Afropolitan Journals

ISSN: 3027-2114 www.afropolitanjournals.com

Effect of Passive Energy Efficiency Measures in Designing Sustainable Primary Healthcare Facilities in Nigeria

Usman Ismail; Usman Bukar Wakawa; Aminu Umar; Bashir Usman Mohammad; and Shamsuddeen Ismail

Department of Architecture, Abubakar Tafawa Balewa University Bauchi.

DOI: https://doi.org/10.62154/qd6jn632

Abstract

The aim of this study is to develop a design for a sustainable healthcare centre through passive energy efficiency measure with a view to improving the thermal comfort, cooling, lighting and ventilation requirement for primary healthcare centre in Nigeria. The methodology adopted for the study included both primary and secondary data collection. Primary data were collected from the administered questionnaire (5point Likert scale closed- ended), a total of 350 set of questionnaires administered and 87% were valid. A case study research strategy was adopted to ascertain the effectiveness and efficiency of building design with an emphasis on sustainable architectural design principles. A significant regression equation was revealed (F (2,257) = 33.619, p <.000, with an R^2 of 0.294, which revealed that implementing passive measures for energy optimization has a significant and positive effect on designing sustainable healthcare centres. Its further recommends the integration of passive design, design for deconstruction, adaptive reuse, and design for human comfort as part of architectural design principles that would result in sustainable energy optimization should be adopted in every design of primary healthcare centres by architects.

Keywords: Passive Measures, Primary Healthcare, Design, Sustainable Primary Healthcare.

Introduction

Primary healthcare is essential healthcare based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community and the country afford to maintain at every stage of their development in the spirit of self-reliance and self-determination. PHC forms an integral part both of the country's health system of which it is central function and main focus and of the overall social and economic development of the community. (World Health Organization, 2013). Passive design is an element utilized from natural sources intended to maintain the comfort of the building's occupants. This source consists of natural lighting and ventilation adapted through openings in buildings. Building orientation is essential for design openings to be optimized more efficiently. However, occupants usually respond to their immediate environment to achieve the comfort and convenience of their space.

Aflaki (2015) reviewed studies on the operation of natural ventilation in buildings as a passive design strategy in order to find the most effective architectural elements and techniques in building facades and ventilation openings in tropical climates. Passive design relates to the design that provides the user with the convenience of using natural components. These components can provide heating and cooling for buildings, such as lighting and ventilation for user's comfort (Butters, 2015). Healthcare centre also require standby electricity generators to ensure a continuous supply of power in emergencies and critical operations. When considering energy-efficiency in healthcare centre, it is important to keep in mind that it is not the end-use of energy alone, but also the need to control the indoor climate, that is one of the principal requirements (Kapoor, 2011). Energy efficiency practices in buildings consist of passive or active measures. Active measures include improving HVAC systems, efficient appliances, efficient lighting systems, and utilization of renewable energy, and distributing the energy as effectively as possible while maintaining the comfort of occupants (Amirifard, 2019). Passive measures, on the other hand, aim at reducing energy demand by increasing the use of natural heating, cooling, and lighting potentials as well as reducing the energy losses through the building envelope. Although passive measures in building sector have been widely practiced, we require knowledge about available alternatives and how to choose among them to achieve the best performance and efficiency gains in building refurbishment projects. Energy efficiency encompasses policies, strategies, and technologies designed to reduce energy consumption, pollutant gas emissions, and costs (Franco et al., 2017). Therefore, efficient energy management in healthcare has the potential to improve energy efficiency.

Sustainability in architectural design is a purposeful design of the building and the environment by the architect and other allied professionals in the building industry with the aim of implementing the principles of social, economic, and ecological sustainability, in essence, the architectural design for sustainability should minimize environmental impact and building energy consumption (Wael, 2017). Lack of introduction of a sustainable approach as a design principle at the early stage of design would impact negatively the design output. (Wael, 2017).

Passive Measures in Sustainable Design: An Overview

Passive design strategies include, but are not limited to, the building layout design, shading devices, envelop thermophysics, fenestration and infiltration & air-tightness. Proper passive designs can be implemented by architects at the early design stage to achieve a high building performance. To counteract the impacts of climate change, various passive adaptation strategies were appraised by researchers worldwide. To investigate whether improving building energy efficiency can improve the heat resilience in this nursing home case, we applied multiple passive and active EEMs to the baseline model and evaluated the impact quantitatively. The application of passive design strategies is crucial at the early architectural design stage for building energy use minimization.

