Effective Daylight Design Strategies of Colonial Mosques in Malaysia

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Abstract
This study evaluates the effective Daylighting design strategies of Colonial Mosques in Malaysia. There are two objectives, and the first objective is to examine the Daylighting performance of the main prayer hall of three Colonial Mosques in Malaysia. The second objective is to identify effective Daylighting design strategies from the Colonial Mosques in Malaysia. The triangular research methodology was applied for this study. The research methodology consists of literature review, field observation, and Daylighting analysis simulation with Sefaira simulation software. In conclusion, window heights influence the Daylighting performance of the main prayer hall. Higher windows give more effective Daylighting.

Keywords: Daylight; Mosque; Colonial; Malaysia

DOI: https://doi.org/10.21834/ajebs.v6i18.381

1.0 Introduction

The functions of mosques are the same all around the globe. It is a place where Muslims perform their prayers, religious education, and other religious activities, either individually or congregational. It is accessible 24 hours, which requires long hours of sufficient lighting. Therefore, artificial lighting should only be for nighttime use, and natural Daylighting should be utilized during the day. Using natural Daylighting is one of the passive design strategies, and excessive energy consumption can be avoided (Standards Malaysia, 2014). Daylighting has no cost, and it is part of renewable energy (Al-Ashwal & Hassan, 2017). It also plays a role in zero-carbon emission buildings initiatives (Lo Verso & Pellegrino, 2019)

The utilization of natural Daylighting to illuminate the indoor space is called Daylighting (Heschong et al., 2002). The source of natural Daylighting and energy is primarily the Sun. Natural Daylighting is distributed directly and indirectly. The intensity and quality of Daylighting received depend on the solar geometry of that particular site location. The site location has its regional climate, sky condition, geographical latitude, and solar geometry (Wong, 2017).

The study focused mainly on the main prayer hall area of the three colonial mosques. The main prayer hall is often at the center of the mosques, surrounded by open corridors or verandas. These spaces function as over-spilled areas when the congregation prayer crowd turns out to be more than the capacity of the main prayer hall. However, having these over-spilled areas make the main prayer hall further away from the natural Daylighting source. Therefore, this research intended to investigate effective Daylighting strategies of three Colonial Mosques in Malaysia; Ubudiah Royal Mosque, Pasir Pelangi Royal Mosque, and Sultan Ibrahim Jamek Mosque. These three colonial mosques were selected based on their similar spatial organizations. There are two (2) objectives to this research. The first objective is to evaluate the Daylighting performance of the main prayer hall of Colonial Mosques in Malaysia. The second objective is to identify effective Daylighting design strategies in the main prayer hall of the Colonial Mosques.

This study responded to the United Nations Agenda 2030 Sustainable Development Goals, SDG 7, 11, and 12. It responded to SDG 7, which stands for Affordable Clean Energy, by utilizing natural Daylighting from the Sun and minimizing artificial lighting consumption. It relates to SDG 11, which stands for Sustainable Cities and Communities, by finding solutions in sustaining the operation of the mosques with natural resources rather than being dependant on artificial resources. Lastly, it relates to SDG 12, which stands for Responsible Consumption and Production, where this study demonstrated the value of heritage buildings.

A verse in the Quran stated, "O children of Adam, take your adornment at every masjid, and eat and drink, but be not excessive. Indeed, He likes not those who commit excess" (Quran 7:31). The verse reminds the human race not to be wasteful and avoid excessive energy consumptions.

2.0 Literature Review

This chapter consists of three sub-topics; Colonial Mosques, Malaysia Climate, and The Principle of Daylighting.

2.1 Colonial Mosques

There are three mosque architecture styles in Malaysia, which are classified as Vernacular, Colonial, and Modern (A Ghafar Ahmad, 1999). Vernacular and Colonial mosques are part of Malaysia Architectural Heritage. They were built between the years 1728 and 1956. Meanwhile, mosques, which were built after 1957 are classified as modern Post-Independence and Contemporary Mosques (Rosniza, 2011) Figure 1 shows the chronology of Colonial Mosques built in Malaysia from 1808 to 1938.

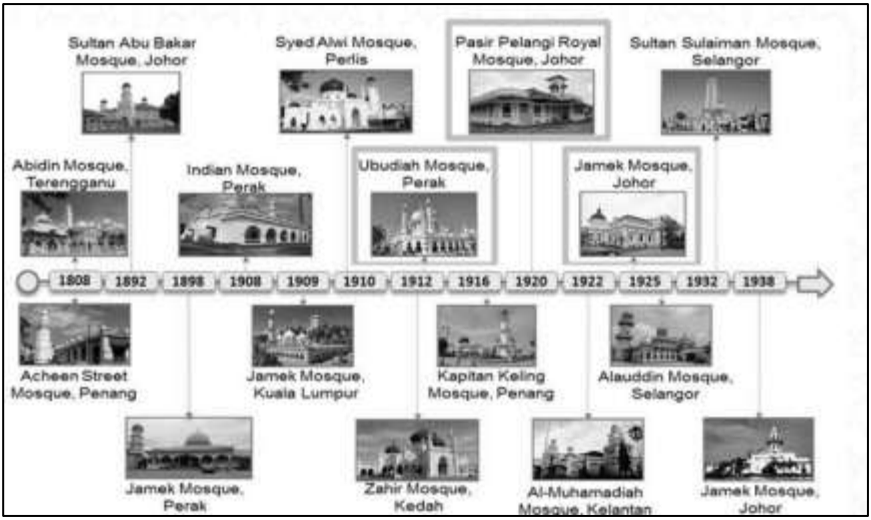


Figure 1: The chronology of Colonial Mosques in Malaysia
(Source: Sanusi et al., 2019)

This study focused on three Colonial Mosques shown in Figure 1; Ubudiah Mosque in Perak, Pasir Pelangi Royal Mosque and Sultan Ibrahim Jamek Mosque in Johor.

