score = (5n5 + 4n4 + 3n3 + 2n2 + 1n1)/(n5 + n4 + n3 + n2 + n1), where n5, n4, n3, n2, and n1 are the numbers of responders on the five-point Likert scale. The mean ratings were compared with the theoretical mean rating of 3.50. As a result, any mean score of 3.50 or greater was interpreted as unanimous agreement among the respondents on the topic provided to them. However, mean values less than 3.50 showed otherwise. Based on the survey results, the analysis employed factor analysis, descriptive analysis, and inferential statistics. For the quantitative aspect of the study, data analysis was carried out using SPSS version 23. A Pearson's correlation test (p=0.05) was used to determine whether there was a significant association between the observed variables. Furthermore, the ideal inter-item correlation means (factor loadings) should be between 0.2 and 0.4 in terms of factor dependability. This study used a value of at least 0.3 [66]. The qualitative data was analysed with the

content analysis method. The qualitative data was represented using numerical codes supplied by the authors as respondents' numbers. This was done to safeguard the participants' confidentiality.

4. Quantitative Results

4.1 Demographic Background of the Respondents

The demographic background of the respondents shows a gender distribution of 61% male and 39% female. The age breakdown shows that 61.4% of respondents are between the ages of 18 and 22, 32% between 23 and 27, and 4.7% between 28 and 32. The academic level distribution reveals that 41.6% are 100L (first-year) students. There are 18.6% 500L (final-year) students, 16.7% 300L (third-year), and 12.6% 200L (second-year) students. 83.9% are undergraduates. 6.2% are graduates with an HND (Higher National Diploma), BSc (Bachelor of Science), or BTech (Bachelor of Technology), and 7% are postgraduate students. These findings have the following implications:

i. The sample contains a higher number of male respondents (61%) than female respondents (39%). This could imply a gender imbalance in either the population under study or in the response rate.
ii. The vast majority of responders are young, with 61.4% aged 18-22 and 32% aged 23-27. This shows that the sample is primarily made up of people in the early stages of their academic or professional careers.
iii. First-year students (100L) account for 41.6% of all responders, followed by final-year students (500L) at 18.6%. This could indicate that newer students are more interested or accessible to the survey, or that enrolment is higher in the first year.

4.2 Perception of Library Users Regarding the Environmental Conditions of the Library

To answer study question one, which aimed to investigate library customers' perceptions of the library's environmental conditions. Figure 1 reveals that a considerable majority (74.4%) of respondents believed that the lighting in the library is adequate, with a mean score of 3.96 indicating agreement. This shows that the library's lighting system is usually regarded as acceptable by its customers, which is critical for establishing a comfortable environment for reading and learning. Good lighting can increase visual comfort, alleviate eye strain, and boost overall user satisfaction and productivity in the library. Respondents were impartial on the independence of the lighting system, with a mean score of 3.43. According to a study conducted by Majidi *et al.,* [67], consumers frequently express neutral comments on technical features such as lighting system independence, indicating a need for improved communication and education regarding these systems. Meanwhile, Gupta *et al.,* [68] discovered that effective communication about lighting controls can considerably boost user happiness, implying that the study's neutrality may be addressed by increased user awareness and control over lighting systems. Neutrality in this aspect suggests that users may lack a clear opinion or awareness of the lighting system's autonomy. This could signal that the lighting system's functioning and control methods are not clearly conveyed or evident to consumers. Ensuring that users understand how to alter illumination independently may improve their experience.

The majority (59.4%) agreed that the lighting control system is dependent on natural lighting, with a mean score of 3.61 indicating agreement. This demonstrates a successful integration of natural lighting into the library's design, resulting in energy economy and a nice ambiance. Using natural light can minimise dependency on artificial lighting, saving energy costs and promoting a more sustainable atmosphere. However, it also emphasises the importance of effectively managing natural and

artificial lighting to ensure optimal light levels throughout the day. 79.2% of respondents agreed that the lighting creates a unique and comfortable environment, with a mean value of 4.18. A high degree of agreement on the lighting's comfort factor indicates that the library has successfully established a welcome and pleasant environment for its users. Comfortable lighting can improve the library's appeal and use, resulting in longer and more frequent visits from students and faculty. 79.4% of respondents felt that natural light from windows helps to illuminate the library, with a mean score of 4.13.

The strong endorsement of natural lighting's contribution emphasises the appropriate utilisation of windows and natural light sources in the library's design. This can enhance the overall atmosphere, minimise energy use, and provide a healthier and more welcoming environment for library patrons. 56.3% of respondents agreed that the building's insulation prevents noise pollution, with a mean value of 3.5. A moderate level of agreement implies that, while noise insulation is fairly successful, there may be potential for further development. Effective noise insulation is essential for maintaining a calm study environment, which improves attention and productivity. Improving insulation could help to improve the user experience. Respondents were neutral on external noise disturbance during reading periods, with a mean value of 3.07. This neutrality suggests that external noise may not be a significant problem, but it is not entirely absent either, which could indicate occasional disturbances that may affect some users. Additional measures to reduce external noise could help in creating a consistently quiet and undisturbed environment.

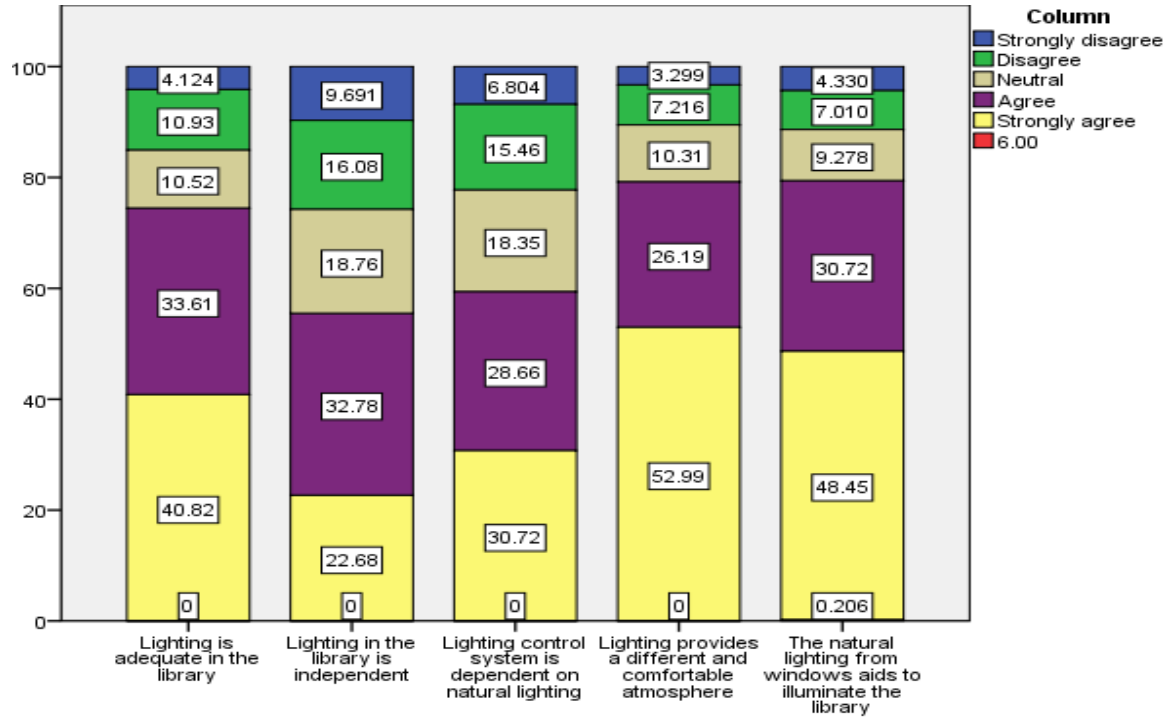

Fig. 1. Library users' perceptions of the appropriateness of library lighting systems compared to natural lighting

Figure 2 and Figure 3 demonstrate that a considerable majority (66.8%) of respondents felt that the furniture's design and suitability were satisfactory, with a mean value of 3.79. This suggests a good attitude towards the furniture design and its suitability for the library environment. Well-designed furniture improves user comfort and functionality, resulting in a suitable study and reading environment. Ensuring that the furniture design meets the needs and preferences of users can lead

to increased satisfaction and longer-term use of library resources. 56.1% of respondents agreed that there are various seating options available, with a mean value of 3.54.

