Programme

AcE-Bs2021KotaBharu

9th Asian Conference on Environment-Behaviour Studies
28-29 Jul 2021

e-IPH, UK emAs

AMER ABRA cE-Bs

https://amerabra.org/ https://cebs.uitm.edu.my/

Published by e-IPH Ltd., UK@
e-International Publishing House, Limited
(Registration No: 10062603, for England & Wales)
18, Westpoint, 58, West Street,
S1 4EZ, Sheffield, United Kingdom
Tel: 0044 7446 100896
admin@e-iph.co.uk https://www.eiph.co.uk

Publication date: 28 Jul 2021

Acknowledgement

The Association of Malaysian Environment-Behaviour Researchers (AMER), the main organiser, with the co-organisers, ABRA (Association of Behavioural Researchers on Asians/Africans/Arabians) and cE-Bs (Centre for Environment-Behaviour Studies), Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Malaysia, congratulate the many that made this conference possible. In particular the paper contributors, International Scientific Committee / Editorial Team, Breakout Chairs, and the distinguished Keynote Speaker.

Thank you all !

Foreword

The GameChanger 2021 (#GC2021) initiated commencing 2021 is to increase our publications to be contributed by multi-national authors. We believe the initiative would tremendously increases the chances for those publications to be indexed by more reputable indexing bodies, such as Scopus. As such, commencing 2021 only multi-national authored contributions shall be accepted for publications.

Anticipating it could be a daunting task among authors to include other nationals as co-authors from abroad, a list of global potential co-authors was displayed on the conference web. It is hoped that the authors could network, ultimately contributing their papers together

This 9th Asian Conference on Environment-Behaviour Studies, AcE-Bs2021, our 34th international conference to be organised, managed to attract an overall total of 57 numbers of abstracts. Out of the total, 12 abstracts were rejected due to non-compliance.

The #GC2021 initiative seemed to have now borne fruits. Of the 45 abstracts approved, authors from 17 countries contributed, namely from Australia, Brunei, Canada, China, Egypt, Hungary, Indonesia, Iraq, Japan, Malaysia, Pakistan, South Africa, Saudi Arabia, Turkey, United Kingdom, United States of America, and Uzbekistan.

The abstracts were finally transformed into 31 approved papers. The papers approved were simply grouped generally under 16 sub-categories, although quite a number could have been easily placed under more than one category. The top three categories in order of popularity involved the following environments: -
Commercial / Retail / Services Environment (CRSE) and Health / Healing Environment, both 4 papers each, and Design / Creative Environment (DCE), 3 papers.

Hopefully this conference will inspire and encourage more researchers to participate in our forthcomingserial conferences later this year, which shall include the following:-
5th AQoL2021 15-16 Dec 2021 (venue t.b.a.)

Thanks again for your continuous support as always, and hope for an enlightening conference !

Prof. Dr. Mohamed Yusoff Abbas
Chair
AcE-Bs2021Kotabahru, Malaysia, 28-29 Jul 2021
myusoff801@uitm.eu.my

28 Jul 2021

Table of Contents

About the Conference

Background

The success of the 1st National Conference on Environment-Behaviour Studies, InCEBS2009 held at UiTM Shah Alam, Malaysia, from 14-15 Nov 2009, inspired the organiser to organise future conferences beyond the nation. The AcE-Bs, an initial acronym for ASEAN Conference on Environment-Behaviour Studies, which targeted venues at ASEAN countries, was later extended to be held in Asian countries, thus the current acronym for the Asian Conference on Environment-Behaviour Studies.

AcE-Bs conferences main theme address Environment-Behaviour (E-B) issues affecting the Asian communities living in both Asian and non-Asian countries. E-B issues affecting non-Asian communities are also most welcome.

Prior to 2014, AcE-Bs was organized by cE-Bs (Centre for Environment-Behaviour Studies, FSPU, UiTM, Malaysia, supported by AMER (Association of Malaysian Environment-Behaviour Researchers) and ABRA (Association of Behavioural Researchers on Asians). Post-2014, with AMER and ABRA being formalised, cE-Bs took the supporting role. AMER's Event Management & Services (emAs), a private entity, manages all of AMER's events, under emAs (Emas Emas Resources).

Thus far, the AcE-Bs were organised as follows:-
8th AcE-Bs2019Langkawilsland, Malaysia, 18-19 Dec 2019
7th AcE-Bs2016Taipei, Taiwan, 09-10 Apr 2016
6th AcE-Bs2015Tehran, Iran, 21 – 23 Feb 2015
5th AcE-Bs2014Seoul, South Korea, 25-27 Aug 2014
4th AcE-Bs2013Hanoi, Vietnam, 19-22 Mar 2013
3rd AcE-Bs2012Bangkok, Thailand, 16-18 Jul 2012
2nd AcE-Bs2011Bandung, Indonesia, 15-17 Jun 2011
1st AcE-Bs2010Kuching, Malaysia, 07-08 Jul 2010

9th AcE-Bs2021KotaBahru

Further to our first hybrid (F2F + Virtual) conference, the 33rd international AicQoL2021BukitTinggi, Pahang on 17-18 Mar 2021, our 34th international conference, the WoS-indexed AcE-Bs2021 (9th Asian Conference on Environment-Behaviour Studies), was supposed to be held at Perdana Kota Bharu, Kelantan, Malaysia from 28-29 Jul 2021. However, the prolonged uncertainty of the Movement Control Order (MCO) due to the Covid 19 pandemic, had led us to organize it virtually from the Faculty of Architecture, Planning & Surveying (FSPU), Universiti Teknologi MARA, Shah Alam, Malaysia.

