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Sustainability Analysis Of TETFund Intervention Buildings in Kaduna Polytechnic using Architectural Design Quality Indicators

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ABSTRACT: ***The quality and sustainability value of intervention buildings by the Tertiary Education Trust Fund (TETFund) has been of concerns because of the impact buildings can have on the academic environment and the quality of education. It is thus paramount to constantly check and update the quality of our academic environment by ensuring delivery of sustainable buildings and structures that would have economic, environmental and socio-cultural benefits. This study aimed at assessing the influence of Design Quality Indicators (DQI) on the quality of academic spaces. The study applied the United Kingdom Construction Industry Council's (UK-CIC) Design Quality Indicators (DQI) on deliberately selected academic-oriented buildings in Nigerian higher institutions. It explored the proportionate stratified random sampling in choosing two buildings from two different campuses out of four in Kaduna Polytechnic. Data collection involved literature reviews, visual surveys, participant observation and interviews. Analysis incorporated both quantitative and qualitative methods, utilizing the Statistical Package for Social Sciences (SPSS) version 19.0 and Microsoft Excel to extrapolate DQI variables identified in the reviewed literature. Findings indicated DQI has commendable reputation that strongly influenced TETFund intervention building sustainable performance as perceived by users. The study concludes that application of DQI enhances design quality, provides benchmark for building quality and supports user's sustainability desire. Consequently, the study recommends a continuous review of the quality, performance management, and monitoring processes, employing the content of the UK-CIC developed DQI by architects and other stakeholders in the building industry.***

Keywords: Architectural Quality, Design Quality Indicators, Kaduna Polytechnic, Nigeria Sustainability, TETFund Intervention.

1. Introduction

Government interventions typically arise from the aim to address financial constraints and hardships faced by its citizens. The Tertiary Education Trust Fund (TETFund) is one such intervention program for public educational institutions in Nigeria. In its pursuit of accelerating economic growth, development, and ensuring quality service delivery, the government established TETFund through collaboration with the private sector to enhance efficiency and effectiveness in providing structural facilities to tertiary institutions. However, concerns have been raised about the quality and integrity of some TETFund intervention buildings nationwide, with reported cases of collapses in schools like Kano University of Science and Technology in Wudil, Kano, Imo State University in Owerri, and Ibrahim Badamasi Babangida University in Lapai, among others (Baffa, 2016). Azeanita and Safuan (2015), Asuquo (2011), and Oweh (2015) assert that both the architectural community and user groups have expressed doubts about the quality and sustainability of TETFund buildings. Jawando (2015) further notes that the Nigerian Senate has observed that many intervention buildings in tertiary institutions lack functionality and attractiveness to users, being shabby, dilapidated, and often run down in some cases.

Collaboration among architects, building industry professionals, higher institution managers, and other TETFund stakeholders such as end users of the buildings is essential to achieve optimal outcomes in project delivery, operation, and maintenance (Ferrone, 2023). Despite differences in their areas of focus, these stakeholders share common goals such as waste reduction, enhanced efficiency,

and improved user satisfaction. Through joint efforts, they can identify opportunities to streamline processes, minimize environmental impacts, and boost profitability. Quality and sustainability are pivotal aspects of the built environment, from design to operations and maintenance, aiming to eliminate potential issues. Quality refers to the achieved excellence or standard in a product or service, while sustainability involves maintaining or improving that quality over time while minimizing negative impacts on the environment, society, and the economy (Ferrone, 2023). Sustainable buildings are constructed to minimize harm to the environment and conserve natural resources. The integration of quality and sustainability results in increased efficiency and cost savings. The Design Quality Indicators (DQI) process allows for the assessment of all phases or aspects of design quality throughout the construction process, from inception to post-occupancy analysis (Construction Industry Council [CIC], 2023). DQI enables stakeholders to actively review design quality through structured workshops and online tools, involving construction and design professionals. DQI not only contributes to BREEAM ratings but also aids in developing more sustainable buildings. Therefore, it is imperative for these diverse stakeholders to collaborate in implementing DQI, fostering a holistic approach to achieving high-quality and sustainable built environments.