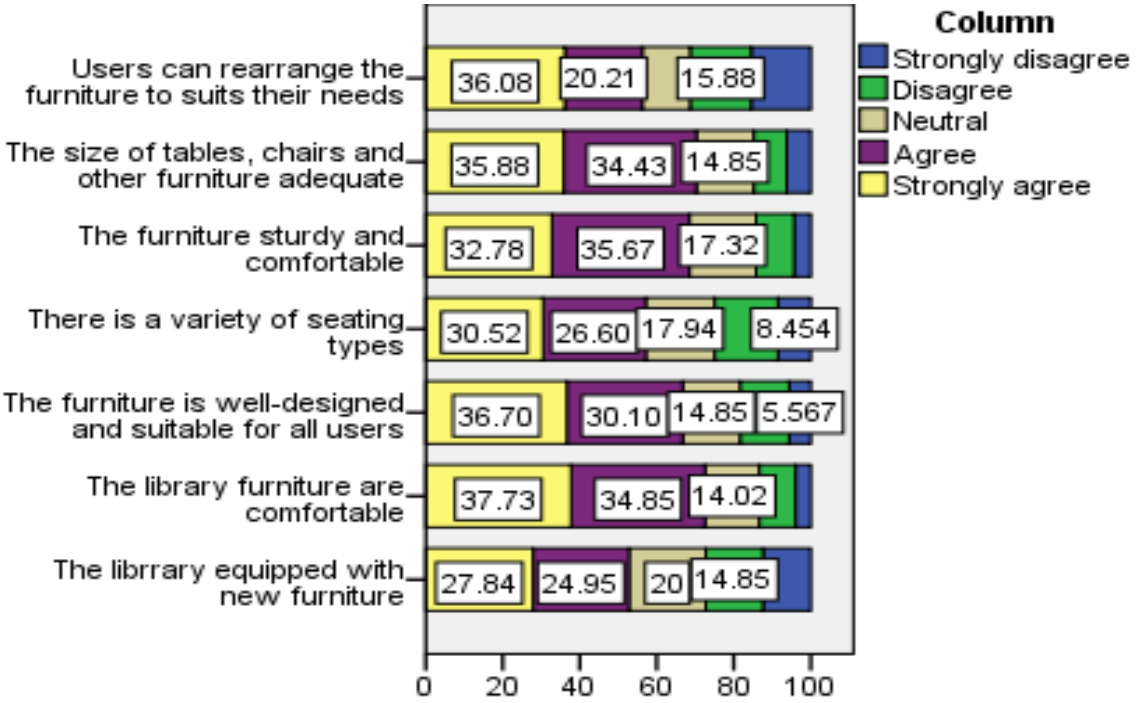

Fig. 2. Library users' perceptions of library furniture appropriateness

The agreement on the range of seating kinds implies that the library provides various seating options to accommodate different user preferences and activities. This variety allows for solo study, group work, and informal reading, making the library more adaptable and user-friendly. A broad selection of sitting options can improve the library's appeal and functionality, encouraging more people to use the area. 68.5% of respondents felt that the furniture is durable and comfy, with a mean rating of 3.82. The excellent comments on the furniture's durability and comfort demonstrates that the library has invested in high-quality furniture that meets the physical comfort needs of its patrons.

Sturdy and comfortable furniture is essential for establishing a pleasant and productive environment, as it relieves physical strain and encourages longer study sessions. This can increase user satisfaction and improve overall library experiences. Respondents were ambivalent about the size of tables, chairs, and other furniture, with a mean score of 3.87. The neutrality on the sufficiency of furniture size implies that there may be variation in consumers' experiences or expectations regarding the dimensions of the furniture. This could imply that, while some users find the furniture sizes appropriate, others may find them uncomfortable or inadequate for their requirements.

Addressing this issue may entail determining the exact size requirements of the user population and maybe introducing a variety of furniture sizes to better satisfy varied tastes and ergonomic needs. The overall good opinions indicate that library customers have positive attitudes towards the academic library's environmental conditions, lighting, and furniture. The positive feedback on these characteristics indicates that the library effectively meets its users' basic needs and expectations. This good response suggests that the library's setting is generally conducive to studying, reading, and other academic activities. Maintaining these high standards might assist to keep users satisfied and encourage regular library visits.