The AcE-Bs2021 focuses on Environment-Behaviour issues affecting the Asian/African/Arabian communities in both their countries and nons. Issues affecting other communities are also most welcomed.
AcE-Bs2021 is organised by AMER (Association of Malaysian Environment-Behaviour Researchers), ABRA (Association of Behavioural Researchers on Asians/Africans/Arabians) and cE-Bs (Centre for Environment-Behaviour Studies, Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Malaysia. The event shall be fully managed by AMER's subsidiary, emAs (AMER Event Management & Services) under emAs emAs Resources.

The e-IPH, UK shall publish both the Abstract Book (eISBN 978-1-913576-03-5), and the Proceeding in the E-BPJ (Environment-Behaviour Proceedings Journal), eISSN 2398-4287, 6(17) Aug 2021, issue. Currently, the E-BPJ is indexed in Clavirate Analytics Web of Science (WoS) and ScienceOpen. Extended versions of the selected papers shall be published as freely accessible articles, online, in our other international journals – AjBeS, AjQoL, ajE-Bs or jABs, @ no publication charges.

Continuing with our Game Changer 2021 initiative, #GC2021 – only *internationally-authored papers shall be considered for publications in the Proceedings (E-BPJ), and in our other four international journals. (*non-internationally-authored papers are subjected to an additional 30% surcharge of the Registration Fees).

Conference Tracks

Paper contributions involved the following environments (though not exhaustive):-
Children / Youth Environment;
Climatic Environment
Commercial/Retail/Services Environment;
Communication / Social Media Environment;
Community Environment / Social Psychology;
Construction Environment;
Design & Creative Environment;
Educational / Learning Environment;
Elderly Environment;
Energy Environment;
General Psychology;
Green Environment;
Healthcare / Healing Environment;
Hospitality / Tourism Environment;
Inclusive Environment;
Landscaping Environment;
Legal Matters;
Leisure / Recreational / Sports Environment;
Local Cultural / Heritage Environment (Food included);

Management & Production Environment;
Natural Environment;
Policy Matters
Public Sector Environment,
Residential Environment;
Rural Environment / Rural Psychology;
Sustainable Environment;
Technology-related Environment;
Transportation / Travelling Environment;
Urban Environment / Urban Psychology;
Workplace Environment

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International Organisations

AMER (ABRA*malaysia*)

Association of Malaysian Environment-Behaviour Researchers
https://amerabra.org

AMER was formally registered in Malaysia on 27th January 2012. The establishment of AMER (ABRAmalaysia), the membership of which is also opened to non-Malaysians, was to meet amongst others the following objectives:-

1) To represent Malaysia as the nation's official NGO on matters pertaining to the research andconsultancy works that involve all Environment-Behaviour studies (EBS).
2) To widen networking and co-operation in the field of EBS with institutions, establishments anduniversities both nationally and internationally.
3) To create the nation's database in identifying, registering, administering and coordinatingMalaysian researchers involved in the research and consultancy works that involve EBS
4) To be the nation's hub and source of reference in all matters pertaining to EBS
5) To organize nationally and collaborate internationally, dialogues / seminars / conferences in EBS
6) To obtain and distribute research grants to registered members.
7) To conduct research and consultancy works that involves all EBS
8) To provide expert services in all matters pertaining to EBS
9) To highlight local/international events /conferences to registered members for their participation.
10) To disseminate research findings and knowledge gathered in the field of EBS in the form ofpublished materials and also electronically
11) To produce future researchers who shall be experts and competent in all matters pertaining toEBS.

ABRA

Association of Behavioural Researchers on Asians / Africans / Arabians
https://amerabra.org

Upon tremendous responses shown by researchers involving behavioural studies on Asians living in both Asian and non-Asian countries presented during the AcE-Bs / AicE-Bs conferences held since 2009,the formation of ABRA, an international organisation was considered necessary and timely.

To propel further internationalisation, the cE-Bs had during AicE-Bs 2010 Kuching, Malaysia, 7-9 December 2010 mooted the idea for the formation of an international organisation, ABRA (Association of Behavioural Researchers on Asians). Following the successful registration of AMER, and further interest expressed by representatives from several countries during the recent AcE-Bs 2012 Bangkok, a formal meeting amongst ABRA representatives was held during AicQoL2013Langkawi.

ABRA was finally formalised as an international research organisation by the Malaysian Registrar of Societies on 20th October 2014, with AMER as the Permanent Secretariat, headquartered in Shah Alam,Malaysia.

Since Jun 2020, ABRA is represented in 10 countries worldwide namely, Egypt, India, Indonesia, Iran, Malaysia, Morrocco, Nigeria, Saudi Arabia, Taiwan, and Turkey. One benefit in becoming an ABRA member is the huge discount given to members who attend forthcoming activities to be organized. The discount given to members would more than pay back members' annual fees.

International Publications

https://www.e-iph.co.uk

All our journals published by the e-IPH, UK with the ISSN obtained from the British Library, UK are international multidisciplinary Open Access Journals which adhere to the BOAI definition of open access:that users have the right to 'read, download, copy, distribute, print, search, or link to the full texts of these articles'. The journals published double-blind peer-reviewed, original research articles relating issues affecting the Asian communities living in both the Asian and non- Asian countries, worldwide. Successful articles published had attained an equivalent minimum score of 90% for the English Language and Similarity Index (Plagiarism) of not more than 15%, based on Grammarly.

Environment-Behaviour Proceedings Journal (E-BPJ)
https://ebpj.e-iph.co.uk/index.php/EBProceedings
The E-BPJ is currently indexed in Clarivate Analytics Web of Science (WoS), and SCIENCEOPEN. It publishes original research conference papers relating to Environment- Behaviour, General Psychology, and Quality of Life issues. The selected papers published were presented at the multiple serial annual international conferences held worldwide since 2010, jointly organised by the Association of Malaysian Environment-Behaviour Researchers (AMER), Association of Behavioural Researchers on Asian (ABRA), and Centre for Environment- Behaviour Studies (cE-Bs), Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA (UiTM), Malaysia.

