VOL. 29 NO. 2
ISSN: 2910-1083
JUNE, 2023

African Scholar Publications & Research International

African Scholar Journal of African Innovation & Advanced Studies (JAIAS-2)

Investigation of Sustainable Design Strategy to Maximise Energy Efficiency: A Case Study of Silverbird Mall, Abuja and Ado Bayero Mall, Kano.

Abubakar Yusuf; Ahmad Abubakar; & Zakari Tijjani Abdullahi

Department of Architecture, Faculty of Earth and Environmental Sciences, Kano University of Science and Technology, Wudil.

Abstract

Due to the intensive use of shopping mall, it is imperative to monitor and compare sustainable design strategy that will aid in reduction of energy consumption. There is limited knowledge on sustainable design strategy, in shopping malls at northern part of Nigeria. The aim is to identify the sustainable design strategy that maximizes energy efficiency in some selected shopping malls. During the study, two shopping malls were selected due to their intrinsic qualities which were in consonance with the phenomenon. The research was based on case study approach and data was collected through visual survey and review of existing literature. Inadequate external insulation, smooth surface finishes, spectrally selected glass (natural lightening), site external spaces, horizontal and vertical shading devices, recessed walls, landscape, natural gas and over reliance on PHCN energy source in both Silverbird mall and Ado Bayero shopping malls revealed that sustainable design strategies to maximize energy efficiency was not considered during construction of this *shopping* malls. The *study recommends that sustainable design strategies* should be considered when designing future shopping malls so as to optimize energy efficiency. This comparative study will provide reference and assist decision making for effective sustainable design in other parts of the country.

Keywords: Sustainable design strategy, Shopping mall, Energy, Energy efficiency and Energy consumption.

Introduction

The significance of shopping malls to man cannot be ignored. Shopping mall is a complex facility which encompasses several retail stores, restaurants and other businesses with a common interest in soliciting sales (Adewale *et al.,* 2022). Globally, shopping malls serve as a place for socialization and extensively contribute to the economy where it is sited (Lin *et al.,* 2020). Regardless of its importance, shopping mall is ranked as one of the highest energy consuming buildings worldwide in terms of embodied and operational energy needed to operate (Bayhan and Polat, 2019; Yaman *et al.,* 2022). There is wide spread of shopping malls universally, including some parts of Nigeria. Martin *et al.* (2022) reported that shopping malls sited in Nigeria is a major concern due to high rate of energy consumption and its influence to the environment and social wellbeing of the society. Increasing energy demand can lead to greenhouse gas emissions and environmental pollution (Yaman *et al.,* 2022) In order to obtain a quality indoor and outdoor mall, sustainable design strategies that maximize energy efficiency have to be implemented. Similar inference was reported by Arslan and Ergener, (2022) were they made emphasis on analyzing plans and designs of shopping malls. They reported that shopping mall contain a wide variety of functions and have a complex architectural plan scheme thus, sustainable designs should be considered. Sustainable buildings can save 36% of total energy use, 65% of electricity consumption, 30% of greenhouse gas emissions, 30% of raw materials use, 30% of waste output and 12% of portable water consumption (Mekonnen *et al.*, 2023). A good sustainable designed building does no only generate profit but preserve the environment (Bajcinovic, 2016; Hong Lin and Xujun Zhai *et al,* 2023). Despite the significance of a sustainable buildings, some shopping mall at the time of construction did not consider sustainable design strategies that reduce energy consumption.

This study would provide accurate and precise information on the different sustainable design strategies employed in the selected shopping malls and ascertain which of the shopping mall had considered sustainable design strategies in terms of materials of the building envelope, wall and window shading as well as natural means of cooling and lighting,

Research methodology

The aim of this research is to explore the concept of sustainable design strategies in an attempt to achieve energy efficiency in shopping mall specifically in Kano, Nigeria. In order to achieve this aim, several stages were undertaken as to gather relevant information. Firstly, a thorough literature review on the subject matter was conducted. Information concerning energy consumption and

energy efficiency in shopping mall as well as sustainable design strategies have primarily been obtained from research papers. The second step was to choose shopping mall purposely based on the function, the climatic zone to which the case belongs, the scope of facility provided and their adaptation to sustainable design strategies. The following cases were selected due to their inherent qualities which were in consonance with the phenomenon under investigation. One of the shopping mall were randomly selected from Abuja and Kano state Nigeria as shown in table 1 below:

Table 1: Sample size.