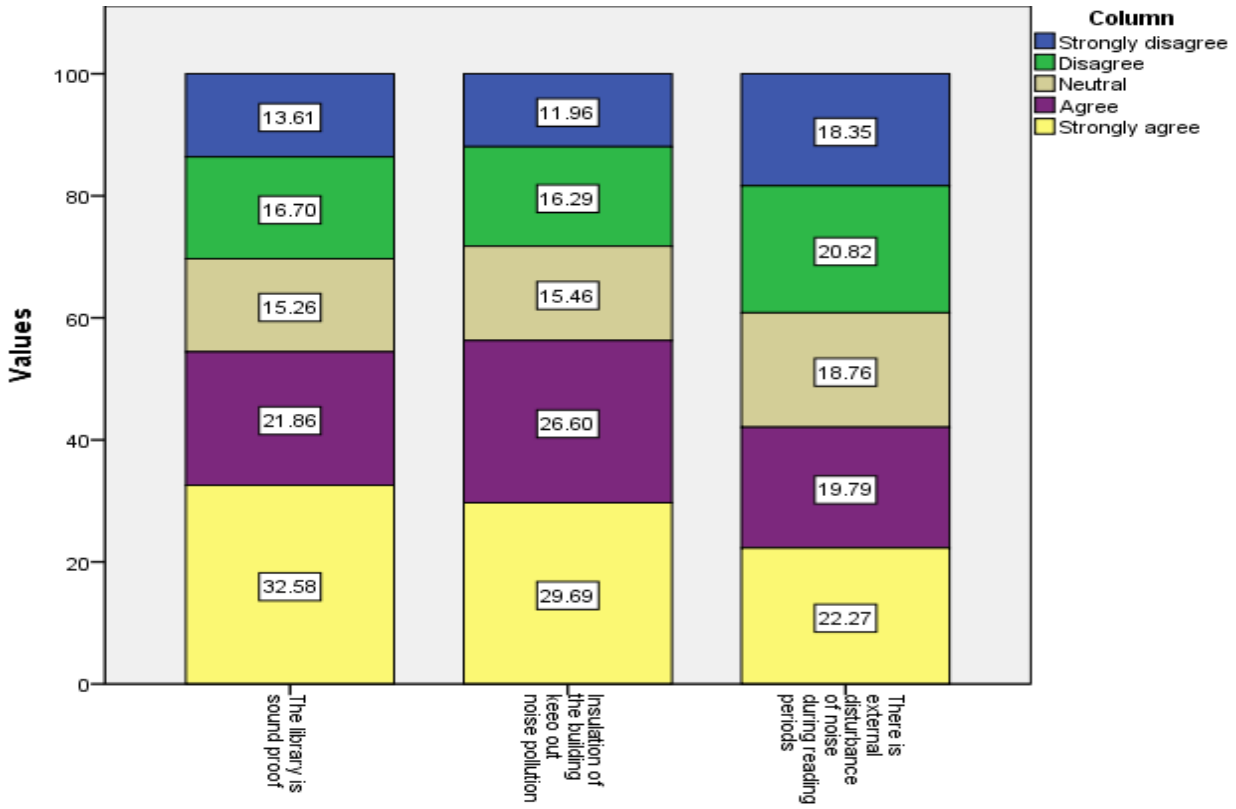

Fig. 3. Library users' perceptions of the peacefulness of reading space

User attitudes about the independence of lighting systems are more diverse, with some respondents staying neutral. The conflicting opinions on the lighting system's independence indicate that there may be inconsistencies or places for improvement in how lighting is administered. Ensure that lighting systems are both autonomous and flexible to changing needs to improve user comfort and functionality. Addressing these difficulties could entail improving lighting controls or giving customers more options for customising their lighting settings. Opinions on the appropriateness of furniture sizes vary, with a neutral mean value. This finding is comparable to that of Shohel Parvez *et al.,* [69] who stated that users frequently have neutral judgements on furniture size, highlighting the need for more specialised solutions that satisfy specific ergonomic needs. On the other side, addressing furniture size adequacy might result in large gains in customer satisfaction, implying that the neutral perception may be due to a lack of adequately sized furniture options. The neutrality in furniture sizes suggests that present offerings may not entirely fulfil all users' various ergonomic needs. This highlights a need to reconsider and possibly diversify the sizes and styles of furniture to better fit varied user preferences and physical constraints. Implementing these modifications can increase user comfort and happiness, making the library a more welcoming and accessible location.

4.3 Space Requirements for 21st-century Library User

To achieve the objective related to understanding the space requirements for 21st-century library customers. Figure 4 depicts the significant insights gained from examining these needs. A substantial majority (85.5%) selected e-learning classrooms as a critical requirement, with a mean score of 4.39. This emphasises the increasing importance of digital learning environments in academic contexts. Libraries should prioritise the creation of e-learning classrooms to promote modern teaching approaches and provide environments favourable to digital learning. 86.8% of respondents emphasised the necessity for a technology hub, with a mean value of 4.44. The high need for

technology hubs indicates that libraries should include innovative technological resources. This can promote digital literacy, facilitate research, and provide access to cutting-edge tools and information. 84.1% agreed on the relevance of a group work component, with a mean value of 4.34. Collaborative learning environments are vital in modern libraries. Libraries can promote team-based initiatives and improve learning experiences by adding group work areas.

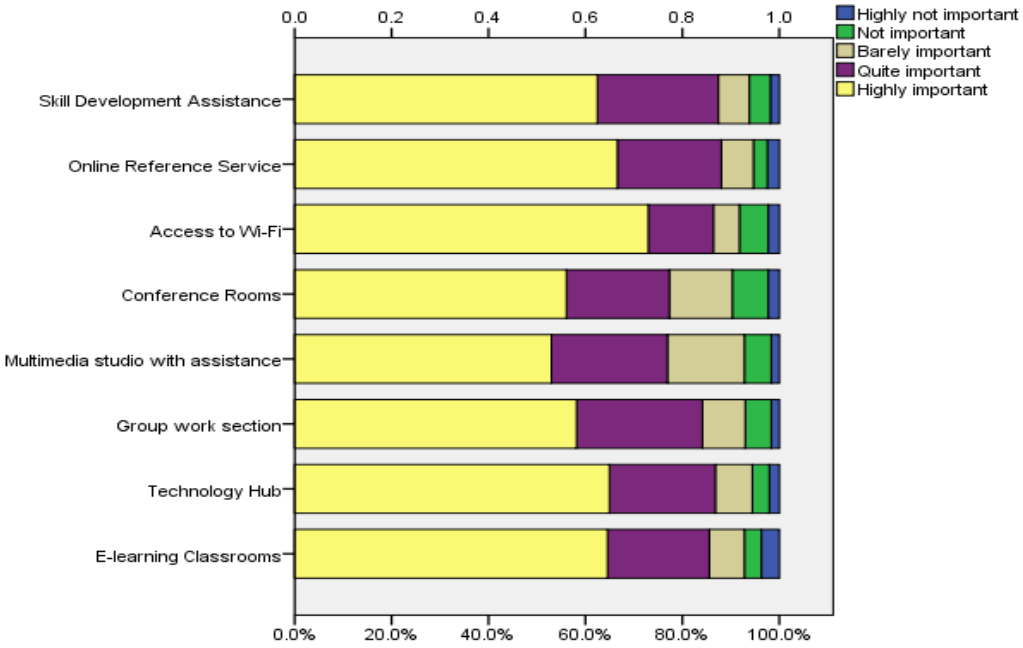

Fig. 4. Space requirement for 21st century library users

Significant agreement exists about the requirement for a multimedia studio (76.9%) and conference rooms (77.3%), with mean values of 4.21 for both. These resources are critical to providing comprehensive support for multimedia projects and academic conversations. Libraries can consider incorporating these features to provide different, adaptable areas for a variety of academic and artistic activity. 86.4% felt that Wi-Fi access was necessary, with a mean score of 4.49. Reliable internet access is essential in modern libraries. Ensuring strong and high-speed Wi-Fi will meet users' digital needs and provide smooth access to online resources. A large percentage (88%) agreed on the importance of online reference services and skill development support (87.4%), with mean values ranging from 4.31 to 4.48. These services are critical to user support and academic performance. Libraries should establish comprehensive online reference services and programs that improve a variety of abilities, making them valuable tools for academic and professional growth.

Educational training on e-libraries (85.2%) and research consulting (87.6%) were highly valued, with mean values indicating strong agreement. Providing training and consultation services can considerably improve users' capacity to use library resources successfully. Libraries should invest in these services to help users maximise their research and academic achievement. 80.7% agreed on the significance of internet video on demand services, while 85.4% agreed on the need for interactive areas. Incorporating digital content and interactive sections will suit users' different needs, resulting in a dynamic and engaging library experience. These features may attract more people and improve the overall library experience. 83.5% agreed on the necessity for photocopying services, with a high mean value. Despite the digital transformation, conventional services such as photocopying remain relevant. Libraries should continue to provide these services to meet the diverse needs and interests of its patrons. The findings highlight the various and changing demands of 21st-century library patrons, emphasising the significance of contemporary amenities and services. Addressing these

objectives allows libraries to improve their relevance and functionality, thereby meeting their users' academic and technical needs. These observations can inform future planning and growth, ensuring that libraries stay lively, adaptable, and important to the academic community in an ever-changing information landscape.

4.4 Adequacy of the Current Library Design for 21st-century Library Users

In other to achieve the objective of the study, analysis was carried out to examine the suitability of present library design for 21st-century library users; Figure 5 depicts the results of the assessment, which examined many components of the library environment. An overwhelming 84.9% of respondents were satisfied with the provision of windows, rating it as quite adequate to highly adequate. Only a small fraction (7.8%) thought it was barely adequate, and 7.2% said it was extremely deficient or inadequate. The mean score of 4.29 suggests a significant agreement that the windows are suitable. The high satisfaction with window provision emphasises the importance of natural light and ventilation in producing a conducive learning environment.

Libraries should continue to prioritise large, well-designed window spaces to improve user experience and comfort. 69.4% of respondents thought the provision of fans was adequate or very adequate, while 20.1% thought it was barely adequate. A modest fraction (10.3%) said it was extremely insufficient or inadequate. The mean value of 3.94 indicates widespread agreement on the sufficiency of fans. The widespread satisfaction with fans implies that they are effective at providing the necessary airflow and cooling. However, a sizable proportion of users found them barely adequate or unsatisfactory, indicating the necessity for additional or upgraded fan systems to meet all requirements. Opinions on air conditioning were more varied, with 52.1% feeling it was quite adequate and highly adequate, 21.9% finding it barely adequate, and 26% perceiving it as highly inadequate or inadequate. The mean value of 3.41 indicates a more neutral stance. The mixed responses regarding air conditioning highlight the need for a more consistent and efficient air conditioning system.

