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A Comparison Study on Daylight Performance between Bandar Universiti Masjid and Abijo Masjid

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Abstract
The term "sustainable building" refers to how a building is designed to be economically, ecologically, and socially beneficial. This research aims to study the daylight performance efficiency between two sustainable masjids in the same Tropical Climate but in different regions. The selected masjid is 1) Seri Iskandar, Perak, Malaysia: Bandar Universiti Masjid 2) Lagos,Nigeria's Abijo Masjid. The performance of daylighting in a building determines the effectiveness of the specific building's space area. Inadequate daylighting in a building can affect both the occupants and the overall performance of the space. Lack of daylight has a number of detrimental implications, including impaired sight, decreased productivity, reliance on artificial lighting, noncompliance with building codes, and other issues. In identifying the level of daylight sufficiency in the selected masjid, LightStanza computer simulation is being used to simulate daylighting for each of these masjid 3D models. The findings of this study show that Abijo Masjid has better daylight performance than Bandar Universiti Masjid. The climate, the building's orientation, the building layout, the material used on the exterior, and the room's depth all have an impact on the space's illuminance efficiency. However, based on computer simulations, the average daylighting illuminance transmitted into both buildings is below a recommended level stipulated by organizations that establish the standards for optimal illuminance for mosque buildings, including 1) Malaysia; MS1525, JKR Standard 2) Leed v4 Daylight. Therefore, it is suggested that the elements mentioned above should be given attention by designers to optimize the use of daylight in masjid buildings in the future.

Keywords: *Daylighting, Masjid, Sustainable building layout, Computer simulation, Room depth.*

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I. INTRODUCTION

Daylight combines the luminous properties of direct solar energy from the sun and diffuse solar radiation from the sky. In contrast to electric illumination, daylight is far more dynamic, changing in intensity, color, diffuseness, and direction throughout the day, throughout the year, and in response to the weather. Daylighting is illuminating interior rooms with natural light that enters through openings in a building's surface [9]. Daylight is another source of light to consider for the lighting designer in any facility, including places of worship. Using daylight as a primary source of illumination is strongly advised [7]. Daylight is essential for visual comfort as well as sanitary and hygienic conditions on the premises. The significance of natural light, as well as its aesthetic and functional features in the architectural environment, has received a lot of attention. [15]. Optimal use of daylight as the main light source for vision has the potential to reduce energy consumption by artificial lighting. Nevertheless, an overflow of daylight or sunlight should not lead to heat discomfort or glare [6].

A For sacred places, light has been employed in many ways to illuminate indoor locations with holy and symbolic meanings since the dawn of culture. Light has nearly the same meaning in every religion; yet, we have distinct notions of light in Islam, such as divine light, divine unity, and unity of God, which distinguishes Islam from other religions. In Islamic architecture, masjids make the best use of light. Masjids, without a doubt, are sacred spaces that exude a strong sense of God's presence. As a result, the use of light in the masjid is significant both symbolically and spiritually [2]. However, to ensure the effectiveness of the place, the light of space and its implications must be considered as they have been adapted in traditional architecture [13].

Nigeria has a varied landscape climate. The far south is defined by its tropical rainforest climate, everything in between the far south and the far north is tropical savannah, and most north is a hot arid desert. Malaysia's climate is classified as tropical based on its location near to the equator and with hot and humid conditions. The average temperature is 27 degrees Celsius (80.6 degrees Fahrenheit). Coincidentally, the city of

Lagos is in the south of Nigeria and shares the same climate as Malaysia, but there is a significant difference in terms of temperature, which is 31°c in Nigeria and 27°c in Malaysia, which means Nigeria received more sunlight penetration compared to Malaysia.

Seasonal temperatures at various latitudes are influenced by the angle of incoming solar energy. The incoming solar radiation is more direct (almost perpendicular or closer to a 90-degree angle) when the sun's rays contact the Earth's surface near the equator. As a result, solar radiation is focused over a smaller area, resulting in warmer temperatures. The angle of solar radiation is smaller in higher latitudes, resulting in more energy being dispersed over a broader region of the surface and cooler temperatures. Surface temperatures are warmer at lower latitudes and cooler at higher latitudes because the angle of radiation varies with latitude, even though higher latitudes have more hours of daylight during the summer months [16].

Local climate often contributes to handling daylight. Thus, every region has its own approach to dealing with the local climate. In sweltering climate zones, only small openings or filtered daylight are allowed to enter. In moderate climate zones, clear glass windows are usually used to admit more natural light into a masjid than coloured glass [14]. For instance, in Malaysia, pitched roofs, wide eaves, and large windows are vernacular designs, while Nigeria is famous for its flat roofs and narrow windows. Design that takes into account the characteristics of the regional environment makes traditional construction successfully adapted to the local environment and climate [11].

It is compulsory for a masjid to be oriented facing qibla in a northeast-southwest direction as it is very much coinciding to reduce direct daylight and glare from sunlight. The soft, cool, and uniform light provided by the northern light is essential to prevent heat and glare from entering the building [5]. Especially at the main prayer hall, the ambient daylight from the north will enter and provide calm and dimness in the interior. This determination of orientation plays a unique role in the daylighting of the masjid. It provides the perfect space inside the masjid to turn and receive more northern light, which helps control the illuminance of the interior space [12].

To increase the performance of the masjid, an evaluation of the aspects that can lead to the remarkable design and the implementation of successful concepts should be conducted. Identifying and adequately manipulating passive sunlight can lead to significant savings in building energy efficiency. Many elements influence building energy performance, including ambient weather conditions, building structure, material's thermal properties, user pattern behavior, lighting, and HVAC system in the building [17]. Thus, the best design strategy needs to be carefully considered.

Therefore, this study chooses to observe and identify the daylight performance between two masjids in Tropical climates but in different regions with distinct designs. The selected masjid is Bandar Universiti Masjid, Malaysia (figure 1) and Abijo Masjid, Nigeria (figure 2). Prior to that, the selected mosques were subject to inclusive criteria to ensure that the results obtained were not biased. The recently built masjid, with a similar pattern layout plan typology, where the layout of the main hall prayer is surrounded by supporting buildings and built area within a 1500m² - 2000m². Nevertheless, the masjid has implemented traditional vernacular building characteristics, and the application of sustainable elements provided is most considered in this study.

Figure 1: Bird's eye view of Bandar Universiti Masjid
Source: Noorzali, 2018

The Bandar University Masjid has one of the icons in Seri Iskandar, Perak and has become the talk of the town with its attractive design and comfort. Began use in 2018, the masjid with a 1982m² built area never idle from the visits of pilgrims. The main hall prayer is surrounded by male and female open prayer halls, a wudhu area and a verandah (figure 4). Maintaining traditional characteristics such as a pitched roof, tiered roof, and large overhang as it blends with the culture of the local Malay's Traditional building typology shows how these buildings adapted to the local climate. The application of the SPAH system, photovoltaic for the selected area, ample overflow space with natural ventilation, and the existence of the courtyard for stack effect, Bandar University Masjid are seemingly to be an example of a project for an implement sustainable element in a small-scale community building. This selected masjid was awarded a Smart Mosque by the State of Perak in 2018.

Figure 2: External view of Abijo Mosque, Lagos, Nigeria
Source: Abijo mosque / Patrickwaheed design consultancy, 2021

The international masjid building selected is Abijo Masjid, located in Lagos, Nigeria (figure 2). Completed in 2020, Abijo Masjid's main goal is to encourage educational, religious, and socio-cultural activities that are centered on the community. With a spacious 1963m² built area sufficient to meet the needs of the local community. The main hall prayer is surrounded by a foyer and office room (figure 6). Built with a rectangular and flat roof, the structure combines accepted and indigenous design and execution. The structure combines spirituality and materialism to create a feeling that is both pleasing to the eye and pleasing to the senses. In trying to achieve design sustainability, perforated sunscreens created from reused pavement stones obtained from another project shade the window openings, and high-level louver windows assist in controlling the building's stack-effect ventilation, the use of local material, laterite soil, as a wall with the insulation characteristic creates a comfortable cooling effect on the masjid.