Introduction to Energy Optimization in Primary Healthcare Design

Architectural design is a complicated process which involves the integration of building, inhabitants' requirements, and environmental conditions (Gharouni Jafari et al., 2020). Daylighting is an integral aspect of indoor environmental quality assessment in buildings. The usage of daylight in the built environment not only causes the reduction of electrical energy, but also contributes to the creation of a space that has a positive influence on the health and well-being of building users. However, daylight can result in visual discomforts like glare and unwanted reflections and ultimately lead to the disruption of the thermal balance of rooms through overheating. For this reason, keeping the balance between the maximization of daylight harvesting and risk management of potential discomforts is the most ambitious challenge for designers (Tabadkani et al., 2018).

Space Design Quality in Sustainable Primary Healthcare Buildings

Healthcare is one of the most complex and rapidly changing industries. It is continually transformed by new technologies, technique, pharmaceuticals and delivery systems (Boone, 2012). In this concern, it is a fact that the hospital architecture incorporates a development project that has as main concerns the adequacy of technological advances in medicine, compliance with rules and regulations (that seek to ensure the quality of designed environments), the complexity and flexibility required for the project and the high cost of premises. This means that the designer often forgets or not gives the adequate importance to sustainable principles that this type of project should follow (Shaw, 2010).

Key Parameters for Passive Measures

The parameters for measuring passive measures refers to as design solutions for healthcare buildings to create environments that are therapeutic, supportive of family involvement, efficient for staff performance, and restorative for workers under stress (Hamilton, 2003).

Statement of the Problem

Healthcare centre buildings consume half the daily consumption of energy. Due to the homogeneous environment created by the energy being used designers (architect) and standardized engineering solutions, in building rise significantly (Buonomano, Calise, Ferruzzi, & Palombo, 2014). Most buildings today tend to waste a lot of energy by failing to respond to the inhabitant's climatic circumstances and comfort needs. Architectural design is a complicated process which involves the integration of building, inhabitants' requirements, and environmental conditions (Gharouni Jafari et al., 2020). The most crucial architectural design stage is the early design phase, when most of the critical decisions are made and the largest impacts on building performance and occupant comfort are set (Taghizade et al., 2019).

In Nigeria, most of the hospitals depend on alternative gasoline or diesel fueled power generating sets. Consequently, a high proportion of the operating cost of hospitals and consequently, patients' bill is related to energy. Thus, for most of the hospitals, particularly those in rural locations, the actualization of the critical efficient and effective healthcare delivery is very adversely affected, (Nwanya & Ekechukwu, 2013). the study area (Bauchi metropolis) PHC depends largely on electricity power supply, but lack of steady power supply has affected services and discouraged attendance by patients. workers said lack of regular electricity at the PHC is the main problem stopping them from providing round the clock healthcare services to the community. a laboratory technician at one of the PHC in the study area, lamented that the laboratory was unable to carry out most tests required by patients because electricity supply is irregular and limited and for a laboratory to function efficiently, it needs regular power supply to operate some equipment such as the microscope.

To the best of the authors' knowledge, improving passive energy conservation can be the first strategy to reduce energy demand in existing buildings. As such this research would breach the gap by exploring the impact of passive measures on energy optimization in designing sustainable primary healthcare centre with a view of improving heating and cooling needs of healthcare buildings in Nigeria.

Aim and Objective

The aim of this study is to develop a design for a sustainable healthcare centre through passive energy efficiency measure with a view to improving the thermal comfort, cooling, lighting and ventilation requirement for a primary healthcare building in Nigeria.

The objective is to examine the effect of passive measures in designing a sustainable energy optimization in the study area.

