engineering proceedings

MDPI

Proceeding Paper

Natural Lighting Evaluation of MAN Cimahi as Educational Building in Indonesia Using Sefaira Software †

Hilmy Allamsyah [1], Luthfiyati Halimatussya'diyah [2], Salsabella Tazkia [3] and Beta Paramita [4,*]

[1] hilmyallamsyah@upi.edu
[2] hluthfiyati@upi.edu
[3] tazkiasalsa@upi.edu
* Correspondence: betaparamita@upi.edu
† Presented at the 1st International Online Conference on Buildings, 24–26 October 2023; Available online: https://iocbd2023.sciforum.net/.

Abstract: Building sector contributes 40% of carbon emissions to the atmosphere. Several studies show that high-performance MAN (Madrasah Aliyah Negeri) buildings contribute to reducing carbon emissions. This study discusses the evaluation of natural lighting in educational buildings, the MAN (Madrasah Aliyah Negeri) Cimahi building. The research was conducted using direct survey methods by measuring and simulations to the natural lighting using Sefaira. The simulation results show that natural lighting in the building has not met the lumination standard. This article concludes that the addition of roof overhang dimension, the area of openings, façade elements, and shading strategies are factors that affect natural lighting in MAN (Madrasah Aliyah Negeri) Cimahi building.

Keywords: natural lighting; thermal comfort; educational building

Citation: Allamsyah, H.; Halimatussya'diyah, L.; Tazkia, S.; Paramita, B. Natural Lighting Evaluation of MAN Cimahi as Educational Building in Indonesia Using Sefaira Software. *Eng. Proc.* **2023**, *53*, x. https://doi.org/10.3390/xxxxx

Academic Editor(s): Name

Published: 24 October 2023

1. Introduction

Global warming is increasing and impacting the environment. In Indonesia, there was a year with the largest anomaly of 0.8 °C, namely in 2016 released by the BKMG (Badan Meteorologi, Klimatologi, dan Geofisika). According to the EECCHI (Energy Efficiency and Conservation Clearing House Indonesia) in 2012, the building sector contributes 40% of carbon emissions to the atmosphere. As an effort to help reduce gas emissions, it can be done by high-performance MAN (Madrasah Aliyah Negeri) buildings and the use of technology [1]. The design of educational buildings needs to take into account the use of energy and the comfort of its users. Moreover, comfort in space, considering that the delivery of knowledge through visuals and sounds occurs in the room [2].

One of the educational facilities that has problems with the thermal comfort of users is MAN (Madrasah Aliyah Negeri) Kota Cimahi. Energy efficiency efforts in buildings can be done through the maximization of natural lighting, shading, ventilation, thermal mass, solar air preheating, openings, air filtration, and passive solar heating [3].

Sefaira is an energy, natural lighting, thermal, and HVAC (Heating, Ventilation, and Air-Conditioning) analysis software in buildings that can calculate 3 main components, namely energy, natural lighting, thermal, and heating and air conditioning systems. The calculation of natural and thermal lighting in educational buildings is necessary to find out the comfort of the building connected with lighting and thermals in the building and provide recommendations for design or MAN (Madrasah Aliyah Negeri) managerial improvements in user habits.

2. Materials and Methods

Natural lighting is lighting obtained from direct sunlight, where this light is obtained in the morning to evening [4]. Based on SNI (Indonesian National Standard) 03-2396-2000, natural lighting is said to be good at 08.00 WIB (Western Indonesian Time) to 16.00 WIB (Western Indonesian Time). Thermal Comfort is a thermal condition that is perceived by humans MAN (Madrasah Aliyah Negeri), but conditioned by the environment and objects around with his thermal environment [5]. Thermal comfort is closely related to natural conditions, but can be improved and minimized with architecture [6]. Natural lighting is influenced by the openings and orientation direction of the sun [7]. The wider the opening, the more likely the room will be exposed to sunlight, but also the indoor temperature will increase. Therefore, there is a standard of good lux quantity in the room.

2.1. Types of Research

The type of research carried out using quantitative research methods is by conducting a field survey then conducting a simulation process through the Sefaira software, so as to obtain the data needed to answer research cases.

2.2. Research Location

The research was conducted at MAN (Madrasah Aliyah Negeri) Kota Cimahi located in Leuwigajah, Cimahi, Indonesia (Figure 1). This location was chosen based on field surveys and interviews with users.