From the information and description given above, it found that both masjids are almost similar in terms of function, building layout, and built area but different in terms of building design characteristics. This is because of different locations and cultures; designers are more likely to adapt to the culture and suitability of the local nature to ensure that the buildings built are more sustainable. Using daylight is also one element that adds value to achieving a sustainable building. However, direct sunlight should be avoided due to heat and glare on occupants. The study of building orientation and position indicates to us how this building responds to daylight. For better performance, daylight was received in these two masjids, and a simulation study was done. All approaches and information implemented in the studied building will prove if the building has been used and provided daylighting to users. The significance of the simulation is that input is given benefits to the researcher in applying it in the real world. Via a simulation process, it can also give the designer a more in- depth understanding of the functionality level for each aspect or element used [4].

The goal of this research is to observe daylight performance between Bandar Universiti Masjid and Abijo Masjid through computer simulation experiments on both buildings and to analyze daylight performance by comparing them with the standard average daylight illuminance. The objective of this paper is to examine and understand the implication of climate between both masjids, to determine the layout plan effectiveness, and to identify the relation between window opening and room depth toward daylight in selected buildings to achieve optimal daylight as recommended.

II. RESEARCH METHODOLOGY

This research is separated into two data collection methods, which are as follows: LightStanza met simulations are the primary data sources. Secondary data is from drawings collected for both masjids. Meanwhile, the first data is from the literature review, such as in journals, books, and articles. LightStanza software and Sketchup modeling programs were used to form 3D buildings and calculate the daylight distribution based on the specific month and hour. Figure 3 shows the data collection flowchart in how to obtain the result.

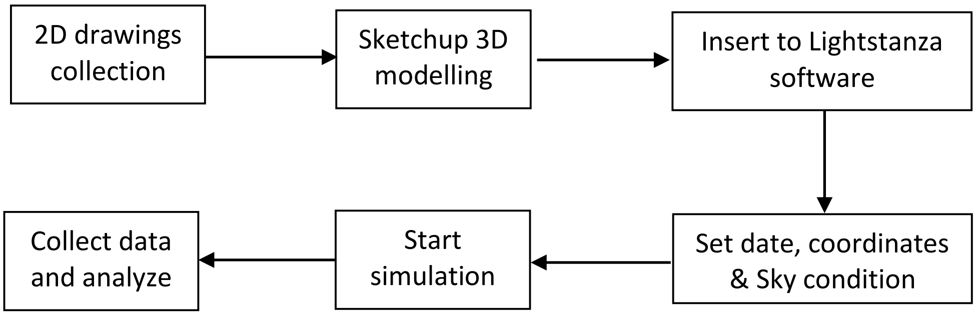


Figure 3: chart

(i) Secondary data

The architects in charge, official websites, publications, and the Arch daily website were used to access the 2D drawings for both buildings. Two masjid buildings from different regions with similar typologies and sizes (1500m² - 2000m²) also sustainable buildings are chosen to examine the differences in daylighting performance for each building. The chosen buildings for Malaysia are Bandar University Masjid and for Nigeria is Abijo Masjid. A study focuses on a few elements that respond to daylighting simulation.: a) Climate, b) Building typology, c) Building orientation, d) Type of windows, e) Depth of room, & Daylight rating tools.

(ii) Sketchup 3D Modeling

Sketchup is the easiest 3D modeling software that can be used to create 3D objects in a 2D environment. Therefore, after obtaining a complete building plan, the 2D drawing next has been developed using Sketchup 2020 software to form the 3D models of the existing buildings. All floor, facade, door, window, and roof elements are included in the model development process.

Once the model is done, the position of each building is set up using Sketch Up to qibla's direction. The floor plan and an axonometric view are shown in figure 3 & 4 for Bandar Universiti Masjid, while figure 5 & 6 shows the plan and axonometric view of Abijo Masjid. The red part indicates the location of the main prayer hall space for both buildings where the daylight average illuminance level will be studied.

(iii) LightStanza Daylight Simulation

To investigate the performance of daylighting by both buildings, a daylighting simulation of both buildings is required. LightStanza is the most advanced daylight analysis simulation tool. Its ability to complement other software tools, including Sketchup, is beyond doubt by allowing it to bring studied models directly to the platform to gain unparalleled observations of how natural light interacts with model space. Several steps have been specified in the simulation process to ensure that operations are carried out in a methodical timeline, and that accurate results may be obtained. The following are the procedure's specifics:

Step 1: Generate chosen to build in a 3D model and building dimension; after finishing, save the file into the COLLADA file.

Step 2: Import the COLLADA file to LightStanza, set the location base on the coordinate for each building and set the date on 21 March 2022, hourly for 12 hours (8.00 am- 7.00 pm)

Step 3: Choose and set the building material according to the existing building. For the simulation, these materials are kept the same as the original because differences will affect the results.

Step 4: On the date set, both countries are in overcast climate type, so the simulation will be run with the cloud type set to overcast to obtain the result of daylight performance and building energy performance reading response to all the variables that will be indicated to identify the most recommended passive design strategy for the building in the specific climate of the building. LightStanza programmed records and generated the outcome.

Step 5: The results and data acquired at the main hall prayer from both simulations are graphed using an Excel sheet. The chart and figures are examined, debated, and concluded. Whether the chosen building has good daylight performance or not will be decided based on the graph and tabulated statistics.

(iv) Analyzation of Existing

The ideal requirements of MS1525 (300-400 lux), JKR (300 lux) which is the standard outlined for multi-purpose public buildings used for the Bandar Universiti Masjid [8]. For Abijo Masjid, LEEDv4 (270-500Lux) will be used to compare data that have been obtained from daylight illumination simulations. Discussions and recommendations for more sustainable strategies for the building will then be conducted from the charts and tables analyzed.