2.2 Malaysia Solar Geometry

Sun is the primary source of Daylighting. Therefore, an understanding of the site solar geometry is crucial to achieving good indoor space Daylighting. Located near the equator with a latitude 3.2°N and longitude 101.7°E, Malaysia receives 12 hours of sunlight per day. The Sun rises around 7:00 a.m. and sets before 8:00 p.m. throughout the year. However, the solar intensity started low after sunrise and gradually increases towards the afternoon. The solar radiation reaches its peak between 12:00 p.m. to 3:00 p.m. during non-rainy days, where the sun angle is almost 90o perpendicular to the ground surface (Figure 2). The solar intensity starts to decrease back after 3:00 p.m. Figure 2 shows the sun path diagram for Malaysia. It illustrates hourly solar angles throughout the year. In March, the sun angle is 90o from the ground, whereas the sun angles are tilted slightly to the North in June. In December, the sun angles tilted slightly to the South (Standards Malaysia, 2014). Building designers should be aware of the solar geometry at the initial stage of design. Late morning sun at 11:00 a.m. from the East and late afternoon sun at 4:00 p.m. from the West can give intense solar radiation. Building openings in Malaysia should avoid direct sunlight from the east and west direction and implement a passive Daylighting strategy (Arifin & Denan, 2015).

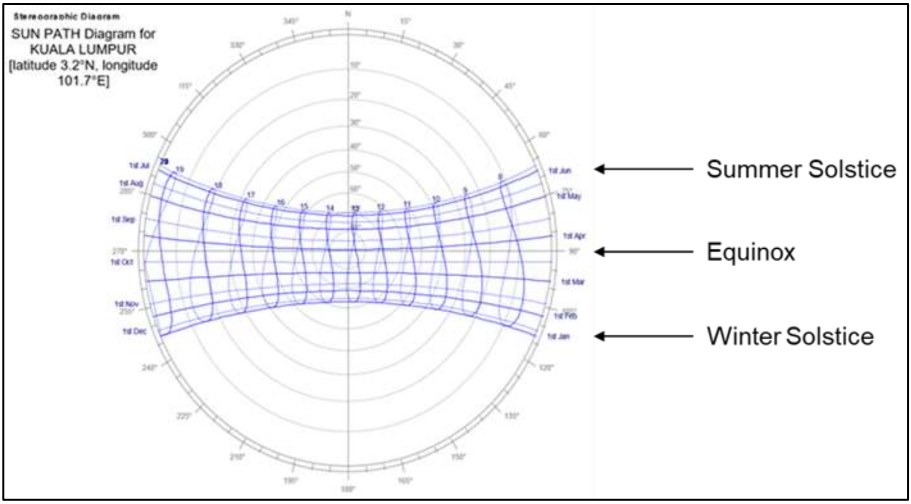


Figure 2: Sun Path diagram for Malaysia, latitude 3.2^{o}N, longitude 101.7^{o}E
(*Source: Standards Malaysia, 2014)*

Building occupants would experience visual discomfort caused by direct solar glare. Therefore, it is crucial to consider appropriate Daylighting penetration to ensure visual comfort. The building occupants will achieve visual comfort in a condition that is free from any distraction, sensitivity, and pain towards visual performance (Nasrollahi & Shokri, 2016). Andersen et al. (2013) suggested using diffused lights as part of the passive Daylighting approach.

2.3 The Principle of Daylighting

Effective Daylighting uses natural resources that help minimize building energy consumption and operational cost (Womeldorf, 2018). Daylighting can be effective when the indoor spaces are lit up by natural light through openings in the building façade (Knoop et al., 2020). Apart from the opening and façade design, appropriate site configuration also needs to be considered to avoid visual discomfort caused by direct sunlight. Naamandadin et al. (2016) stated that building designs should be responsive to the site orientation to be good designs. It can be achieved through responsive façade design, by having appropriate shadings on the sun-facing façade. Besides façade design, good landscaping can also be part of the passive Daylighting design approach. The tree canopies act as natural shading devices to the sun-facing façade (Standards Malaysia, 2014).

The most well-known principle of Daylighting is the Daylighting Rule of Thumb (DRT). DRT is often used to predict the depth of daylit zones from the window of space. It gives a daylit zone depth (D) to the top window height (H) ratio as D=2H (Figure 3). The daylit zone depth (D) to window height (H) ratio is D = 2H (Figure 3). Deep daylit zones can be achieved with a higher window (From this DRT, the higher the window the deeper the daylit zone will be achieved (U.S. Environmental Protection Agency and U.S. Department of Energy, 2003).

