Study of daylight optimization for autism school in Cempaka Putih, Jakarta

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Abstract. The Autism school have a specific design’s requirements. Daylight is one of many important factors that help create comfort atmosphere for autistic children in school. Moreover, Autism Spectrum disorder (ASD) children tend to be easily distracted by their visual sensory. Most of them have very sensory sensitive against the use of direct fluorescent lighting. The study is aimed to investigate the required illumination, skylight orientation, skylight opening for comfort lighting that suitable with Autism Children. The results showed certain skylight opening and orientation affect the glare free room, lighting and thermal comfort inside the classroom. The steps of research is as follows: (1) Study the optimum light and illumination for classroom, (2) Study the size of the opening or skylight surfaces, and (3) Study the optimal skylight orientation and type. The result expected to meet the skylight requirement that help student with Autistic to get education to improve the quality of life and prepare to live independently.

Keywords: Daylight, autism school, Skylight, lighting comfort.

1. Introduction

This study was raised based on one of United Nations sustainable development goals point 11th called Sustainable Cities and Communities that focused on make cities inclusive, safe, resilient and sustainable. The goal is to increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion. This vision basically occur, since currently many cities in the world are facing a challenge of Autism Spectrum Disorder (ASD). It is estimated that worldwide one in 160 children has an ASD [1]. In Jakarta the prevalence of ASD reach 16,000 based on BPS Data DKI Jakarta.

| No. | School Name          | Location           | Building Type    |
|-----|----------------------|--------------------|------------------|
| 1.  | Pantara School       | Tebet Barat, South Jakarta | School building |
| 2.  | Kyriakon School      | Ulujami, South Jakarta | School building |
| 3.  | Cita Buana           | Jagakarsa, South Jakarta | School building |
| 4.  | Talitakum            | Kebon Jeruk, West Jakarta | House            |
| 5.  | Rumah Autis          | TanjungPriok, North Jakarta | House            |
| 6.  | Yayasan Baik         | Jagakarsa, South Jakarta | House            |
| 7.  | Sarana Sekolah Terpadu | TB Simatupang, South Jakarta | Office          |
The ratio of the number of ASD is not proportional with the number of environmental and education facilities. Table 1 shows only some partial list of schools provide specific facility for Autistic Children. As stated seven school above, only RumahAutis and Yayasan that built specifically for children with Autism.Meanwhile, the rest are the Special Education School with inappropriate facilities. These school buildings are not specifically designed for Autism Children. Rumah Autis and Yayasan Baik are even more inappropriate. Both schools are actually a house which provide therapy for Autistic Children in basic level. Many other schools located in South Jakarta act as therapy center in shophouses that stiff and narrow. There are almost not yet Autism school with adequate facilities that can be found in central of Jakarta. Cempaka Putih, Central Jakarta, the selected area for this study, is one of five region in Jakarta that has no education facility for Autistic Children. This site conforms to the inclusivity school location criteria according to the Minister of Education regulations.

According to Dyah Septia, the behavior of children with autism affected design space. Classroom design’s requirements must be different with regular school, natural lighting is one of many important factors in providing comfort for autistic children in school. Moreover, ASD children tend to be easily distracted by their visual sensory [2]. The majority in the sensory sensitive against the use of direct fluorescent lighting. Some researchers maintain that individuals with autism are more vulnerable to the sub-visible flicker that can cause headaches, eyestrain, and increased repetitive behavior. Windows placement also affects the comfort of ASD children, suitable skylight can provide natural lighting to buildings without visual disturbance. The use of sidelight will make students easily distracted to look out the window [3]. West site area also supports the application of skylights, because the result of simulations with surrounding buildings shows optimal lighting.

![Daylight System](image)

**Figure 1.** Daylight System

To utilize daylight in buildings (Figure 1) need several strategies, for the organization of buildings there are several parts, one of which: skylight, skylight is one of strategies that can create a glare-free room. This glare-free room has an option that can be arranged by placing windows in the rooms. Window placement affects several elements such as Low Contrast, Daylight hole, and Light Shelf. Low Contrast is one of the strategies to create a comfortable glare in the eye, do not create exceed bright lighting in the room [4].

It is very necessary to design schools with the appropriate skylight’s design so that we can accommodate learning and therapies facilities with the child's authentication. Autistic children have a disruption to interaction, so they have a different response to their environment and sensory compared to other normal children to light. The Skylight furthermore will provide therapy as well as education for autistic people so that they have the ability to socialize, manage in complexity, improve their abilities, reduce hyperactivity, and emphasizes that they are able to live independently. This is also expected to provide awareness about the importance of providing appropriate facilities especially education for children with autism.

2. The methodology

The research method used is comparative descriptive method using quantitative descriptive such as Literature Study. Research using the study method is carried out by comparing similarities and
differences to look for factors that can cause the emergence of particular design. The study begins to compile the data and then compare it. After searching for the similarities and differences in causes, several factors are determined. Descriptive studies begin by comparing with the use of variables that are determined based on theories that have been obtained from the book include: Building Orientation, Skylight orientation, Geometric Buildings, Location / climate, Opening size, Room glare-free, Roof type.