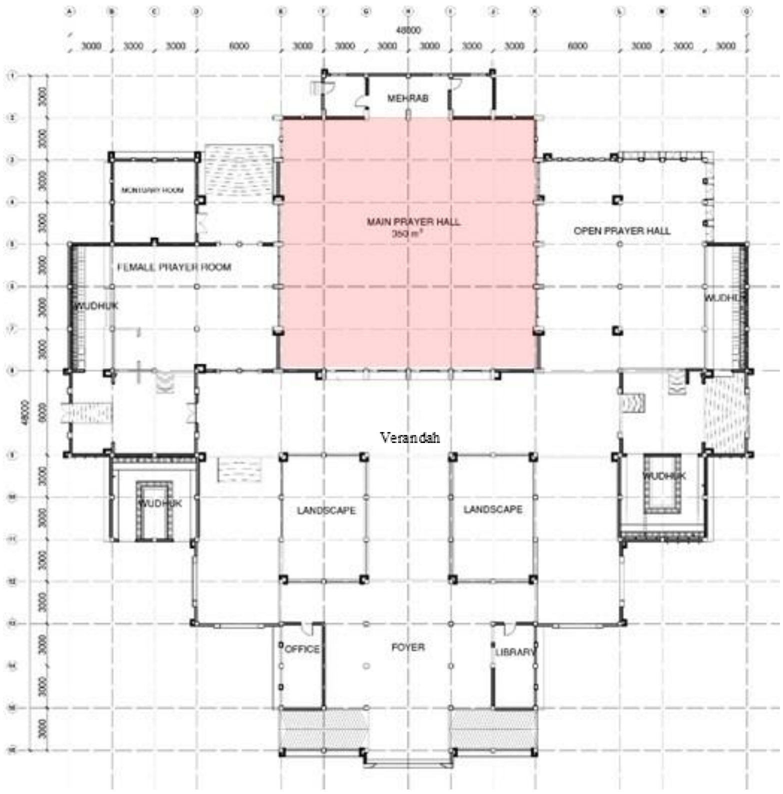


Figure 4: Bandar Universiti Masjid Floor Plan

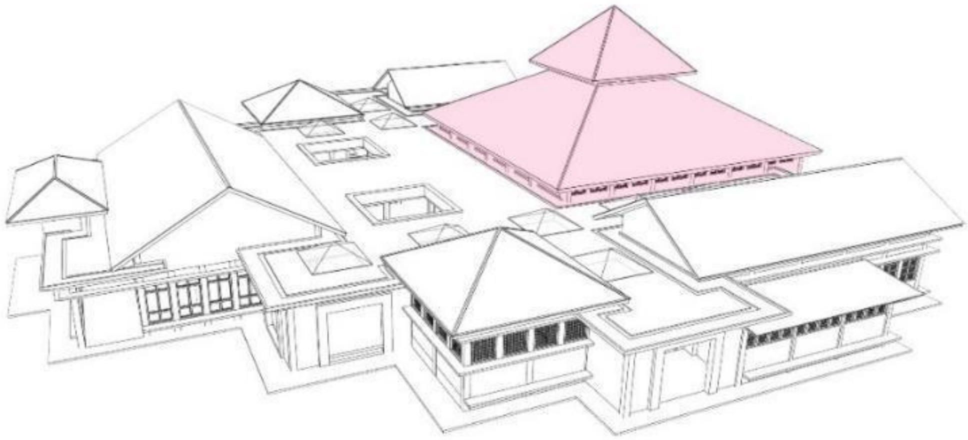


Figure 5: Bandar Universiti Masjid Axonometric view

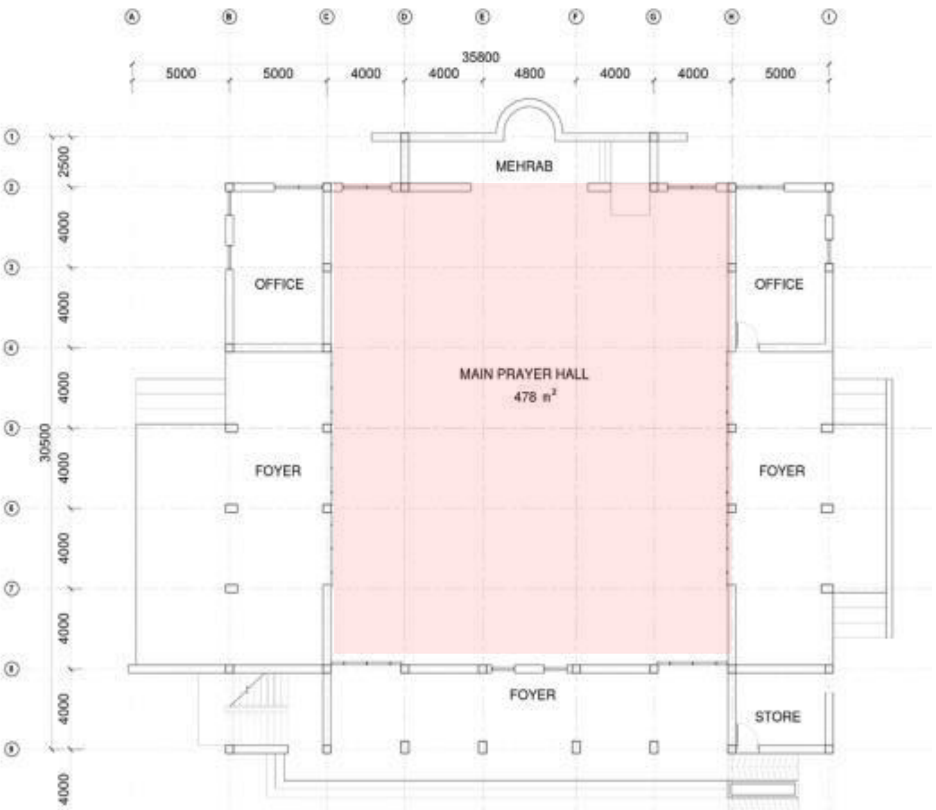


Figure 6: Abijo Masjid Floor Plan

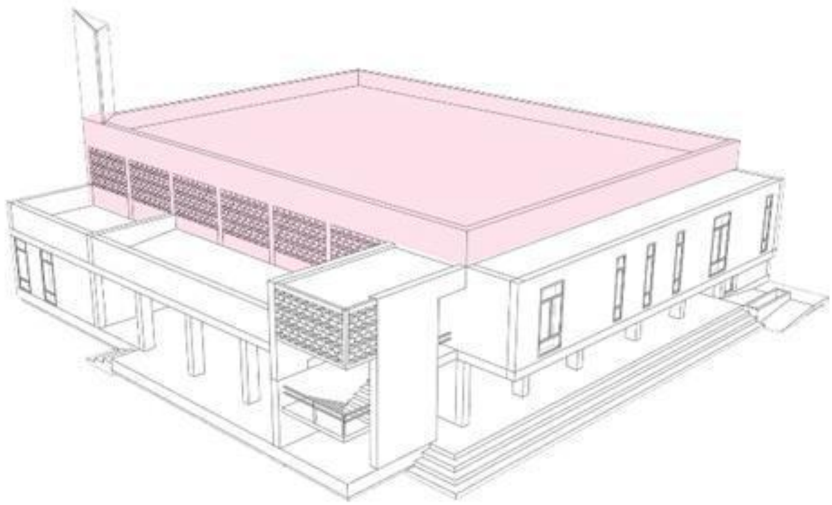


Figure 7: Abijo Masjid Axonometric view

III. RESULT

3.1 Daylight Performance between Bandar Universiti Masjid and Abbijo Masjid

After completing the daylight simulation for the Bandar University City Masjid and the Abijo Masjid, the results obtained are then tabulated as shown in Tables 1 and 2. Table 1 for Bandar University Masjid shows that there is a lack of permeability of daylight. The daylight achieved ideal quality illumination for only 4 hours from 11.00 am until 2.00 pm within only 1 meter of the opening. Other than that hour, the depth of the permeability of daylight is not achieved good quality illuminance to the main hall prayer. In this case, the orientation of the masjid also contributes to this effect. As stated above, the orientation is oriented to the northeast-southwest, so there is no direct sunlight that penetrates directly into the opening and allows more daylight to enter. The table also shows that the existence of a clear glass top hung in between the tiered roof does not help to give ideal visual quality in this particular area. In addition, the depth of the main hall prayer up to sixteenth meter is far compared to the opening, causing daylight cannot reach even the middle of the main hall prayer. It is even worse on the right and left sides of the hall, which is surrounded by other support buildings, where the daylight illuminance is not visible even if skylight is provided at the supported buildings.