S/N	Shopping mall	Location	Area
1	Silverbird mall	Abuja	33,000 m^2
2	Ado Bayero Mall	Kano	24,000 m^2

Source: Author, 2023

Due to the qualitative approach of the study, data was gotten through visual surveys of selected architectural sites, using general data collection techniques such as walking tours and note-taking. Data analysis used include descriptive, visual, and ranking systems, using a 5-point scale ranking system to evaluate the use of sustainable design strategies. Data gotten was used to address the first objective of this study which was to determine the extent these sustainable design strategies have been applied as it exists in selected shopping malls.

Results, Analysis and Discussion

As previously stated, the case studies used for this research are chosen from within a group of shopping mall base on the climatic zone to which the case belongs, the scope of facility provided and their adaptation to sustainable design strategies. Checklist was adopted to assess and record the extent to which sustainable design strategies were employed in the three centers. This served as a tool for measuring the level of application of sustainable design features in the shopping mall selected. The local cases under study and the inferences obtained were used to draw results that were relevant in achieving the first objective of this research which is to determine the extent of the application of sustainable design strategies.

Case Study Is Silverbird center, Abuja

ilverbird center is a 33,000sqm retail development located on Memorial Drive, by Shehu Musa Yar'adua's mall, Abuja. The shopping mall consists of 57 retail outlets, fashion boutique, children store, restaurants, pharmacy, gyms a supermarket, a state of the art 12-screencinema located in the building. This section analyzes the

sustainable design features present on the mall. The checklist shall be used to annotate the degree of compliance of the building to the sustainable design features.

Table 2: Compliance level of Sliverbird center to sustainable design strategies

S/N	VARIABLES	CHECK LIST	Level of Application				
			Very Inadequate	Inadequate	Average	Adequate	Very Adequate
1	Building envelope	Suitability of the materials to the climate				✓	
		Use of smooth surface finishes	✓				
		Use of light colours				✓	
		Use of externa insulation	✓				
2	Natural lighting	Wall to window ratio (40%)				✓	
		Use of spectrally selected glass	✓				
3	Natural ventilation	Use of openable windows				✓	
4	Site and external spaces	Use of interwoven landscape		✓			
		Use of impervious surfaces		✓			
5	Building form	Large building surface area				✓	
6	Building orientation	Sun orientation; E-W	✓				
		Wind orientation; SW-NE				✓	
7	Wall/Window shading	Use of horizontal and vertical shading devices	✓				
		Use of interior blinds					✓
		Use of recessed walls	✓				
		Use of overhangs			✓		
		Use of plants	✓				

8	Existing energy source	Use of PV cells		✓
		Use of natural gas	✓	

The exterior of the building consists of plastered masonry unit (CMU) painted with beige and grey exterior and different variety of colours for different spaces within the building. The masonry unit is highly suitable for the tropical climate of the region. However, the building is not insulated externally to prevent heat radiated from exterior from spreading the interior of the building, hence the need for heating, ventilation and cooling (HVAC) system achieves thermal comfort leading to high energy consumption in the shopping mall. The finishes on the exterior wall utilized light beige colour which doesn't contribute to the heat generated in the interior of the building.

The use of reflective glass to help reflect light, the shape and direction of the building wasn't adequate enough. Efforts were made to have adequate lighting through the use of large windows which spans from one end to the other in the various functional spaces to allow adequate coverage of natural light in some spaces. Natural ventilation was also achieved through the use of large windows, some of which were openable. Inadequate interwoven landscape and impervious surfaces of the building is observed. This indicates that sustainable design strategies with respect to landscaping was not considered in the initial stage of the design of the mall In addition, the implication of inadequate landscape is that, air flow from exterior of the building to the interior will not be diffused with enough soft landscape elements like trees and shrubs thus, making the interior of the building thermally inconvenient for users resulting to high energy consumption.

The shopping center is well orientated to accommodate sunlight and airflow. This is maximized by the provision of openable windows on the perimeter walls of the mall. There are eave projections in some areas especially along the restaurant extension, but they don't shade the windows, Venetian blinds do shade from within. No horizontal or vertical shading device was utilized in the mall. The existing energy source is municipal power from PHCN which is not reliable so they depend mainly on generators. These generators use about 10000 liters (average) of diesel per month resulting in increase in energy consumption. The mall was constructed using concrete and glazing (reflective glasses) for walls, marble tiles for floor, white patterned suspended ceiling and plaster of Paris (POP) ceiling.