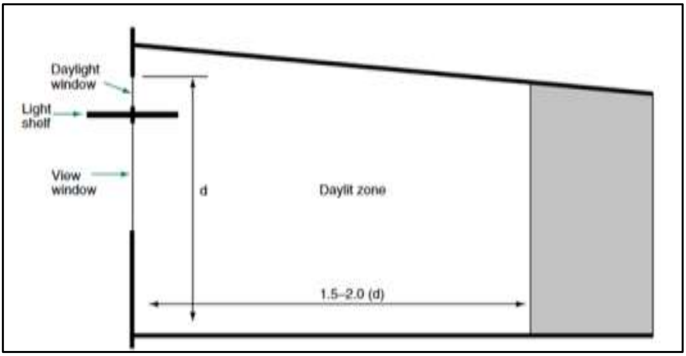


Figure 3: Daylight Rule of Thumb; daylight penetration depth (D) to the window height (H) ratio.
D = 2H.
(Source: U.S. Environmental Protection Agency & U.S Department of Energy, 2003)

Effective Daylighting is identified by its Daylight Factor (DF) measures (Standards Malaysia, 2014) It is measured in percentage with the following formula;

$$DF = E_{internal} / E_{external} \times 100\%$$

This study used two daylighting performance measures; Spatial Daylight Autonomy (sDA) and Daylight Factor (DF). Spatial Daylight Autonomy (sDA) is the autonomy of daylight achieved in space. sDA will predict how many percent of the spaces can achieve the desired illuminance level, for example, 300 lux. The acceptable percentage of sDA of space is above 55%. A more preferable sDA value is above 75% is much preferred for more effective Daylighting (Ayoub, 2020).

Meanwhile, Daylight Factor (DF) is a ratio of the indoor illuminance level ($E_{internal}$) to the outdoor illuminance level ($E_{external}$). $E_{internal}$ is measured at the working area of the indoor space. and of the percentage amount of daylight penetrated inside the building indoor space from the external (BRE, 1986). Regarding Table 1, the acceptable DF ranges from 1.0% to 3.5%, with acceptable thermal comfort and acceptable glare. (Standards Malaysia, 2014).

Table 1: The impact of each Daylight Factor (DF) range

DF (%)	Lighting	Glare	Thermal Comfort
> 6.0	Intolerable	Intolerable	Uncomfortable
3.5 – 6.0	Tolerable	Uncomfortable	Tolerable
1.0 – 3.5	Acceptable	Acceptable	Acceptable
<1.0	Perceptible	Imperceptible	Acceptable

(Source: Standards Malaysia, 2014)

3.0 Methodology

The research methodology responded to the two objectives (Figure 4). It comprises of Literature Review, Observation, and Daylight Simulation (Figure 4).

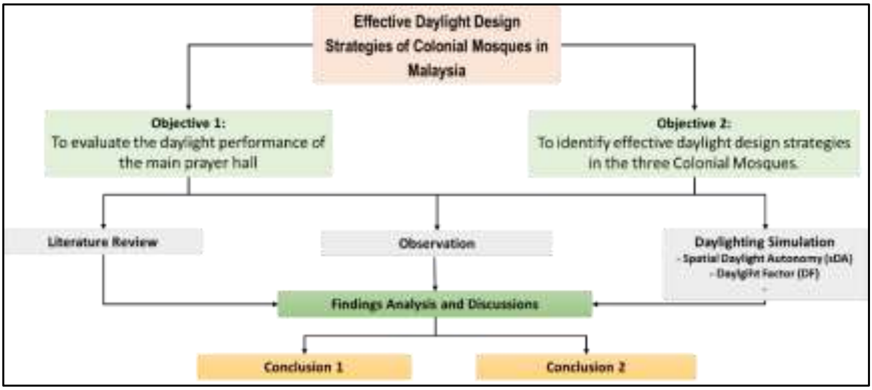


Figure 4: Research Methodology Chart

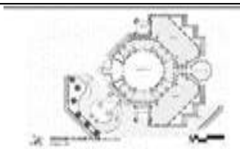
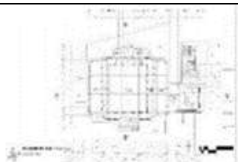
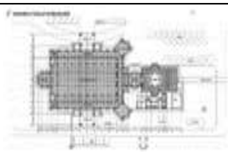
3.1 Literature Review

Table research was carried out on the three Colonial Mosques; Ubudiah Mosque (Azmin et al., 2018), Pasir Pelangi Royal Mosque (Abdullah et a., 2018), and Sultan Ibrahim Jamek Mosque (Azmin et al., 2014). Comparative analysis was carried out between the passive daylighting design strategies of the three Colonial Mosques to findings from other research works conducted previously on other mosques by other researchers.

3.2 Observation

Observations were carried out on the three Colonial Mosques. Initial findings are tabled in Table 2.