Table 1: Day illuminance for Bandar Universiti Masjid

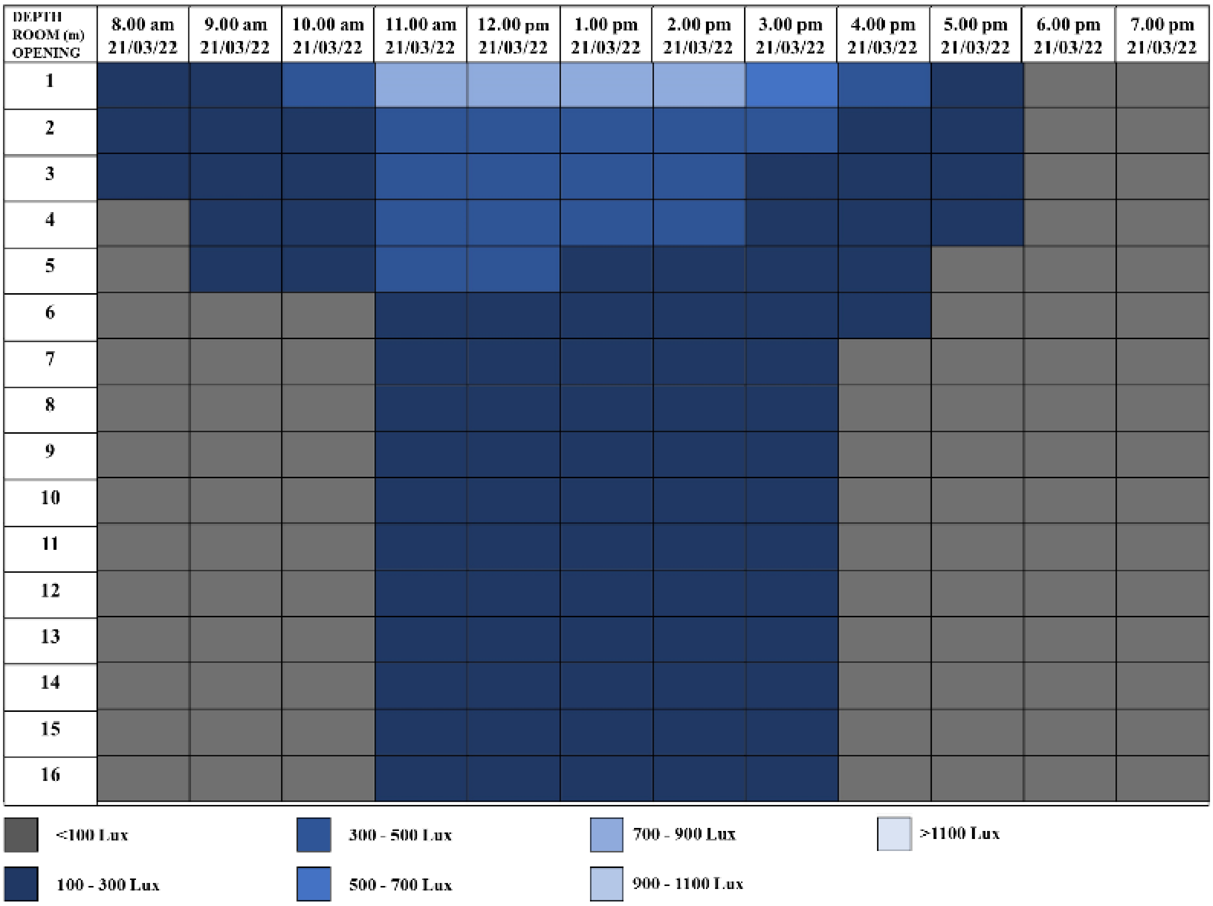
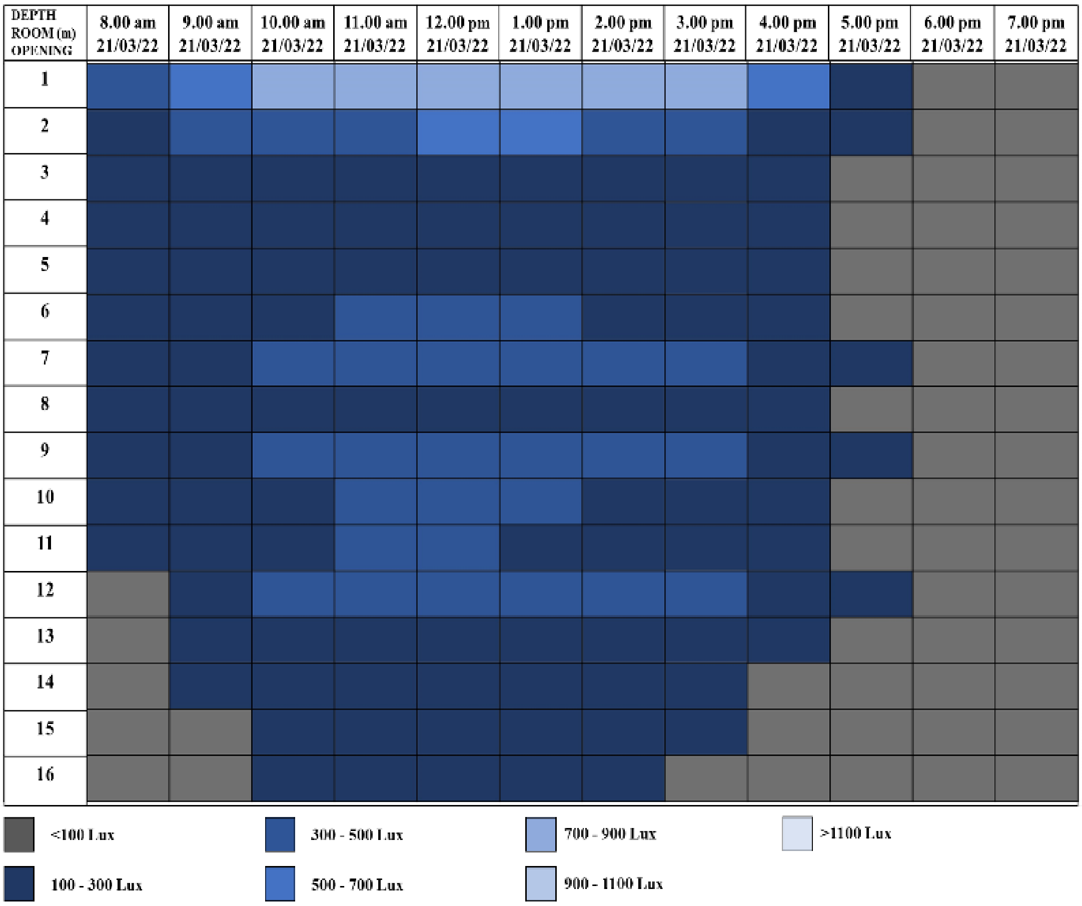


Table 2 shows the simulation results of Abijo Masjid. At the Abijo Masjid, the daylight permeability increases better than in a previous case study. The daylight permeability is wider and deeper up to 2 meters from the opening. The ideal visual quality is longer, up to 8 hours from 9.00 am to 4.00 pm. The opening from perforated sunscreen did help to illuminance the middle of the main prayer hall. Because of the indigenous design, which is a flat roof and straight wall, it allows more permeability compared to the tiered and large overhang in the previous study. The same goes for Abijo Masjid; the surrounding support reduces daylight permeability, shown clearly in gray color on right and left sides of the table. The information from Tables 1 and 2 was then graphed in 12 graphs (figure 8 to figure 19) to make a more direct comparison between the two models. To directly compare the illuminance attainment compared to depth in the research building hourly.

Table 2: Day illuminance for Abijo Masjid



The illuminance ideal parameters mentioned above are presented and shown in a different color green for MS1252 standard (300-400 lux), dotted green for JKR Standard (300 lux) implemented for Bandar Universiti Masjid, and pink color LEEDv4 standard (270-500 lux) for Abijo Masjid. The yellow line shows the illuminated level per meter depth at Abijo Masjid, while the blue line shows Bandar University Masjid.

The result from the comparison between illuminate to depth shows that Abijo Masjid achieved ideal illuminance from 8.00 am at 1st one meter. When the time increases and the sunlight gets brighter, the illuminance distance increases up to 2 meters starting at 9.00 am till 4.00 pm. The presence of additional daylight from the sunscreen wall in the middle of the hall also increases from 10.00 am to 1.00 pm, at 2.00 pm, the illuminance in the middle hall starts to decrease due to sun movement and decreasing sunlight penetration. At 4.00 pm, the illuminance source was only from the window beside the mihrab. The illuminance is completely not ideal starting 5.00 pm onwards, and artificial light is needed.

Bandar University Masjid only gets the ideal illuminance starting at 10.00 am at a 1-meter depth. The illuminance depth then gets wider to 5 meters till 2.00 pm and slowly decreases back to the 1-meter depth at 4.00 pm then after that, there was no more illuminance stated.