Asian Journal of Behavioural Studies (AjBeS)
https://ajbes.e-iph.co.uk/index.php/ajbes

Asian Journal of Environment-Behaviour Studies (ajE-Bs)
https://aje-bs.e-iph.co.uk/index.php/ajE-Bs

Asian Journal of Quality of Life (AjQoL)
http://ajqol.e-iph.co.uk/index.php/ajqol

Journal of ASIAN Behavioural Studies (jABs)
https://jabs.e-iph.co.uk/index.php/jABs

All the journals above are currently indexed in the SCIENCEOPEN. The AjBeS focus on human behavioural issues; the ajE-Bs on Environment-Behaviour issues; the AjQoL on Quality of Life issues; and the jABs on General Psychology issues.
Articles to be published should be about 4,500 words (excluding References) to be submitted as per the Journal Template (which includes payment instructions), together with the Publication Agreement and non-refundable Article Submission Charge and the Article Processing Charge (Publication Fees) @ USD300 per article, inclusive of the double-blind peer-review, for successful article to be published. Commencing 2019 all the journals are published three times annually.

Available Online at www.e-iph.co.uk
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E-B Environment - Behaviour Proceedings Journal

AcE-Bs2021KotaBharu

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9th Asian Conference on Environment-Behaviour Studies

Perdana Kota Bharu, Kelantan, Malaysia, 28-29 Jul 2021

e-IPH e-International Publishing House Ltd., United Kingdom

Passive Daylighting Design Strategies of Colonial Mosques in Malaysia

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Abstract
This study aims to investigate the daylight performance of Colonial Mosques in Malaysia. The first objective of this study is to identify passive daylighting strategies from colonial mosques. The second objective of this study is to evaluate the daylight performance of the colonial mosques. The research methodology consisted of table research, field observation, and daylight analysis simulation of the prayer hall in the Colonial Mosques, using Sefaira daylighting simulation software. The results have shown that the daylight in Colonial Mosques was affected by the building orientation, shading elements, window to wall ratio, and window type. In conclusion, the clerestory window type enhances indoor daylight performance.

Keywords: Passive Daylighting, Colonial Mosques.

DOI: https://doi.org/10.21834/ebpj.v6i17.2811

1.0 Introduction

A mosque is a place for Muslims to perform their congregational prayers, which needs optimum lighting for the occupiers to perform religious activities. However, the implementation of excessive artificial lighting in mosques may lead to additional costs for electrical energy consumption. Hence, using readily available daylighting is considered as one of the passive design strategies that should be implemented in mosque design (Malaysian Standard, 2014). Daylight can be part of renewable energy, that is free of charge (Al-Ashwal & Hassan, 2017). Utilizing daylight is also part of zero-carbon emission buildings initiatives (Lo Verso & Pellegrino, 2019). The use of natural daylight could reduce the electrical energy consumption for artificial lighting systems inside mosques.

Daylighting is a terminology to describe the utilization of natural light to illuminate the living space inside buildings (Heschong et al., 2002). As the sun is the primary source of light and energy to the earth, natural daylight is classified as a source of light distributed from direct and indirect sunlight. Nevertheless, the quality and intensity of daylight received at a certain region depend on the regional climate, sky condition, geographical latitude, and building geometry (Wong, 2017).

In Malaysia, most of the mosques are generally equipped with artificial lighting systems, especially at the main prayer halls which normally are located at the center of mosques. This is because the main prayer halls are usually designed with surrounded verandah areas, that leave the inner space of mosques lacking natural light casting. This typical layout of mosques requires the excessive use of artificial lighting, which may lead to very high energy consumption. A question arises on how the daylighting performance of mosques is. Hence, this research aims to investigate the daylight performance of colonial mosques in Malaysia; Ubudiah Royal Mosque, Pasir Pelangi Royal Mosque, and Sultan Ibrahim Jamek Mosque. These three colonial mosques were chosen to be investigated due to the

DOI:

similarity of their layout plans. The research has two (2) main objectives. The first objective is to identify the effective passive daylighting strategies from the selected colonial mosques, and the second objective is to evaluate the daylight performance of the main prayer halls in the colonial mosques.

As stated in a Quranic verse, "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). Based on the verse, the Muslim communities must be aware of the responsibility towards the environment and self-awareness from being wasteful. Thus, excessive energy consumption is becoming an issue for mosques.

This study is aligned with the United Nations Agenda 2030 Sustainable Development Goals, SDG 7, 11, and 12. SDG 7 is Affordable Clean Energy which this study gave the solution in minimizing artificial lighting consumption and utilize natural daylight, which is more affordable and clean energy. SDG 11 is Sustainable Cities and Communities, which this study provided solutions in sustaining the operation of the mosques with natural resources rather than depending mostly on artificial resources. SDG 12 is Responsible Consumption and Production, where this study demonstrates the value of heritage buildings.

2.0 Literature Review

2.1 Mosque Design

The mosques in Malaysia are classified into three architectural styles. They are the vernacular mosque style, colonial mosque style, and modern mosque style (A Ghafar Ahmad, 1999). Rosniza (2011) came up with a list of Historical mosques: Traditional/vernacular and Colonials built between 1728 to 1956 and Post-Independence Mosques and Contemporary Mosques built from 1956 to 2005. Figure 1 shows the chronology of colonial mosques in Malaysia from 1808 to 1938. The figure highlighted the 3 case study mosques.