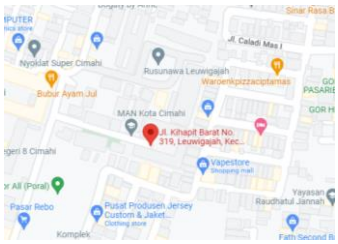


Figure 1. Studied educational building location by Google Maps.

2.3. Data Collection Techniques

Data collection is carried out into two stages, namely:

1. Primary data, data collected by conducting field surveys.
2. Secondary data obtained through the literature study method as a reference for standardization and research support.

2.4. Technical Data Analysis

After obtaining field data, an analysis is carried out and matched with existing standards. Here are the steps:

1. Conducting simulations to obtain thermal comfort data through the Sefaira software.
2. Compare with existing standards to get a conclusion on whether the building is appropriate or requires recommendations.

3. Results and Discussion

MAN (Madrasah Aliyah Negeri) Kota Cimahi building has a centralized building orientation with 2 2-story buildings and 1 1-story building. The master plan of the building can be seen in Figure 2. The building material uses red brick walls, windows with an aluminum frame and 5 mm float glass, as well as a saddle-shaped tile roof.

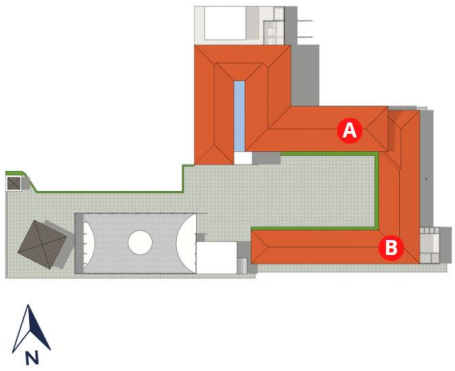
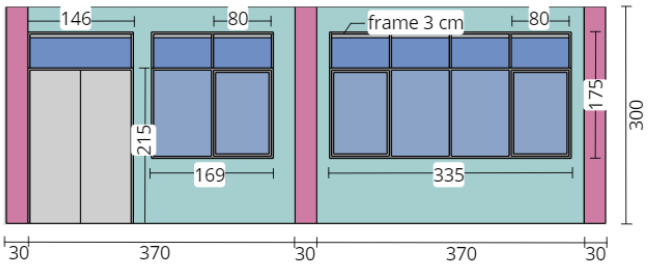


Figure 2. Master plan by field survey.

The lux standard according to SNI (Indonesian National Standard) for classrooms is 250–300 lux [8]. Some spaces have fairly large window dimensions, so the room is quite exposed to sunlight (Figure 3). This leads to an increase in room temperature and discomfort due to overheating that can be seen in Figure 5. There are also some buildings that are less exposed to sunlight (Figure 4), so it is humid, especially the space in the south building at the east end that can be seen in Figure 6.

(**a**)



(**b**)

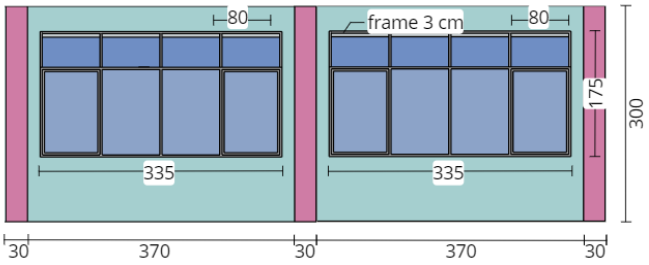
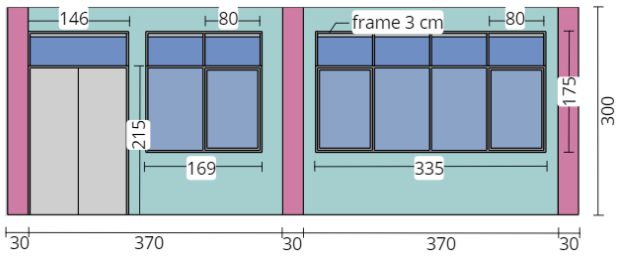


Figure 3. (**a**) Dimensions of south side openings of sample A by SketchUp; (**b**) Dimensions of north side openings of sample A by SketchUp.