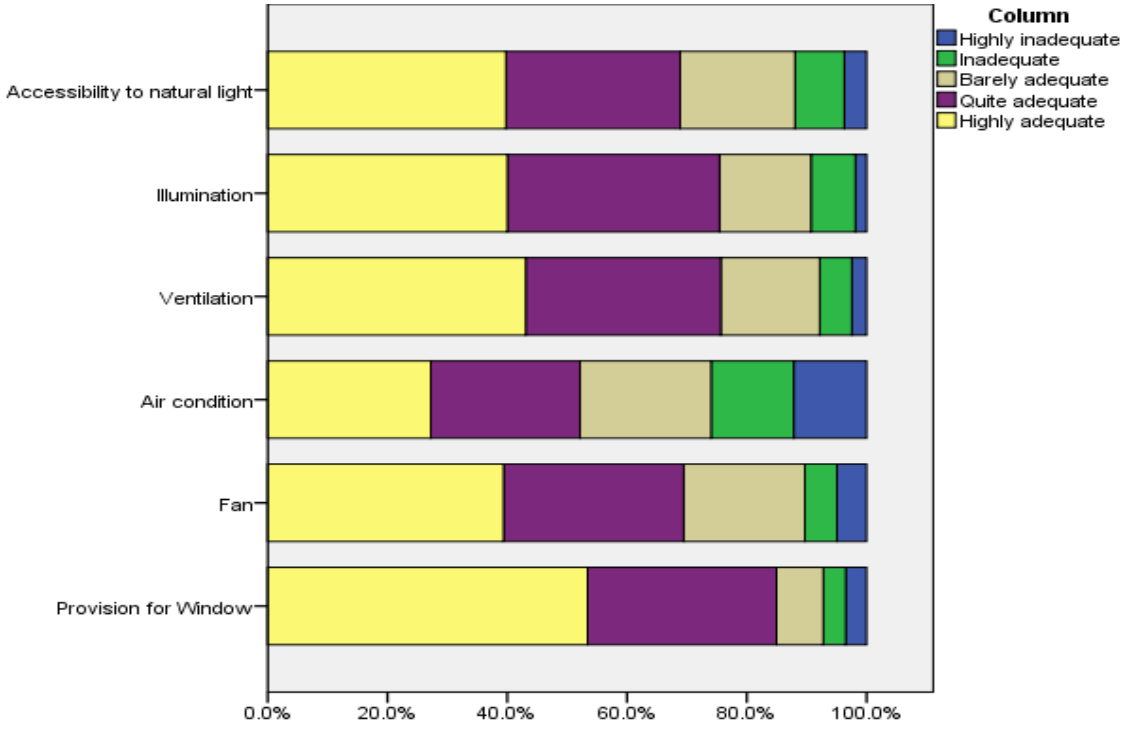

Fig. 5. Current library design for the 21st century library users

Libraries should assess and upgrade their air conditioning to ensure it meets the needs of all users, particularly in hot climates like Nigeria. A substantial 75.7% of respondents considered the ventilation quite adequate and highly adequate, with 16.5% finding it barely adequate. A small percentage (7.9%) viewed it as highly inadequate or inadequate. The mean value of 4.08 suggests a consensus on the adequacy of the ventilation system. Adequate ventilation is crucial for maintaining a healthy and comfortable environment. The positive feedback underscores the effectiveness of current ventilation systems, but attention should still be given to improving areas where respondents found it lacking. 75.5% of respondents perceived the illumination as quite adequate and highly adequate, with 15.3% finding it barely adequate. A minor percentage (9.3%) considered it highly inadequate or inadequate. The mean value of 4.04 indicates a shared belief in the adequacy of illumination. Good illumination is essential for reading and studying.

The general satisfaction suggests that current lighting arrangements are effective, but continued evaluation and upgrades are necessary to maintain high standards. 68.9% of respondents found accessibility to natural light quite adequate and highly adequate, while 19.2% considered it barely adequate. A smaller percentage (11.9%) perceived it as highly inadequate or inadequate. The mean value of 3.93 suggests a general agreement on the adequacy of natural light accessibility. Access to natural light is important for creating a pleasant and productive environment. While most respondents are satisfied, the significant minority who are not suggests that improving natural light access could further enhance user satisfaction. The findings reveal a generally positive perception of the library environment's design adequacy for 21st-century users. There is strong satisfaction in areas such as windows, fans, ventilation, illumination, and accessibility to natural light. However, the more varied opinions on air conditioning suggest this area requires further consideration and improvement. These insights can guide future improvements in library design, ensuring they meet user expectations and provide a comfortable, conducive environment for study and research.

4.5 Impact of Environmental Conditions on Library Usage Frequency

To determine the impact of environmental conditions on library usage frequency; the question on “how often do you use the library”? was posed to the respondents. The survey results are presented in Table 2 which provide insights into the frequency of library usage among respondents as follows: 13.8% never utilize the library. 29.7% rarely engage with the library. 31.5% occasionally use the library. 12.2% are consistent users. 12.8% frequently access the library.

Table 2
Environmental conditions on library usage frequency

How often do you use the library	Frequency (percentage)
Never	67 (13.8)
Rarely	144 (29.7)
Sometimes	153 (31.5)
Always	59 (12.2)
Often	62 (12.8)

To test whether or not environmental conditions affect library use, two hypotheses were proposed. The results, as shown in Table 3, provide substantial conclusions about the impact of ambient circumstances on library utilisation.

Table 3
Correlation between environmental conditions and library usage

		How often do you use the library
Environmental on Day lighting	Correlation Coefficient	.063
	Sig. (2-tailed)	.073
	N	485
Environmental on Acoustic	Correlation Coefficient	-.012
	Sig. (2-tailed)	.741
	N	485
Environmental on Ergonomics	Correlation Coefficient	.111**
	Sig. (2-tailed)	.001
	N	485

From the result shown in Table 3, there is a significant positive relationship between the environmental condition related to ergonomics and library usage, with a coefficient of 0.111 and a p-value of 0.001. This indicates that as the ergonomic conditions of the library improve, the frequency of library use increases. There is no significant relationship between the environmental conditions related to daylight and acoustics and the use of the library, with p-values of 0.073 and 0.741, respectively, both of which are greater than 0.05. The diverse usage patterns indicate that while a significant portion of the population engages with the library at least occasionally (31.5%), a noteworthy percentage (43.5%) rarely or never use the library. This highlights the need for libraries to better understand and address the barriers to frequent usage. The significant relationship between ergonomic conditions and library usage suggests that improving the ergonomic aspects of the library environment (such as furniture comfort and workspace design) can positively impact how often the library is used. Libraries should prioritize ergonomic improvements to enhance user comfort and attract more frequent usage.

4.6 Library Facilities and Spaces that Affects the use of Library

To ascertain whether the library facilities and spaces affect the use of library; the effect of the available spaces and facilities on how frequent the respondent uses the library was tested by putting forward two hypotheses (i.e., H_0: Library facilities and spaces do not affect the use of library; H_1: Library facilities and spaces do affect the use of library). The findings from the correlation analysis provide the following insights as presented in Table 4. The result shows no significant influence of library facilities and spaces on library usage, with a p-value of 0.631. This value is well above the significance threshold of 0.05, indicating that variations in facilities and spaces do not statistically correlate with changes in library usage.

