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Daylight Strategies in Learning Space in Covid-19 Pandemic
(Case Study: Taman Pendidikan Al Quran (TPA) As Sakinah Kopelma Darussalam and Balee Aleh Ba Kajhu)

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ABSTRACT
Adaptation of new habits or new normal has a major impact in various sectors, including education. The learning process in all educational institutions either formal or non-formal, begins with blended learning, a combination of online and offline learning methods. By implementing health protocols, some educational institutions such as Taman Pendidikan Al-Qur'an (TPA) are conducting face-to-face learning, for example, TPA As Sakinah in Kopelma Darussalam, Banda Aceh and Balee Aleh Ba in Kajhu, Aceh Besar. The purpose of this study is to examine the adequacy of natural lighting and airflow in both TPA learning spaces. This study aims to assess the feasibility of learning activities to adapt to the covid-19 pandemic that still happens today. The method used daylight application to simulate and measure the adequacy of incoming light intensity. Based on observation data in the field, a three-dimensional modeling simulation will be conducted for design improvement as an intervention in the adaptation of space functions with activities based on covid-19 pandemic conditions.

Keywords: *New normal, Learning space, Daylight, COVID-19.*

1. INTRODUCTION

The impact of the COVID-19 pandemic has greatly affected various sectors, one of which is the education sector. In the early days of the pandemic, all educational institutions, both formal and non-formal, had to close face-to-face learning activities. This is done to prevent the potential spread of the coronavirus. Entering the era of Adaptasi Kebiasaan Baru (AKB) or new normal, the government issued a policy to continue the learning process with an online and offline combination system.

Offline learning activities are closely related to the risk of spreading the Covid-19 virus. Therefore, it is necessary to consider aspects of building design that can reduce the risk of spreading the virus. One aspect that needs to be the main concern is the optimum amount of daylight and airflow.

Based on the new learning phenomenon of the new normal era, the research team wanted to test the evaluation of natural lighting in non-formal education facilities. This is done to assess the feasibility of recitation activities to adapt to the Covid-19 pandemic conditions that are still happening today.

The research objects taken were TPA As Sakinah located in Kopelma Darussalam and TPA Balee Aleh Ba located in Kajhu Village (figure 1). These two non-formal education facilities implemented an offline (face-to-face) learning system in the new normal.

Figure 1 The object of research; TPA As Sakinah - Kopelma Darussalam and Balee Aleh Ba – Kajhu.

2. LITERATURE REVIEW

2.1. Natural Lighting

According to Ander [1] in his book "Daylighting Performance and Design", natural lighting is a method of utilizing sunlight during the day for building illumination to meet the needs of the user activities. According to Dora, P. E. and Nilasari [2] natural lighting is a light that comes from natural source objects such as the sun, moon, and stars.

Because it comes from nature, natural light can change due to the climate, season, and weather, it can also be said to be erratic. In terms of lighting, of all-natural light sources, the sun has the most powerful and high-intensity rays so that it is very useful for illuminating a space. However, sunlight also varies greatly in light intensity that made each part of the day, season, and place can vary the intensity itself.

According to Lechner [3], there are 3 design steps are most often used to introduce light into a room, such as:

2.1.1. Top Lighting

Top lighting is the most efficient way to enter light into the room because the distribution of light is more evenly distributed throughout the room and the use of glass can be minimized.

2.1.2. Side Lighting

The light that enters through the side openings can be used as natural light which is effective in saving energy throughout the day. Side openings in the form of windows have a role to fulfill the basic needs of a building, namely the aesthetics of the building, the surrounding view, the media for the entry of the light, ventilation, sound dampening, and emergency doors.

According to Milaningrum [4], the side lighting system is the most widely used natural lighting system in buildings. In addition to internal lighting, it also provides the flexibility of view, orientation, outside & inside connectivity, and air ventilation.

2.1.3. Combination of Both

This step lets the light into the room through the top and side openings.

Based on Badan Standardisasi Nasional [5] natural lighting during the day can be said to be good if (a) between 08.00 and 16.00 if there is enough light entering the room, (b) the distribution of light in the room is even and does not cause disturbing contrasts.