Therapeutic Environment Design Approach

Design for Deconstruction

Deconstruction according to Fernada et al (2015) is the act of putting into use demolished materials from a demolished building. This process of restoring demolished building materials serves as a strategy for preserving raw materials (Webster, 2007). The difficulties associated with deconstructing a building are the hazards, economics, and assembly time, these problems can be overcome if planned for from the design stage of the building, if the projects are designed intentionally for deconstruction throughout its life cycle, and this architectural design principle is called design for deconstruction (Fernada *et al*., 2015). Design for Deconstruction (DfD) is a means of achieving sustainability through waste reduction, resource conservation, and recovering of waste for reuse and recycling. It is therefore imperative that architects and other professionals in the built environment to introduced design for deconstruction from the design stage and as a design approach for sustainable design (Chris & Fionn, 2005).

Adaptive Reuse

Adaptive reuse is the process of changing a building's overall character with a focus on the function and other variations made to the building itself, through orientation and the relationship between spaces which can be an addition or demolition with the sole aim of preserving the building or site (Fiorani, 2017).According to Schmtid, adaptive reuse is a condition whereby a building maintains and performs the basic developmental requirements of the users and still undergoes a steady change in a perfect manner and retains maximum value in its lifecycle (Zahraa and Sana, 2020) cite Schmtid (2009).

Design for Human Comfort

Buildings and the environment are designed for human comfort, these buildings run on energy for users‟ comfort. In order to achieve comfort, there must be a balance between human comfort and the environment, the architect at the design phase should factor in the user's comfort as part of his architectural design principles for sustainability (Geun and Jeong, 2014). Fundamentally, architecture is to protect man from external environmental impact, thus providing comfortable shelter, which can result in an increase in energy consumption in the building. But Geun and Jeong, argued that if a new comfort theory is introduced; the energy usage in the building can be reduced with better satisfaction of occupants‟ comfort (Geun and Jeong, 2014). Vitruvius, architectural design principles can be used for better internal comfort by relating the building with the adjacent natural environment Sustainable building energy and comfort cannot be separated; therefore, the architect is expected to incorporate the five categories of sustainable site, energy & atmosphere, materials & resources, water & efficiency, indoor environmental quality, and innovation in design (Bauer *et al*, 2009).

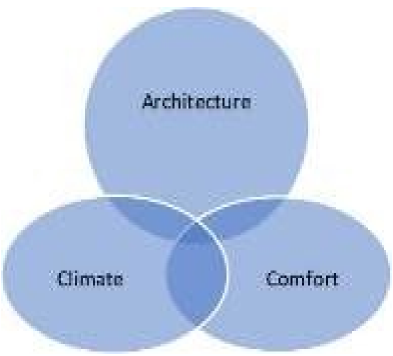


Figure 1. Vitruvian Model of Environment in Architecture

Conceptual Framework

Conceptual framework is an illustration, in the form of diagram, graph or in a narrative form about the main constructs or variables composed in the study. It entails the main variables and their hypothesized relationship and effect/impact among or between them. It simplifies the research preparation task as it gives the general focus of the study (Kothari, 2004).

The conceptual framework for this study involves a structured approach to identifying, evaluating, and implementing energy-efficient strategies in the design and operation of primary healthcare facilities. This framework considers the importance of sustainability, energy conservation, and cost-effectiveness in healthcare infrastructure.

Passive measures refer to design strategies that leverage natural processes and elements to optimize energy efficiency without relying on active mechanical systems. Examples of passive measures include proper building orientation, natural ventilation, insulation, daylighting, and thermal mass.