As highlighted by Asuquo (2011), there is a scarcity of information regarding the design quality of TETFund building projects, which makes it challenging to assess whether the intended quality and sustainability of these buildings have been achieved. To address this gap, the study undertook a comprehensive review of the relationship between Design Quality Indicator (DQI) attributes that bear significance for sustainable building practices. The primary objective was to assess how sustainability of TETFund buildings at Kaduna Polytechnic are met through quality architectural design needs of stakeholders by applying DQI and subsequently provide recommendations for the application of DQI variables in future projects.

In essence, this study seeks to contribute valuable insights into the design quality and sustainability of TETFund building projects, leveraging the framework provided by DQI. Therefore, gauging quality of building employing the United Kingdom – Design Quality Indicators (UK-DQI) strategy is an indispensable element in achieving sustainable building outcomes (Ferrone, 2023). DQI can significantly enhance the efficiency of sustainable Design quality building delivery. Through this analysis, it is aim to offer a foundation for informed decision-making and improvements in the planning, construction, and maintenance of TETFund-sponsored structures, ensuring they align with the principles of sustainability and high design quality.

2. Literature review

2.1: Concept of Sustainability

The "Brundtland Commission" within the World Commission on Environment and Development (WCED) identifies three key dimensions of sustainable development: economic, environmental, and socio-cultural, as illustrated in Figure 1. Challenges such as climate change, resource utilization, economic prosperity, and societal well-being can effectively be addressed through the sustainable development of buildings (National Planning Policy Framework [NPPF] & Cross Sector Group on Sustainable Design and Construction [CSGSDC], 2012).

a. Economical Sustainability

The linkage between micro and macro-economic development, employment generation, revenue creation, and government intervention in cost reduction for sustainable building practices should be intricately tied to housing policies, design principles, and construction methodologies (United Nations Human Settlements Programmes [UNHSP], 2012). Achieving an economically sustainable system necessitates a continuous operational capability, particularly in terms of effective management and maintenance. This holistic approach emphasizes the importance of aligning economic strategies, employment initiatives, revenue frameworks, and governmental interventions with sustainable practices in housing design and construction.

b. Environmental Sustainability

According to UNHSP (2012), environmental sustainability guarantees energy conservation and efficiency by prioritizing the use of natural and recycled materials. This involves eliminating harmful substances and pollutants during the manufacturing and transportation of materials, as well as in the design, planning, and construction of buildings. Environmentally sustainable systems aim to maintain a secure resource base, prevent overuse, and reduce renewable resource depletion by preserving biodiversity, atmospheric stability, and other essential ecosystem functions. In essence, environmental sustainability in building practices involves a conscientious approach to

resource management and ecological balance throughout the entire lifecycle of a structure.

c. **Socio-cultural Sustainability**

Socio-cultural sustainability entails incorporating community members in planning, design, and governance decisions, fostering skills development and empowerment within disadvantaged communities, and promoting social integration and equity (UNHSP, 2012). A socio-culturally sustainable system should prioritize distributional fairness, ensure an ample supply of social services, encourage political accountability and participation, and preserve the unique characteristics and identities of the people involved. This approach emphasizes the importance of addressing social and cultural dimensions in the development and maintenance of systems to ensure inclusivity, equality, and the preservation of individual and collective identities within a community.