12 graphs then simplified to figure 20 that show average illuminance per hour for both buildings. The figure shows that the average illuminance at Bandar University Masjid is totally under the ideal quality standard, while for Abijo Masjid, ideal quality illuminance is only acquired for 5 hours from 10.00 am to 3.00 pm. From figure graph 20 also can be concluded that both buildings are below the level of visual comfort.

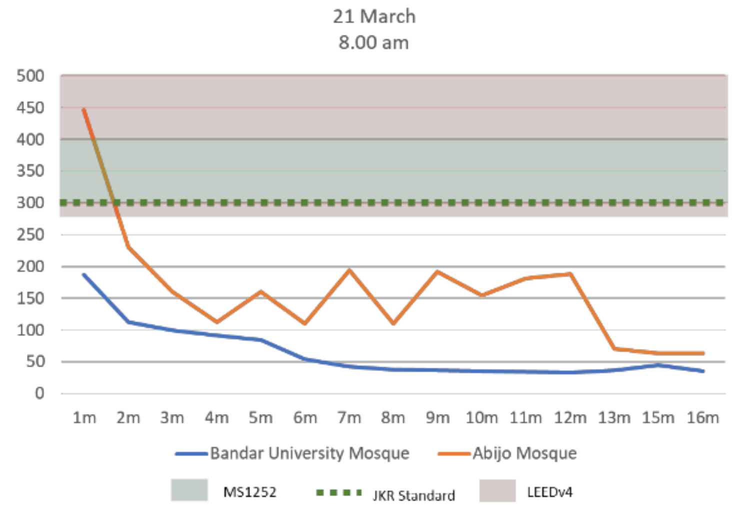


Figure 8: Comparison of daylight illuminance on 21 March 2022 (8.00 am)

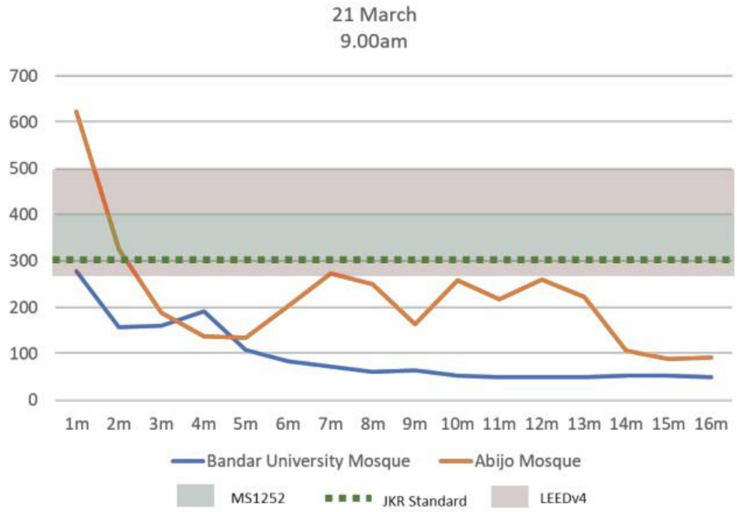


Figure 9: Comparison of daylight illuminance on 21 March 2022 (9.00 am)

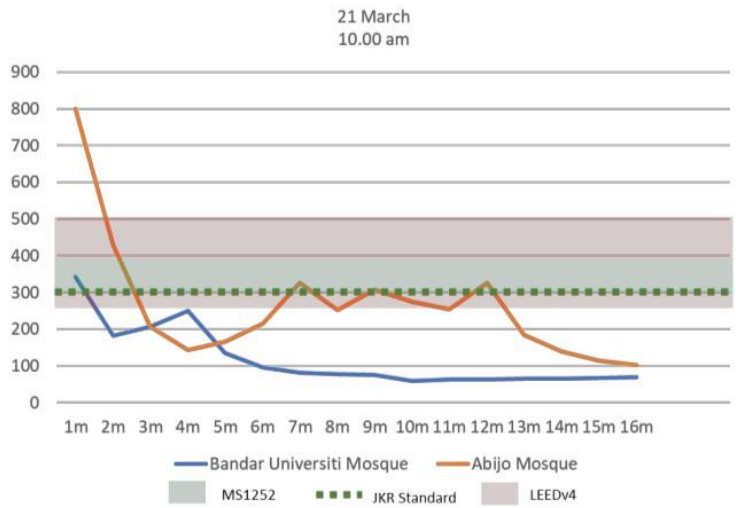


Figure 10: Comparison of daylight illuminance on 21 March 2022 (10.00 am)

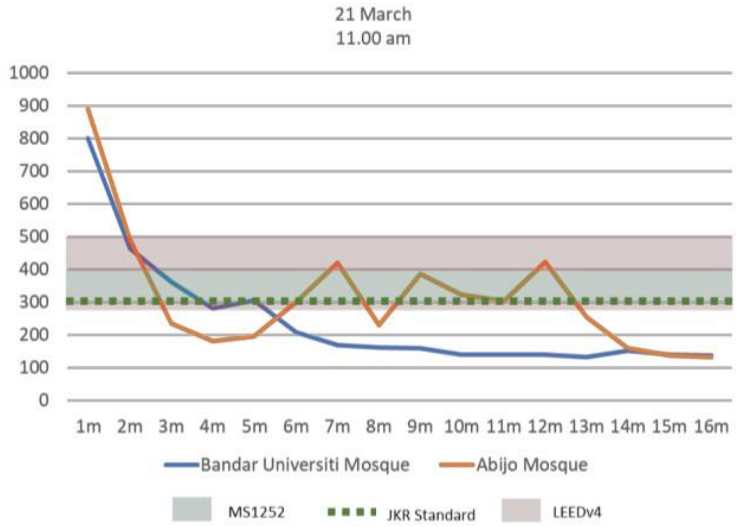


Figure 11: Comparison of daylight illuminance on 21 March 2022 (11.00 am)

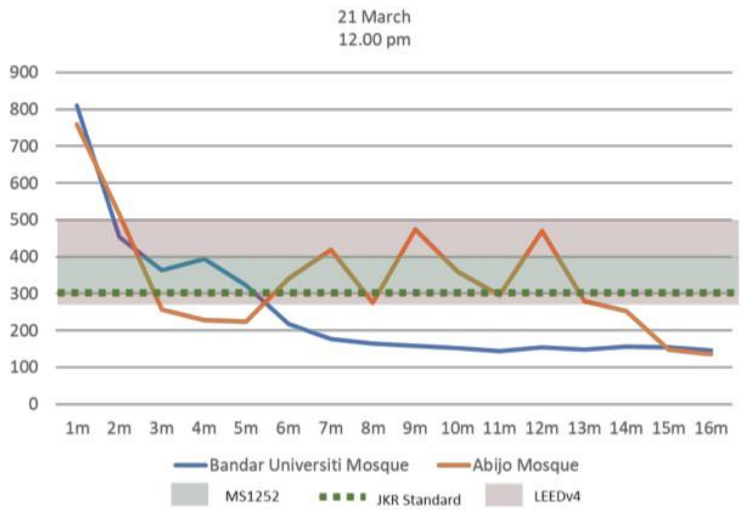


Figure 12: Comparison of daylight illuminance on 21 March 2022 (12.00 pm)