3. Result and Discussion

3.1. The optimum skylight orientation

At tropical climate, the most of skylight is flat but has slope. It can be concluded that the optimal skylight surface orientation for schools is facing opposite to the equator, using a flat type skylight, and with a diffuse light system so that the distribution is better distributed and reduce sun radiation to get into the room inside the building.

| No. | Location | Build. Ort. | Skylig. Ort. | Climate | Size % | Dirr. Light | Diff. Light | Roof Type |
|-----|----------|-------------|--------------|---------|--------|-------------|-------------|-----------|
| 1   | Singapore| NW - SE     | North East   | TR      | 21%    | ✓           | ✓           | Dual-pitched |
| 2   | Bekasi   | East-West   | Flat         | TR      | 11%    | ✓           | ✓           | Mono-pitched |
| 3   | Bogor    | North-South | Flat         | TR      | 21%    | ✓           | ✓           | Mono-pitched |
| 4   | Bali     | East-West   | North        | TR      | 3%     | ✓           | ✓           | Conical    |

TM : Temperate Climate; TR : Tropical Climate

It also can be concluded, Nafa School’s skylight design (Figure 2) is suitable for the location of Cempaka Putih Barat site. In addition to the climate equation which is the Tropical Hot climate with Nafa, the spread of light is also carried out using diffuse light with reflections

![Figure 2. Skylight Detail Nafa School Singapore](image)

- Pro aspect: On the surface of the skylight is facing the opposite of the equator. Then the geometry of the skylight is designed to insert the light indirectly in order to reduce excessive heat get into the classroom area. The orientation of the building is also in accordance with the Tropics Climate, where the widest building mass faces North-South.
- Contra Aspect: Percentage of skylight opening more than 15%, according to Energy Government standards it have to less than 15% for building with few windows.

3.2 Site Index Analysis

Figure 3 is the mass composition from the site index in the government design regulations as previously stated in the existing site analysis. The choice of mass composition letter L was obtained from the literature study, then supported by location conditions that are not perpendicular to the equator and the theory that the most optimal building orientation is the widest side of the building is facing north and south.
The classroom area will be placed in the position as marked in the Figure 4. Considering the morning sunlight and noise, the position of the classroom is in the eastern part because the surrounding environment are small houses of residents whose noise pollution was not as noisy as the highway.

3.3 Skylight Simulation
3.3.1. 10% opening of the roof

The 10% skylight opening with dimensions (4.16 x 0.6 x 0.5) x 2 pieces (Figure 5, Table 3) in March did not bring out optimal results. It can be seen in the simulation results that in the morning the lighting is lacking, so it does not reach the Lux standard which is 250 Lux. For daytime, sunlight exposure is only part of the area, so there is considerable visual contrast. While in the afternoon, the incoming light is quite evenly distributed but it is ignored because the classroom will rarely be used during the afternoon.
Size (l x w x h) (4.16 x 0.6 x 0.5) x 2 pcs

Table 3. Skylight Simulation 10%

| Time  | March  | June   | December |
|-------|--------|--------|----------|
| 09.00 | 65-99  | 55-76  | 68-108   |
| 12.00 | 140-260| 92-160 | 160-250  |
| 15.00 | 160-220| 88-185 | 88-160   |

3.3.2. 12% opening of the roof

The 12% skylight opening with dimensions (3 x 1 x 0.5) x 2 pieces (Figure 6, Table 4) in March produces optimal results. It can be seen in the simulation results that in the morning, the lighting reaches Lux's standard number, 250 Lux and the light distribution is evenly distributed. For daytime, light exposure is quite even too. Whereas in the afternoon, the incoming light is less but it is ignored because the classroom will rarely be used during the afternoon.

Size (l x w x h) (3 x 1 x 0.5) x 2 pcs

Table 4. Skylight Simulation 12%

| Time  | March  | June   | December |
|-------|--------|--------|----------|
| 09.00 | 132-250| 150-230| 170-250  |
| 12.00 | 180-300| 160-260| 100-260  |
| 15.00 | 75-100 | 66-100 | 48-90    |

3.3.3. 15% opening of the roof

The 15% skylight opening with dimensions (2.5 x 1.5 x 0.5) x 2 pieces (Figure 7, Table 5) in June do not bring out optimal results. It can be seen in the simulation results that in the morning the lighting is less than 250 lux, so it does not reach the Lux standard number. For daytime, light exposure is only
part of the area and sufficient light. Whereas in the afternoon, the incoming light is not evenly distributed but it is ignored because the classroom will rarely be used during the afternoon.

Size (l x w x h) (2.5 x 1.5 x 0.5) x 2 pcs; June

![Figure 7. Skylight Simulation 15% 50 cm](image)

### Table 5. Skylight Simulation 15%

| Time   | March      | June       | December  |
|--------|------------|------------|-----------|
| 09.00  | 160-250    | 100-167    | 230-260   |
| 12.00  | 200-300    | 150-280    | 230-400   |
| 15.00  | 92-180     | 88-93      | 92-140    |

**Conclusions**

The optimal skylight surface orientation for this Autism schools is facing opposite to the equator, using a flat type skylight, and with a diffuse light system so that the daylight is better distributed and reduce sun radiation to get into the room.

The sun's position simulation has been carried out to determine the position of the sun against the site in CempakaPutih in a year and it was concluded that the area that is longer exposed to the sun is the northern part of the building. The sun is in the north for 7 months, and in the south for 5 months. Then the surface area of the skylight faces south to avoid excessive radiation exposure from the sun and opposes the equator. So the light taken is indirect sunlight.

As we have found the optimal position for skylight surface orientation, and due to the government regulation for skylight area to be not more than 15% in the roof, so we use 10%, 12%, and 15% of roof area to be transparent skylight. The simulation shows that the best opening on the roof to get maximum comfortable light is 12% of roof area. The dimensions of the skylight 2 x 0.4 x 0.5 sqm of roof total 30 m2 of roof, can produce the best light illuminance for this Autism school.

**References**

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