Table 2: The case study details for three different mosques

Mosque	Ubudiah Royal Mosque 	Pasir Pelangi Royal Mosque 	Sultan Ibrahim Jamek Mosque 
Location	Kuala Kangsar, Perak	Johor Bahru, Johor	Muar, Johor
Year	1917	1920	1927
Plan (Current)	 Symmterical Layout, North-West orientation due to Qiblat direction.	 Symmterical Layout, North-West orientation due to Qiblat direction.	 Symmterical Layout, North-West orientation due to Qiblat direction.

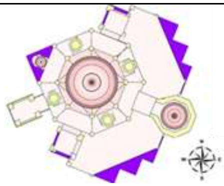
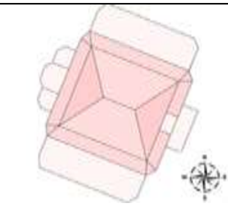
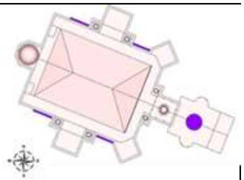
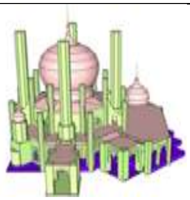
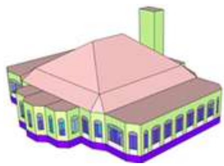
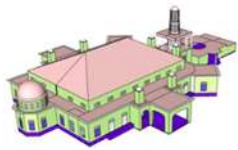
(Source: Azmin et al., 2018, Abdullah et a., 2018 and Azmin et al., 2014)

3.3 Daylighting Simulation

The Daylighting Simulation was carried out with the aid of Simulation Software, called Sefaira. The three Colonial Mosques were modeled in Sefaira with the correct environment settings, as shown in Table 3. The Sefaira models of the three Colonial Mosques were used for daylighting simulation. It evaluated the daylighting performance of the three Colonial Mosques. However, this study is only limited to the measures of Daylight Factor (DF) and Spatial Daylight Autonomy (sDA). Before daylight simulation, specific environment parameters were keyed in, which was required by Sefaira.

Table 3: Virtual Model of the case study mosques in Daylight Simulation Software, Sefaira.

Mosque	Ubudiah Royal Mosque	Pasir Pelangi Royal Mosque	Sultan Ibrahim Jamek Mosque
Latitude, Longitude	4.7641°N, 100.9508°E	1.4881°N, 103.7858°E	2.046468°N, 102.558267°E

Virtual Model in Plan. Scale: n.t.s.			
Virtual Model in 3D. Scale: n.t.s.			

4.0 Results

4.1 Findings on Passive Daylighting Strategies in Mosques from Literature Review

As mentioned earlier, most mosques have a veranda circulating the main prayer hall and acts as an extra area or overspilled area during congregational prayers when the main prayer hall could not contain the whole congregation. From an environmental perspective, the veranda protects the main prayer hall from excessive direct sunlight and glare. Sanusi et al. (2019) concluded that verandah is one of the passive Daylighting strategies in Colonial Mosques.

Mosque façade functions as an envelope that protects the indoor spaces from excessive glare. Abdullah et al. (2016) concluded that a façade design will affect the occupant's visual comfort (Abdullah et al., 2016).

One of the passive Daylighting strategies found in Colonial Mosques is their large opening, which provides good Daylighting as well as ventilation (Sanusi et al., 2019). The daylighting in mosques could be maximized by the vertical and horizontal arrangement of the windows. They are installed to allow natural lights into the indoor spaces (Baharudin & Ismail, 2014).

Arel & Öner (2017) carried out a daylight analysis on three historical mosques in Spain, Iran, and Turkey. He studied the daylight effect in the Great Mosque of Cordoba in Spain, Sheikh Lotfollah Mosque in Iran, and Selimiye Mosque in Turkey (Figure 4). From the findings of his study, he concluded that Daylight penetration is essnetial in mosques design. It goes beyond just lighting up the space naturally. The daylight penetration effect connects the worshipers to God. However, the openings in Selimiye Mosque are as high as the dome level, which distributed daylight equally through every corner of the huge indoor space of the prayer hall (Arel & Öner, 2017). According to Aljofi (2018), the windows at dome level could act as part of daylighting strategies in mosques with a series of windows at the bottom of the dome.

Figure 4: Windows placed around the dome of Selimiye Mosque, Turkey
(Source: Arel & Öner, 2017)

Dome-level windows and clerestory windows are located at a higher level than the walls. The high window, providing effective daylighting to the indoor space relates to the Daylight Rule of Thumb (DRT) mentioned earlier. In 2016, El-Darwish, & El- Gendy evaluated the daylight performance of four 19th century historical mosques in Alexandria. From his findings, he concluded that the higher the clerestory window is located, the more floor area gets effective daylight. Therefore, the study also concluded that clerestory windows are essential to have in mosque designs to achieve effective daylighting (El-Darwish, & El-Gendy, 2016).

Another daylight design factors are the window to wall ratio (WWR). This design factor should be considered in the windows and opening designs of building facades. Alabdulazeem et al. (2019) concluded from their research findings, that windows should be placed above the eye level of the worshipers performing their prayers. This is to protect the worshipers from visual discomfort caused by glare. Furthermore, he also concluded that higher windows increase light distribution to the indoor spaces.