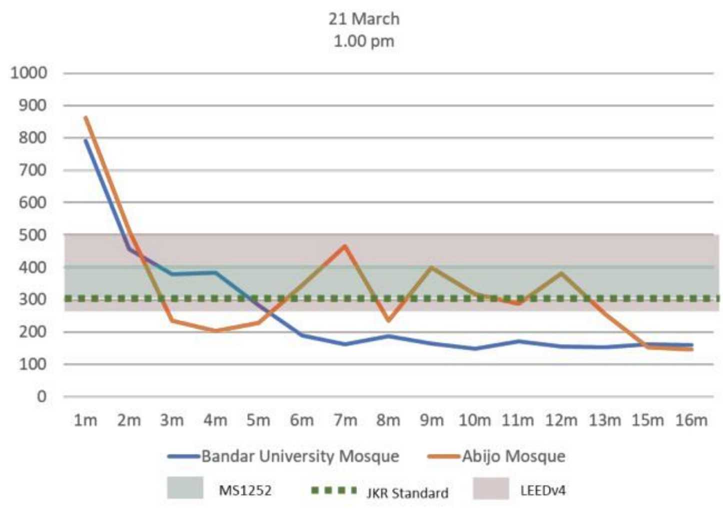


Figure 13: Comparison of daylight illuminance on 21 March 2022 (1.00 pm)

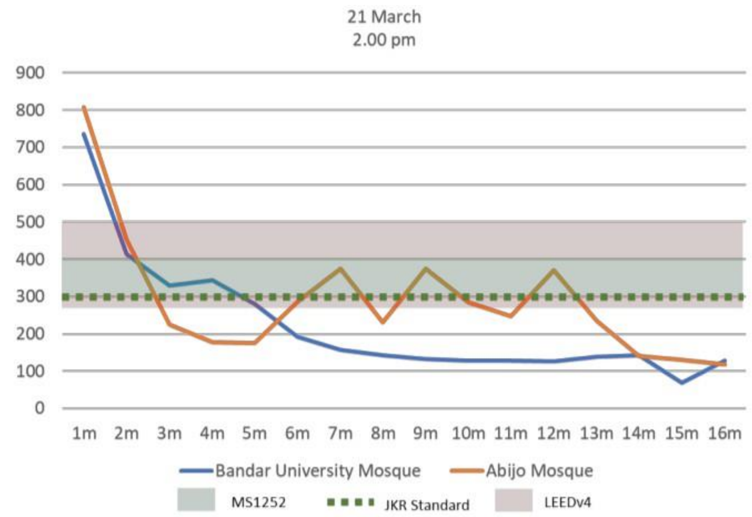


Figure 14: Comparison of daylight on 21 March 2022 (2.00 pm)

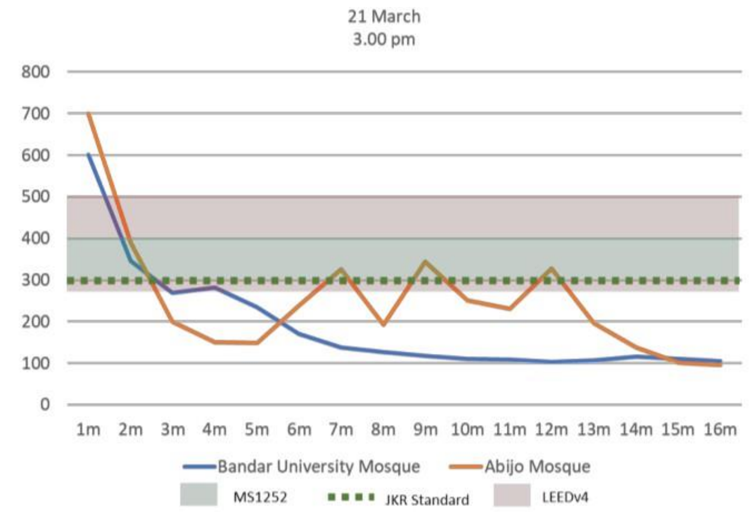


Figure 15: Comparison of daylight on 21 March 2022 (3.00 pm)

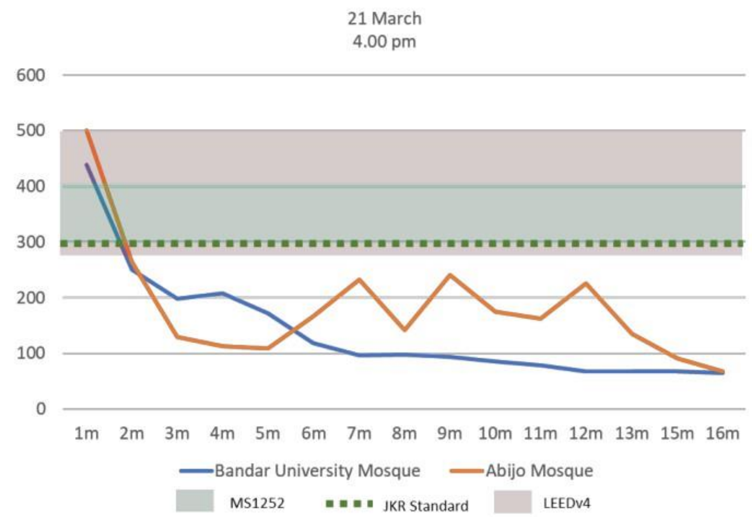


Figure 16: Comparison of daylight illuminance on 21 March 2022 (4.00 pm)

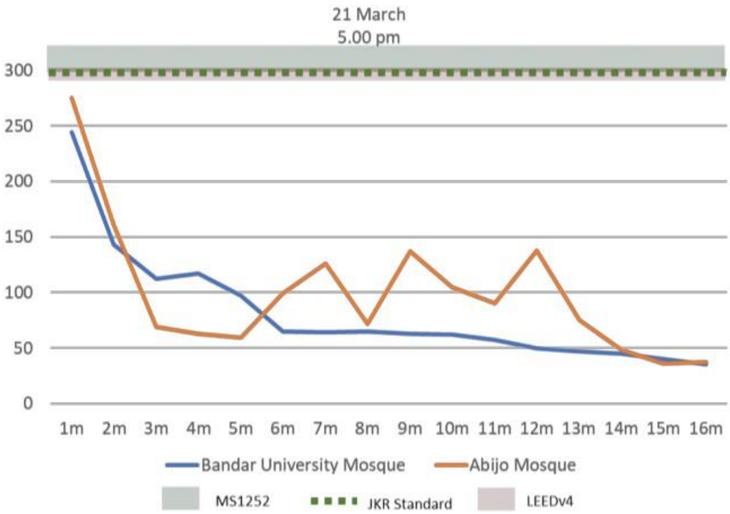


Figure 17: Comparison of daylight illuminance on 21 March 2022 (5.00 pm)

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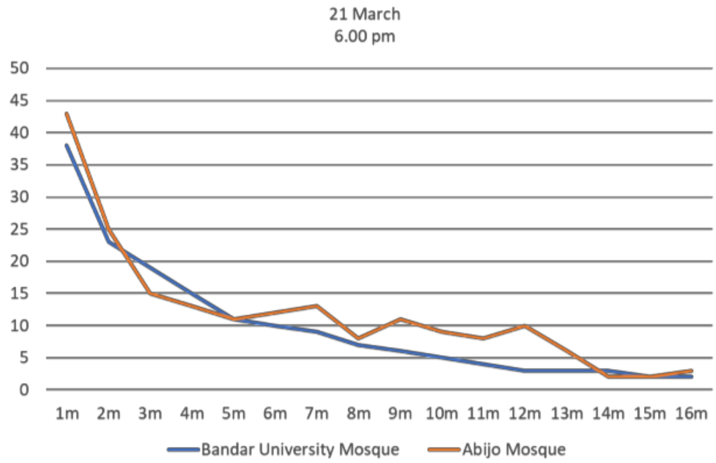


Figure 18: Comparison of daylight illuminance on 21 March 2022 (6.00 pm)

