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The Effect of Orientation and Material On Thermal Comfort In Museum Perkebunan Indonesia Building

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Abstract. Thermal comfort is something that must be considered in a building to create comfort for its users. One of the factors that influence thermal conditions is the orientation of the building towards the sun and building materials. The Museum Perkebunan Indonesia is one of the famous and oldest museums in Medan, Indonesia. Besides that, the museum still has the dutch colonial architecture style, which is mostly known as a building with good air circulation because of the amount of ventilation and window they have. Based on that, this study aims to measure the thermal comfort of each room with a different orientation in Museum Perkebunan Indonesia and then to examine the effect of thermal comfort in Museum Perkebunan Indonesia. Moreover, the study also discusses the material used in Museum Perkebunan Indonesia building. The methodology of this study is qualitative-descriptive by solving the existing problems based on quantitative data that is done by the measurement of air temperature that was carried out for six different days, starting from morning to evening. Furthermore, the study also analyses and describes the object research. The analysis itself shows that the orientation effect has a significant effect compared to the influence of building materials on the museum building. And the result of the analysis shows that Museum Perkebunan Indonesia Building falls into the uncomfortable category according to the Standard Procedure for Planning Energy Conservation in Buildings.

Keywords: material, museum, orientation, thermal comfort

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1 Introduction

The primary influence on a building is the condition of temperature and humidity that leads to thermal comfort. Thermal comfort is needed so that residents or building users can move well. According to Masarrang [1], comfort depends on climate variables namely the sun or solar radiation, air temperature, air humidity, wind speed, and several subjective factors such as clothing, acclimation (an adaptation of living things to a new environment), age and gender, obesity level, health level, type of food and drinks consumed, and skin color. Muhaling [2] also stated that thermal comfort is affected by climatic factors (solar, radiation, air temperature, wind

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speed, and humidity) and two individual factors named activity and clothing used by someone. Karyono [3] said that solar radiation is a factor that can cause tropical buildings to feel warm.

According to Resink [4], it took the Netherlands more than 300 years to conquer almost all of Indonesia. On the other hand, Soekiman [5] said that Dutch architecture developed in Indonesia as long as Indonesia was still under Dutch rule, from around the beginning of the 17th century to 1942, and according to him, Dutch colonial architecture is a European graft architecture, which means it is an architecture from the Netherlands developed in Indonesia. Colonial buildings in Indonesia may have been able to adapt to the tropical climate of Indonesia so that it can survive until now. However, it needs to be reviewed again whether the Dutch colonial buildings (Museum Perkebunan Indonesia Building) have achieved ideal thermal comfort. The purpose of this study is to determine and examine the effect of orientation and building envelope material on thermal comfort in Museum Perkebunan Indonesia (Musperin) as well as a benchmark of knowledge about tropical architecture and thermal comfort which is very much needed in designing a building with the conditions of Indonesia's tropical climate.

2 Literature Review

The museum is a permanent institution that serves the needs of the public openly by conducting collection, conservation, research, communication, and exhibiting tangible objects to the public. According to the collection owned, the museum is divided into two museums that collect evidence of human material and technology. Second is the museum with a collection of evidence of human material or the environment associated with branches of art, branches of science, or technology. The requirements for the establishment of a museum that is must be in a strategic location, easy to reach, and healthy (not in a muddy area/swampland), must meet the principles of conservation so that the collection can be well maintained, the collection on display must have historical, scientific value, aesthetics and historical, geographical origins. The museum must also have facilities and infrastructure near related to the preservation activities of its collections, namely vitrine, collection care facilities such as air conditioners, dehumidifiers, CCTV, alarms, lights, labels, etc.