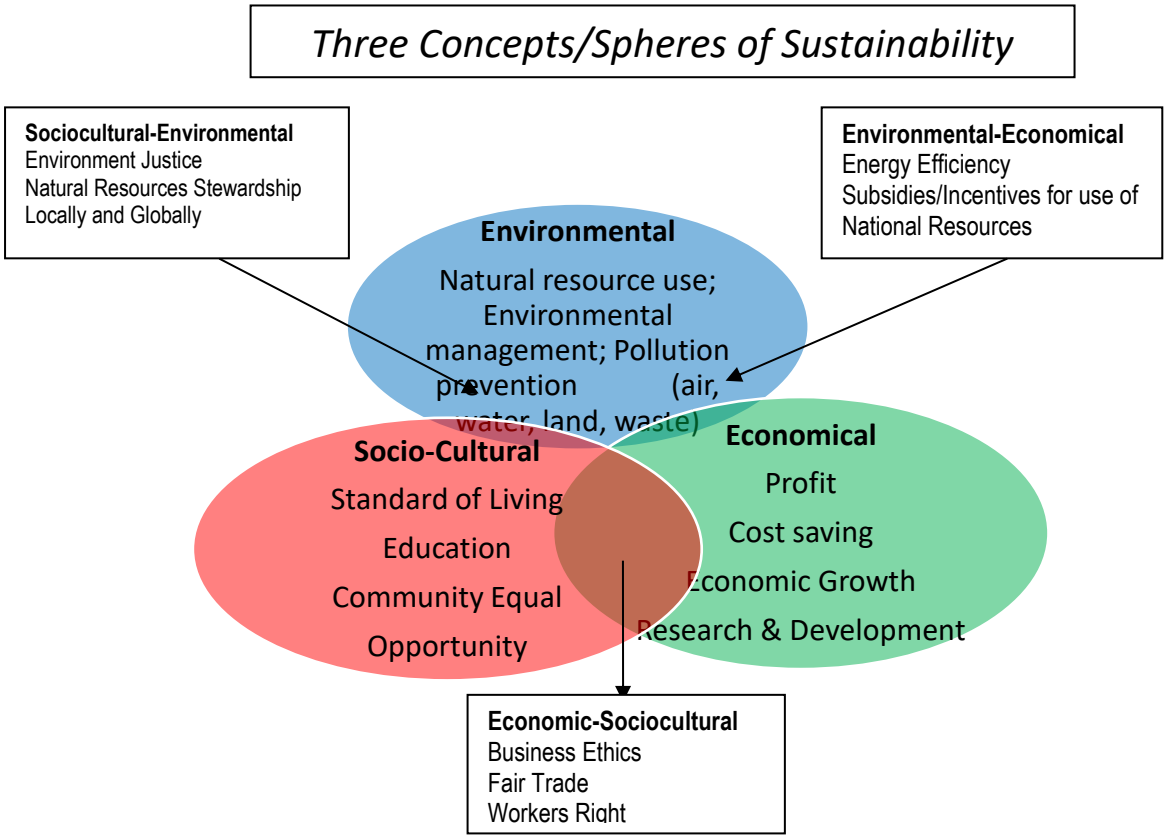

Figure 1: The Three Concepts/Spheres of Sustainability
Source: Adopted from University of Michigan Sustainability Assessment, (2002).

The three major sustainability concepts of environmental, socio-cultural and economic are usually tied to establish the relationship between sustainability and housing (UNHSP, 2012).

Gilkinson and Sexton (2007) recommend focusing on the robustness, permeability, and buildability of distinct material resources, along with considerations for building construction, structural stability, and acoustic features. Sustainable buildings should be comprehensive, encompassing affordability, adequacy, positive impacts on the environment, and enhancement of the social life of occupants, all while emphasizing resource-saving principles. This holistic approach underscores the need for balance and integration of various sustainability dimensions in housing practices.

2.2 Sustainability and Architectural Quality Measurement Tools

According to Giddings et al. (2015) and Design Quality Indicator (DQI) (2016), several well-known contemporary tools are available for assessing sustainability and design quality. These tools include the Housing Quality

Indicator (HQI), Post Occupancy Review of Buildings and their Engineering (PROBE), Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), Building Quality Assessment (BQA), among others. These tools primarily evaluate the construction of new buildings and the refurbishment of existing ones.

The Architectural Design Quality Indicators (DQI), serving as a tool for evaluating Architectural Design Quality, was developed by the United Kingdom Construction Industry Council (UK-CIC) with collaborative support from the Department for Trade and Industry (DTI), Office of Government Commerce (OGC), and the Commission for Architecture and the Built Environment (CABE) (Construction Industry Council [UK-CIC], 2021). DQI places a strong emphasis on meeting the needs of end-users, involving them throughout the design and construction process. Its functionalities include enabling feedback and learning for future projects, creating a straightforward graphic profile to highlight strengths and weaknesses in a design or existing building, providing a framework for briefing and design reviews, supplying benchmarking information through Facilitator's Reports, and contributing to the development of more sustainable buildings (Construction Industry Council [CIC], 2023). This user-centric approach underscores DQI's pivotal role in elevating the overall quality and sustainability of architectural designs and buildings.