Case Study 2: Ado Bayero Mall, Kano

The Ado Bayero Mall, Kano was built in 2014. The mall is the first ultramodern shopping mall in the northern part of Nigeria and was built to provide a world class retail environment and set the benchmark for retailing in Nigeria. Owned by Beverly

Development and Realties Limited (Belli), the mall offers retail and Entertainment spaces comprised of two major international shopping retailers (SHOPRITE AND GAME), and modern indoor multiscreen cinema (film house cinemas) and a broad range of other offerings including Restaurants, media stores and an indoor play area for young children.

Figure 1: Building envelope of Sliver bird center
Source: Author 2023

Figure 2: Exterior wall of the building with window openings
Source: Author 2023

Figure 3: External wall painting of the mall
Source: Author 2023

Figure 4: Interior blinds of Sliver bird center
Source: Author 2023

Case Study 2: Ado Bayero Mall, Kano

The Ado Bayero Mall, Kano was built in 2014. The mall is the first ultramodern shopping mall in the northern part of Nigeria and was built to provide a world class retail environment and set the benchmark for retailing in Nigeria. Owned by Beverly Development and Realties Limited (Bdrl), the mall offers retail and Entertainment spaces comprised of two major international shopping retailers (SHOPRITE AND GAME), and modern indoor multiscreen cinema (film house cinemas) and a broad range of other offerings including Restaurants, media stores and an indoor play area for young children.

Table 3: Compliance level of Ado Bayero Mall to sustainable design strategies

S/N	VARIABLES	CHECK LIST	Level of Application				
			Very Inadequate	Inadequate	Average	Adequate	Very Adequate
1	Building envelope	Suitability of the materials to the climate				✓	
		Use of smooth surface finishes	✓				
		Use of light colours				✓	
		Use of externa insulation	✓				
2	Natural lighting	Wall to window ratio (40%)		✓			
		Use of spectrally selected glass	✓				
3	Natural ventilation	Use of openable windows		✓			
4	Site and external spaces	Use of interwoven landscape		✓			
		Use of impervious surfaces	✓				
5	Building form	Large building surface area				✓	
6	Building orientation	Sun orientation; E-W	✓				
		Wind orientation; SW-NE				✓	

7	Wall/Window shading	Use of horizontal and vertical shading devices	✓				
		Use of interior blinds					✓
		Use of recessed walls					✓
		Use of overhangs	✓				
		Use of plants		✓			
8	Existing energy source	Use of PV cells			✓		
		Use of natural gas	✓				

This section analyzes the sustainable design strategies present on the mall. The exterior of the building is painted with light colors. The concrete masonry unit is highly suitable for the tropical climate of the region as shown in Table 3 above. However, the building is not insulated externally to prevent heat radiated from exterior from spreading the interior of the building, hence the need for heating, ventilation and cooling (HVAC) system achieves thermal comfort resulting in an increase of energy consumption in the mall. The modes of admission of daylight into the building are Electrical means and some windows, however, most spaces still made use of artificial lighting.

Windows were provided in the various functional spaces some of which are openable and others fixed. This however did not provide adequate ventilation therefore; most spaces are artificially ventilated. This connotes that a failure of the mechanical system of the building will lead to poor air exchange in the building.

Presence of hard and soft landscape within the environment. Driveways were tarred and interlocking tiles were used for walkways. Grassed areas and plants were also used to beautify as well as cool the environment. This indicates that consideration was given to the soft landscape when the building was designed. The walls were not shaded but areas carrying windows and doors were. Absence of eave projection and overhangs to shade the mall from solar radiation was seen. Venetian blinds were also used inside the building. The existing energy source is PHCN which is not reliable so they depend mainly on generators and to minimal extent solar cells.

Other energy efficiency factors employed was the use of energy saving bulbs, introduction of special concepts that decreases the inflow of water while increasing its pressure, and the use of solar heating systems for the heaters (most of the heaters were isolated and were not powered by electricity but by solar cells). Wind shadow effect was very primary in choosing the location of the windows and wind corridors were

analyzed. The results of the analysis informed the shape, location of the dome and orientation of the complex. The mall was constructed using concrete walls, glazing, marble tiles for floor and concrete for ceiling.

