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Evaluation of the Thermal Conditions of Wooden Houses Based on Air Temperature, Relative Humidity, and Air Velocity in Grobogan Regency

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Abstrak. This study aims to evaluate the thermal conditions of wooden houses, a form of vernacular architecture in Grobogan Regency, based on air temperature, relative humidity, and air velocity parameters. A descriptive quantitative approach was employed, involving direct field measurements at five indoor observation points: four at the room's corners and one at its center. Measurements were taken hourly between 06:00 and 18:00 WIB. The results indicate that air temperature rose from morning to midday, peaking at approximately 34.6°C between 13:00 and 14:00 WIB, before dropping to around 31.1–31.4°C by 18:00 WIB. Relative humidity exhibited a pattern inverse to that of temperature: values ranged from approximately 74.7–78.5% in the morning, fell to about 54.1% at midday, and rose again to approximately 73.4–73.6% in the late afternoon. Meanwhile, air velocity was recorded at 0.0 m/s across all observation points and times, indicating that airflow was below the instruments' detection limit. Overall, the measurements reveal that the most critical thermal conditions occurred during midday, characterized by high air temperatures and air velocities below the instruments' detection thresholds. The findings highlight the importance of managing openings and enhancing natural ventilation, specifically through the implementation of cross-ventilation as strategies to improve air circulation within these wooden houses.

Keywords: wooden house; thermal conditions; air temperature; relative humidity; air velocity

1. Introduction

Traditional houses are a form of local architecture that reflects the relationship between culture, community needs, local materials, and local environmental conditions. Vernacular architectural characteristics emerge through a process of adaptation to climatic and environmental conditions, resulting in passive strategies that vary by region. In a tropical climate context, these characteristics are significant because ambient temperature and humidity influence the thermal conditions of interior spaces [1] [2].

Thermal conditions are a crucial aspect of the quality of the residential environment. Air temperature, relative humidity, and air movement are among the environmental parameters that shape the thermal conditions of a space. In buildings utilizing natural ventilation, thermal conditions are influenced not only by climatic characteristics but also by the building's ability to regulate airflow and respond to external environmental conditions. Research on naturally ventilated houses in Indonesia indicates that occupants of tropical buildings exhibit adaptive responses to thermal conditions and tend to prioritize increasing air movement when environmental conditions become hotter [3].

Vernacular houses employ various passive strategies that have evolved based on local environmental and cultural characteristics. Research on vernacular houses in Indonesia indicates that architectural elements, the building envelope, orientation, openings, and spatial configuration can play a role in shaping the building's thermal conditions [2] [4]. In houses constructed of wood, the characteristics of the walls and building envelope are also factors that must be considered when understanding the thermal performance of interior spaces. Research on wooden-walled vernacular houses in Slagi Village, Jepara, for instance, highlights the importance of wooden wall facade characteristics in the study of building thermal performance [5].

In addition to building materials, natural ventilation is a key strategy for regulating thermal conditions in vernacular houses. Openings and spatial layout can influence air movement within the building [6]. Research on Pontianak Malay vernacular houses indicates that spatial layout and building elements can support natural ventilation [7]. Other research on Javanese vernacular houses also indicates that natural ventilation strategies are a crucial part of Javanese architectural adaptation to environmental conditions and can serve as a basis for developing sustainable design strategies [8].

Research on vernacular houses across various regions of Indonesia has provided insights into the relationships between architectural characteristics, ventilation, and thermal conditions. However, empirical studies regarding the actual thermal conditions of wooden houses in Grobogan Regency specifically those based on direct measurements of air temperature, relative humidity, and air velocity at multiple indoor points require further development. Understanding these conditions is crucial, as the characteristics of wooden houses and the local environment may result in thermal responses that differ from those of vernacular houses in other regions.

Given this context, this study aims to evaluate the thermal conditions of wooden houses in Grobogan Regency based on air temperature, relative humidity, and air velocity. Measurements were conducted at five indoor locations over the course of a single day, from 06:00 to 18:00 WIB. The findings are expected to provide an initial overview of daily thermal fluctuations in the wooden houses under study and serve as a basis for considering strategies to enhance natural ventilation in such buildings.

2. Methods

2.1 Research Approach and Object

The measurement data were analyzed using descriptive quantitative methods. The analysis involved examining patterns of change in air temperature, relative humidity, and air velocity at five observation points throughout the measurement period. The data were then presented in graphical form to illustrate the fluctuations of each parameter between 06:00 and 18:00 WIB. Comparisons between points were used to observe trends in the distribution of thermal conditions within the space, while temporal changes were analyzed to identify thermal condition patterns from morning to late afternoon.