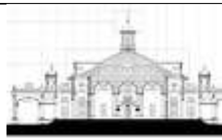
Besides window and façade design, Belakehal et al., (2016) found that white and bright surfaces could improve the Daylighting performance of the indoor spaces. As for orientation, in mosques design, the main prayer hall orientation is pre-determined by the direction of the Qiblah, which is North-West direction in Malaysia.

4.2 Comparative Analysis of the Passive Daylighting Strategies in Colonial Mosques

Table 4 summarises the comparative analysis of the passive daylighting strategies of the three Colonial Mosques.

Table 4: Comparative analysis of the passive daylighting strategies of the three Colonial Mosques.

PASSIVE DAY-LIGHTING	Ubudiah Royal Mosque	Pasir Pelangi Royal Mosque	Sultan Ibrahim Jamek Mosque

STRATEGIES			
Prayer Hall	√	√	√
Veranda	√	√	√
Ablution Area	√	√	√
Peripheral Openings	√	√	√
Clerestory or Dome level Windows	√	X	√
Images of Window Types			
Window to Wall Ratio	16%	22%	12%
Total Window Heights	 *(Source: Azmin et al., 2018)* 10m	 *(Source: Abdullah et a., 2018)* 3.75m	 *(Source: Azmin et al., 2014)* 8m
Floor Depth	20m	15m	18m
Shading - Overhang	√	√	√
Daylight Rule of Thumb	D = 2H	D = 4H	D = 2.25H
Shading Fins	√	√	√
Louvers	X	X	X
Arches	√	√	√
Floor Surface	Bright/White	Bright/White	Bright/White
Wall Surface	Bright/White	Bright/White	Bright/White
Ceiling Surface	Bright/White	Bright/White	Bright/White

(Source: Azmin et al., 2018, Abdullah et a., 2018 and Azmin et al., 2014)

The passive Daylighting strategies of the three Colonial Mosques were compared. Table 4 shows they are similar in having a praying hall, veranda, ablution area, peripheral openings, shading overhangs, shading fins, arches, and bright indoor surface colours. However, the three Colonial Mosques differ in clerestory windows, window to wall ratio, and maximum window heights to floor depth ratio (DRT).

4.3 Daylight Simulation

Daylight simulation was carried out in two measurements. This study measures the Spatial Daylight Autonomy (sDA) and Daylight Factor (DF) of the main prayer hall of the three Colonial Mosques. The site and design parameters of the three Colonial Mosques were set up in Sefaira along with the building simulation model. They are the site location, the orientation of the mosques, and minimum illuminance required, which was 300 lux.

Table 5 and Figure 5 show the summary results of the average Spatial Daylight Autonomy (sDA) percentage in the overall building spaces, the main prayer hall, and the verandah of the three Colonial Mosques. From the results, it is shown that the sDA percentage in the main prayer hall of Ubudiah Royal Mosque is 61.0%, which is an acceptable percentage of space that achieved 300 lux in daylighting performance. Whereas the other two mosques, Pasir Pelangi Royal Mosque and Sultan Ibrahim Jamek Mosque sDA percentages are very low.

Table 5: Average sDA percentage for the three Colonial Mosques

	Spatial Daylight Autonomy (%)		
Mosque	**Ubudiah Royal**	**Pasir Pelangi Royal**	**Sultan Ibrahim Jamek**
Main Prayer Hall	61.0%	7.0%	5.0%
Veranda	90.0%	94.0%	69.0%
Overall	82.0%	56.0%	32.0%

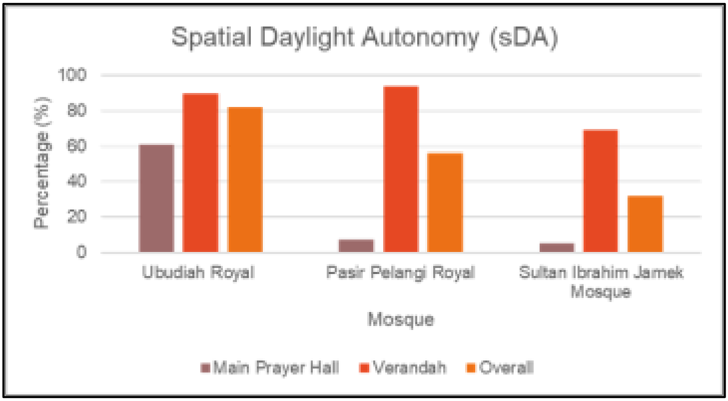


Figure 5: Average Spatial Daylight Autonomy (sDA) of the main prayer hall, veranda and overall spaces in the three Colonial Mosques.

Figures 6, 7, and 8 show the average sDA of the overall spaces, the main prayer hall, and the verandah area of the three Colonial Mosques. Figure 6 image shows the center area of the main prayer hall gets a sufficient amount of 300 lux daylight. Meanwhile, Figures 7 and 8 show that the main prayer hall of the other two Colonial Mosques did not achieve 300 lux in most areas.

