

INVESTIGATING THE IMPACT OF AFTERNOON SUNLIGHT ON HUMIDITY AND TEMPERATURE WITHIN FACADE ENVIRONMENT: A CASE STUDY OF WARNA COFFEE & NORTHWAY COFFEE

Abid Hanif Dhiya Ulhaq Sandhiya¹, Johanita Anggia Rini², and Hilmi Nur Fauzi,³

¹Department of Architecture, Universitas Islam Indonesia

¹E-mail: 20512162@students.uii.ac.id

ABSTRACT: *The influence of the afternoon sunlight on thermal comfort encompasses humidity and temperature generated by building facade materials made of glass and the building's orientation. Excessive exposure to the afternoon sunlight tends to reduce productivity, especially in coffee shops where they are now used not only as places to enjoy coffee but also as places to enhance productivity. Humidity and room temperature undoubtedly support users in feeling comfortable in a place. To achieve this, an assessment is needed in a place frequently used by several people to improve their productivity. In this case, a direct measurement survey was conducted in two coffee shops: the first one (Warna Coffee) located at Palagan Tentara Pelajar Km 12.5 Gondanglutung, Gondong, Donoharjo, Ngaglik, Sleman, Yogyakarta, and the second one (Northway Coffee) located at Jl. Kaliurang No.Km 12, Sardonoharjo, Kec. Ngaglik, Kabupaten Sleman, Daerah Istimewa Yogyakarta. This research used data collection and processing methods from readings, theoretical internet sources, and developed all the materials to produce a good article. This research is more analytical or descriptive in nature. Additionally, the study conducted a survey to obtain field data and conditions at the research locations. After conducting the survey and obtaining several data points, the research performed testing using Computational Fluid Dynamics (CFD) applications, where CFD measured various parameters that needed to be known and achieved. In addition to using CFD, direct measurements were also taken using tools to measure temperature and humidity. The humidity result at Northway Coffee was 66.7%, while Warna Coffee had a humidity level of 67.1%. The temperature obtained at Northway Coffee was 27.5%, and Warna Coffee was 29.3%. This research is more analytical or descriptive in nature. It is hoped that with this research, the productivity level in a coffee shop, as observed in this study, will not be disrupted by productivity. It may even increase productivity in the location, which is an additional positive outcome desired from the conducted study.*

Keyword : Evening Sunlight, Humidity, Productivity, Temperature.

INTRODUCTION

Sunlight is very influential on human daily life, sunlight produces ultraviolet light, the rotation of the earth against the sun has an impact on the exposure of buildings to sunlight which continues to move every second. Starting from the east direction of sunrise, part of the building facade will be exposed to sunlight until it sets in the west, all parts of the building facade will be exposed to sunlight based on the direction of the sun's arrival, especially the afternoon sun which is exposed will have a higher temperature of 1-1.5 degrees Celsius compared to the morning sun, this is based on research conducted by Rahmawati, 2022. Humidity in the afternoon sun also tends to decrease by 0.7%-2.3% compared to the morning sun. In glass materials, excessive exposure to afternoon sunlight can be a serious problem. This will result in decreased productivity because users who are exposed to excessive light tend to avoid the afternoon sunlight (Gunawan, 2019).

According to Kepmenkes RI No 1405/MENKES/SK/XI/2002 concerning Health Requirements for Office and Industrial Work Environments, comfort for the human body regarding air temperature ranges from 18 degrees Celsius to 28 degrees Celsius. On the other hand, room humidity that is considered comfortable ranges from 40% to 60%. Rooms that have humidity of more than 60% can be a breeding ground for pathogenic organisms or allergens. However, room humidity that is less than 40% can cause eye discomfort and

irritation (Rahmwati, @all, 2022).

According to Kepmenkes RI No 1405/MENKES/SK/XI/2002 concerning Health Requirements for Office and Industrial Work Environments, comfort for the human body regarding air temperature ranges from 18 degrees Celsius to 28 degrees Celsius. On the other hand, room humidity that is considered comfortable ranges from 40% to 60%. Rooms that have humidity of more than 60% can be a breeding ground for pathogenic organisms or allergens. However, room humidity that is less than 40% can cause eye discomfort and irritation (Rahmwati, @all, 2022).

It is inversely proportional to the conditions in Northway Coffe where almost the entire facade of the building is made of concrete material, but in Northway Coffe there are many openings that can even be said to be semi outdoor because there are more openings than partitions that cover between rooms, therefore in this research compares 2 different conditions in two coffee shops in Yogyakarta.