Table 4
Showing the correlation analysis between the available spaces and usage

		How often do you use the library
Library facilities spaces	Correlation Coefficient	.017
	Sig. (2-tailed)	.631
	N	485

Meanwhile, the effect of library designs on how frequent the respondent uses the library was also tested by putting forward two hypotheses (i.e., H_0: library design and spaces do not affect the use of library; H_1: library design and spaces do affect the use of library). Table 5 however, indicates a significant impact of library design on library usage, with a correlation coefficient of 0.071 and a p-

value of 0.041. This p-value is below the 0.05 threshold, signifying those improvements in library design are positively associated with an increase in library visits. The lack of a significant relationship suggests that simply having good facilities and spaces may not be enough to attract more users. This could mean that the quality or relevance of these facilities might not meet user needs or that other factors are more influential in determining library usage. Libraries should consider evaluating the quality, relevance, and usability of existing facilities and spaces to ensure they align with user needs and preferences.

Table 5
Showing the correlation analysis between the available spaces and usage

		How often do you use the library
Library design	Correlation Coefficient	.071*
	Sig. (2-tailed)	.041
	N	485

The positive correlation between improved library design and increased usage indicates that how the library is designed plays a crucial role in attracting users. Elements such as layout, aesthetics, accessibility, and overall ambiance contribute significantly to user satisfaction and engagement. Libraries should prioritize investment in thoughtful, user-centered design improvements. This could include modernizing interiors, optimizing layouts for better navigation and use, and creating inviting, comfortable spaces. The findings suggest that library design can be a strategic tool for increasing patronage. Libraries might benefit from engaging architects and designers who specialize in creating functional and appealing educational spaces. Understanding that design has a more significant impact on usage than facilities and spaces can guide better resource allocation. Investments should focus on comprehensive design improvements rather than just adding more facilities. Libraries should adopt a user-centered approach in their design processes, involving feedback from current and potential users to ensure the new designs meet their needs and expectations.

Principal Component Analysis (PCA) was employed as a data reduction method to condense a large set of linked variables into fewer components that account for the majority of the original variables' variation. In this study, 14 variables related to library facilities and spaces was reduced to fewer components so that each variable can be classified as one of the components. Where the variables were highly associated, just the variables in the questionnaire that best represent the library facilities and spaces were kept, while those that do not were deleted. In addition, PCA was used to determine whether the library facilities and spaces being measured loaded into all of the variables or just some of the variables, as well as whether some of the variables chosen were not sufficiently representative of the library facilities and spaces the researchers were interested in were removed. The four most important processes for Principal Component Analysis were followed:

ii. Verifying the Principal Component Analysis assumptions. The Kaiser-Meyer-Olkin and Bartlett's sphericity tests are critical assumptions for Principal Components analysis. The Kaiser-Meyer-Olkin test measures sample adequacy, while Bartlett's test of sphericity determines whether or not the test is significant. It is vital to note that the Keiser-Meyer-Olkin test must be greater than 0.5, whereas the Bartlett's test of sphericity must be less than 0.05, in order to be significant. If all of these prerequisites are met, the analysis can proceed with the factor analysis. The results in Table 6 showed that the Bartlett's test of sphericity was 0.00, which was significant, and the KMO test was 0.894, which was more than 0.5. This implies that the analysis can proceed further.

Table 6
KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.894
Bartlett's Test of Sphericity	Approx. Chi-Square	2307.729
	df	78
	Sig.	.000

ii. Total Variance explains and provides the number of factors into which the library facilities and spaces are divided, as well as the total variation that was explained by the model. A total of 5 components were identified and 3 were extracted, accounting for 62.209% of the total variation explained by the model. The first component accounted for 43.796% of the model's variation, whereas the second and third components accounted for 10.579% and 7.835%, respectively. Table 7 and Figure 6 exhibit the factor extracted table and eigenvalue scree plot, respectively, for three (3) factors extracted from the variables under consideration.

Table 7
Factor extraction

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	Percentage of Variance	Cumulative Percentage	Total	Percentage of Variance	Cumulative Percentage
1	5.693	43.796	43.796	5.693	43.796	43.796
2	1.375	10.579	54.375	1.375	10.579	54.375
3	1.019	7.835	62.209	1.019	7.835	62.209
4	.826	6.354	68.563			
5	.653	5.026	73.589			
6	.605	4.651	78.240			
7	.590	4.535	82.775			
8	.490	3.766	86.541			
9	.413	3.173	89.714			
10	.383	2.948	92.663			
11	.337	2.595	95.257			
12	.331	2.547	97.804			
13	.285	2.196	100.000			

The scree test, parallel analysis, and Kaiser's criterion were used to determine how many elements should be kept (Figure 6). One of the most often used strategies is Kaiser's criterion, also known as the eigenvalue rule, which essentially reserves items with an eigenvalue of 1.0 or higher, as well as other parameters, for future research. Using this procedure, factors having an eigenvalue of 1.0 or above are retained for further investigation. This investigation also utilised Catell's scree test. To accomplish this, plot the eigenvalues of each element and inspect the plot to discover the point at which the curve's shape becomes horizontal.

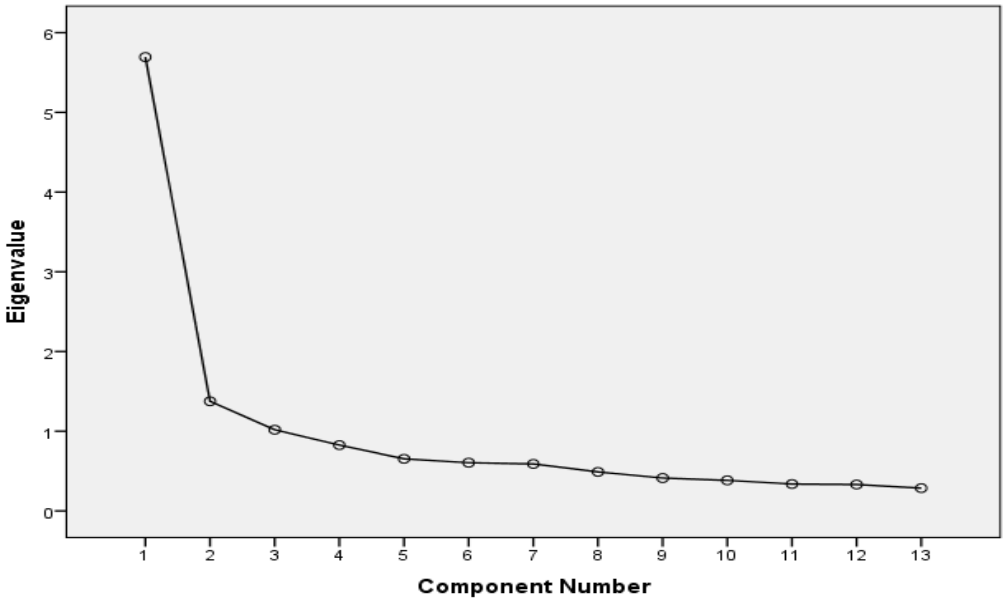

Fig. 6. The scree plot of the eigenvalue

According to Catell [70], any factor(s) beyond the elbow or break in the plot should be evaluated because they will account for the majority of the variance in the data. Catell's scree test resulted in the retention of three components for further research. This validated the Parallel Analysis results, which revealed three components with eigenvalues greater than the matching criteria values for an identically sized data matrix produced at random.

iii. The Rotated Component Matrix (Table 8) displays a list of variables for each of the retrieved components. Three components have been extracted, and the details of each are listed in the table.