2.3 Design Quality Indicators (DQI) as a Measurement Tool for Sustainability

According to the United Nations Industrial Development Organization (UNIDO) and the International Centre for Science and High Technology (ICSHT) (2008), as well as the International Telecommunication Union (ITU) (2012), effective designs, including the orientation and location of a building, should aim to reduce energy consumption. Additionally, systems must adhere to key design criteria such as functionality, proper circulation, and adequate ventilation. Clear instructions on the operation and maintenance of equipment are also crucial for optimal performance. In line with the recommendations from the Commission for Architecture and the Built Environment [CABE] (2005) and the United Kingdom Construction Industry Council [UK-CIC] (2021), three major variables of the Design Quality Indicator (DQI) are highlighted: Functionality, Design Impact, and Build Quality. These variables underscore the importance of assessing how well a building meets its intended function, the impact of its design on users and the environment, and the overall quality of its construction. This comprehensive approach aligns with the principles of sustainable and high-quality architectural design.

a. Functionality: is the degree to which the facility meets its operational objectives, achieved through the careful consideration of use patterns, accessibility measures, and the strategic arrangement of spaces. This ensures the facility optimizes the user experience for all stakeholders.

b. Impact: is how well the facility creates a sense of place and a positive effect on the local community and environment with its sub-variables as Character and Innovation, Form and Materials, Internal Environment, Urban and Social integration.

c. Build quality: This encompasses sub-variables that delve into engineering, facility performance, and construction. These sub-variables specifically target elements like structural stability, the integration of health and safety considerations, and the resilience of systems, finishes, and fittings throughout the entire project lifecycle. The assessment in this dimension aims to guarantee not only high construction standards but also enduring structural integrity, compliance with safety regulations, and sustained durability in systems and finishes throughout the building's lifecycle. In 2005, the UK-DQI for Education was introduced and commissioned by the Department for Education, playing a pivotal role in the "Schools of the Future" program, spanning over 800 educational facilities in the UK to date. The DQI for Schools, sharing around 90% of its indicators with the original DQI, places specific emphasis on spaces within schools, including teaching areas, halls, staff spaces, school grounds, dining areas, and the relationship between the school and the community. DQI is utilized for both Post Occupancy Evaluation (POE) and during the design stages of projects. Its extensive application includes over 1,400 projects, comprising 55% new buildings, 10%

refurbishments, and 35% mixed-use projects, engaging over 7,000 stakeholders (Design Quality Indicators [DQI], 2016). Azeanita and Safuan (2015) also adopted this instrument in their study, evaluating its applicability within the context of the Malaysian construction industry.

In the context of this study, the evaluation of the architectural design quality of TETFund intervention buildings is grounded in the extent to which both the physical facility (product) and the construction process (service) facilitated by DQI can significantly enhance the efficiency of sustainable building delivery expectations of the Stakeholders. The assessment employs the United Kingdom – Design Quality Indicators (UK-DQI) strategy to gauge the sustainability of the building.

3. Research methodology

This study adopted participatory opinion survey and field assessment through observation technique. Therefore: Quality assessment methods used in this study was divided into; statistical methods, visual methods and feedback (questioning) methods as recommended by Okoye, Okolie and Agu, (2019). So the Research Design methods and data collection was on the bases of the three research objectives; aims at finding the relationship among different building quality variables and sustainability index as explained below:

a) Significance of Design Quality Variables on Sustainable Building: The study adopted in-depth literature review reveals relevant variables such as access, and natural lighting are among the design quality indicators that were perceived as the most important to be looked at (Azeanita, Chee-Ming and Safuan, 2016).
b) Innovative Use of DQI variables on Building Sustainability: The interviews / targeted at specific stakeholders was used: Such included: The Principal Officers of the institutions, the professionals in the building industry i.e.: TETFund officials, project Architects and Engineers.
c) Adaptation/Sustainable (IMPROVE) of DQI to suit Nigeria Environment: The study adopted theory-based assessment technique which was based on Researcher environmental visual perception using interview for data collection.

These approaches helped the research to simultaneously look through both objective (Functionality and Built quality) and subjective (Sustainability) point of views of this work. The study was conducted in Kaduna Polytechnic, using the proportionate stratified random sampling technique in the choosing two out of the four Colleges of the Polytechnic for the study. Academically related buildings: (Laboratory, Classroom, Lecture Theater, Library/ICT, Workshops). Various classes of stakeholders and end users: (staff, Students and Others).

4. Findings and discussions

4.1 Findings from Literature Review and Interview

The questionnaire result was categorised into four sections, the demographic characteristics of respondents and result on DQI as relates to the three research objectives and question.