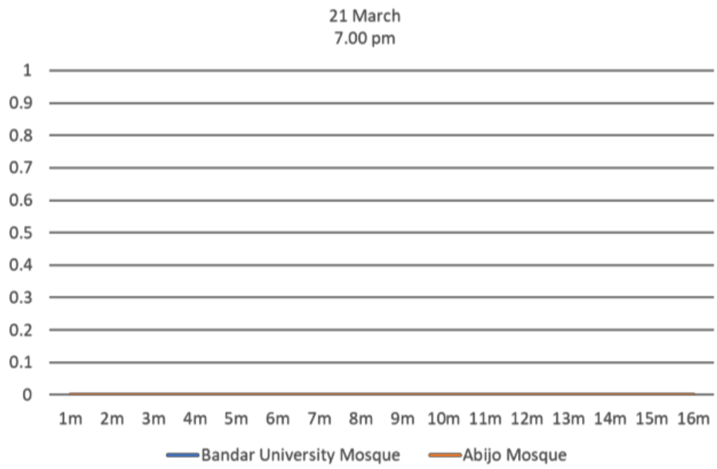


Figure 19: Comparison of daylight illuminance on 21 March 2022 (7.00 pm)

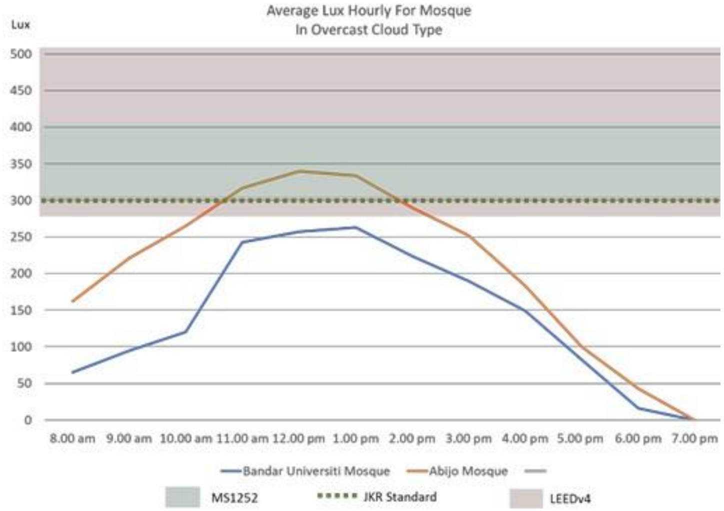


Figure 20: Comparison of average daylight illuminance on 21 March 2022 (from 8.00 am to 7.00 pm)

The simulation graph from figure 20 is further simplified in tables 3 and 4 for both buildings. Tables 3 and 4, which illustrate areas that receive a lot of light and those that receive less light, reveal significant changes. The red color shows the brightest area, followed by the yellow color, then the green color and finally, the blue color is no illuminance received. This table includes the following information:

a) The outcomes of the 3D simulation;
b) The minimum and maximum Lux values in each area; and
c) The average Lux reading in the area

According to findings, most of the average lux for both Bandar University Masjid and Abijo Masjid is below recommended lux, either MS1525, JKR Standard for local buildings or LEEDv4 for international buildings. The increase in daylight rate from 10.30 am to 2.30 pm only affects the good lighting of the Abijo Masid when it reaches 290 Lux to 315 lux on average, but not for the Bandar University Masjid, where it has not achieved any recommended lux. Daylight performance is declining after 3.00 pm to 6.00 pm for both buildings. The main Prayer Room for both buildings continues to be 0 lux when it is 7.00 pm. The comparison analysis between both masjids next table in figure 21 for more clear information.

Table 3: Simulation result 8.00 am -1.00 pm for both building

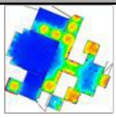
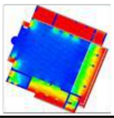
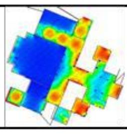
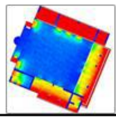
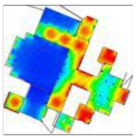
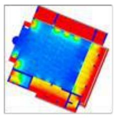
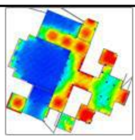
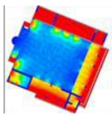
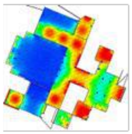
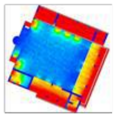
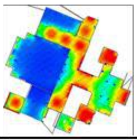
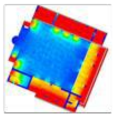
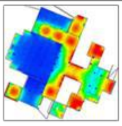
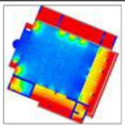
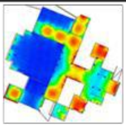
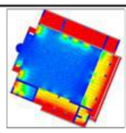
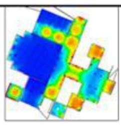
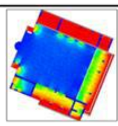
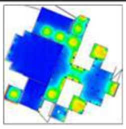
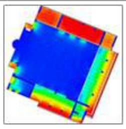
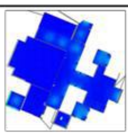
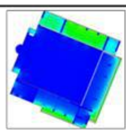
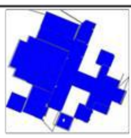
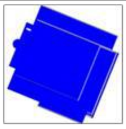
Hour	Bandar Universiti Mosque, Seri Iskandar, Perak (Ground Floor Plan)	Summary Area ($1982.5m^2$) Sky Type: Overcast Overall Average = 580.60 lux	Abijo Mosque, Lagos, Nigeria (Ground floor Plan)	Summary Area ($1963.5m^2$) Sky Type: Overcast Overall Average = 1,304.74 lux
8.00 am		Average:450.6 lux Average/Min: ∞ Max: 4,784.9 lux Min: 0.0 lux		Average: 1,102.5 lux Average/Min: ∞ Max: 6,295.4 lux Min: 0.0 lux
9.00 am		Average:450.6 lux Average/Min: ∞ Max: 4,784.9 lux Min: 0.0 lux		Average: 1,586.9 lux Average/Min: ∞ Max: 9,039.5 lux Min: 0.0 lux
10.00 am		Average: 802.3 lux Average/Min: ∞ Max: 8,494.3 lux Min: 0.0 lux		Average: 1,964.5 lux Average/Min: ∞ Max: 11,250.9 lux Min: 0.0 lux
11.00 am		Average: 901.4 lux Average/Min: ∞ Max: 9,538.1 lux Min: 0.0 lux		Average: 2,207.9 lux Average/Min: ∞ Max: 12,617.7 lux Min: 0.0 lux
12.00 am		Average: 940.5 lux Average/Min: ∞ Max: 9,949.8 lux Min: 0.0 lux		Average: 2,303.0 lux Average/Min: ∞ Max: 13,174.9 lux Min: 0.0 lux
1.00 pm		Average: 918.6 lux Average/Min : ∞ Max: 9,737.2 lux Min: 0.0 lux		Average: 2,245.0 lux Average/Min : ∞ Max: 12,771.0 lux Min: 0.0 lux

Table 4: Simulation result 2.00 pm -7.00 pm for both building

Hour	Bandar Universiti Mosque, Seri Iskandar, Perak (Ground Floor Plan)	Summary Area (1982.5m²) Sky Type: Overcast Overall Average = 580.60 lux	Abijo Mosque, Lagos, Nigeria (Ground Floor Plan)	Summary Area (1963.5m²) Sky Type: Overcast Overall Average = 1,304.74 lux
2.00 pm		Average: 833.4 lux Average/Min: ∞ Max: 8,818.2 lux Min: 0.0 lux		Average: 2,036.1 lux Average/Min: ∞ Max: 11,608.7 lux Min: 0.0 lux
3.00 pm		Average: 689.3 lux Average/Min: ∞ Max: 7,300.5 lux Min: 0.0 lux		Average: 1,688.2 lux Average/Min: ∞ Max: 9,516.5 lux Min: 0.0 lux
4.00 pm		Average:503.3 lux Average/Min: ∞ Max: 5,325.3 lux Min:0.0 lux		Average: 1,230.8 lux Average/Min: ∞ Max: 7,012.0 lux Min:0.0 lux
5.00 pm		Average: 282.7 lux Average/Min: ∞ Max: 3,001.2 lux Min: 0.0 lux		Average: 691.5 lux Average/Min: ∞ Max: 3,956.2 lux Min: 0.0 lux
6.00 pm		Average: 16 lux Average/Min: ∞ Max: 38 lux Min: 0.0 lux		Average: 43 lux Average/Min: ∞ Max: 42.99 lux Min: 0.0 lux
7.00 pm		Average: 0.0 lux Average/Min: ∞ Max: 0.0 lux Min: 0.0 lux		Average: 0.0 lux Average/Min: ∞ Max: 0.0 lux Min: 0.0 lux