Table 8
Rotated Component Matrix[a]

	Component		
	1	2	3
E-learning Classrooms	.165	.115	.773
Technology Hub	.116	.420	.690
Group work section	.113	.598	.468
Multimedia studio with assistance	.191	.850	.124
Conference Rooms	.293	.668	.273
Access to Wi-Fi	.380	.113	.618
Online Reference Service	.724	.044	.367
Skill Development Assistance	.759	.113	.251
Educational Training on E-library	.684	.140	.351
Research consultation	.741	.120	.191
Online video on Demand systems	.646	.489	-.022
Interactive spaces	.705	.368	.003
Provision for photocopying materials	.640	.210	.100

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

The first component includes online reference services, skill development support, educational training on E-library, research consultation, online video on demand systems, interactive spaces, and

photocopying facilities. These aspects helped to create abilities for the e-library. These factors account for 43.796% of the overall variation. Component two consists of a group work section, a multimedia studio with support, and a conference room. These aspects include cooperative effort as well as collaborative instruments or technologies. These factors account for 10.579% of the overall variation. Component three includes an e-learning classroom, a technology hub, and access to Wi-Fi. These factors include the internet-assisted tool for e-library, which accounts for 7.835 of the total variation. This finding represents crucial components for the long-term development of academic library buildings in Nigeria, emphasising the need of meeting modern user demands and expectations. In line with the title of this study, the findings reveal the following insights:

i. Component 1: e-library and support services (43.796%) This component emphasises the importance of online reference services, skill development support, e-library training, research consulting, and interactive technology in establishing a strong digital library ecosystem. The high variance % implies that they are the most important features for achieving 21st-century user expectations, since they improve accessibility, learning, and research capacity in a digitally driven academic environment.
ii. Component 2: Collaborative spaces and tools (10.579%). Component two emphasises the importance of group work sections, multimedia studios, and conference rooms, which promote collaborative learning and teamwork. Such spaces are consistent with modern educational paradigms that emphasise group dynamics and the use of technological technologies. Despite contributing less diversity, these facilities are critical to developing a comprehensive learning environment.
iii. Component 3: internet-assisted tools (7.835%). This demonstrates the importance of e-learning classrooms, technology hubs, and Wi-Fi connections in enabling internet-based research and education activities. While accounting for a lesser amount of variation, these characteristics are crucial for incorporating technology into learning and reflecting the expectations of digitally literate users. These components highlight the necessity for a complete remodelling strategy that includes digital infrastructure, collaborative places, and internet-enabled tools. This alignment shows a clear path towards the long-term redesign of Nigerian academic library buildings, ensuring that these facilities suit the changing needs of 21st-century users while also promoting innovation, accessibility, and cooperation. The emphasis on digital tools and collaborative spaces contributes to sustainability by lowering reliance on traditional paper-based resources and encouraging a tech-savvy academic atmosphere.

5. Qualitative Results

5.1 Background Information

The respondents comprised majorly the students from year one to the final year, the postgraduate students and the academic staff. Under this part, the themes highlighted from the interviewees' responses were library utilisation patterns, motivation, and deterrents of library usage.

5.1.1 Library usage patterns

The replies revealed that students and academic staff predominantly use the library for assignments, research, and resource access. However, undergraduate students are more focused on accessing the library for their homework. This is illustrated by an excerpt of the responses. According

to a year 1 interviewee, "I visit the library at least twice a week to read and complete assignments." A year 3 respondent said, "I use the library for research and group discussions about twice a week." The postgraduate students and academic staff emphasise the importance of using the library for research and resource access. Meanwhile, the frequency of library use by users varies, ranging from twice a week for students to more targeted visits for academic staff. Some of the responses are provided: A postgraduate respondent stated, "The library is my go-to for accessing journals and reference materials for my thesis." While one academic staff member noted, "I mainly use the library to review new publications and for meetings with students."

5.1.2 Motivations and Deterrents

Library users categorised their reasons for accessing the library as either motivators or deterrents. The findings revealed that what motivated consumers to utilise the library was the availability of materials and the desire for study space. According to a year 2 respondent, "the lack of updated books and internet connectivity makes it less useful sometimes." Another statement from an academic staff member: "Poor environmental conditions, such as ventilation and noise, frequently discourage me from long-term use." The respondents' main deterrents were restricted internet connectivity, out-of-date resources, insufficient ventilation, and noise levels. Thus, based on the comments supplied by library users, it is possible to conclude that, while the library is seen as an important venue, its shortcomings, such as environmental and resource-related issues, discourage extended or frequent visits. As a result, the library's resources are underutilised.

5.2 Spatial Requirements

The replies gathered in this part resulted in three key themes. The themes are adequate space, planned additions, and the layout and organisation of library areas. On the appropriateness of space, interviewees were asked if they thought the library had enough space to suit the demands of its users, and why or why not. The interviewees' most common issues/complaints about using the library were overcrowding, particularly during peak seasons like examinations, and a lack of specialised zones for different user needs, such as group talks and individual study. According to a Year 4 student, "There's not enough space for the number of students, especially during exams." A postgraduate student responded by saying, "There are limited study rooms for research-oriented discussions and collaborations." When asked what kind of places they would want to see added to the library, both students and staff expressed the need for quiet reading rooms, collaboration spaces, computer labs, and faculty-specific zones. Below are some excerpts from the interviewee's responses: A Year 2 student responded with: "I'd like more quiet reading areas and computer labs for research." An additional response from an academic Staff expressed a preference for "a mix of individual workspaces and collaborative zones, as well as faculty-specific resource areas."

When asked whether the existing structure promotes effective study or research activity. Respondents with postgraduate and academic backgrounds prioritise research-oriented spaces and resource areas to suit their needs. Regarding the library layout and organisation, some respondents noted that the rigidity of sitting configurations inhibits functioning, while others noted that the lack of designated zones impedes effective use. Below are some excerpts from the interviewee's responses: A Year 3 student responded, "No, the seating arrangement feels rigid, and it doesn't allow for group studies." A postgraduate student commented, "It needs better organisation and designated zones for different activities." Thus, based on the comments in this section, it is possible to conclude

that the current spatial design of the libraries does not meet the different demands of users, highlighting the need for a more user-centric redesign that prioritises flexibility and utility.

5.3 Indoor Environmental Performance

In this section, respondents were asked three questions, including (i) how they rated the lighting in the library. Was it sufficient for their needs? (ii) How would they describe the library's ventilation and temperature control systems? (iii) What were their thoughts on noise levels in the library? Within this part, three themes arose from the interviewees' responses: illumination, ventilation and temperature management, and noise levels in the library. The findings from the responses demonstrate that lighting is unequal, with daytime brightness contrasted with inadequate evening illumination. In addition, it was discovered that poorly lit places reduce usability and comfort. A Year 1 student responded: "It's bright during the day but quite dim at night." Another academic staff member commented, "The lighting is uneven; some areas are well-lit, while others are too dark to use effectively." The question of “how would you describe the library's ventilation and temperature control”? In terms of ventilation and temperature management, most respondents reported that the library's internal environment was hot and stuffy, particularly in the afternoons, which were significant deterrents. Furthermore, there is a lack of proper mechanical ventilation, such as fans or air conditioning, which causes further discomfort. A Year 2 students responded, "It's too hot and stuffy, especially during the afternoons." Another Year 4 respondent stated: "The library doesn't have enough fans or air conditioning, making it uncomfortable to stay for long hours."

When asked, what are your thoughts on noise levels at the library? It was found that open-plan designs contribute to noise pollution, particularly during group talks. The interviewees expressed a desire for improved zoning of the library space to divide quiet and discussion sections. A Year 1 student replied, "It's mostly quiet, but the open-plan design sometimes allows noise from group discussions to distract others." Another feedback from a Postgraduate student stated: "The library could use better zoning to separate quiet areas from discussion zones." Thus, based on these reactions, it is possible to conclude that the ambient conditions in some areas of the library are suboptimal, reducing user comfort and productivity. As a result, modifications in lighting, ventilation, and zoning are required for optimal operation.