LITERATURE REVIEW

Humidity

In order to maintain physical health and work capacity, the built environment must offer a certain level of comfort in terms of climate and heat (thermal comfort). More specifically, thermal comfort depends on temperature (natural ventilation), humidity, air movement and solar radiation (natural lighting). (Snyder & Catanese; 1980). This article examines an object, namely flats whose study is limited by natural lighting and also radiation produced by the sunlight exposed to the flats.

Temperature

Minimizing excessive temperature on building facades can be achieved by using materials that have high resistance to heat, so that the rate of heat flow that penetrates the material can be properly inhibited, besides this reduces the surface area facing east and west, limiting the exposure to sunlight entering the room, protecting walls with shading devices can also slow down the flow rate of heat exposed to sunlight, heat gain can also be reduced by reducing heat absorption from the surface, especially for the roof surface.

Wind Velocity

To ensure occupants' thermal comfort, ASHRAE 55 recommends that the air speeds in interior spaces should not exceed 0.2 m/s (meters per second) or approximately 0.447 mph (miles per hour). This limitation is crucial to prevent discomfort caused by excessivedrafts or wind chill effects, which can lead to feeling too cold even when the air temperature is within a comfortable range.

RESEARCH METHOD

This research uses the method of collecting and processing data from readingsources, theoretical internet sites and developing all these materials to make good writing. Which this research is more analytical or descriptive. In addition, this research also conducts a survey to find out field data and conditions at the location under study, after conducting a survey and obtaining some data, this research conducts testing using CFD applications where CFD will measure various parameters to be known and achieved, in addition to using CFD, direct measurements are also made with tools to measure temperature, humidity.

RESULT AND DISCUSSION

Direct Simulation

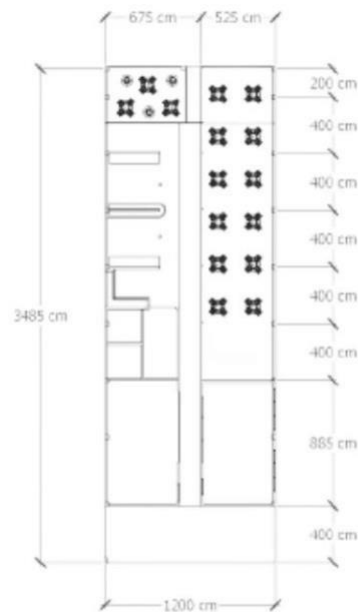


Figure 1 Northway Coffee floor plan
Source: Author, 2023

Northway Coffee is located on Jl. Kaliurang No.Km12, Candi, Sardonoarjo, Kec. Ngaglik, Sleman Regency, Yogyakarta Special Region, namelyat Northway Coffe, there are two different rooms in this coffee shop, one is closed using airconditioning and the other is an outdoor room that has shade around it, the facade material used is brick coated with cement, there are many openings in the outdoor part but there are no windows, there are only vents that are punched on the right side of the building, the rest uses a solid wall without any openings / ventilation. The first case criterion is:

1. Has many openings
2. Opening is found on the wall parallel to the human chest, and also some without skates.
3. The dominance of materials using concrete
4. The land is elongated
5. Area around densely populated land
6. Located not far from the highway

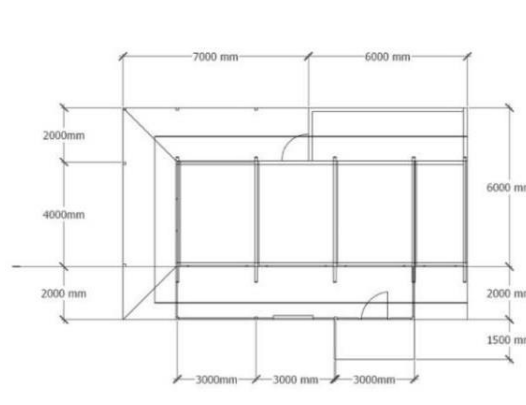


Figure 2 Warna Kopi floor plan
Source: Author, 2023

In this research case, it is located on Jalan Palagan Tentara Pelajar Km 12.5 Gondanglutung, Gondong, Donoharjo, Ngaglik, Sleman Regency, Special Region of Yogyakarta, namely in

WarnaKopi where most of the facade materials used are made of wood and glass with a little opening. The second case criterion is:

1. Has little opening
2. Dominated by glass material
3. Little concrete and concrete material
4. Opening is located at the top between the transparent wall and the roof.
5. There is lush plant shading around it
6. The surrounding land is not densely populated