FINDINGS on objective 1: Design Quality Indicators (DQI) Attributes that is significant for Quality Building: This research objective was achieved using secondary data. The DQI attributes formed the basis of interview, thirty-four (34) parameters identified for benchmarking building projects in order to achieve a good performance.

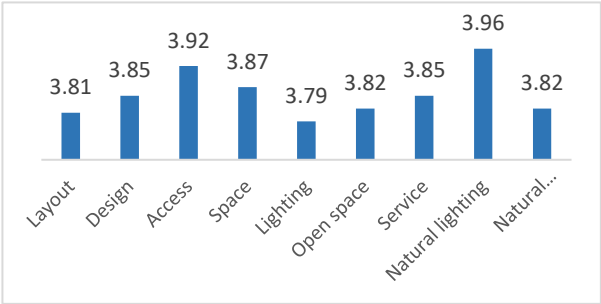

Figure 2: Average index of indicators – Functionality

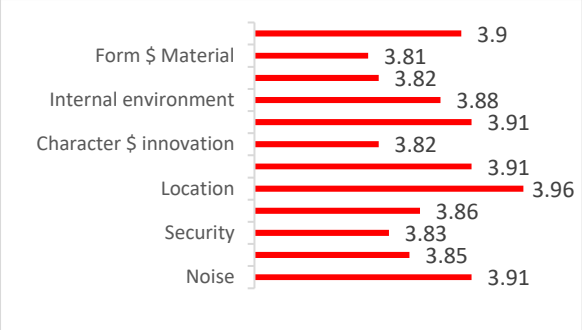

Figure 3: Average index of indicators – Build Quality

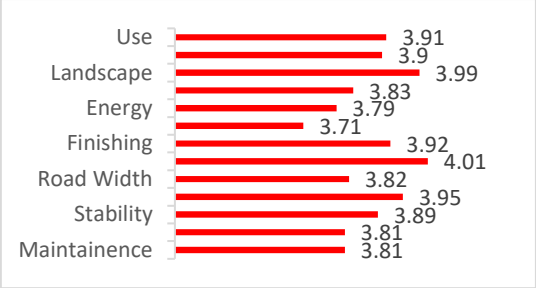

Figure 4: Average index of indicators – Impact **Source: Azeanita and Safuan, 2015**

The Average Index (AI) value of all the indicators under functionality, build quality and impact aspects are within the range of 3.50 < AI 4.50, suggesting: The indentified design quality indicators are likely to be useful to all building Stakeholders especially owner, user, contractor and designer who have direct participation in producing or utilizing the building.

FINDINGS on objective 2: Specific identifiable innovative application of DQI indices associated with TETFund buildings: This objective was achieved by adopting the worksheet. Therefore the fieldwork observation focuses on the five critical performance areas that are essential to the success of every innovation practice.

The outcome of the Mean and Standard Deviation on all the variables reflected a significant innovative application of DQI on TETFund buildings.

FINDINGS on objective 3: Design Quality Indicators (DQI) that needs to be improved upon for building sustainability and suitability for Nigeria Environment: This objective was achieved by using the outcomes of descriptive statistics to infer the state of design quality of the buildings being investigated.

This further eases the interpretation of whether design quality of buildings is low or high. Hence determinants of these areas of DQI that needs to be improved upon. (For those scored LOW)

4.1.1: Modification of Design Quality Indicators (DQI) for Application in Nigeria.

The modification of Design Quality Indicators (DQI) to align with the unique characteristics of the Nigerian environment resulted from an interactive review and descriptive analysis of DQI assertions derived from building survey responses, as detailed in Table below.

TABLE 1: Observation and Inference of DQI based on Statistical Analysis (Standard Deviation – SD)

S/N	DQI Variables	SD	Observation	Proposed Solution Based on Literature
	A. Functionality			
	Use	0.686	The SD for space is high which implies that there is need for improvement	The right size for Users. Functional space requirement must be met using appropriate design space standards
	Access	0.794		
	Space	0.846		
	B. Build Quality			
	Engineering	0.760	Very poor in respect of the three variables of the build quality due to high	The mechanical and electrical system in the building must be designed and installed to function properly. It must be ensured that all structural elements are efficient. The structure must be stable from all natural elements such as
	Performance	0.818		
	Construction	0.939		

			wind, rain and all other peculiar whether conditions.
C. Impact Quality			
Forms and Materials	0.810	The need for improvement	The internal environment atmosphere such as the relationship between light and space are adequate The external environment must be of good quality Building design must provide sense of security, in cooperate Comfort and pleasant visual effect for Users
Environment	0.979	due to very high value of	
Character and Innovation	0.927	SD in environment, character and innovation	
Urban Integration	0.673		

Source, Researchers Fieldwork, 2022

The proposal on above table could be used to develop a modified DQI in terms of their identification of visual relationship and their properties.