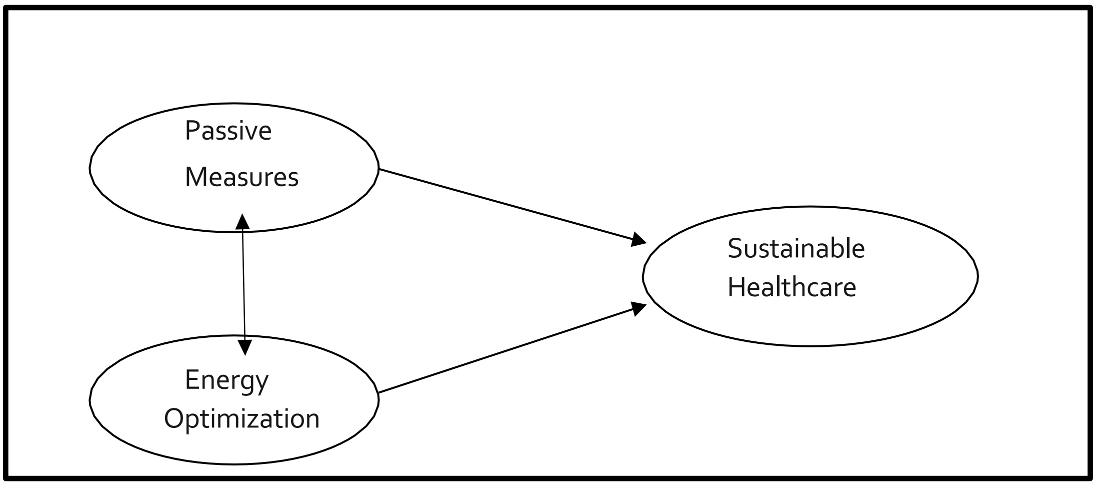


Figure 2: Conceptual framework

Methodology

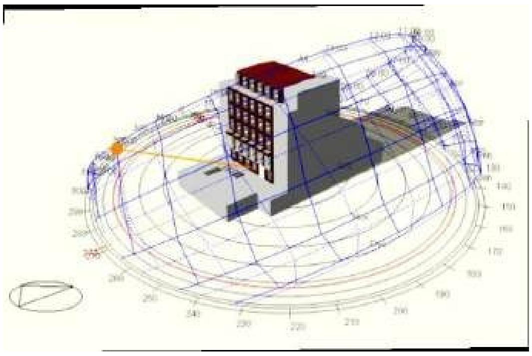
The aim of this study is to develop a design for a sustainable healthcare centre through passive energy efficiency measure with a view to improving the thermal comfort, cooling, lighting and ventilation requirement for a primary healthcare centre in Nigeria.

The methodology adopted for the study included both primary and secondary data collection. Primary data were collected from the administered questionnaire (5point Likert scale closed- ended). A total of 350 set of questionnaires were administered to the case study areas and 87% responses were received while 83% are valid. Regression analysis was adopted using SPSS software and a case study research strategy was adopted to ascertain the effectiveness and efficiency of building design with an emphasis on sustainable architectural design principles.

Results and Discussion

Effect of Thermal Comfort

Achieving thermal comfort through sustainable design involves the Careful balancing of interdependent factors and the results regarding Energy efficiency, productivity and wellbeing are worth it. Achieving thermal comfort through sustainable design Involves the careful balancing of interdependent factors, including orientation, thermal mass, glazing, shading and ventilation. The benefits of getting it right are worth it, not just regarding energy efficiency, but also productivity and well-being which are increasingly becoming the criteria against which to judge a buildings quality.

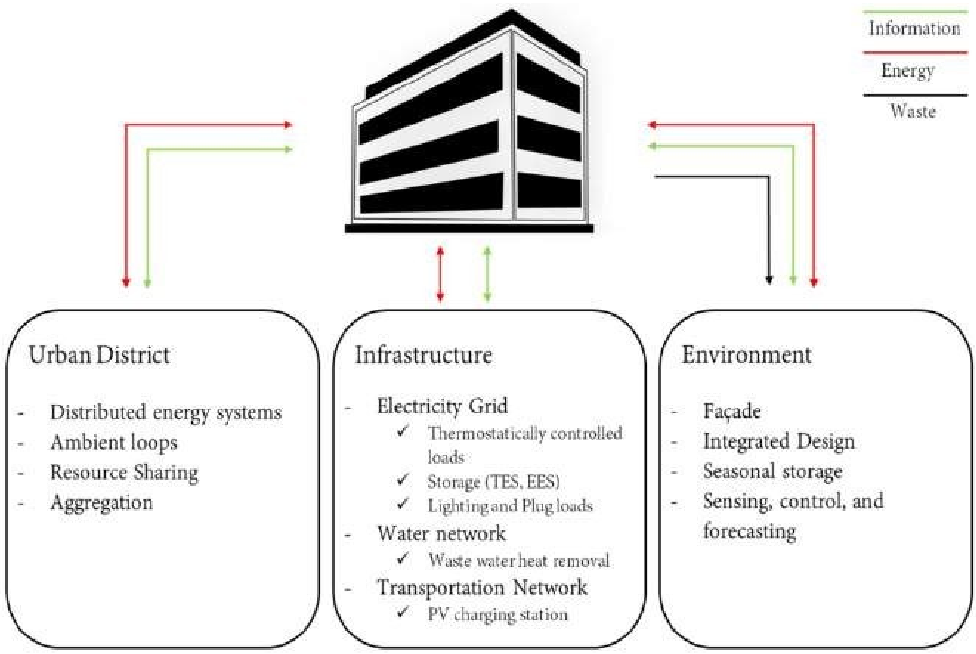


Solar and heat protection design techniques;