5.4 Technology and Modern Resources

"Are there sufficient technological resources in the library" was one of the questions in this section. The respondents' replies in this part revealed rising themes around technology resources and intended technological advancements. Regarding technological resources, respondents stated that their issues in using the library were primarily due to a lack of computers and sluggish internet connectivity, which limited their research possibilities. Similar to this, they have limited access to academic databases, which presents a significant problem, particularly for postgraduate students and staff. A Year 3 student responded, "There aren't enough computers, and the internet is often slow or unavailable." A postgraduate student also responded, saying, "The lack of access to academic databases limits the quality of research I can do here." The respondents were asked, "Would you like to see additional technologies such as interactive screens or e-learning facilities"? In terms of desired technical enhancements, interviewees expressed a strong preference for interactive screens, e-learning capabilities, and increased internet connection. Interviewees also emphasised the importance of current technology for both academic and collaborative tasks. A Year 2 student responded: "Yes, these would make studying more engaging and efficient." An academic staff

member commented that: "Interactive technologies would greatly enhance both teaching and learning experiences."

The comments in this section indicate that the library's technology is obsolete and unsuitable for modern academic standards. As a result, library patrons anticipate the incorporation of digital technologies to supplement traditional resources.

5.5 Recommendations for Improvement

This section questioned interviewees about what they would recommend to enhance the current library situation in their institutions. The questions were: "What changes would you prioritise in a library redesign"? Two major themes arose from their comments. The themes found were immediate adjustments and a vision for the future. According on the interviewees' responses to immediate adjustments, environmental upgrades such as improved seating, ventilation, and lighting would increase frequent library use. Furthermore, the introduction of discrete zones for diverse activities, such as leisure, group learning, and quiet work, will improve the user experience. A Year 1 student responded with: "More comfortable seating and better ventilation." Another Year student responded with: "A variety of study zones, such as quiet areas, group workspaces, and leisure zones." An academic staff member responded with: "Improved digital resources and better environmental controls like lighting and ventilation." Regarding the question "What is your vision for a 21st-century academic library"? Several replies were received regarding the users' vision for the future library or what they hope to see in a remodelled library design. The responses focused on the need for a multipurpose, technologically sophisticated library that balances traditional and modern user needs. This should be combined with flexible and adaptable facilities to suit a variety of activities and learning styles. Thus, it is clear that consumers imagine a library that meets both intellectual and social demands. In regard to this, there is a need for modernisation and user-centric designs in order to satisfy 21st-century expectations.

A Year 3 student's response was to see: "A library with updated technology, modern seating, and spaces for both group and individual learning." Meanwhile, a Postgraduate student desires: "A multifunctional space that integrates digital tools, comfortable environments, and collaborative opportunities." And academic staff prefers: "A space that balances traditional academic resources with cutting-edge technology and flexible, adaptive environments." Based on the analysis of library user comments, we may conclude that the most prevalent issues faced by academic library users are limited space, bad environmental conditions, and outdated technology. These are the key impediments to optimal library usage. Meanwhile, the user must meet their 21st century expectations, which revolve around improved zoning, environmental upgrades, and technology integration. As a result, library patrons would like to see a comprehensive redesign that prioritises flexibility, functionality, and cutting-edge technology as potential answers to these concerns. The interview replies show the essential need for long-term redesigns of academic libraries to better meet the changing needs of 21st-century users. By solving these shortcomings, academic libraries in Nigeria's north central zones can become multipurpose environments that promote academic progress and creativity.

6. Discussions

The results indicate that the library's lighting and natural light integration are generally well-received and contribute positively to the users' experience. However, the neutrality in the perception

of the independence of the lighting system and external noise disturbance suggests areas for potential improvement. Ensuring better communication about the lighting controls and enhancing noise insulation could further optimize the library environment for its users. When compared to the study of Spezi [71] who found that good lighting significantly enhances user satisfaction in academic libraries. Their findings support the positive perception of lighting and natural light integration reported in this study. Similarly, Choy & Goh [72] highlights that natural light positively impacts the ambiance and user experience in libraries aligns with the findings of positive user feedback on the library's lighting conditions. Meanwhile, on the contrary, while lighting is important, its impact can be overestimated compared to other environmental factors such as noise control and space layout, which might explain the neutrality regarding the independence of the lighting system and external noise disturbance found in this study.

The overall positive feedback on the design, variety, sturdiness, and comfort of the library furniture indicates a generally favorable user experience. This confirms Kim [73] study who confirm that well-designed, sturdy, and comfortable furniture significantly enhances the user experience in academic libraries, corroborating the positive feedback reported in the study. However, in contrast to Rai & Zaveri [74] their study indicated that while furniture design is important, its impact on overall library satisfaction can be overshadowed by other factors such as technology access and resource availability, suggesting a more complex interplay of elements affecting user experience. However, the neutrality regarding the adequacy of furniture sizes points to an area that may require further attention and improvement.

By conducting a more detailed assessment of user needs and preferences concerning furniture dimensions, the library can enhance its environment to better meet the ergonomic and functional needs of its diverse user base. This can lead to improved user satisfaction, increased usage, and a more supportive study and reading environment. These outcomes corroborate with the findings of Shohel Parvez *et al.,* [69] who found that users often have neutral opinions on furniture size, pointing to the need for more tailored solutions that address specific ergonomic needs. In addition, the findings agree with Ramu *et al.,* [75] suggestions that addressing furniture size adequacy can lead to significant improvements in user satisfaction, indicating that the neutral perception might stem from a lack of appropriately sized furniture options.

Other findings highlight a generally positive perception of the library's environmental conditions, lighting, and furniture, indicating that the library is performing well in these areas. However, the varied opinions on specific aspects such as lighting independence and furniture sizes underscore the need for targeted improvements. By addressing these specific concerns, the library can further enhance its environment to better align with user expectations and preferences. This, in turn, can lead to higher levels of user satisfaction, increased usage, and a more effective support system for academic activities. The lack of a significant relationship between daylight, acoustics, and library usage suggests that these factors are not primary drivers for library engagement. While these elements are important for creating a conducive study environment, their improvement alone may not significantly boost library usage.

Libraries might focus on a holistic approach that includes ergonomics along with other factors like resource availability and technology integration to enhance overall user experience. These insights can guide library management in strategic planning and resource allocation. Emphasizing ergonomic improvements could be a key strategy to increase library patronage. According to the findings of Seki *et al.,* [76] which support the finding that ergonomic improvements can increase library usage, aligning with this study's emphasis on the importance of ergonomics. However, it could be argued that while environmental conditions like daylight and acoustics are important, their improvement alone may not significantly boost library usage, suggesting that a more holistic approach is necessary.

Further research could explore other factors influencing library use to develop comprehensive strategies that address various user needs. Libraries should consider user-centered design principles that prioritize the physical comfort and practical needs of their patrons. Engaging with users to gather feedback on ergonomic conditions can provide valuable data to inform these improvements.

Policymakers and educational institutions should support initiatives aimed at improving library ergonomics, as this can enhance student engagement and academic performance. Investments in ergonomic enhancements might yield significant returns in terms of increased library usage and user satisfaction. Whilst environmental conditions like daylight and acoustics are important, ergonomics play a crucial role in library usage. Libraries in Nigeria can leverage these findings to create more inviting and user-friendly environments, ultimately fostering greater engagement and utilization. Continuous assessment of both design and facilities can help identify further improvements. Libraries can conduct regular user surveys to gather insights on design preferences and usability. While design is crucial, a holistic approach that also considers other factors such as service quality, technological integration, and program offerings will likely yield the best results in enhancing library usage. These findings emphasize the importance of library design in attracting and retaining users. Libraries in Nigeria, and elsewhere, can leverage these insights to create more engaging, functional, and aesthetically pleasing environments that meet contemporary user expectations, ultimately fostering greater usage and satisfaction.