2.2. Natural Lighting Performance Standard

Neufert [6] stated that the total area of all windows should be at least 1/10 of the total area of all the walls, considering that windows are crucial tools to illuminate the room by admitting daylight into a space.

Concerning the activities carried out such as teaching and learning activities, reading, and writing, the standard of lighting intensity set according to BSN [7] for classroom lighting needs is 250 lux. Therefore, several strategies for applying natural lighting to classrooms at TPA As Sakinah and Balee Aleh Ba are needed to obtain lighting intensity values according to the standards set by SNI (National Standard of Indonesia) (figure 2).

Fungsi ruangan	Tingkat pencahayaan (Lux)	Kelompok renderasi warna	Temperatur warna		
			Warm white <3300 K	*Cool white* 3300 K~5300K	*Daylight* > 5300 K
Rumah tinggal :					
Teras	60	1 atau 2	♦	♦	
Ruang tamu	120 ~ 150	1 atau 2		♦	
Ruang makan	120 ~ 250	1 atau 2	♦		
Ruang kerja	120 ~ 250	1		♦	♦
Kamar tidur	120 ~ 250	1 atau 2	♦	♦	
Kamar mandi	250	1 atau 2		♦	♦
Dapur	250	1 atau 2	♦	♦	
Garasi	60	3 atau 4		♦	♦
Perkantoran :					
Ruang Direktur	350	1 atau 2		♦	♦
Ruang kerja	350	1 atau 2		♦	♦
Ruang komputer	350	1 atau 2		♦	♦
Ruang rapat	300	1	♦	♦	
Ruang gambar	750	1 atau 2		♦	♦
Gudang arsip	150	1 atau 2		♦	♦
Ruang arsip aktif	300	1 atau 2		♦	♦
Lembaga Pendidikan :					
Ruang kelas	250	1 atau 2		♦	♦
Perpustakaan	300	1 atau 2		♦	♦
Laboratorium	500	1		♦	♦
Ruang gambar	750	1		♦	♦
Kantin	200	1	♦	♦	

Figure 2 Recommended illuminance, color rendering and temperature (Source: SNI 03 2000).

2.3. Effect of Sun Exposure on Covid-19 and the Body's Resilience and Recovery

Sun exposure and adequate sleep are important factors in body resistance [8] Daylight increases vitamin D production and bone health [9] and has disinfectant properties, especially against Severe Acute Respiratory Syndrome CoronaVirus-2 (SARS-CoV-2) [10].

Sun exposure also increases the recovery rate of COVID-19 patients [11]; another study showed that high doses of vitamin D reduced inflammatory markers significantly in patients with COVID 19 without any side effects [12]. Based on the results of the study, sun exposure is not only a factor in the body's resistance during the pandemic, but also helps in its recovery.

2.4. The Effect of Natural Lighting on Health

Daylight or natural lighting can affect health, social interaction, psychology, feelings, and the ability to do a visual job. These things affect one's learning ability, performance, concentration and health, and psychological well-being. Daylight is important even

though excessive light exposure can be harmful to health, therefore there needs to be a balance so that it can create optimal quality and quantity of natural lighting [13].

Natural light can also affect the production of the hormone Cortisol. High levels of Cortisol can reduce sociability and in medium levels can improve concentration and focus on children. Some of the effects are related to each other, that related and influenced by natural lighting. The length of time children spend in the school environment indicates the need to facilitate design to support health and quality of learning, especially in countries with high solar exposure [14].

2.5. The Effect of Natural Lighting on the Learning Process

There are several related studies on the impact of natural lighting in the learning process of a classroom. According to a study conducted by Stone and Irvine [15], there was no significant difference between students who studied in a windowed room with a closed room, the only difference being their creativity tasks, students in a windowed room completed more creativity tasks than those in a closed room.

In a study conducted by Nicklas et al [16] which compares the performance of 3 specially designed schools with natural light intake and compares them to other schools in the same area. The result is that schools with natural lighting have an improvement of 5-14% over a year, in the longer term, students in schools that have natural lighting on average have a 14% increase in learning compared to schools in general.