- Orientation of Building shape
- Building Shape/Form
- Thermal Considerations
- Ventilation Considerations
- Window placement

Figure 3:

SITE SELECTION CRITERIA DESIGN CONSIDERATION



*(**Figure 4:** Building and environmental framework)*

Source: Field survey, 2024

Site Evaluation

After identifying possible locations for a site, the next step is to evaluate the sites, this simply means to look at certain features the site has and to identify which site among the two is the best option for the project.

Figure 5:

SITE A

LOCATION: TIRWUN, ALONG MAIDUGURI BYPASS.

2 AREA: 50,222.43M

PERIMETER: 909.6M

SITE B

LOCATION: ALONG KANO ROAD, BAUCHI STATE.

2 AREA: 65,215.96m

PERIMETER: 1,026.87m

Table 1: Site Evaluation

S/N	CRITERIA	SITE A	SITE B
1	Hydrology	O	X
2	Future expansion	O	O
3	Visual Quality	X	O
4	Utility Access	O	O
5	Vegetation	O	X
6	Existing Infrastructure	O	X
TOTAL		5	3

Source: Field Survey, 2024

Analysis of Questionnaire Administered

A total of 350 set of questionnaires were administered to the case study areas and 304 responses were received as shown in table 3. Of these, twelve (12) were not fully completed and therefore discarded. Specifically, those who left out or ticked noting or few items in the questionnaire were discarded. This resulted in an overall response rate of 83%. This is reasonable considering the fact that majority of the respondents were proportionally captured.

Table 2: Questionnaire Administration

Questionnaire	Number	Response rate
Administered	350	-
Received	304	87%
Valid	292	83%

Source: Field Survey, 2024

Linear regression analysis was carried out to determine the effect of passive measures in designing sustainable energy optimization in the study area. The results were presented accordingly in the tables below. The coefficient of determination (*r2*) is an estimate of the percentage variation in the dependent variable (designing sustainable energy optimization) which can be predicted from the independent variable (passive measures). This coefficient demonstrates how well the linear regression model fits the data. A value close to 0 shows a weak fit whereas a value close to 1 implies a good fit. The *r2 – value* of 0.207 in Table 1, indicates that 20.7% of the variation in dependent variable can be explained by the predictor variable of facilities performance, identified in the regression equation. The beta (β) coefficients reflected in Table 2, are the values for the regression equation for predicting the dependent variable from the independent variable.

A linear regression was calculated to predict dependent variable (energy optimization) based on independent variables (passive measures). A significant regression equation was found (F (2,257)
= 33.619, p <.000, with an R^2 of .294. The results show how much of the variance in the dependent variable designing sustainable energy optimization is explained by the independent variables passive measures.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.455[a]	.207	.201	.34954

A linear regression was calculated to predict dependent variable (energy optimization) based on independent variables (passive measures). A significant regression equation was found (F (2,257) = 33.619, p <.000, with an R^2 of .294. The results show how much of the variance in the dependent variable designing sustainable energy optimization is explained by the independent variables passive measures. the result suggests that implementing passive measures for energy optimization has a significant and positive effect on designing sustainable healthcare centres. The coefficient estimates and their significance provide valuable insights for decision-makers in the healthcare and architectural sectors aiming to enhance sustainability in healthcare infrastructure.

Table 4: Path Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.029	.144		14.048	.000
	ENERGY OPTIMIZATION	.294	.044	.401	6.642	.000

The Comparative Case Study

Case Study One: PHCC, State Low-cost Bauchi

The State Low-Cost Primary Healthcare Centre is a public hospital, located at Dan Iya, Bauchi Local Government, Bauchi State. It was established on 2/3/2008, and operates on 24hrs basis. The State Low-Cost Primary Healthcare Centre is Unlicensed hospital by the Nigeria Ministry of Health, with facility code 05/02/1/1/1/0094 and registered as Primary Healthcare Centre.