4.1.2: Fieldwork Visual Assessments of Selected Buildings

The study involved the assessment of two buildings within the institution to determine the sustainability of TETFund intervention buildings using Design Quality Indicators (DQI). The primary focus of the assessment was on the main DQI variables, namely functionality, build quality, and impact quality. Kaduna Polytechnic, being the oldest and largest polytechnic in Nigeria and sub-Saharan Africa, boasts four campuses. The first building under scrutiny is situated in the College of Environmental Studies (CES), where one of the researchers conducted the study. The second project was selected from another campus, the College of Administration and Social Science Studies (CASSS).

a. Department of Environmental Sciences, College of Environmental Studies (CES).

The Environmental Sciences Department building stands out as the most recently constructed modern building in both design and construction at the CES Campus of Kaduna Polytechnic. This one-story building houses various facilities, including administrative and teaching staff offices, classrooms, lecture halls, a laboratory for environmental studies, a material workshop, and ample toilets for all users. The departmental administrative offices extend into a well-landscaped courtyard, while the academic staff offices are situated on one side of the upper floor. The building features two main entrances/exits leading to a veranda that runs alongside the lecture hall, opening into the courtyard, allowing for natural ventilation and lighting. The circulation around the two staircases is deemed very adequate, suggesting that the building has been well-designed to cater to the needs of its users.However, there are noted concerns about the finishes, particularly the rendering and decoration of the building, as well as the use of suspended ceiling materials, which are deemed inappropriate. Furthermore, the observable failure of the building commission in less than five years due to poor workmanship raises doubts about the overall integrity of the building and the presence of sustainability measures. These aspects suggest areas that may require attention and improvement for the building to align with sustainability principles and endure over time.

b. Department of Library Science/CASSS library

The CASSS Library building stands out as arguably the most environmentally friendly structure on the campus. Its design features a simple courtyard surrounded by blocks of lecture rooms built opposite each other, with a recessed configuration closing up at the two ends of the facing classroom blocks. This design, described by Qurix and Sagada (2022), exemplifies Contemporary Architecture, characterized by the integration of plants and alternative energy sources into the building. The enclosed courtyard is thoughtfully landscaped with green carpet grass, adorned with ornamental shrubs and trees, maximizing

natural ventilation and lighting. This environment creates an ideal, noiseless zone suitable for a library design. The building is easily accessible from the main road within the campus, and the car parking space for users is deemed adequate. The entrance foyer to the building is prominently celebrated, providing sufficient circulation space for the easy movement of users, particularly during peak usage periods. Overall, the design and features of the CASSS Library building align with contemporary architectural trends and prioritize environmental considerations, making it a noteworthy and user-friendly structure on the campus.

Table 2: Summary of Fieldwork Visual Assessment based on Sustainability and DQI Variables for Department of Environmental Sciences, CES and Department of Library Science/CASSS Library Kaduna Polytechnic, Kaduna.

Sn	Sustainability/ Quality Indicators	Observation/ Findings	
		Department of Environmental Sciences, CES	**Department of Library Science/CASSS library**
A	**Functional Quality**		
I	Use	All necessary facilities for the department was provide; the administrative and teaching staff offices, lecture halls, laboratory for environmental studies, material workshop and adequate toilet for all categories of users.	The library building is arguably the most environmentally friendly building in the campus.
II	Access	Academic staff offices are located on one side of the upper floor. There are two main entrances/ exits leading to the veranda	Easily accessible from the main road that runs within the campus.
III	Space (Size)	The massive building has 15 classrooms and lecture halls, each designed to accommodate 20 students. 10 of these classrooms are on the ground floor.	The site location has the advantage of a repetition of another similar building of the same size for future expansion.
B	**Build Quality**		
I	Performance	Circulation around the two stair cases provided is very adequate.	The environment gives the necessary noiseless zone ideal for a library design.
II	Engineering	Open courtyard provided the natural ventilation and lighting.	Dotted with ornamental scrubs and trees creating the maximum advantage of natural ventilation and lighting.
III	Construction	Environmental Sciences building is the latest modern building both in design and construction.	Structures are recessed in such a fashion closing up at the two ends of the blocks of the classroom that faces each other.
C	**Impact Quality**		
I	Character and Innovation	The one story building accommodates a department. It is not of much beauty and attraction	This building is unique in design and the serenity of the structure is a great innovation.
II	Form and Materials	Finishes, especially rendering and decoration of the building and the use of suspended ceiling material were inappropriate;	Concept is simple courtyard surrounded by lecture rooms blocks built opposite each other.