Another study conducted by Heschong [17], using a method like that of Nicklas et al to compare the learning process with natural lightings such as windows, skylights, windows, and skylights, and closed. For one year, students with the greatest natural light exposure performed 20% better in math and 26% on reading tests compared to students with the least natural light exposure. Students with the largest window area ratios had 15% improvement in math and 23% in reading compared to students with the smallest window area ratios.

In a study room that has skylights, learning increases by 20% faster than in a room without skylights. This study also showed an increase in learning by 7-18% in the class with the most daylight compared to the class with the least skylight.

3. METHODOLOGY

This research was conducted on 2 objects, including Taman Pendidikan Al-Quran (TPA) As Sakinah in Kopelma Darussalam and Balee Aleh Ba in Kajhu. Data collection is done through direct observation and field survey of the objects. Based on a similar study on lighting optimization [18]. This study can be carried out in 3 stages, namely: (1) existing 3D modeling (figure 3), (2) measuring the quantity and quality of natural light using the Lux Light Meter application, and (3) simulation using Velux Daylight Visualizer, and (4) exploration of the ideal model.

The existing conditions were modeled using the Google SketchUp application based on the results of space measurements using a laser meter (Krisbow series 10106734).

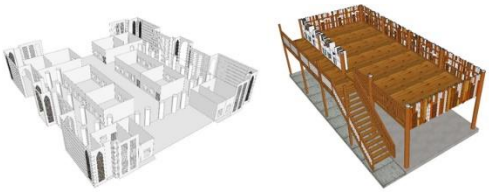

Figure 3 Modelling of TPA As Sakinah and Balee Aleh Ba.

The next step is to measure the quantity and quality of natural light using the Lux Light Meter application as many as five points on each research object (figure 4).

Figure 4 The interface of lux light meter application.

This point is taken based on the shape of the space, namely in the middle, and the four corners of the room. Measurements were carried out at 12.00-13.00. Measurement with Lux Meter is done by determining the measurement point based on the distance of the light source and the area of the room/building (figure 5). Measurements are carried out using a light sensor application tool on the Gadget.

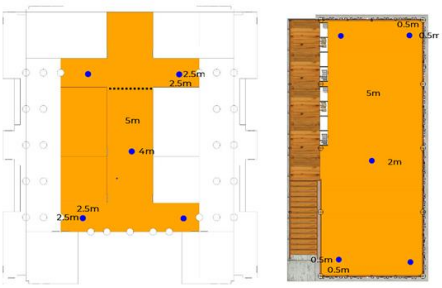

Figure 5 Point of measurement of quantity and quality of natural light.

After measurement, the ideal quantity and quality of natural light will be simulated with Velux Daylighting Visualizer, a software for visualization of the natural lighting. Research model is imported from SketchUp file.

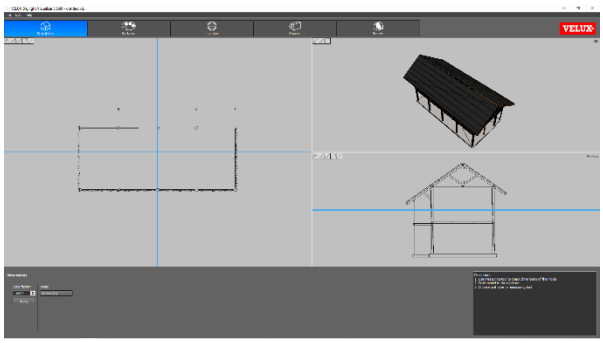

Figure 6 The interface of velux daylight visualizer application.

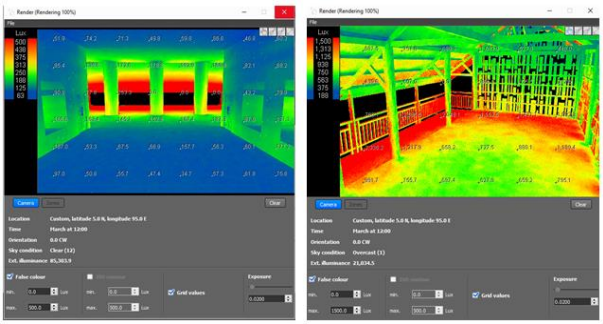

Figure 7 Simulation result using velux daylight visualizer.