Source: Field work, 2024

(***Figure 6:*** *Some of the pictures taken during field survey at state low-cost primary healthcare centre)*

Case Study Two: PHCC, Tasha Babiye, Bauchi

The Tashan Babiye Primary Healthcare Centre is a public hospital, located at Dankade, Bauchi Local Government, Bauchi State. It was established on 3/4/1978, and operates on 24hrs basis. Tashan Babiye Primary Healthcare Centre is Unlicensed hospital by the Nigeria Ministry of Health, with facility code 05/02/1/1/1/0014 and registered as Primary Healthcare Centre.

Services offered: Antenatal Care (ANC), immunization, HIV/AIDS services, tuberculosis, non-communicable diseases, family planning, intensive care services, communicable diseases, hepatitis, child survival, accidents and emergency, nutrition, health education and community mobilization, maternal and newborn care and scanning.

Source: Field work, 2024

*(**Figure 7:** Some of the pictures taken during field survey at tashan babiye primary healthcare centre)*

Case Study Three: PHCC, Bayan Fada, Bauchi

The Bayan Fada Primary Healthcare Centre is a public hospital, located at Dan Amar A, Bauchi Local Government, Bauchi State. It was established on 6/8/1968, and operates on 24hrs basis. The Bayan Fada Primary Healthcare Centre is Unlicensed hospital by the Nigeria Ministry of Health, with facility code 05/02/1/1/1/0009 and registered as Primary Healthcare Centre.

Source: Field work, 2024

(***Figure 8:*** *Some of the pictures taken during field survey at bayan fada primary healthcare centre)*

Case Study Four: PHCC, Kofar Ran Bauchi

Kofar Ran Primary Healthcare Centre is a public hospital, located at Kofar Ran, Bauchi Local Government, Bauchi State. Services Offered: Antenatal Care (ANC), Immunization, HIV/ AIDS Services, Tuberculosis, Non-Communicable Diseases, Family Planning, Intensive Care Services, Communicable Diseases, Hepatitis, Child Survival, Accidents and Emergency, Nutrition, Health Education and Community Mobilization, Maternal and newborn care and Scanning.

Source: Field work, 2024

(***Figure 9:*** *Some of the pictures taken during field survey at kofar ran primary healthcare centre)*

Table 5: Appraisal Report

S/N	Case Study	Merits	Demerits
1	PHCC, STATE LOWCOST BAUCHI	Good adequate storage facilities Materials use for construction are renewable materials.	Poor zoning concept Inadequate circulation space Undefined parking lots Absence of trees for shading and wind breaking Inadequate waiting areas for client/patient Poor exterior environment Absence of landscaping
2	PHCC, TASHA BABIYE, BAUCHI	Good adequate storage facilities materials use for construction are renewable materials. The land and size is averagely adequate. it is easy to access from the town major road.	Poor zoning concept Inadequate circulation Poor zoning concept Inadequate circulation space Undefined parking lots Absence of trees for shading and wind breaking Poor lightening Poor exterior environment Absence of landscaping space Undefined parking lots Absence of trees for shading and wind breaking Poor lightening Poor exterior environment Absence of landscaping
3	PHCC, BAYAN FADA, BAUCHI	Good adequate storage facilities Materials use for construction are renewable materials.	Poor zoning concept Inadequate circulation space Undefined parking lots Absence of trees for shading and wind breaking Inadequate waiting areas for client/patient Poor exterior environment Absence of landscaping

4	PHCC, KOFAR RAN BAUCHI	Good adequate storage facilities Materials use for construction are renewable materials. The land and size is averagely adequate. It is easy to access from the town major road.	Poor zoning concept Inadequate circulation space Undefined parking lots Absence of trees for shading and wind breaking Absence of landscaping

Table 6: Summary of Site Selection Criteria

S/N	Criteria	Site A	Site B	Remarks
1	Hydrology	O	X	Site A are endowed by sufficient water sources.
2	Future expansion	O	O	Both sites have future expansion.
3	Visual quality	X	O	It has aesthetic advantages.
4	Utility access	O	O	Access to utility services are present in both sites.
5	Existing infrastructure	O	X	Site A has existing infrastructures.
6	Vegetation	O	X	Site A has vegetation management which can enhance environmental sustainability.