Figure 5: Glazed opening in Ado Bayero Mall
Source: Author 2023

Figure 6: Exterior of Ado Bayero Mall
Source: Author 2023

Figure 7: Recessed internal wall view. Ado Bayero Mall
Source: Author 2023

Figure 8: Artificial lighting in Ado Bayero Mall
Source: Author 2023

3.3. Analysis of sustainable design strategies between variables in case studied

Table 4: Analysis of sustainable design strategies between variables in case studied

S/N	VARIABLES	CHECK LIST	Case Studies		Remarks
			Sliver bird mall	Ado Bayero mall	
1	Building envelope	Suitability of the materials to the climate	Adequate	Adequate	-No insulation material was used on the external walls to prevent heat radiated in both cases studies.

		Use of smooth surface finishes	Very Inadequate	Very Inadequate	- The exterior of both buildings is painted with light colors.
		Use of light colours	Adequate	Adequate	-The entire exterior surface of both case studies' building envelope was rough.
		Use of external insulation	Very Inadequate	Very Inadequate	-The masonry unit of each cases are highly suitable for the tropical climate of the region.
2	Natural lighting	Wall to window ratio (40%)	Adequate	Inadequate	-The use of extensive large windows made of single clear glass cause heat gain was used in both cases
		Use of spectrally selected glass	Very Inadequate	Very Inadequate	-Wall to window ratio is adequate in sliver bird mall but very in adequate in Ado Bayero mall
3	Natural ventilation	Use of openable windows	Adequate	Inadequate	-Adequate natural ventilation was provided for in Sliver bird mall but was inadequate in Ado Bayero mall
4	Site and external spaces	Use of interwoven landscape	Very Inadequate	Inadequate	-Presence of soft and hard landscape, but not interwoven in both cases. However, it can be noted that more consideration was given to the soft landscape in Ado Bayero mall compare to Sliver bird mall
		Use of impervious surfaces	Very Inadequate	Very Inadequate	
5	Building form	Large building surface area	Adequate	Adequate	-Appropriate building form was utilized based on climate for both case studies
6	Building orientation	Sun orientation; E-W	Very Inadequate	Very Inadequate	The optimum orientation is NW-SE for both cases
		Wind orientation; SW-NE	Adequate	Adequate	
7	Wall/Window shading	Use of horizontal and vertical shading devices	Very Inadequate	Very Inadequate	-Absence of horizontal and vertical shading devices for both cases. Very adequate provision of interior blinds was spot on both cases studied.
		Use of interior blinds	Very Adequate	Very Adequate	-Ado Bayero Mall utilized more of recessed walls compare to sliver bird mall
		Use of recessed walls	Very Inadequate	Very Adequate	-The use of fixed overhangs at some point was spotted in Sliver bird mall while absent in Ado Bayero Mall.
		Use of overhangs	Average	Very Inadequate	
		Use of plants	Very Inadequate	Inadequate	- Both shopping mall was not properly shaded with the use of plants
8	Existing energy source	Use of PV cells	Inadequate	Average	-Both Sliver bird mall and Ado Bayer Mall utilized PHCN energy source and depend mainly on generators. However, Ado
		Use of natural gas	Very Inadequate	Very Inadequate	

		Bayero Mall uses minimal extent solar cells for energy efficiency

Source: Author, 2023

From the analysis in table 4, building envelope and building form of both Ado Bayero Mall and Sliver bird mall were adequate as they were taken into consideration in the design of the malls. However, no insulation material was used on the external walls to prevent heat radiation from exterior from spreading to interior in both cases studies.

With regards to natural lighting, the use of extensive large windows made of single clear glass causing heat gain was used in both cases. Wall to window ratio is adequate in sliver bird mall but very inadequate in Ado Bayero mall. Adequate natural ventilation was provided for in Sliver bird mall but was inadequate in Ado Bayero mall.

With respect to site and external spaces, presence of soft and hard landscape, but not interwoven in both cases were observed. However, it can be noted that more consideration was given to the soft landscape in Ado Bayero mall compare to Sliver bird mall.

Very adequate provision of interior blinds was spot on both cases studied. Ado Bayero Mall utilized more of recessed walls compare to sliver bird mall. The use of fixed overhangs at some point was spotted in Sliver bird mall while absent in Ado Bayero Mall. Both shopping mall was not properly shaded with the use of plants.