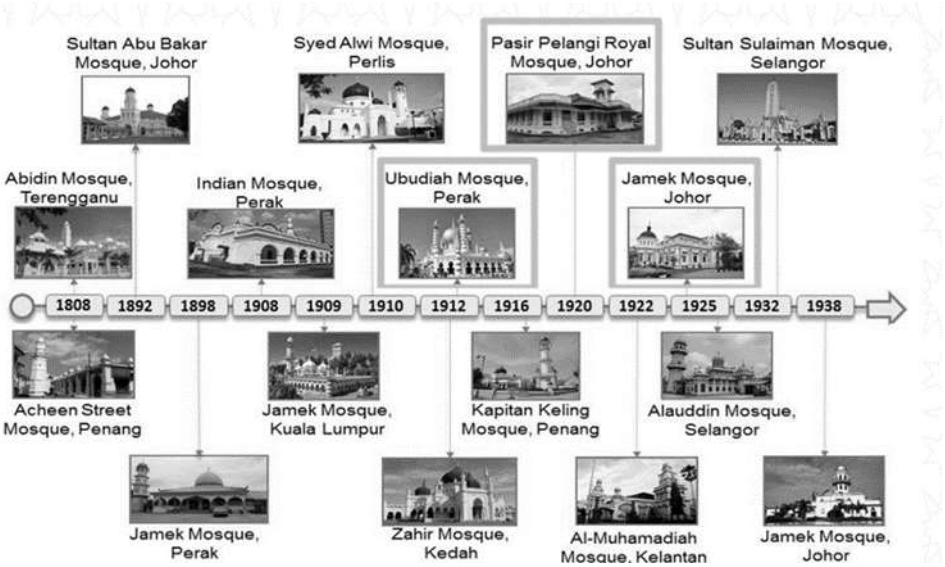


Figure 1: Chronology of Colonial Mosques in Malaysia from 1808 to 1938. The case study mosques are; Ubudiah Royal Mosque (1912), Pasir Pelangi Royal Mosque (1920) and Sultan Ibrahim Jamek Mosque (1925)
(*Source: Sanusi et al., 2019)*

2.2 Malaysia Climate

Malaysia, located near the equator, receives 12 hours of sunlight per day throughout the year, from 7:00 a.m. to 7:00 p.m. The intensity of the solar increases and peaks at 12:00 p.m. until 3:00 p.m. At this hour, the solar radiation is at the maximum level and the sun angle is almost 90o perpendicular to the ground surface. After about 4:00 p.m., the solar intensity decreases back. Figure 2 shows the sun path diagram for Malaysia, which includes hourly solar angles throughout the year. In March, the sun angle is at 90^0 from the ground. In June, the sun angle is tilted slightly to the North, while in December, the sun angle tilted slightly to the South (Standards Malaysia, 2014). The East and West solar radiation can be quite intense at about 11:00 a.m. and 4:00 p.m. Therefore, building designers should be aware of the solar angles at the initial stage of the design. Building openings in Malaysia should avoid direct sunlight from the east and west direction and implement a passive daylighting strategy (Arifin & Denan, 2015).

The direct solar glare can also cause visual discomfort to the indoor environment. Careful consideration of daylight penetration is crucial to maintain visual comfort. Visual comfort is the condition of being free from any distraction, pain, and sensitivity towards visual performance (Nasrollahi & Shokri, 2016). Diffused lights are part of passive daylighting strategies (Andersen et al., 2013).

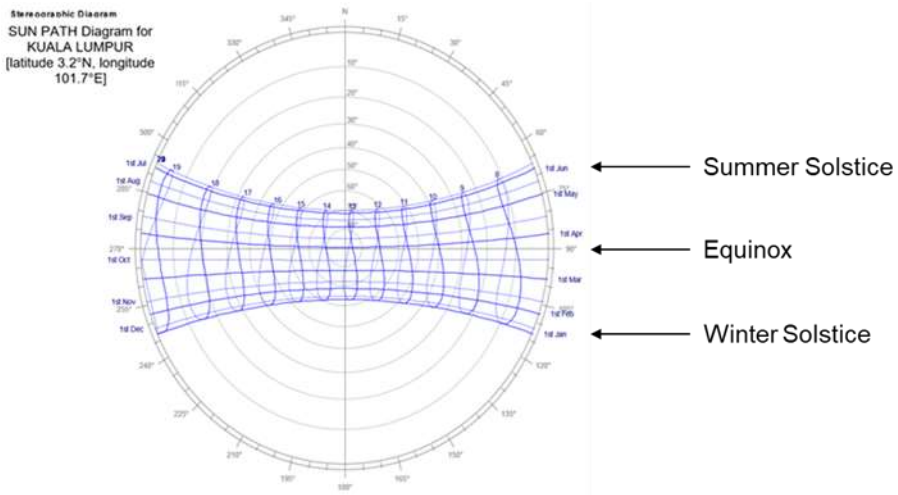


Figure 2: Sun Path diagram for Malaysia, latitude 3.2°N, longitude 101.7°E
(*Source: Standards Malaysia, 2014)*

2.3 The Principle of Daylight

Passive daylight strategy is part of passive design strategies, which uses natural resources as the source of energy and operation while reducing energy consumption and operation costs (Womeldorf, 2018). Daylighting is the natural light that illuminates the indoor spaces through openings in the building's skin (Knoop et al., 2020). Furthermore, the windows or openings should be designed to receive the natural daylight and avoid glare at the same time (Standards Malaysia, 2014). Site configuration is also essential to solve the visual discomfort caused by direct sunlight through the building openings. As stated in Standards Malaysia (2014), good building designs are those that responded to the site orientation by having the facades protect the indoor spaces from the direct sunlight from the East and West (Naamandadin et al., 2016). The designer should understand the local solar geometry at the initial stage of design. The landscaping can be part of the passive daylighting strategies. It could reduce the glare, act as shading devices, and shield from excessive solar glare (Standards Malaysia, 2014).

The effectiveness of indoor daylight distribution is identified through its Daylight Factor (DF) measures (Standards Malaysia, 2014). Daylight Factor is measured in percentage; the amount of daylight inside the building can be identified by comparing the total amount of daylight inside with the total daylight at the outside of the building, $DF = E_{internal} / E_{external} \times 100\%$ (BRE, 1986). Table 1 shows that the acceptable DF ranges from 1.0% to 3.5%, with acceptable glare and thermal comfort (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)

Another daylight measures used to ensure visual comfort is Spatial Daylight Autonomy (sDA). sDA is described as the parameters to predict the percentage of space getting specific natural daylight (for example 300 lux) from the range 0% to 100%. For 300 lux, the percentage of sDA recorded > 55% is acceptable and >75% is preferred for daylighting (Ayoub, 2020).