Source: Field survey, 2024

Conclusion and Recommendations

The achievement of a sustainable building and environment starts with a sustainable design approach used by the architect. Therefore, the role of the architect in the implementation of sustainability cannot be overemphasized. The professionals in the built environment especially the architect must double their effort toward mitigation and resilience, new techniques, and technology in the design of buildings that must support the sustainability movement. The architect in his approach to the built environment starts Principles of architectural design remains a takeoff point to every successful building design and achievement of energy-efficient building.

Based on the finding of this study and the conclusions made by this very study, this study wishes to make the following recommendations;

- The integration of passive design, design for deconstruction, adaptive reuse, and design for human comfort as part of architectural design principles that would result in sustainable energy optimization should be adopted in every design of primary healthcare centres by architects.

- Hospitals should endeavor to make use of courtyards in its design as it has been established that courtyards can greatly improve passive cooling which will reduce dependence on HVAC systems for cooling.
- The study also recommends that all courtyard design variables such as form, aspect ratio and orientation should be considered in the design phase so that the courtyard can perform optimally.
- The design of subsequent primary healthcare facilities should take into consideration building orientation to maximize day lighting, sun path, nature's views and natural air.

References

Abdulraheem, I. S., Olapipo, A. R., & Amodu, M. O. (2012). *Primary healthcare services in Nigeria: Critical issues and strategies for enhancing the use by the rural communities*. *4*(January), 5–13. https://doi.org/10.5897/JPHE11.133

Aflaki, N. Mahyuddin, and Z. A. Mahmoud, "A review on natural ventilation applications through building components and ventilation openings in tropical climates," Energy Build., vol. 101, pp. 153–162, 2015.

Ahmed, S. S., Majid, M. S., Novia, H., & Rahman, H. A. (2007). Fuzzy logic-based energy saving technique for a central air conditioning system. Energy, 32(7), 1222–1234.

Amirifard, F., Sharif, S. A., & Nasiri, F. (2019). Application of passive measures for energy conservation in buildings–a review. *Advances in Building Energy Research*, *13*(2), 282–315. https://doi.org/10.1080/17512549.2018.1488617

Azizpour, F., Moghimi, S., Lim, C., Mat, S., Zaharim, A., & Sopian, K. (2011). Thermal comfort assessment in large scale hospital: case study in Malaysia. In Proceedings of the 4th WSEAS international conference on Energy and development-environment-biomedicine (pp. 171–174). World Scientific and Engineering Academy and Society (WSEAS).

Becker, F., Parsons, K. S., Becker, F., & Parsons, K. S. (2009). *Hospital facilities and the role of evidence-based design*. https://doi.org/10.1108/14725960710822559

Boden, R., & Epstein, D. (2006). Managing the research imagination? Globalisation and research in higher education. Globalisation, Societies and Education, 4(2), 223-236.

Bosch, J.P., Glaser, E., 2012. Powering Health: Electrification Options for Rural Health Centres, United States Agency for International Development, USAID. Available at: http://www.pdf.usaid.gov/pdf_docs/PNADJ557.pdf, Accessed on March 2, 2013

Buonomano, A., Calise, F., Ferruzzi, G., & Palombo, A. (2014). Dynamic energy performance analysis: Case study for energy efficiency retrofits of hospital buildings. Energy, 78, 555–572. https://doi.org/10.1016/j.energy.2014.10.042

Butters, C. (2015). Enhancing Air Movement By Passive Means In Hot Climate Buildings. ELITH Research Program, Energy and Low-Income Tropical Housing, Warwick University, UK, (May 2015).

Cama, R. (2009). Evidence-Based Healthcare Design. John Wiley and Sons, New Jersey.

Chan, M., & Guo, J. (2013). The Role of Political Efficacy on the Relationship Between Facebook Use and Participatory Behaviors: A Comparative Study of Young American and Chinese Adults.

Cyberpsychology, Behavior, and Social Networking, *16*(6), 460–463. https://doi.org/10.1089/cyber.2012.0468

Fellows R., & Liu A. (2015). Research methods for construction, 4th edition, John Wiley & Sons.

Fischl, G. (2006). Psychosocially supportive design in the in-door environment. Department of Human Work Sciences. Lulea University of Technology. Doctor: 135.