Humidity Diagram in Yogyakarta

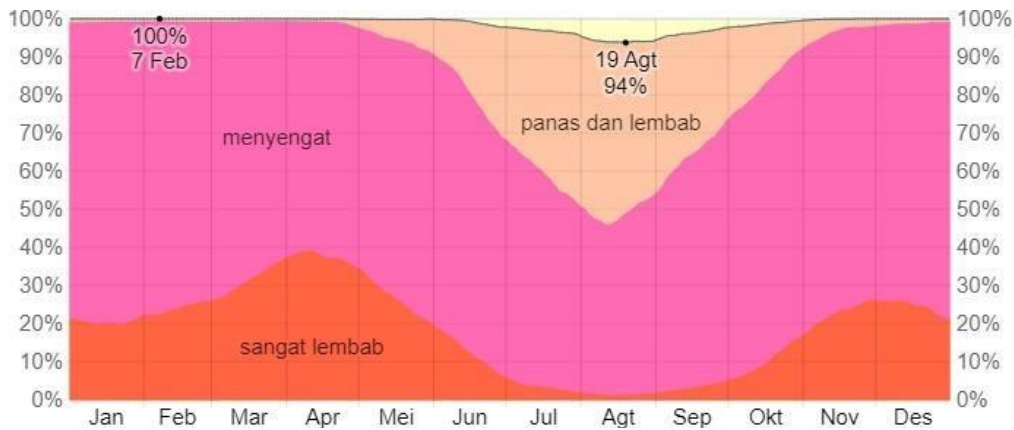


Figure 3 Humidity Diagram of Yogyakarta Region
Source: Author, 2023

Based on data obtained from the internet, it can be generalized that the humidity in Yogyakarta is averaged as the diagram above from January to December, the humidity level is relatively stable, it's just that around August from the diagram the humidity drops due to rising heat. This case is a comparison of two coffee shops in Yogyakarta, namely Northway Coffee and Warna Coffee, which focus on Thermal comfort consisting of Humidity and Temperature produced by the building facade, it requires more specific data, therefore the use of a digital illuminance meter tool is applied directly to the two case sites in order to get accurate data.

After collecting initial data through online sources, a subsequent live simulation was conducted using a lighting meter to measure the illuminance and humidity levels. The purpose of this live simulation was to obtain real-time and on-site measurements, to ensure a more comprehensive and accurate assessment of the environmental conditions in the two different cases. Data collection was specifically conducted between 3pm and 5pm, a critical period in the afternoon when natural lighting conditions undergo significant changes. By focusing on this time frame, the study aimed to capture variations in lighting levels, taking into account the interaction between daylight and artificial lighting sources.



Figure 5 Northway Coffehumidity data with Digital Illuminance Meter
Source: Author, 2023



Figure 4 Warna Kopi humidity data with Digital Illuminance Meter
Source: Author, 2023