Daylight Rule of Thumb (DRT) is used to predict the depth of daylit zones of the space from the window. The daylit zone depth (D) to window height (H) ratio is D = 2H (Figure 3). From this DRT, the higher the window the deeper the daylit zone will be achieved.

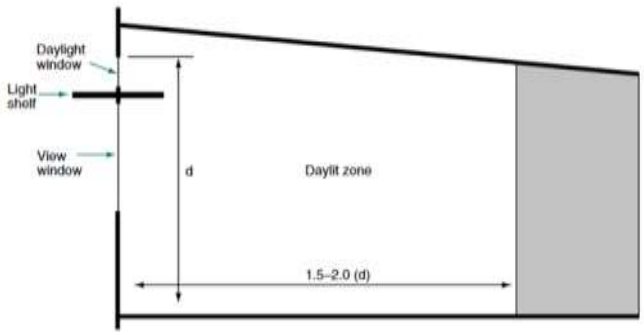


Figure 3: Daylight Rule of Thumb; depth (D) of daylight penetration in relation to the window height (H), Depth = 2H.
(Source: U.S. Environmental Protection Agency & U.S Department of Energy)

3.0 Methodology

Figure 4: Research Methodology Chart

The research methodology consists of both qualitative and quantitative methods. It consists of Literature Review, Observation, and Daylight Simulation (Figure 4).

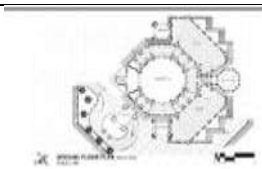
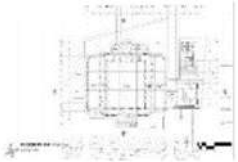
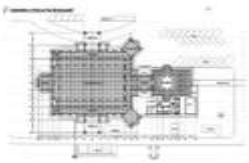
3.1 Literature Review

A literature review is used in this study to identify the sufficient daylighting level for a mosque in Malaysia. Furthermore, the literature review was carried out to determine the passive daylight strategies applied in mosques from the findings of other research works conducted previously.

3.2 Observation

Observations were carried out on the three case studies through site visits and desk research. The findings are presented in Table 2.

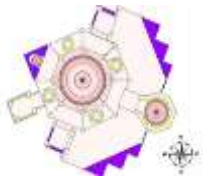
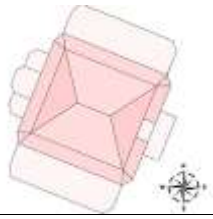
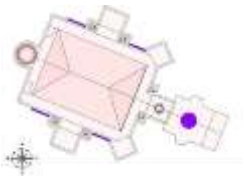
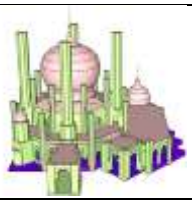
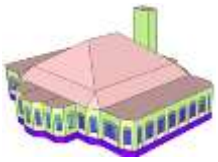
Table 2: The case study details for three different mosques

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	 Symmterical Layout	 Symmterical Layout

3.3 Daylighting Computer Simulation

The Daylight Environmental Simulation was carried out in Simulation Software Sefaira. The three case studies were modeled in Sefaira with appropriate environment settings (Table 3) The virtual model is used for daylighting simulation to identify the building daylight performance, only limited to Daylight Factor (DF) and Spatial Daylight Autonomy (sDA); all the input considerations have been complied with as required by Sefaira software to simulate the daylighting analysis.

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 Findings

4.1 Findings on Passive Daylight Strategies in Mosques from Literature Review

Large openings are one of the passive design strategies of Colonial Mosques in Malaysia. It provides good daylighting as well as ventilation (Sanusi et al., 2019). Large openings or glass panels are installed to allow natural lighting, the arrangement of the windows vertically and horizontally could help maximize the daylighting in the mosque (Baharudin & Ismail, 2014).

In 2017, Arel & Öner conducted a study on daylight in three historical mosques; Selimiye Mosque in Turkey (Figure 4), Great Mosque of Cordoba in Spain, and Sheikh Lotfollah Mosque in Iran. The study concluded that lights play a role in mosques design, which connects the worshipers to God. However, in Selimiye Mosque, the openings in the dome provide the same illumination level in every corner of a huge space (Arel & Öner, 2017). Dome could act as part of daylighting strategies for the mosque with a ring of windows at the bottom of the dome (Aljofi, 2018).

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

El-Darwish, & El- Gendy (2016) has evaluated daylight performance on four historical mosques of the 19th century in Alexandria. The study concluded that clerestory window in mosque design is essential in providing daylight into the main prayer hall. The higher the clerestory window, the higher chance the daylight has penetrated the space (El-Darwish, & El-Gendy, 2016). The impact of window height relates to the daylight rule of thumb mentioned earlier.

The window to wall ratio is part of the elements that should be considered while designing the opening or windows in the building. The windows should be located above eye level to protect the worshipers from glare while performing their prayers. It can also increase the light distribution inside the mosque (Alabdulazeem et al., 2019).

Some mosques have a verandah, which circulates the main prayer hall. This space acts as overspilled area when it gets crowded. The verandah also protects the main prayer hall from getting unwanted direct sunlight. It is also part of passive daylight strategies in Colonial Mosques (Sanusi et al., 2019). The mosque facade in Malaysia functions to protect the indoor spaces from direct sunlight. The building façade could affect the occupant's visual comfort inside the mosque (Abdullah et al., 2016).