Table 6 and Figure 9 show the summary results of the average Daylight Factor (DF) in the overall building spaces, the main prayer hall, and verandah of the three Colonial Mosques. The results have shown that the Daylight Factor (DF) of the main prayer hall in Ubudiah Royal Mosque is 1%, which is an acceptable DF value. Meanwhile, the DF value for the main prayer hall of Pasir Pelangi Royal Mosque and Sultan Ibrahim Jamek Mosque are both 0.35%, which is low.

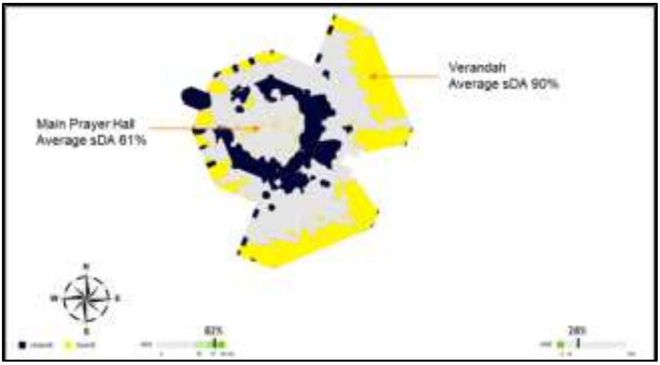


Figure 6: The average sDA in the main prayer hall and verandah of Ubudiah Royal Mosque.

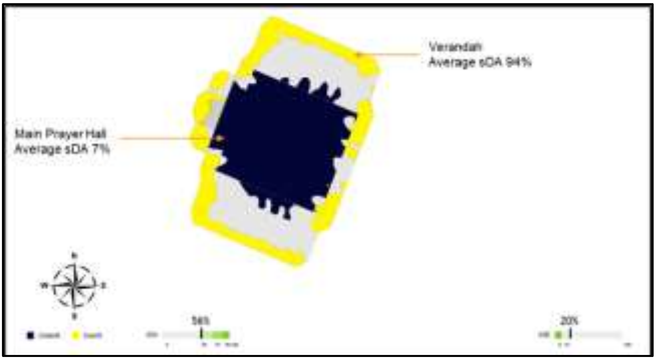


Figure 7: The average sDA in the main prayer hall and verandah of Pasir Pelangi Royal Mosque.

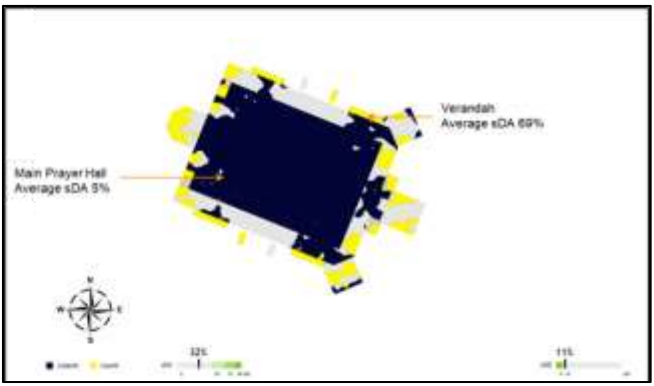


Figure 8: The average sDA in the main prayer hall and verandah of Sultan Ibrahim Jamek Mosque.

Table 6: Average DF for the three Colonial Mosques

	Average Daylight Factor (%)		
Mosque	**Ubudiah Royal**	**Pasir Pelangi Royal**	**Sultan Ibrahim Jamek**
Main Prayer Hall	0.90%	0.35%	0.35%
Veranda	6.17%	3.61%	1.53%
Overall	4.68%	2.17%	1.76%

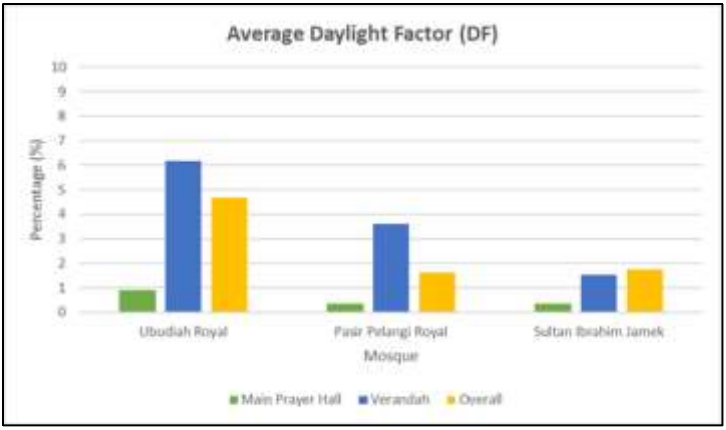


Figure 9: Average Daylight Factor (DF) of the main prayer hall, veranda and overall spaces in the three Colonial Mosques.

Figures 10, 11, and 12 show the average DF of the overall spaces, the main prayer hall, and the veranda area of the three Colonial Mosques. The Daylight Factor is represented in the colour scale from dark blue to bright yellow. Dark blue colour represents the least illuminated areas and bright yellow represents the most illuminated area. The images show that the main prayer halls are all surrounded by a well-lit veranda.