Temperature Diagram in Yogyakarta

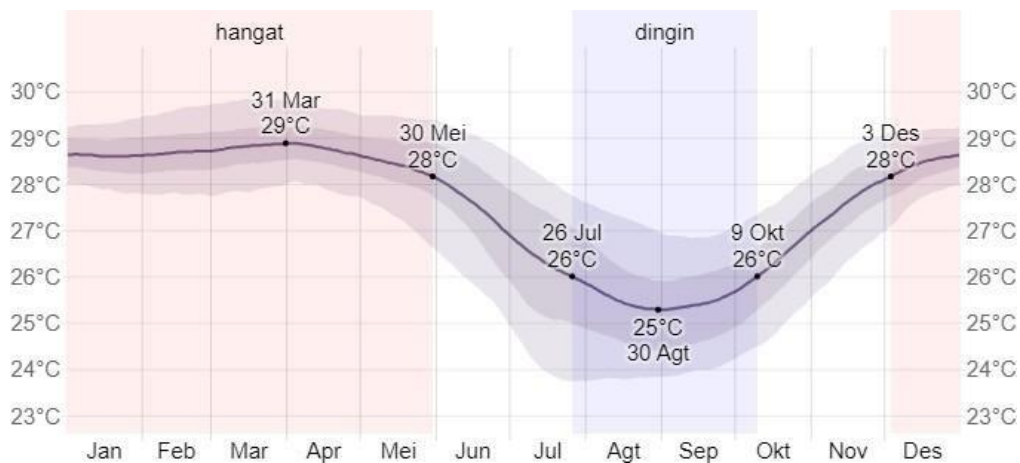


Figure 6 Temperature Diagram in Yogyakarta
Source: Author, 2023

From the data diagram above shows that the temperature in Yogyakarta from January to May tends to be stable at 29 Celsius and decreases to 28 Celsius in May, then from June to decrease at 26 Celsius, and in August and September it is cold at 25 Celsius, in October and November it starts to rise slowly from 26 Celsius to 28 Celsius until December. In this particular scenario, a digital illuminance meter was used to collect data for both cases. Data collection was conducted during the time span from 3pm to 5pm, which is a critical period when humidity conditions usually change significantly. The purpose of this data collection was to assess and compare the humidity levels at the two different locations. By using a digital illumination meter, precise and objective humidity measurements could be obtained. The data collected offers valuable insight into the actual temperature conditions at the specified locations over a defined period of time, allowing for a thorough analysis of the temperature environment.



Figure 7 Northway Coffee temperature data using Digital Illuminance Meter
Source: Author, 2023



Figure 8 Warna Kopi temperature data using Digital Illuminance Meter
Source: Author, 2023

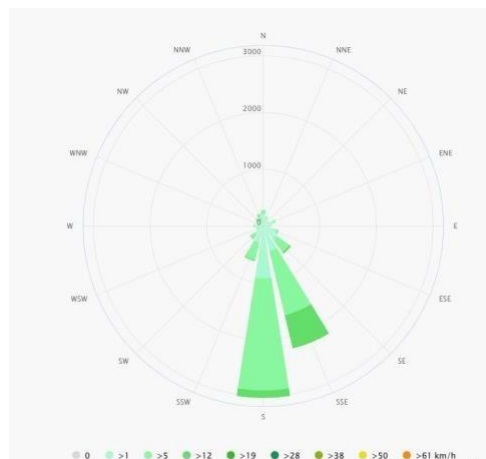


Figure 9 Windrose diagram ofYogyakarta Region
Source: Author, 2023

This wind rose diagram is used as the basis for simulations using applications that require wind speed and wind direction data. The data taken is the most dominating data or the average wind speed and direction in Yogyakarta, then adjusted to the existing case and simulated using the cfd application. As shown on Figure 10, the result of a simulation using the cfd application where the wind direction orientation based on the windrose is applied to the simulation this time, in addition to the wind speed orientation also applied to the simulation, namely the largest part of the diagram is taken based on the windrose, which is 5Km/h.

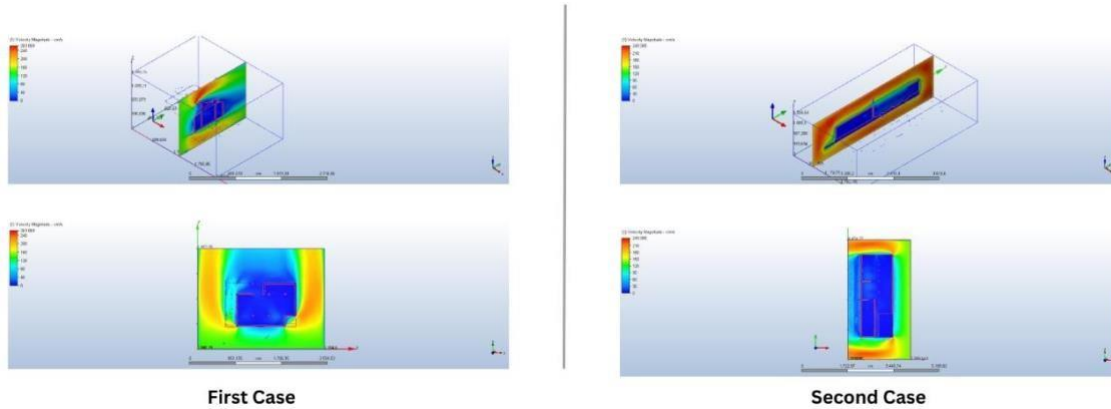


Figure 10 Simulation on CFD
Source: Author, 2023

CONCLUSION

After going through several observations obtained from the two different cases, several differences were found with the following conditions. The first case is the Northway Coffee building with the characteristics of

1. Has many openings
2. Opening is found on the wall parallel to the human chest, and also some without skates.
3. The dominance of materials using concrete
4. The land is elongated
5. The area around densely populated land
6. Located not far from the highway

It has a lower humidity level of 66.7% and the temperature is also lower than the second case at 27.5 Celsius.