CRITERIA	BANDAR UNIVERSITI MASJID, PERAK MALAYSIA	ABIJO MASJID, LAGOS NIGERIA
BUILDING INFORMATION	Architect: ArAZ Architect Location: Perak, Malaysia	Architect: Patrickwaheed Design Consultancy Location: Lagos, Nigeria
BUILDING TYPOLOGY	Mosque (Main Hall Prayer)	Mosque (Main Hall Prayer)
CLOUD CONDITON (March 2022)	increasing cloud cover, sky is overcast or mostly cloudy increasing from 75% to 86%	increasing cloud cover, sky is overcast or mostly cloudy increasing from 75% to 85%.
DAYLIGHT PERFORMANCE FACTOR	- **Building orientation** Turned to qibla that is in northeast–southwest very much coincide for reduce heat and glare from direct sunlight and give calm ambient. - **Opening Type** Clear glass sliding door and casement windows are used because of their capacity to let in light and fresh air. Other than that clear glass top hung also provided in between tiered roof to enter natural light. - **Support Building** The existence of support buildings such as Open Prayer Hall, Female Prayer Hall and width Verandah around the main hall is affecting the entry of daylight. - **Depth of Room** Mostly daylight came from opening beside the Mehrab. The depth of Main Prayer Hall is up to 16m from the opening. From finding we can see this depth are too far and hall area are wide, extra daylight access are needed from either from the side of hall or from tiered roof.	- **Building orientation** Turned to qibla that is in northeast–southwest very much coincide for reduce heat and glare from direct sunlight and give calm ambient. - **Opening Type** Clear glass sliding door and casement windows are used because of their capacity to let in light and fresh air. The existence of vent block at upper wall help daylight penetration into the main hall prayer. - **Support Building** The existence of support buildings such as wide foyer and office around the main hall is affecting the entry of daylight. - **Depth of Room** Daylight came from opening beside the Mehrab and vent block at side of hall. The depth of Main Prayer Hall is up to 16m from the opening. From finding we can see this depth are quite far and hall area are wide, but with extra opening from vent block at side of hall are help give extra daylight access.
DAYLIGHT RATING TOOL	MS1525:2014, JKR STANDARD (BUILDING ASSEMBLY- Multipurpose Hall)	LEED v4.1 DAYLIGHT
ILLUMINATION LEVEL STANDARD	Guideline: Achieve illuminance level 300-400 Lux (MS1525), 300 Lux (JKR STANDARD) Simulation: The average daylight at main prayer hall are under ideal quality which is mostly below 300 lux in average.	Guideline: Achieve illuminance levels 270 lux to 500 lux. Simulation: Mostly achieving ideal quality 300 lux and above at 9.00am – 4.00pm. Other than that, it's are under ideal quality of daylight.

Figure 21: Comparison of Overall analysis for Bandar Universiti Masjid and Abijo Masjid

IV. DISCUSSION

In general, according to the findings indicated in figures graph 20, neither building received enough light penetrates to the main prayer hall, except for a few hours at the Abijo Masjid. From the above data, it is also recommended that each illuminance below the range of requirements listed needs to be improved with artificial light to increase the effectiveness of space in attaining appropriate lighting while offering comfort to the user. However, too much dependence on artificial lighting will increase building operation costs which should be avoided but still, daylight overflow that lead to heat and glare should be taken seriously [6].

In both of the case studies, the data readings show that the illuminance reading rate in the room depends on daylight permeability, while daylight permeability depends on the depth, distance of the room and the various periods of the sun's movement. The orientation of the building cannot be faulted because it has been in the best position to avoid direct sunlight, which brings glare and heat. However, the existence of other obstacles, such as being surrounded by other buildings, small windows, and large overhangs, somewhat hinder daylight permeability. Therefore, it is important to tackle sunlight penetration and movement because the natural movement of sunlight cannot be changed, but the reception of sunlight can be manipulated by ensuring the position and size of the opening in the building is appropriate to enable ideal lighting in the building. Prior to that, it is also important to make sure no daylight overflow is received to avoid glare and heat.

The position of the Main Prayer Hall of the two buildings, which are located in the middle and surrounded by other support buildings, makes it difficult for daylight to enter. The existing clear glass window at the North-East building, the glass sliding door, and the glass wall surrounding the main hall prayer should be sufficient for some buildings, but not these two studied buildings. It is recorded not enough to achieve recommended daylight lux. In Bandar Universiti Masjid, the existent skylight at the right side of the main hall prayer is seen to have no big effect on the rate of daylight entry; the same goes with the existing top- hung windows between the tiered pitch roof. While for Abijo Masjid, the graph shows daylight has entered and affected daylight performance in the main hall prayer by the perforated opening at the upper wall. However, it only achieved the illuminance recommendation for only 4 hours out of the 12 hours of the entire study, from 10.30 am – 2.30 pm; the rest of the artificial lighting was required. It is seen not to achieve the purpose that innovative lighting systems are made to guide sunlight or skylights to a specific location without glare [3].

Overall, both building sustainable strategy is not sufficient for visual comfort, especially in the most actively used space i.e., the Main Prayer Hall. However, visual comfort from natural sources such as daylight should also be taken into account and should be improved with better strategies according to the location of the window; the sizes and numbers are important to allow daylight to get in and provide illuminance to the interior. The size and positioning of windows, as well as occasionally the use of light shelving, all contribute to perimeter illumination [5].

After comparing the illuminance received by these two buildings, it was found that there is a difference in the daylight received by this building. Abijo Masjid shows received more illumination compared to Bandar University Masjid. The significant difference obtained is the existence of an opening from the sunscreen wall in the middle of the hall in Abijo Masjid, which helps the illuminance in the main prayer hall compared to Bandar University Masjid, which depends on the narrow top hung on the tiered roof and skylight in the support building. Apart from that, even though these two buildings share the same tropical climates, but Nigeria received more penetration of daylight compared to Malaysia, making the daylight brighter in Nigeria and helping the illuminance hold longer time at Abijo Masjid.

V. CONCLUSION

The study's goal was to determine if buildings with sustainable element designs function well during the day. By comparing the average illuminance that daylight can enter the buildings with a country-specific daylight rating tool, how well the building performs in daylight can be determined. The findings of the study in the term of sustainable daylight harvest show that these two buildings were built with good consideration in terms of building orientation and type of windows but not in terms of depth of space and building layout, which support spaces attached to the main building space affected the reception of daylight to the Main Prayer Hall.

The results of this study showed that the objectives of the study were achieved. The study reveals how the climate, design layout strategy, windows opening, and room depth give impact indoor daylight performance. Therefore, further study must be done by studying the optimal daylight performance and investigating the effective way to penetrate daylight in between the support buildings that are attached to the main prayer hall to increase daylight performance and, at the same time, reduce the use of artificial lighting and electrical energy**.**

Finally, this paper reveals how masjid building design approaches can affect daylight reception. To achieve the ideal quality of illuminance, more in-depth studies need to be done to enhance the significant impact on daytime lighting systems, to improve energy efficiency in two different regions at Tropical Climate, namely Bandar Universiti Masjid in Malaysia and the Abijo Masjid in Nigeria which was used as case studies. It shows how important it is to give careful thought to building orientation, layout plan, opening design, and proper material selection to ensure each occupant has the best visual comfort, physical well-being, lighting quality, and human satisfaction.

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