8. Limitations and Recommendations for Further Research

Despite the complexity of this investigation, there are significant limitations that must be addressed. For example, the lower percentages in other academic years (300L and 200L) could affect the representativeness of students' experiences across different levels of study. With 83.9% being undergraduates, the sample primarily represents the undergraduate student body. The smaller percentages of graduates (6.2%) and postgraduates (7%) suggest limited insights into the experiences and perspectives of individuals who have completed or are pursuing higher levels of education. In addition, the over-representation of first-year students and undergraduates may skew results towards the experiences and opinions of less experienced individuals. Furthermore, the gender imbalance may affect the generalizability of findings to a broader, more gender-balanced population. Additionally, while the study includes responses from multiple universities, the sample of the study is limited to few universities situated in the North central Nigeria. Hence, the responses do not adequately represent the diverse experiences of all library users across the entire Nigeria. Hence, the conclusions obtained from this study could be limited to the university’s libraries in the North central Nigeria to avoid being biased in generalizing it to the entire country.

Addressing the limitations of this study can help in addressing any biases and improving the study design for future research. Future research should increase diversity to ensure more balanced representation across genders, age groups, academic levels, and educational qualifications as well as enhance the reliability and generalizability of the results. There should also be targeted sampling in future study by implementing stratified sampling techniques to ensure all subgroups (e.g., different academic levels, graduates, postgraduates) are adequately represented. Longitudinal studies should be conducted as a follow-up study to track changes in responses over time, especially as students’ progress through their academic careers. Furthermore, future studies should aim to include a more diverse sample of library users from various regions and types of institutions to enhance the representativeness of the findings.

9. Recommendations

This research contributes valuable insights into the transformation of academic library buildings, aligning them with the expectations and needs of 21st-century users. To address the important challenges that are causing academic libraries in Nigeria to become obsolete as a result of the periodic changes that occur in today's libraries, this study proposes solutions for survival in such a continually changing context. First and foremost, each library must adapt to the needs of today's information society. As a result, the library's design must be established in a systematic manner, in accordance with the principles of urban planning, architecture, engineering, design, and library sciences. Second, the importance of developing an appealing academic library through all means: architectural, functional, services provided, etc., must correspond not only to informational, communicational, but also to leisure, aesthetical, and other user needs, to provide not only traditional library services but also to organise non-traditional and social activity. As a result, the 21st century academic library must be transformed into a new multifunctional type of library based on a flexible model, with one-third of the library area reserved for additional social and learning activities.

Third, the process of designing academic library buildings and/or remodelling existing ones to meet the needs of the 21st-century users should centre on the junction of architecture and library sciences, with each having its own theoretical and philosophical level. Library architecture must integrate some elements from various realms, and the interaction gives these buildings a distinct identity, as is typical of such structures. These factors can be referred to as integrated. The planned spatial solutions of a library are influenced by integrated aspects such as technology, functions, and information medium. This includes architectural factors. Otherwise, architectural solutions define the quality with which library functions are carried out, the rationale of the technical scheme, the nature of information media distribution, etc. Other recommendations and suggestions include:

i. The need for regular user surveys to be conducted to gather feedback on ergonomic conditions and make data-informed improvements.
ii. The design and remodeling of library buildings should prioritize a comprehensive strategy that combines ergonomic enhancements with other user-centric improvements.
iii. Remodeling and design of libraries should invest in areas with the highest impact, such as ergonomic improvements and user-friendly design, to maximize returns.
iv. There is need for advocacy of more funding and resources to enhance library environments that can lead to better student engagement and academic performance.

9.1 Implication for Practice and Strategies for Implementing the Recommendations in Library Design and Services

In other to turn academic library buildings into user-centred, multipurpose environments that meet 21st-century demands, the following practical strategies might be applied, backed up by relevant case studies:

i. There should be incorporation of interdisciplinary principles to guide systematic library design strategies. This should include working with professionals in urban planning, architecture, engineering, library sciences, and user experience design during planning and refurbishment stages. In addition, user needs assessments should be conducted to ensure library design meets their information, communication, and leisure needs. The practical application of these strategies could be drawn from the case study of the New York Public Library (NYPL), USA (i.e.,

The Stephen A. Schwarzman Building) which underwent renovations to modernise infrastructure while maintaining historic its architecture. The incorporation of collaborative spaces, high-speed internet zones, and flexible study rooms within the building appealed to both traditional and digital users.

ii. There should be the creation of multifunctional spaces for various activities. The strategies could be to designate one-third of the library space for additional activities like maker spaces, exhibition halls, cafes, and social interaction zones. Likewise, adaptable venues could be created with modular furniture and adjustable dividers to meet changing events or user needs. In addition to this, the use green spaces, including outdoor reading areas should be added to improve customer experience. The practical application of these strategies could be drawn from the case study of the Hunt Library at North Carolina State University, USA where the building, dubbed the "library of the future," as it features collaboration areas, a game lab, a visualisation studio, and automated book storage. All these smoothly integrates academic and social functionalities.

iii. There should be the integration of architecture and library sciences strategies. These should include the use integrated design approaches that combine architecture and library sciences to produce practical and visually appealing settings. Library buildings should be designed with sustainable materials and energy-efficient features to promote environmental responsibility. Technology should be integrated smoothly and should include self-service kiosks, digital navigation systems, and high-tech media rooms. A typical practical application of thses strategies could be drawn from the case study of the Hive in Worcester, UK where the collaborative university and public library combines cutting-edge architecture and library science techniques. Its design incorporates environmental elements, current technology, and community-oriented places while balancing traditional and digital activities.

iv. There should be focus on technology-driven solutions with strategies to include installing modern ICT infrastructure, such as high-speed internet, interactive screens, and digital borrowing systems. Others include developing VR/AR laboratories for novel learning and making digital collections, including e-books and online journals, available remotely. A typical case study of these strategies is the Singapore Management University Library in Singapore where the library uses innovative technology, including self-check kiosks, e-resources, and collaboration zones, to encourage student innovation.

v. There should be incorporation of Inclusive and user-centred design strategies such as the use of participatory design methodologies to involve students, professors, and staff in planning. Similarly, the use of universal design principles should be prioritized to ensure libraries are accessible to people with impairments. In addition, there should be the provision of specialised zones, such quiet study areas, and faculty research hubs. Lessons from these strategies could be drawn from the case study of University of Helsinki Library, Finland where the library caters to diverse user needs, including quiet reading rooms and collaboration zones, promoting inclusivity and involvement.

vi. There should be enhanced service provision with a focus on social and non-traditional activities. This strategy could include organizing workshops and seminars at the library. The library could also offer leisure amenities like gaming areas or art displays to attract a larger audience. Library staff should also be trained to adapt to changing technology and user expectations. A case study example of these strategies is drawn from the Seattle Central Library (USA) where the library provides both classic and non-traditional activities, such as literary events, public conversations, and technology training. Its architectural design promotes social connection and digital literacy.

By implementing these suggestions in practice, Nigerian university libraries may become dynamic, versatile hubs that satisfy the needs of 21st-century users. Drawing lessons from successful global renovations assures that these strategies are not only feasible, but also proven to produce significant effects.

10. Conclusion

This study evaluated the level of the obsolescence of academic library buildings in Nigeria, by outlining the challenges posed by outdated structures via exploring aspects such as user perception, space requirements, and the impact of environmental conditions on library usage. It provides valuable insights into the perceptions and expectations of library users, emphasizing the importance of adapting library spaces and services to meet the evolving needs of the 21st-century learner. The positive feedback on environmental conditions and the impact of library design on usage frequency indicate areas of strength and potential improvement. The findings offer a foundation for further exploration and actionable recommendations, fostering the continuous enhancement of library environments to better serve the dynamic demands of contemporary users. In conclusion, the findings in this study underscore the importance of library design in attracting and retaining users. While environmental conditions like daylight and acoustics are important, ergonomics play a crucial role in library usage. Libraries in Nigeria, and elsewhere, can leverage these insights to create more inviting and user-friendly environments, ultimately fostering greater engagement and utilization. Continuous assessment and a holistic approach that includes service quality, technological integration, and program offerings will likely yield the best results in enhancing library usage.

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