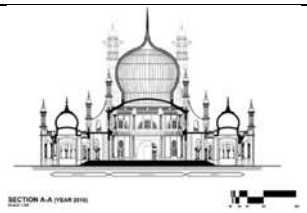
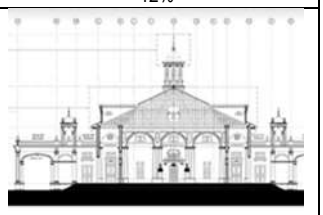
Apart from opening types and design, it was found that bright or white colour surfaces could enhance and reflect the natural daylight into interior building spaces (Belakehal et al., 2016).

The orientation of main prayer hall is determined by the Qiblat direction, which for Malaysia is North-West direction.

4.2 Findings on Passive Daylight Strategies in Mosques from Observation

The observation consisted of spatial orientation and organization of the mosque, the opening properties such as glazing, materials used for the internal surface, and shading devices to avoid visual discomfort. These design considerations observation is referred to according to Malaysian standard MS1525:2014 (Standards Malaysia, 2014)

Table 4: The observation on design consideration for daylighting at the colonial mosques

	MOSQUES		
PASSIVE DAYLIGHTING STRATEGIES	**Ubudiah Royal**	**Pasir Pelangi Royal**	**Sultan Ibrahim Jamek**
Main Prayer Hall	√	√	√
Verandah	√	√	√
Ablution Area	√	√	√
Peripheral Windows	√	√	√
Clerestory or Dome level Windows	√	X	√
Images of Window Types			
Window to Wall Ratio (WWR)	16%	22%	12%
Total Window Heights	 10m	 3.75m	 8m
Floor Depth Between Windows	20m	15m	18m
Shading Elements - Overhang	√	√	√
Floor Depth to Window Height Ratio	D = 2H	D = 4H	D = 2.25H
Vertical and Horizontal Shading Fins	√	√	√
Louvres	X	X	X
Shading Elements - Arches	√	√	√
Surface - Floor	Bright/White	Bright/White	Bright/White
Surface – Wall	Bright/White	Bright/White	Bright/White
Surface - Floor	Bright/White	Bright/White	Bright/White

4.3 Daylight Analysis

The analysis consisted of Daylight Factor (DF) and Spatial Daylight Autonomy (sDA) analysis. The parameters of the three mosqeus were set up in Sefaira. They are the location of the mosque, the orientation of the mosque, and the minimum illuminance required, which is 300 lux.

Table 5 and Figure 5 show the summary results of the average DF in the main prayer hall of the three mosques. The results show that the DF in the main prayer hall of Ubudiah Royal Mosque is acceptable, while the Daylight Factors (DF) in the other 2 colonial mosques are low, 0.35%.

Table 5: Average DF for the colonial mosques in Malaysia

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

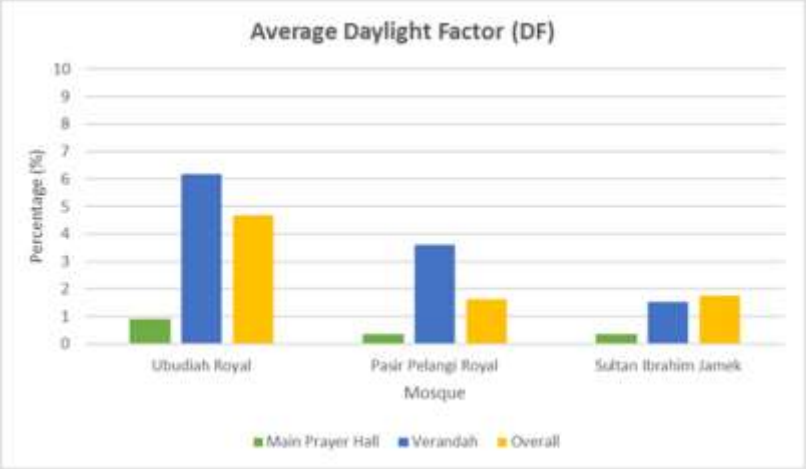


Figure 5: Average DF of the main prayer hall, verandah and overall in the three mosques.