(**a**)



(**b**)

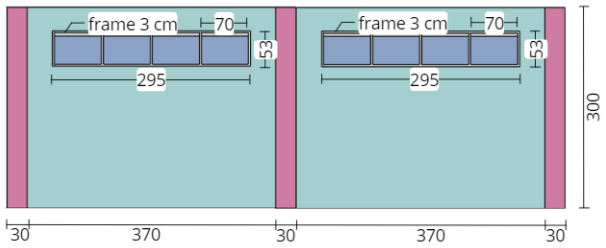


Figure 4. (**a**) Dimensions of north side openings of sample A by SketchUp; (**b**) Dimensions of south side openings of sample B by SketchUp.

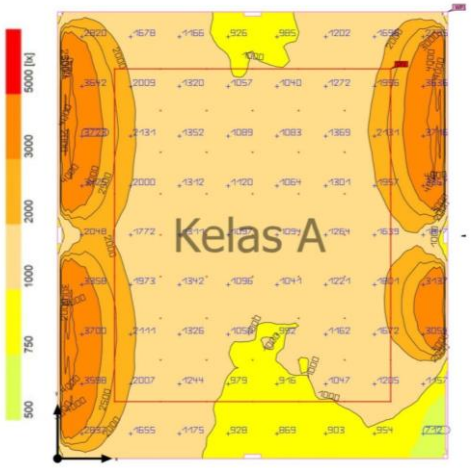


Figure 5. Sample A (Class with a large window, lux 7310) by Dialux Evo 9.2.

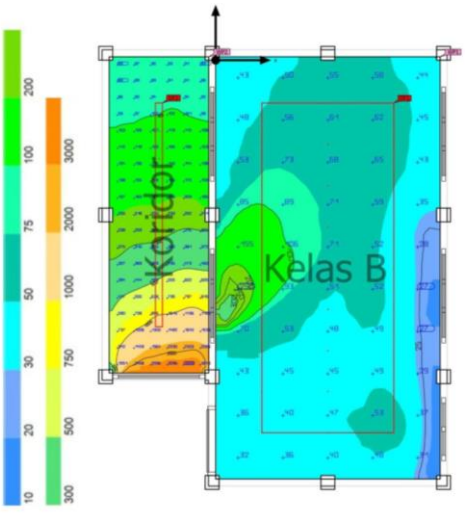
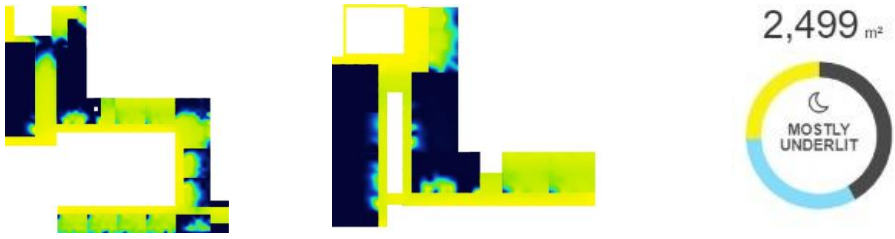


Figure 6. Sample B (Class with less lighting, lux 76) by Dialux Evo 9.2.

In addition to analyzing natural lighting using Dialux Evo 9.2, this study also used analysis using Sefaira to the existing plan (Figure 7) to find out whether the spaces in the building were in accordance with the standards or not. And the result was mostly the space in the building does not have good enough natural lighting (Figure 7).

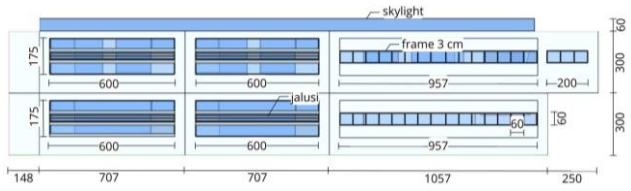


(**a**) (**b**) (**c**)

Figure 7. (**a**) Natural lighting analysis of first floor existing; (**b**) Natural lighting analysis of second floor existing; (**c**) Simulation results.

Based on the data obtained from the analysis above, there are several solutions that can be applied about changing material of the window glass, adjust the shape and dimensions of the window according to the standards and needs, and additional elements such as cantilever windows. After making changes and adding openings, a Sefaira software simulation was carried out again and the results of natural lighting and thermal comfort from the MAN (Madrasah Aliyah Negeri) Kota Cimahi building were better than before (Figure 8).