García-Sanz-Calcedo, J. (2014). Analysis on energy efficiency in healthcare buildings. *Journal of Healthcare Engineering*, *5*(3), 361–374. https://doi.org/10.1260/2040-2295.5.3.361

Hamilton, D.K. and Watkins, D.H. (2009). Evidence-based design for multiple building type. Wiley, Hoboken

Hamilton D. (2003). The four levels of evidence-based practice, Healthcare, Dec3(4):18-26

Harper, D (2011) Online Etymology Dictionary, accessed 21 April 2016. Available at: http://www.etymonline.com/index.php?term=evidence.

Harish, V. S. K. V, & Kumar, A. (2016). A review on modeling and simulation of building energy systems. Renewable and Sustainable Energy Reviews, 56, 1272–1292. https://doi.org/10.1016/j.rser.2015.12.040

John, A. (2014). *A framework for key performance indicators for a holistic facility performance assessment*. paper presented at CIB Facilities Management Conference, Technical University, Denmark. 12–23.

Keyton, J. (2014). *Communication Research Asking Questions Finding Answers*. McGraw-Hill.

Kelly, T. (2008). Evidence: Fundamental concepts and the phenomenal conception. Philosophy Compass, 3(5), 933-955.

Keyton, J. (2014). *Communication Research Asking Questions Finding Answers*. New York: McGraw-Hill.

Krejcie, R.V and Morgan, D.W. (1970) Determining sample size for research activities. Educational and Psychological Measurement, 30: 607–10.

Lim, G., Barry, M., Keumala, N., & Ab, N. (2017). Daylight performance and users' visual appraisal for green building offices in Malaysia. Energy & Buildings, 141, 175–185. https://doi.org/10.1016/j.enbuild.2017.02.028

Lu, Y., Goldstein, D. B., Angrist, M., & Cavalleri, G. (2014). Personalized medicine and human genetic diversity. Cold Spring Harbor perspectives in medicine, 4(9), a008581.

Nwanya, S. C., Sam-Amobi, C., & Ekechukwu, O. V. (2016). Energy performance indices for hospital buildings in Nigeria. *International Journal of Technology*, *7*(1), 15–25. https://doi.org/10.14716/ijtech.v7i1.2094

Omoleke, I. I., & Taleat, B. A. (n.d.). *Contemporary issues and challenges of health sector in Nigeria Enjeux contemporains et défis du secteur de la santé au Nigeria*. *5*(4), 210–216.

Sambo, A. S., Garba, B., Zarma, I. H., & Gaji, M. M. (n.d.). *Electricity Generation and the Present Challenges in the Nigerian Power Sector*. 1–17.

Tan, W. C. K. (2012). *Practical research methods*. Singapore: Pearson Prentice Hall.

Teke, A., & Timur, O. (2017). Overview of Energy Savings and Efficiency Strategies at the University of Jordan Hospital. *International Journal of Thermal and Environmental Engineering*, *14*(1), 242–248. https://doi.org/10.5383/ijtee.14.01.004

Tetlow, R. M., Beaman, C. P., Elmualim, A. A., & Couling, K. (2014). Simple prompts reduce inadvertent energy consumption from lighting in office buildings. Building and Environment, 81, 234–242.

U.S. Department of Energy. (2015). Chapter 5: Increasing Efficiency of Building Systems and Technologies. *Quadrennial Technology Review, An Assessment of Energy Technologies and Research Opportunities*, *September*, 143–181. https://www.energy.gov/sites/prod/files/2017/03/f34/qtr-2015-chapter5.pdf

Udofia, P.E. (2011). *Applied statistics with multivariate methods*, 1st edition, Immaculate Publications limited, Enugu, Nigeria

Wang, B., Wu, Z., & Xia, X. (2017). A multistate-based control system approach toward optimal maintenance planning. IEEE Transactions on Control Systems Technology, 25(1), 374–381.

Wahab, I. A., Ismail, L. H., Abdullah, A. H., Rahmat, M. H., & Salam, N. N. A. (2018). Natural ventilation design attributes application effect on indoor natural ventilation performance of a double storey single unit residential building. International Journal of Integrated Engineering, 10(2), 7–12. https://doi.org/10.30880/ijie.2018.10.02.002