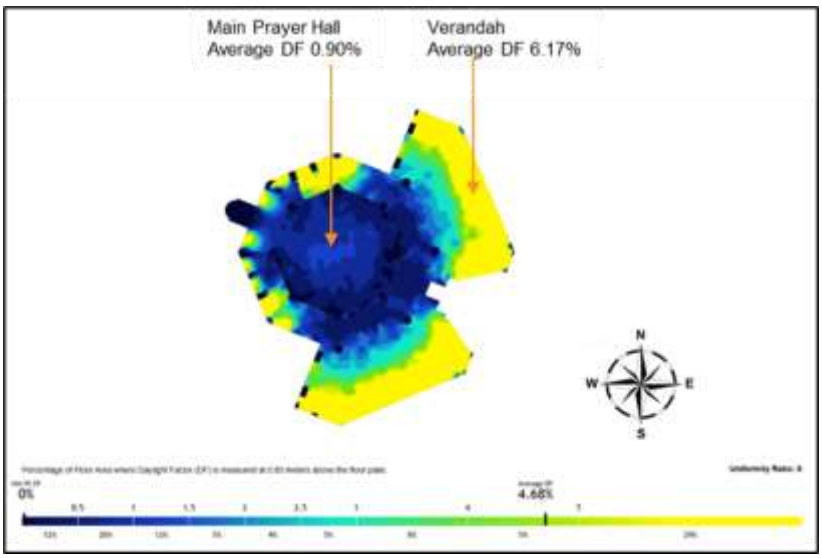


Figure 6: Average DF in Ubudiah Royal Mosque

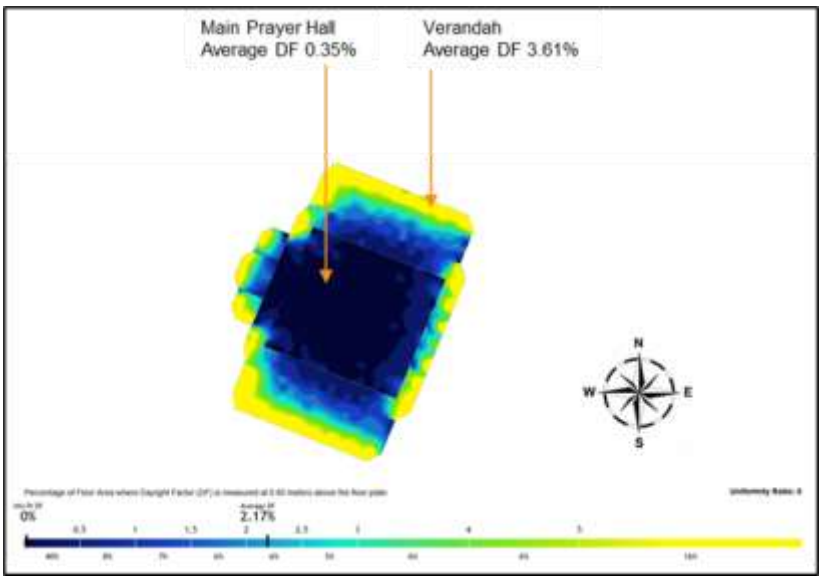


Figure 7: Average DF in Pasir Pelangi Royal Mosque

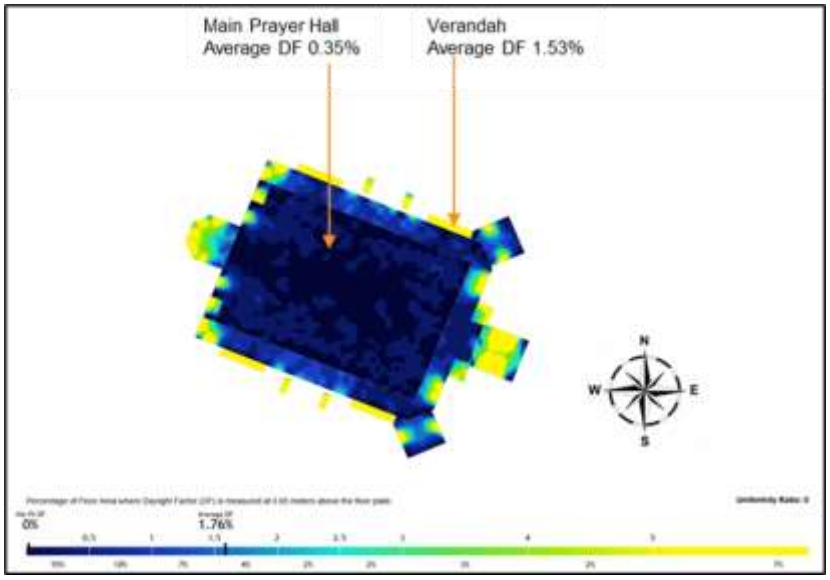


Figure 8: Average DF in Sultan Ibrahim Jamek Mosque

Table 6 and Figure 9 show the summary results of average Spatial Daylight Autonomy (sDA) in the main prayer hall of the three mosques. The results show that the sDA in the main prayer hall of Ubudiah Royal Mosque is acceptable, while the sDA in the other 2 colonial mosques is low.

Table 6: Average sDA for the colonial mosques in Malaysia

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

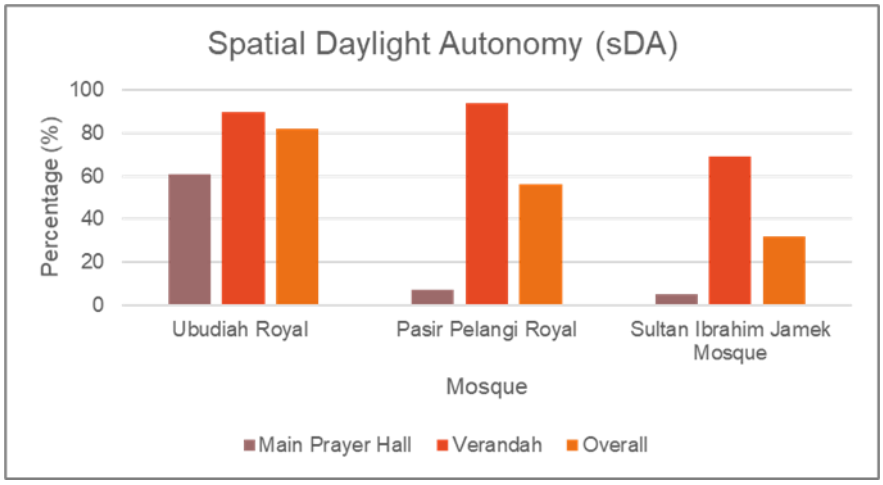


Figure 9: Average sDA of the main prayer hall, verandah and overall in the three mosques.