The results from the data and simulations carried out are used to improve the design as a benchmark so that the functions of space can be adapted to activities based on the conditions of the Covid-19 pandemic (figure 6-8).

Figure 8 Model exploration.

4. RESULTS AND DISCUSSION

In the simulation, the object is based on dimensional measurements in the field to determine the basic shape as a reference for the existing space so that the results of the simulation design response can later be more accurate with the field conditions.

4.1. VELUX Daylight Simulation TPA As Sakinah (figure 9)

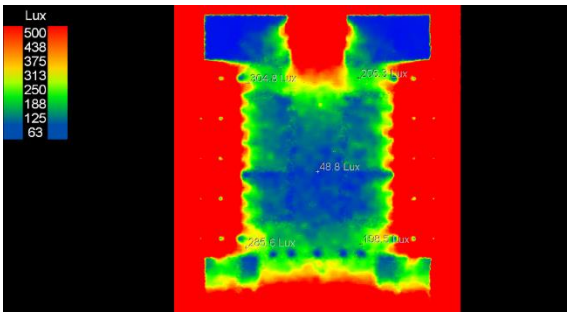

Figure 9 VELUX daylight simulation TPA As Sakinah.

Table 1. Measuring point

Measuring Point	TPA As-Sakinah
Center	10
Corner 1	68
Corner 2	44
Corner 3	65
Corner 4	45

Table 2. Sensor point

Sensor Point	TPA As-Sakinah
1	304,8
2	206,3
3	48.8
4	285,6
5	198,8

In object simulation, the value of light intensity entering the interior of the building tends to be higher than the measurement, this is caused by external factors such as obstructions around the object or weather conditions at the time of measurement. Simulation results and Field Measurements have a similar pattern of results with the four corner points with adjacent values while the middle point has the lowest illumination (table 1 and 2).

In the TPA As-Sakinah, the lack of illumination in the middle is due to its location on the lower floor of the building so that there are many parts of the building that block the reflection of light entering the building.

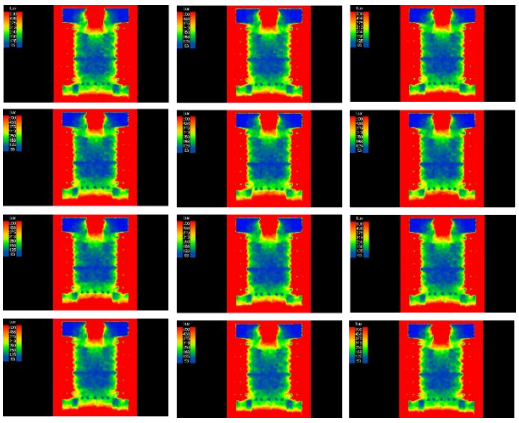

Figure 10 Monthly Simulation Result of TPA As-Sakinah (63-500 lux).

The design response that can be done on this object is limited to the use of materials that reflect lighter and the use of adequate additional lighting. Natural lighting on the objects is limited to the edges according to the simulations that are carried out monthly (figure 10). It can be seen in the simulation that the range of natural light only reaches the outside perimeter, for the interior of the building the use of artificial lighting is needed to meet the set standards. The use of artificial light can increase the potential for transmission of COVID-19 because it does not have disinfectant properties as sunlight does.

The optimal level of light intensity around the room is 250 lux. Meanwhile, in the middle and interior of the room, the light intensity is only 150 lux (less than the recommended value).