III	Internal Environment	The departmental administrative offices extended into well landscaped courtyard	The enclosed courtyard is beautifully landscaped with green carpet grass.
IV	Urban and Social Integration	Observable failure of a building commission in less than five years due to poor workmanship put in doubt the integrity of this building.	Clearly celebrated entrance foyer to the building has adequate circulation space for easy mass movement at the peak period of use.

Source: Researchers' Fieldwork (2022)

Pictorial illustrations of Department of Environmental Sciences, CES and Department of Library Science/CASSS Library Kaduna Polytechnic, Kaduna.

Plate XVII: **Sources, Field work, 2019.** Entrance Approach View

There are two entrances/exits leading to the veranda. The massive building has 15 classrooms and lecture halls each of which is design to accommodate 20 students.

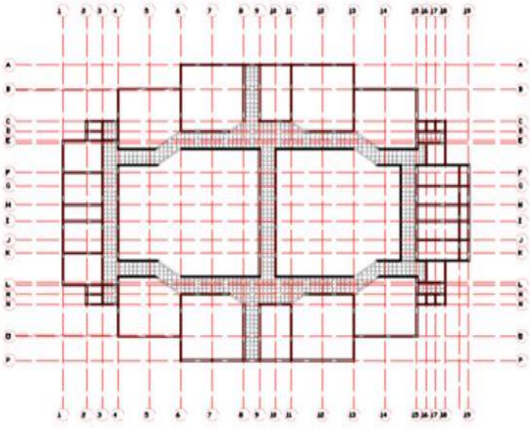

Plate XXI: **Source, Author, 2019** The Floor Plan of the Complex

The advantage of a repetition of another similar building and of the same size for future expansion

Plate XXII: **Source, Field work, 2019.** The Beautifully Landscaped Courtyard

Enclosed courtyard is beautifully landscaped with green carpet grass and dotted with ornamental shrubs and trees that aids noiseless zone which is ideal for a library design (Qurix,2018: Green Architecture and Eco Architecture).

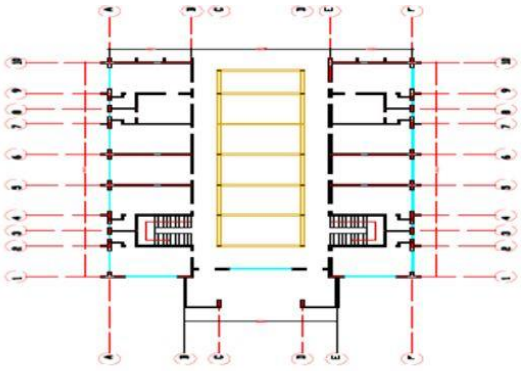

Plate XVI: **Source, Author, 2019** Typical Floor Plan

4.2: Discussion of Results and its Implications

The study was aimed at establishing linkage between Sustainability Analysis of Tetfund Intervention Buildings with Architectural Design Quality Indicators performance attributes using the UK-developed DQI as template of assessment.

4.2.1: Design Quality Indicators (DQI) for Sustainable Building

Study reveals that various buildings as possessing DQI features of good functional quality, form and materials capable of producing satisfactory buildings that meets the desires of the users. This implies DQI reflects positively on the quality of TETFund intervention buildings.

Also, the study underscores the importance of gauging stakeholder opinions and concerns to facilitate project development effectively, ensuring that the outcomes align with stakeholders' needs and sustainable measures.

4.2.2: Innovative use of DQI to determine the Sustainability of TETFund Buildings.