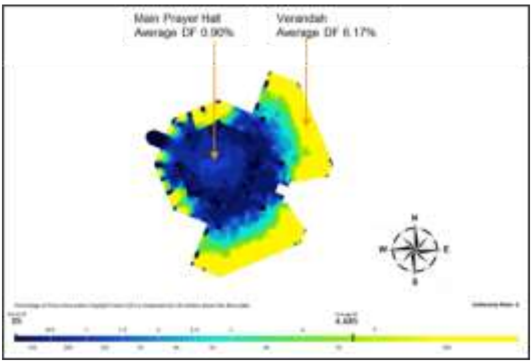


Figure 10: Average Daylight Factor (DF) in Ubudiah Royal Mosque

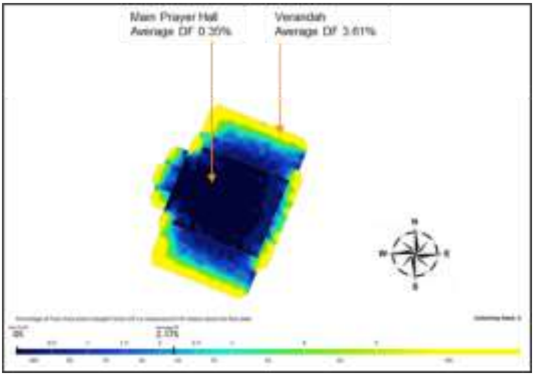


Figure 11: Average Daylight Factor (DF) in Pasir Pelangi Royal Mosque

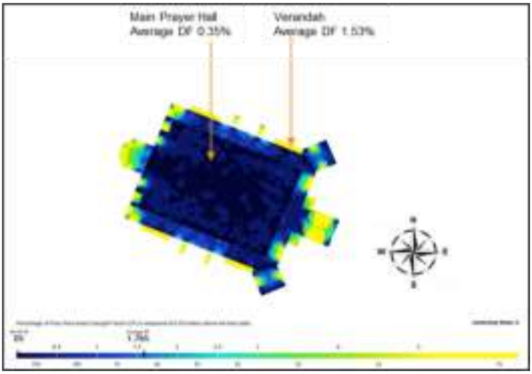


Figure 12: Average Daylight Factor (DF) in Sultan Ibrahim Jamek Mosque

In comparison, the plan image has shown that the center of Ubudiah Royal Mosque's main prayer hall achieved an acceptable Daylight Factor, which is between 1.5% to 2%. This ranges higher than the average DF value, 0.9%. The Daylight Factor value is shown in the colour light blue according to the colour scale in Figures 10, 11, and 12. Meanwhile, the main prayer hall of Pasir Pelangi Royal Mosque is poorly lit. Meanwhile, the image in Figure 12 has shown that some parts of the main prayer hall in Sultan Ibrahim Jamek Mosque have a slightly higher Daylight Factor (DF) than its average Daylight Factor (DF). However, the average Daylighting in the main prayer hall of Sultan Ibrahim Jamek Mosque is 0.35%, which is still insufficient. On average, both prayer halls did not achieve the acceptable range of Daylight Factor.

5.0 Discussion

Among the three mosques, the daylight performance of the main prayer hall inside the

Ubudiah Royal Mosque is sufficient and within the acceptable range. Meanwhile, the other two Colonial Mosques do not have sufficient daylight in their main prayer hall. The differences in daylight performance among the three Colonial Mosques were due to the differences in some of their passive daylight design strategies. As mentioned earlier, the three Colonial Mosques differ in three daylight design strategies. They are the clerestory windows, window to wall ratio (WWR), and maximum window heights to floor depth ratio (DRT).

Two of the mosques have clerestory windows; Ubudiah Royal Mosque and Sultan Ibrahim Jamek Mosque. The original design of Pasir Pelangi Royal Mosque includes a row of clerestory windows just below the ceiling of its main prayer hall. Over the years, roof extensions were added to the roof of the building, which closed up the clerestory windows.

On the other hand, Pasir Pelangi Royal Mosque achieved the highest window to wall ratio, which is 22%. Whereas the window to wall ratio in Ubudiah Royal Mosque is 16% and in Sultan Ibrahim Jamek Mosque is 12%.

Meanwhile, Ubudiah Royal Mosque complies with the Daylight Rule of Thumb (DRT), the floor depth (D) is only twice the window height (H), D=2H (Figure 13). The other two mosques did not comply with the DRT. Pasir Pelangi Royal Mosque has its floor depth (D) four times the window height (H), D=4H (Figure 14) and Sultan Ibrahim Jamek Mosque has its floor depth (D) two and a half times the window height (H), D=2.5H (Figure 15).

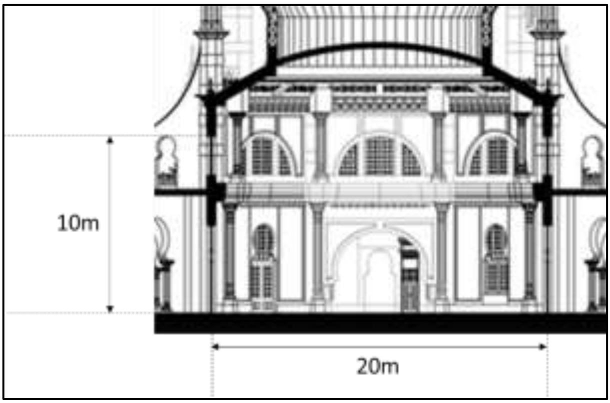


Figure 13: Floor Depth (D) to Window Height (H) ratio for Ubudiah Royal Mosque, D=2H.