For existing energy source, both Sliver bird mall and Ado Bayer Mall utilized PHCN energy source and depend mainly on generators. However, Ado Bayero Mall uses minimal extent solar cells for energy efficiency

Discussion

The study's findings suggest that the design stage of the chosen shopping malls did not adequately incorporate sustainable design strategies. As a result, the shopping mall relies entirely on its HVAC system. While it would be inaccurate to claim that some sustainable design strategies are not present in the selected shopping malls, not all of the sustainable design strategies listed in the checklist were taken into account during the design phase of the centers. Building envelope and form were considered in both the Silver Bird mall and Ado Bayero Mall, while, overhangs and openable windows were more fully considered in the Silver Bird mall than in the Ado Bayero Mall. Other sustainable design strategies, such as insulation, landscape, and the use of natural gas as an energy source, were not considered in the design of the shopping malls. It would be expected that the centers would comply with sustainable building design standards by adopting sustainable design strategies to reduce energy consumption. However, it is evident that most of the sustainable design strategies are lacking in these shopping malls.

Therefore, it is crucial for shopping malls to consider designing and constructing energy-efficient retail centers in order to meet the demand of the Sustainable Development Goal (SDG).

Conclusion and Recommendation

In summary, the thorough analysis of the data collected in previous chapters has allowed the study to draw valid conclusions that address its objectives. Specifically, the study finds that sustainable design is not well emphasized in shopping malls in Nigeria, and there is a need for greater emphasis on energy-efficient and sustainable design in the retail sector to contribute to an eco-friendlier environment. The study recommends the use of sustainable design strategies such as solar shading, natural ventilation, site and external spaces, and building orientation to reduce energy consumption in shopping malls. To ensure energy efficiency, sustainable design strategies like building orientation, window/wall shading, building envelope, natural lighting, and natural ventilation should be considered throughout the design and planning stages of shopping malls.

Furthermore, since the research was conducted as a case study, similar studies should be conducted in other states in Nigeria and around the world. Research can also be carried out in different types of buildings to expand the knowledge base. This will help establish a benchmark for the level of adoption of sustainable design strategies in other types of buildings and identify barriers to the implementation of these methods

REFERENCES

Adewale, B. A., Jegede, F. O., and Sogbetun, O. T. (2022, September). Evaluation of the Effectiveness of Perceptible Principle of Universal Design in shopping malls in Southwest Nigeria. In IOP Conference Series: *Earth and Environmental Science*, 1054, (1), p. 012020). IOP Publishing.

Aghimien, E. I., Li, D. H. W., and Tsang, E. K.-W. (2022). Bioclimatic architecture and its energy-saving potentials: A review and future directions. *Engineering, Construction and Architectural Management*, 29(2): 961-988.

Anshebo, M. A., Mengesha, W. J., and Sokido, D. L. (2023). Selection of the Most Appropriate Sustainable Buildings Assessment Categories and Criteria for Developing Countries: Case of Ethiopia. *Journal of Urban Planning and Development*, 149(1), 04022057.

Arslan. H. D., and Ergener, H. (2022). Comparative analysis of shopping malls with different plans by using space syntax method. *Ain Shams Engineering Journal*, 102063.

Bayhan, H. G., and Polat, G. (2019). Green certified shopping malls undertaken by foreign contractors in Russia: A comparative qualitative study. *Journal of Construction Engineering, Management and Innovation* (Online).

Izobo-Martins, O. O., Oyelami, B. J., Agboola, O. O., and Ejale, E. A. (2022, September). Investigation of Passive Cooling Strategies in Selected shopping malls, Southwestern Nigeria. *In IOP Conference Series: Earth and Environmental Science* 1054, (1), p. 012024. IOP Publishing.

Lin, M. F., Shih, S. G., and Perng, Y. H. (2020). Sustainable shopping mall rehabilitation. Sustainability, 12(17), 6698.

Lin, H., and Zhai, X. (2023). Energy efficiency through user adoption of the sharing economy leading to environmentally sustainable development. *Journal of Innovation and Knowledge*, 8(1), 100315.

Yaman. R., Yaziz, N. S., Ismail, F. Z., and Ahmad, N. (2022, October). Energy Consumption in Open and Enclosed Layout of shopping malls in Malaysia. *In IOP Conference Series: Earth and Environmental Science*, 1067, (1), p. 012018. IOP Publishing.