4.2. VELUX Daylight Simulation Balee Aleh Ba (figure 11)

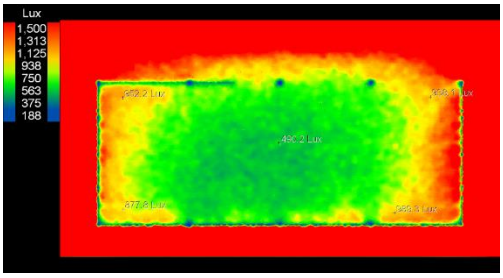

Figure 11 VELUX Daylight Simulation Balee Aleh Ba.

Table 3. Measuring point

Measuring Point	Balee Aleh Ba
Centre	10
Corner 1	4
Corner 2	20
Corner 3	50
Corner 4	47

Table 4. Sensor point

Sensor Point	TPA As-Sakinah
1	952.2
2	938.1
3	490.2
4	877.8
5	989.3

In object simulation, the value of light intensity entering the interior of the building tends to be higher than the measurement, this is caused by external factors such as object obstruction or weather conditions at the time of measurement. Simulation results and Field Measurements have a slightly different pattern of results, especially in corners 1 and 2, this is due to the presence of obstructions on the walls of the building in the form of bookshelves that cover the walls (table 3 and 4).

In Balee Alee Ba, the incoming natural lighting has a higher intensity than the previous object, this is due to several factors, such as the smaller building dimensions allowing light to enter the center of the building and its high location so that it is not obstructed by the surrounding objects. However, because of its high location, direct light rays can easily enter the building so that a design response is needed to reduce direct light intake but also allow an optimum amount of natural light.

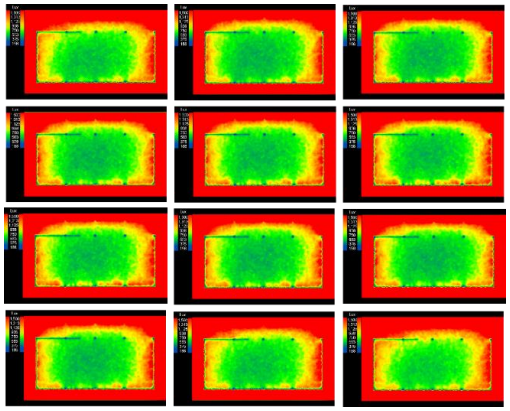

Figure 12 Monthly simulation result of Balee Ale Ba (188-1500 lux).

The design response that can be done to this object is done through modification of the facade to reduce direct lighting and the use of materials that can withstand direct sun radiation. Natural lighting on the object is sufficient for lighting needs according to the simulation carried out every month (figure 12).

It can be seen in the simulation that the achievement of natural light reaches all parts of the room with direct lighting zones at the edges. Natural lighting in objects can reduce the potential for transmission of COVID-19 because sunlight has disinfectant properties and can

improve children's concentration and performance in learning and reciting.

The average light intensity level of natural light is 400-750 lux at 12.00 (Higher than the recommended value).

5. CONCLUSION

Based on the results of the analysis, there is a significant difference in the level of accessibility of natural light between the two objects. The level of natural lighting at TPA As-Sakinah ranges from 40-500 lux. This is caused by the location of the As-Sakinah TPA is on the lower floor of the Jamik Mosque, Kopelma Campus. In addition, the shape of the large mosque building makes the configuration of the layout of the TPA facility space far away from the light source/opening. These conditions require the use of artificial light during the day. The results of this measurement show that the As-Sakinah TPA does not yet have the feasibility of recitation activities that are adaptive to the COVID-19 pandemic.

Meanwhile, the level of natural lighting at the TPA Balee Ale Ba ranges from 331-1300 lux. The availability of natural light at the TPA As-Sakinah is not as optimal as TPA Balee Ale Ba. Balee Ale Ba has a good quality of light entering the interior. This is influenced by the open facade design of the study hall. Under certain conditions, the intensity of direct light around the hall must be minimized by adding overhangs or curtains to reduce the heat. The results of this measurement show that Bale Aleh Ba has the feasibility of adaptive recitation activities to the Covid-19 pandemic.

Bale Ale Ba is smaller in size and has a higher direct light ratio, the illumination in the room is higher but, with direct lighting, new problems such as temperature and heat radiation arise, but this is not so significant considering the use of wood as the material.

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