From the comparative analysis, although Pasir Pelangi Royal Mosque achieved a high window to wall ratio, the window height is too low to allow effective daylighting to penetrate through its main prayer hall. Furthermore, although both Sultan Ibrahim Jamek Mosque and Ubudiah Royal Mosque have clerestory windows, the windows in Ubudiah Royal Mosque are higher and bigger than the windows of Sultan Ibrahim Jamek Mosque. Having the lowest window to wall ratio, which is 12%, the main prayer hall in Sultan Ibrahim Jamek Mosque did not achieve effective daylight performance.

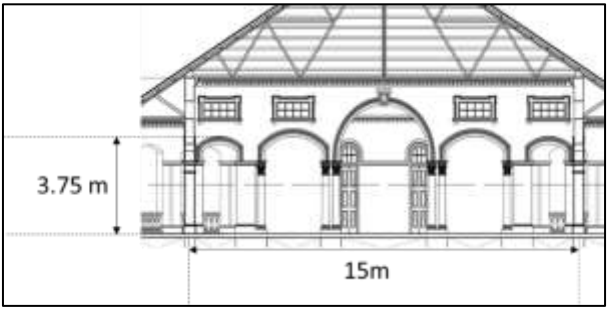


Figure 14: Floor Depth (D) to Window Height (H) ratio for Pasir Pelangi Royal Mosque, D=4H.

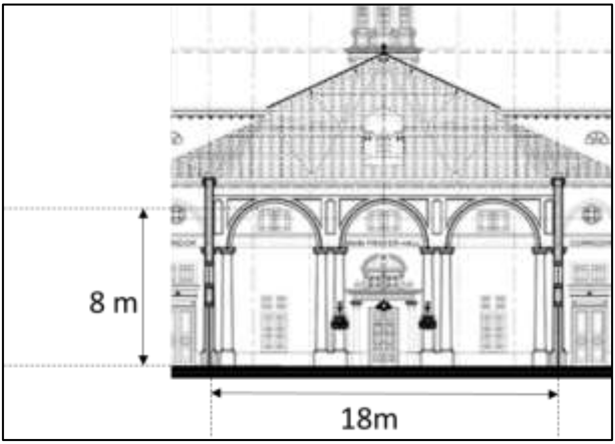


Figure 15: Floor Depth (D) to Window Height (H) ratio for Sultan Ibrahim Jamek Mosque, D=2.5H.

6.0 Conclusion

The study achieves two conclusions, which responded to the two objectives. The first objective is to evaluate the daylight performance of the main prayer hall of three Colonial Mosques in Malaysia; Ubudiah Royal Mosque, Pasir Pelangi Royal Mosque, and Sultan Ibrahim Jamek Mosque. From the findings, it is concluded that the daylight performance of the main prayer hall in Ubudiah Royal Mosque is sufficient. Its average Daylight Factor (DF) is 1%, and the Spatial Daylight Autonomy (sDA) shows that 61% of the area achieved 300 lux. However, the daylight performance of the main prayer hall in Pasir Pelangi Royal Mosque and Sultan Ibrahim Jamek Mosque is insufficient. Their Daylight Factor (DF) and Spatial Daylight Autonomy (sDA) are lower than the acceptable value.

The second objective is to identify effective daylight design strategies in the three Colonial Mosques. From the findings, it is concluded that the effective daylight design strategies are the window to wall ratio, the use of clerestory windows, the floor depth (D) to window height (H) ratio. Above all, the most effective daylighting design strategy is found to be the floor depth to window height ratio. This is the rationale behind the effective daylight performance of the main prayer hall in Ubudiah Royal Mosque because it complies with the Daylight Rule of Thumb (DRT), D=2H. From the findings, it can also be concluded that the window to wall ratio alone is not sufficient. Particularly in buildings with large spaces. Larger spaces require Daylighting from higher windows.

It is recommended to extend the study on effective daylighting in mosque design with various clerestory windows properties, windows on different roof types, such as the tiered roof. Further investigation can also be done in the study of window glass types, such as stained or translucent glass.

Acknowledgement

We would like to express our gratitude to the Heritage Lab of the Department of Architecture, International Islamic University Malaysia (IIUM) for providing information on the three Colonial Mosques; Ubudiah Royal Mosque, Pasir Pelangi Royal Mosque, and Sultan Ibrahim Jamek Mosque. We would also like to extend our gratitude to the administrators of the three Colonial Mosques for providing information on the three Colonial Mosques.

Article Contribution to Related Field of Study

This study has contributed to the research field of Daylight in buildings. The study has shown the possibility of achieving sufficient indoor daylight through natural resources and not depending too much on artificial lighting. This study also shows that we can learn from the past and build climate-responsive buildings. The possibility of having good daylighting lies in the correct placement of the windows.

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