Thermal conditions in a room affect the thermal comfort of a person. The condition of comfort is also defined as thermal neutrality, which means that a person feels neither too cold nor too hot [6] According to Nugroho [7], comfort thermal can be defined as condition of thoughts that express satisfaction with the thermal environment. According to Karyono [8], the surrounding climatic conditions will affect the level of human productivity. Therefore, humans need a comfortable physical condition to support their activities, namely thermally. Thermal comfort is a person's view or judgment about the level of satisfaction with the thermal conditions of their environment. According to Szokolay [9], thermal comfort depends on climate variables (air temperature, humidity, wind speed, solar radiation) and individual factors such as the body's

metabolic rate, body acclimation, clothing, health conditions, types of food and beverages consumed, obesity level, age and gender and colour of a person's skin. According to Ibrahim [10], the speed increases air will reduce the effects of high humidity and increases the evaporation capacity of the body human. The comfortable temperature according to the standard procedure of technical planning for energy conservation in buildings is as shown in table 1. The effective temperature of cool comfortable reaches 24^0C, the optimal comfort is 28^0C, and the warm comfortable is 31^0C.

Table 1 Standard Procedures for Technical Planning for Energy Conservation

Condition	Sufficient Temperature (ET)
Cool Comfortable	$20,5^0$C – $22,8^0$C
Upper Threshold	24^0C
Optimal comfort	$22,8^0$C – $25,8^0$C
Upper threshold	28^0C
Warm Comfortable	$25,8^0$C – $25,8^0$C
Upper Threshold	31^0C

Latifah explains the thermal comfort of buildings in tropical climates, namely cool comfort between 20.80C - 22.80C, optimal comfort, between a sufficient temperature of 22.80C - 25.80C, warm comfortably between a sufficient temperature of 25.80C – 27.10C [11]. According to Soetiadji [12], orientation is a relative position of a form to the primary plane, the direction of the compass, or to the view of someone who sees it. Meanwhile, Prakoso [13] said that building materials that have a large enough value of heat transfer resistance and can reflect sufficient heat would reduce the use of vibrant energy in the form of air conditioners such as air conditioners or fans during the day.

3 Methodology

This study uses qualitative-descriptive and quantitative presentation methods. Qualitative descriptive aims to understand a problem at the Museum Perkebunan Indonesia Building naturally by prioritizing the process of deep communication interaction between researchers with the Indonesian Plantation Museum building. Descriptive research is meant to research that aims to describe or describe Museum Perkebunan Indonesia Building systematically, factually, and accurately. The qualitative approach is to understand the aspects that contain a characteristic or characteristic of the Indonesian Plantation Museum building. Then, quantitative data is presented in the form of air temperature measurements using a thermometer hygrometer at the Museum Perkebunan Indonesia Building for six days and then analyzed the effect of orientation and building material on the thermal comfort of the building by looking at the results of the data in the form of the table. The object of this research is the Indonesian Plantation Museum located

on Brigjend Katamso Street (RISPA), Kampung Baru, Medan Maimun District, Medan City as shown in figure 1.

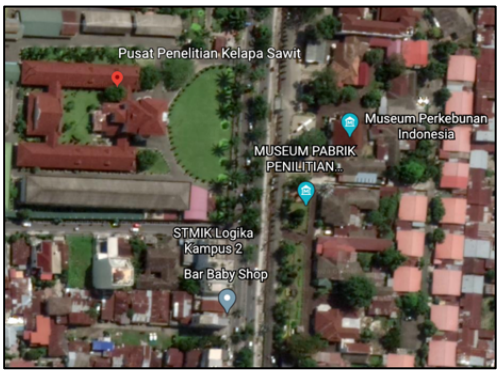

Figure 1 Research Site

4 Result and Discussion

Description Data

Brigjend Katamso is an area located in Medan Maimun Sub-district, north of Medan city, North Sumatera, Indonesia, shown in figure 2 and figure 3. This area is strategic because this area is one of the commercial areas in Medan Area.

Figure 2 Medan City Ma

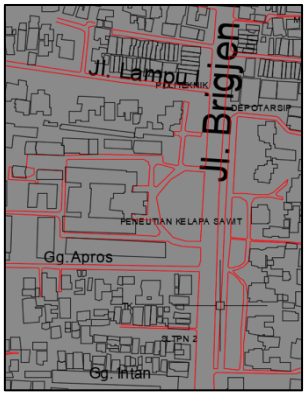

Figure 3 Research Location Area

Brigjend Katamso street is quite crowded with stores, buildings, transportation, people, and traffic jam. From morning to afternoon, this area is full of transportation, and the peak is in the afternoon. However, this area is not really crowded at noon as seen in figure 4. On both sides of Brigjend Katamso Street surrounds by a shophouse.