The findings from interviews reveal that adequate funding from dedicated sources leads to a higher level of commitment from designers, contractors, and all other professionals in the construction industry. Consequently, this heightened commitment results in a more innovative approach, fostering superior design and construction of building structures. More so, the research result revealed that studied buildings meet three innovative requirements: novelty, utility and non-obviousness to a very significant level. Implying that the concept of DQI should be understood as the combination of artistic ambitions and intellectual understanding of design problem requirements. While the primary objective of DQI) remain making architecture enjoyable and align it with its intended purpose. Furthermore, the study indicates that the TETFund Intervention Program serves not only to create physical assets and services but also to address broader environmental and social objectives; this innovative approach to design is well exemplified by the serenity and socially friendly features of the beautifully landscaped CASSS Library building courtyard, showcasing a harmonious blend of aesthetics and functionality. Therefore, it can be concluded that DQI serves as a valuable tool for measuring the sustainability of TETFund buildings.

4.2.3: Design Quality Indicators (DQI) for Application in Nigeria

Study reveals that the UK –CIC developed DQI is universal and applicable with slight peculiar adjustment to suit any specific environment; Implying that the concept of building construction development may be impaired without a good knowledge and successful management of the impact of environmental factors. In this instance, Design Quality Indicators (DQIs) offer a generic framework criterion for assessing successful building performance. However, architecture plays a crucial role in emphasizing, strengthening, and interpreting the cultural character and uniqueness of the surroundings, ensuring that places possess distinctive characteristics (Ronn, 2010). To achieve architectural quality design, it is essential to base the design on an understanding of the existing qualities of the plot, surrounding buildings, and the location. As part of this research, there is a proposal to identify and improve upon DQI variables to better align with the unique characteristics of the Nigerian environment. This suggests a customization or adaptation of DQI criteria to ensure that the assessment framework is not only generic but also contextually relevant and reflective of the cultural and environmental nuances specific to Nigeria.

5. Conclusion and recommendation

The occurrence of TETFund intervention building collapses in certain locations has underscored the importance of analyzing design quality and sustainability using identified Design Quality Indicator (DQI) variables. The case study revealed a good level of design quality but indicated low sustainability measures in TETFund intervention buildings. While TETFund intervention programs enjoy a positive reputation for delivering projects within budget, on time, and with good quality, the findings suggest that there is room for improvement in terms of sustainability. This emphasizes the need to not only meet immediate project goals but also to enhance the long-term viability and environmental compatibility of the constructed structures.

The study recommends the following:

i. The study has revealed that Stakeholder's experiences plays significant roles in shaping their quality

desire. Consequently, more research should be conducted by all stakeholders to explore ways to enhance the sustainability of TETFund. Specifically, there should be investigations into organizational forms and management arrangements that represent best practices for governance. Such research can provide valuable insights into optimizing TETFund's operations and governance structures, leading to improved outcomes and impact in supporting education and sustainable infrastructure development.

ii. Since the results indicate that project circumstances undergo changes over time, particularly due to long durations and the initial lack of incorporation of sustainable features in design and construction, as seen in many TETFund intervention buildings. The study proposes the application of Design Quality Indicators (DQI) for quality and sustainability monitoring throughout the entire lifecycle of the building—from inception to disposal. This approach is recommended for adoption by all stakeholders, with a special emphasis on architects. Continuous monitoring using DQI can help identify evolving needs, ensure sustainability, and enhance the overall quality and performance of TETFund intervention buildings throughout their lifecycle.

iii. The study has established that Design Quality Indicators (DQI) are comprehensive enough to be used for quality assessments of both new and refurbished old building structures. Consequently, it is suggested that the Nigeria Institute of Architects (NIA), as a professional body, should domesticate the contents of the UK-CIC developed DQI and ensure its application, particularly in school building projects. This involves integrating DQI principles into the professional standards and practices of architects in Nigeria, promoting a systematic approach to quality assessment and ensuring that design quality and sustainability are prioritized in architectural projects, especially within the educational sector.

iv. Finally, based on the research findings that TETFund intervention buildings are fully in compliance with the principles of Design Quality Indicators (DQI) and exhibit identifiable features and characteristics of modern buildings, it is proposed to establish DQI techniques as a fundamental tool for architects in approaching design. This recommendation encourages architects involved in TETFund projects to consistently apply DQI techniques throughout the design process. This approach ensures that the design aligns with established quality indicators, fostering not only compliance but also the attainment of modern and sustainable building features. The incorporation of DQI techniques can serve as a valuable guide for architects to enhance the overall quality and sustainability of TETFund intervention buildings.

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