(**a**)



(**b**)

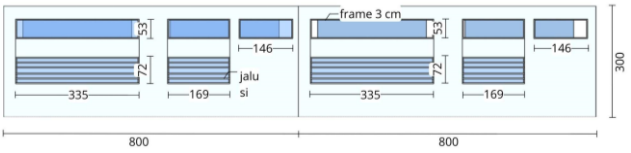
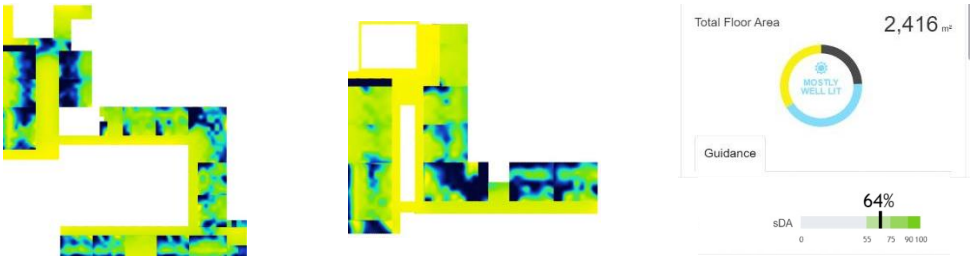


Figure 8. (**a**) Addition and resize of west building windows ; (**b**) Addition and resize of south building windows.



(**a**) (**b**) (**c**)

Figure 9. (**a**) Natural lighting analysis of first floor after treatment; (**b**) Natural lighting analysis of second floor after treatment; (**c**) Simulation results.

4. Conclusions

From the data and analysis results regarding natural lighting and thermal comfort in MAN (Madrasah Aliyah Negeri) Kota Cimahi it can be concluded that the dimensions, materials, shapes, and elements of the openings affect the amount of exposure to sunlight into the room. It can be concluded that natural lighting affects the living of the space. Too much sun exposure makes the room temperature hot, so there are standards regarding

the amount of lux that is good in the room. With the optimization of natural lighting, buildings can reduce the use of electrical energy and air-conditioning.

The MAN (Madrasah Aliyah Negeri) Kota Cimahi building has several classrooms that do not meet the thermal comfort standards based on the size of the lux in the space, there are rooms that are too bright and hot, there are also rooms that are too dark and humid. Therefore, openings are added and treatment is given in the form of material replacement and cantilever windows.

Acknowledgments: This article was supported by Center of Excellence for Low Emission Building Materials and Energy, and the Laboratory of Science, Technology and Building Materials of the Universitas Pendidikan Indonesia. This research funded by BeCool Indonesia.

References

1. Salsabila, F.; Prianto, E. Aplikasi dan Evaluasi Dengan Software EDGE pada Bangunan Dekanat Baru Fakultas Teknik Universitas Diponegoro. *IMAJI* **2020**, *9*, 691–700.
2. Idrus, I. Model Pencahayaan Alami Ruang Kelas Berbasis Persepsi Visual Siswa Sekolah Dasar dan Menengah di Daerah Tropis. Thesis, Universitas Hasanuddin, Kota Makassar, Indonesia, 2020.
3. Szokolay, S.V. *Introduction to Architectural Science the Basis of Sustainable Design*; Architectural Press: Oxford, UK, 2004; p. 17.
4. Nurhaiza; Lisa, N.P. Optimasi Pencahayaan Alami pada Ruang. *Arsitekno* **2016**, *7*, 32–40.
5. Gosal, P.H.; Makarau, V.H. Optimalisasi Kenyamanan Termal Pada Rumah-Rumah Kayu di Kampung Jawa Tondano. *Front. J. Sains Dan Teknol.* **2018**, *1*, 91–104.
6. Snyder, J.M. Election Goals and the Allocation of Campaign Resources. *Econom. J. Econom. Soc.* **1989**, *57*, 637–660.
7. Ching, F.D.K. *Arsitektur, Bentuk, Ruang, dan Susunannya*; Erlangga: Jakarta, Indonesia, 1999.
8. Badan Standardisasi Nasional. Available online: http://sispk.bsn.go.id/SNI/DetailSNI/13243 (accessed on 20 September 2023).