Figure 4 The state of Brigjend Katamso area

Museum Perkebunan Indonesia (Musperin) was established in 1917 and is part of Pusat Penelitian Kelapa Sawit (PPKS North Sumatra) as shown in Figure 5. Initially, the building was named Algemeene Proefstation der Avros / Algemeene Vereeniging van Rubberplanters ter Ooskust van Sumatra (APA), the plantation research institute in Sumatra.

Figure 5 Musperin (left) and PPKS Building (right)

In 1957, this building was taken over by the RISPA (Research Institute of the Sumatra Planters Association) which since 1992 changed its name to the Pusat Penelitian Kelapa Sawit (PPKS) Medan, North Sumatra. This museum building has two floors. Since its establishment, this building has been used as the residence of the head of the office. Moreover, this building is protected as a historic building by Mayor Decree No. 188,342 / 2017 / SK / 2000 and Medan City Regulation No.2 the Year 1912. Museum Perkebunan Indonesia Building (Musperin) was founded and conceived by Soedjai Kartasasmita was inaugurated on December 10, 2016, by the Governor of North Sumatra and the Director-General of Plantations, the Indonesian Ministry of Agriculture. Museum Perkebunan Indonesia is located at Brigjend Katamso Street number 53.

Museum Perkebunan Indonesia is the only thematic museum specializing in plantations in Indonesia and the first in the City of Medan. This building still has a Dutch colonial style. This can be seen from the building's facade and the large yard that characterizes the Dutch colonial buildings. The building has two floors with the floor plan as seen in figure 6.

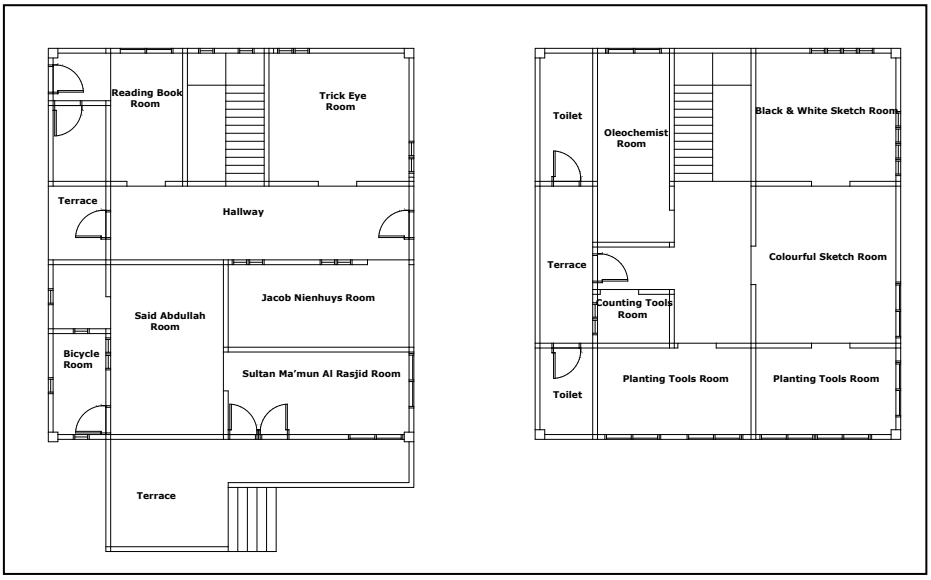

Figure 6 Museum Perkebunan Indonesia Floor Plan

The measurement is done in each room of the Musperin building for 6 days to strengthen the inconvenience level of each room after being calculated. As a result, the average temperature of each room on both floors is as seen in table 2.