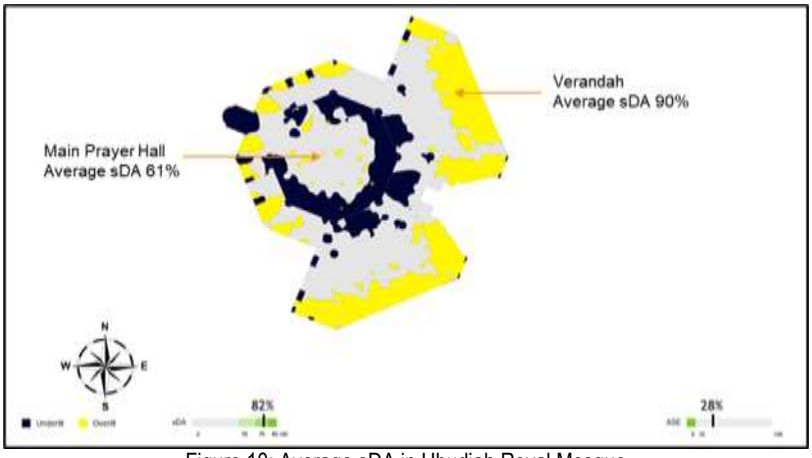


Figure 10: Average sDA in Ubudiah Royal Mosque

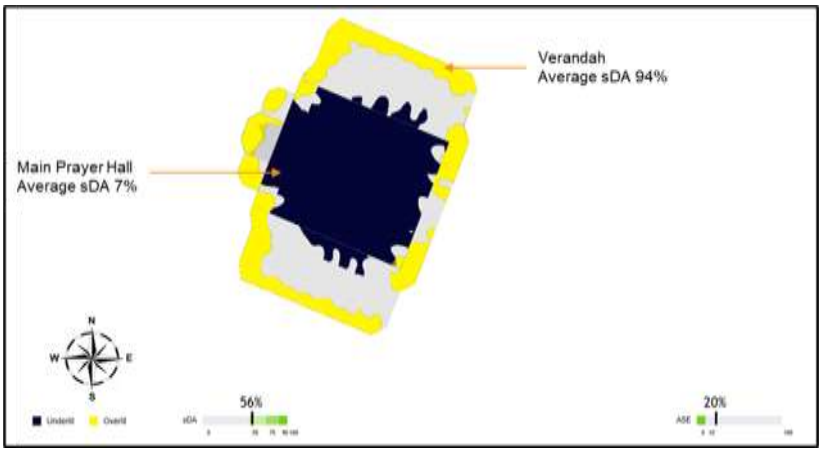


Figure 11: Average sDA in Pasir Pelangi Royal Mosque

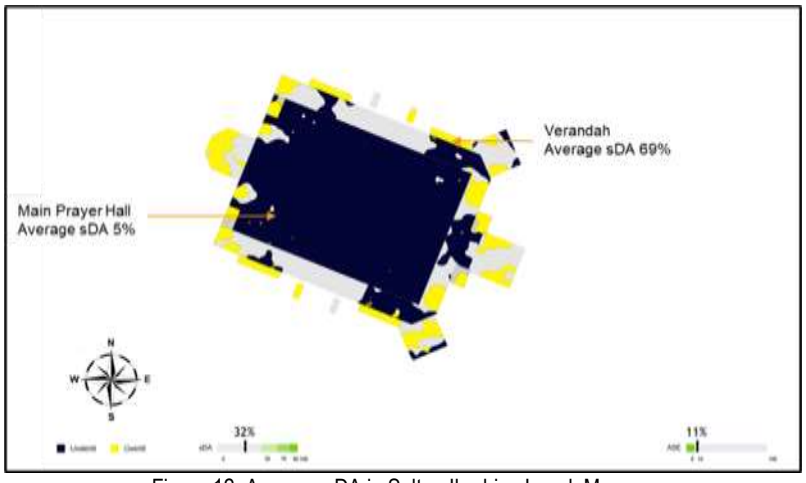


Figure 12: Average sDA in Sultan Ibrahim Jamek Mosque

5.0 Discussion

Among the three mosques, only the Average DF of Ubudiah Royal Mosque's main prayer hall is acceptable. Its WWR is 16%, opening height is 10m and floor depth from window to window is 20m. Therefore, Depth (D) of 2 times the Height (H) of the opening, which complies with the Daylight Rule of Thumb in Figure 3. Comparatively, the WWR for Pasir Pelangi Royal Mosque is 22%, but the window height is low, 3.75m, and the width from window to window is 15m, which is deeper. Meanwhile, in Sultan Ibrahim Jamek Mosque, the WWR is 12%, the opening height is 8m and the floor depth from window to window is 18m. Furthermore, Ubudiah Royal Mosque has bigger clerestory windows than the other two Colonial Mosques.

The opening height and floor depth ratio also influence the average sDA. Figure 10 shows acceptable sDA value in the main prayer hall and verandah of Ubudiah Royal Mosque. Comparatively, the other two mosques have very low sDA values. Among the

three mosques, Ubudiah Royal Mosque has the highest and biggest clerestory windows. Hence, the daylight distribution is better and adequate as compared to the other two mosques.

6.0 Conclusion and Recommendations

The first objective was to identify the effective passive daylighting strategies for mosques. The first conclusion is that there are eight passive daylighting strategies to be considered to achieve good daylight in mosques design. They are building form, opening properties, the height of the opening, verandah area, shading elements, windows to wall ratio (WWR), clerestory windows or openings at dome level, and interior surface properties.

The second objective is to evaluate the natural daylighting performance of the main prayer hall in Malaysia's colonial mosques. The second conclusion is that Ubudiah Royal Mosque has an acceptable DF while the other two mosques, Pasir Pelangi Royal mosque, and Sultan Ibrahim Jamek mosque didn't achieve the acceptable range of DF. The placement and design of the windows at the main prayer hall helps in enhancing the daylighting inside the mosque. Due to many openings with the series of arches at the verandah areas, the verandah area recorded more daylighting as compare to the main prayer hall. However, the large clerestory window provides adequate Daylight Factor DF and Spatial Daylight Autonomy sDA value for Ubudiah Royal Mosque.

For future study, it is recommended to extend the study of the passive daylight with various designs of clerestory windows on different roof types, such as the tiered roof. It is also recommended to study further the effect of various glass window materials, such as translucent or stained glass.

Acknowledgements

We are grateful to IIUM Architecture Department Heritage Lab for providing information on the three colonial mosques case studies. We are also thankful to the administrators of the three Colonial Mosques for giving information on the three mosques.

Paper Contribution to Related Field of Study

This study will contribute to the knowledge of building facade design, in particular mosques facade design. The findings from this study have shown the impact and benefits of openings in allowing passive daylight into indoor spaces.

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