While in the second case the Warna Coffee building with characteristics

1. Has little opening
2. Dominated by glass material
3. Little concrete and concrete material
4. Opening is located at the top between the transparent wall and the roof.
5. There is lush plant shading around it
6. The surrounding land is not densely populated

The second case, the Warna Coffee building, exhibited a humidity level of 67.1% and a temperature of 29.9 degrees Celsius, which were found to be relatively close to the results in the first case. This remarkable similarity is noteworthy, considering the distinct characteristics of each case. The unique aspect lies in the fact that despite having different building features and environmental contexts, the temperature and humidity measurements do not vary significantly between the two locations.

Upon deeper analysis, several factors could account for this phenomenon. One possible explanation is the presence of shading effects around the Warna Coffee building, created by the lush plant surroundings. This shading may moderate the impact of external environmental conditions on the indoor microclimate, contributing to the relatively stable humidity and temperature levels.

Additionally, the level of population density around each building could play a role in shaping the indoor environment. Higher population density in the vicinity of the Northway Coffee building might introduce additional heat sources, potentially influencing its indoor

Temperature. On the other hand, the Warna Coffee building being situated in a less densely populated area could experience fewer localized heat contributions, leading to more

consistent temperature readings.

Furthermore, the distance of each case from the highway may contribute to the observed patterns. Proximity to a highway can introduce external heat sources, such as vehicles, affecting the indoor microclimate. The Northway Coffee building's location, being closer to the highway, might experience subtle variations in temperature and humidity due to this influence. In contrast, the Warna Coffee building's relatively distant positioning from the highway could result in more stable indoor conditions.

Despite their individual characteristics, it is intriguing that both cases exhibit humidity and temperature levels that are not significantly different. This implies that other factors beyond the immediate building features may play a significant role in shaping the indoor climate. By recognizing these complexities, building designers, architects, and engineers can better understand how various environmental elements interact to influence thermal comfort and humidity levels in indoor spaces. Such insights are crucial for optimizing building design, energy efficiency, and occupant well-being, taking into account the intricacies of the surrounding environment and population dynamics.

REFERENCES

- Al-Tamimi, N. A., & Fadzil, S. F. S. (2011). The potential of shading devices for temperature reduction in high-rise residential buildings in the tropics. *Procedia Engineering*, 21, 273–282. <https://doi.org/10.1016/j.proeng.2011.11.2015>
- ASHRAE. (2020). Thermal environmental conditions for human occupancy. In *ASHRAE Standard 55-2020*. ASHRAE
- Ghassan M L, Sari L H, Munir A. (2021) An evaluation of the tropical architectural concept on the building design for achieving thermal comfort (Case study: engineering faculty of Syiah Kuala university) *IOP Conf on Science and Engering*
- Gilani, S. I. U. H., Khan, M. H., & Pao, W. (2015). Thermal Comfort Analysis of PMV Model Prediction in Air Conditioned and Naturally Ventilated Buildings. *Energy Procedia*, 75, 1373–1379.
- Gunawan, I. W. A. (2019). PENGARUH IKLIM, SINAR MATAHARI, HUJAN DAN *Jurnal Teknik Sipil Dan Arsitektur*, 10(14).
- KELEMBABAN PADA BANGUNAN. *Prosiding Seminar Nasional Arsitektur, Budaya Dan Lingkungan Binaan (SEMARAYANA #1)*, 147–156.
- Mishra, A., & Ramgopal., M. (2014). A comparison of student performance between conditioned and naturally ventilated classrooms. *Building and Environment*, 84, 181–188.
- Nasional IPA XII, 134–141.
- Szokolay S. V. (2004). *Introduction To Architectural Science The Basis Of Sustainable Design* Architectural Press An Imprint Of Elsevier Science
- Tyas, I. W., Nabilah, F., Puspita, A., & Syafitri, S. I. (2015). Orientasi Bangunan Terhadap Kenyamanan Termal pada Rumah Susun Leuwigajah Cimahi. *Jurnal Reka Karsa, Jurnal Online Institut Teknologi Nasional*, 3(1), 1–12.
- Yuwono, A. B. (2011). PENGARUH ORIENTASI BANGUNAN TERHADAP KEMAMPUAN MENAHAN PANAS PADA RUMAH TINGGAL DI PERUMAHAN WONOREJO SURAKARTA.
- Zulaiha, L., Rahmawati, A., Hartanto, T., Pratiwi, A. S., Tiaraningrum, F. H., Danah Zulfani, S., Jabbar, A., & Ridho Fariz, T. (2022). PERBANDINGAN KUALITAS UDARA DALAM

RUANG GEDUNG D1 FMIPA BERDASARKAN ARAH SINAR MATAHARI. Proceeding
Seminar