Table 2 Average Temperature Condition in Building

No.	Room	Average Temperature	Room Orientation
1.	Sultan Ma'mun Al Rasjid	31,2^{0}C	South
2.	Jacob Nienhuys	31,4^{0}C	East
3.	Said Abdullah	30,9^{0}C	West
4.	Bicycle Room	33^{0}C	West
5.	Hallway	28,6^{0}C	East
6.	Trick Eye	32,2^{0}C	North
7.	Reading Book	31^{0}C	North
8.	Black & White Sketch	31,8^{0}C	North
9.	Colourful Sketch	31,9^{0}C	East
10.	Planting Tools	32,4^{0}C	South
11.	Planting Tools	32,2^{0}C	South
12.	Counting Tools	31,2^{0}C	West
13.	Oleochemist Room	31,3^{0}C	North

As shown in table 2, the average temperature in Sultan Ma'mun Al-Rasjid room from day 1 to 6, from 9 am to 3 pm, is 31,20C, Jacob Nienhuys room is 31,40C, Said Abdullah room is 30,90C, Bicycle room is 330C, Hallway is 28,60C, Trick Eye room is in 32,20C, Reading book room is 310C, Black & White Sketch is 31,80C, Colorful Sketch Room is 31,90C, Planting tools room I is 32,40C, planting tools room II is 32,20C, Counting Tools Room is 31,20C,

Oleochemist room is 31,30C. Moreover, as the result of the measurements during six different days from morning to afternoon, look at figure 7 explaining the condition based on Standard Procedures for Technical Planning for Energy Conservation.

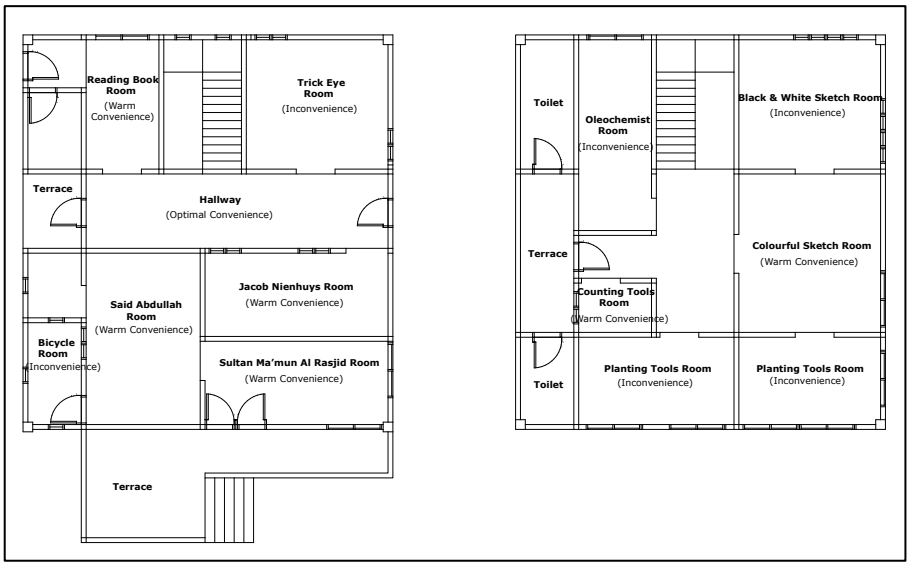

Figure 7 Museum Perkebunan Indonesia floor Plan and its Convenience Level

From all tables of the condition of the air temperature for 6 days, the average temperature in each table proves that the building parts oriented towards East and South experience higher temperatures than the building parts oriented towards North and West. This can prove that the theories of Hamdani [14] in the case of occupancy, the orientation of the building to the sun has a significant influence on the increase in air temperature in the room. In the case of museum buildings, this also applies. Research conducted by Amelia [15] proves that buildings oriented towards the North-West experience the highest discomfort. Whereas in the case of this museum, rooms oriented towards East and South experience higher discomfort compared to rooms oriented towards North and West. The increase in temperature in the room may also be caused by windows that are rarely opened because each room has air conditioners and fans based on interviews with museum guards and spotlights used in buildings. However, the theory in chapter II states that the museum must have facilities and infrastructure near related to the preservation of its collections, namely vitrine, collection care facilities such as air conditioners, dehumidifiers, CCTVs, alarms, lights, labels, etc.

5 Conclusion

The influence of orientation on thermal comfort is more significant than the influence of building materials on thermal comfort, namely precisely at air temperature. The results of data processing prove that the part of the building that leads to the North West according to the

Standard Technical Procedures for Energy Conservation in Buildings. Furthermore, the average room in the Museum Perkebunan Indonesia building falls into the inconvenience category.

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