The analysis results were then interpreted based on the observed trends in these three parameters to provide an overview of the thermal conditions of the wooden house under study.

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2.2 Measurement Location and Timing

Measurements were conducted at the wooden house located in Panimbo, Kedungjati District, Grobogan Regency (Figures 1 and 2). Data collection took place on Monday, April 20, 2026, from 06:00 to 18:00 WIB. Measurements were taken at hourly intervals to capture the changes in indoor thermal conditions from morning through late afternoon. Consequently, this study represents an observation of daily thermal conditions for the subject house and is not intended to characterize the thermal performance of wooden houses across different seasons or the entire year.

Figure 1. Location of the wooden house in Grobogan Regency

Figure 2. Vernacular wooden house building

2.3 Measurement Points and Parameters

Measurements were conducted at five points within the living room or central living area of the house. These five points consisted of four located at the room's corners and one situated in the center of the room. The placement of these five measurement points was intended to provide an overview of thermal parameter conditions at various positions within the space.

The parameters measured included:

1. Air temperature (°C), to determine changes in indoor air temperature during the observation period.
2. Relative humidity (%), to determine the level of air moisture content relative to the room's temperature conditions.
3. Air velocity (m/s), to determine the presence and level of air movement within the room.

A layout of the five measurement points served as the basis for determining the measurement positions in the observed space (Figure 3).

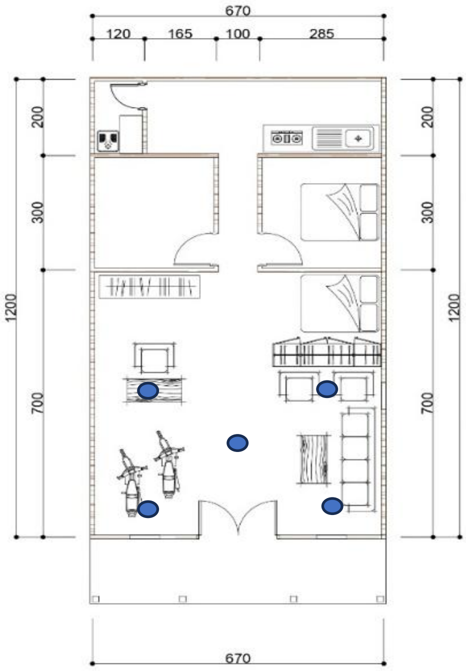

Figure 3. Layout of measurement points for temperature, humidity, and wind speed

2.4 Data Collection Techniques

Primary data were obtained through direct measurements of air temperature, relative humidity, and air velocity inside the wooden house. Measurements were taken at five observation points: four located at the room's corners and one in the center. The measurements were conducted sequentially by moving the measuring instrument from one point to the next. Data collection took place during a predetermined period, specifically from 06:00 to 18:00 WIB. Measurement results for each point were recorded based on the three observed parameters and subsequently organized by time and location for descriptive analysis (Figure 4).

A roving measurement method was employed to capture the conditions of air temperature, relative humidity, and air velocity at various positions within the room. Data from each point were then compared to observe trends in the distribution of thermal conditions inside the room throughout the observation period.

Figure 4. Instruments for measuring parameters: air temperature, relative humidity, and air velocity

2.5 Data Analysis Method

The measurement data were analyzed using descriptive quantitative methods. The analysis involved examining patterns of change in air temperature, relative humidity, and air velocity at five observation points throughout the measurement period. The data were then presented in graphical form to illustrate the fluctuations of each parameter between 06:00 and 18:00 WIB. Comparisons between points were used to observe trends in the distribution of thermal conditions within the space, while temporal changes were analyzed to identify thermal condition patterns from morning to late afternoon.

The analysis results were then interpreted based on the observed trends in these three parameters to provide an overview of the thermal conditions of the wooden house under study.

3. Results and Discussion

3.1 Air Temperature

Air temperature measurements taken at five observation points revealed a pattern of temperature change throughout the observation period, spanning from 06:00 to 18:00 WIB. At the start of the observation, temperatures ranged from 28.3°C to 28.6°C. Temperatures subsequently rose gradually from morning to midday, peaking at approximately 34.6°C between 13:00 and 14:00 WIB. Following this period, temperatures began to decline, reaching a range of 31.1°C to 31.4°C by 18:00 WIB. This pattern of temperature change indicates variations in the space's thermal conditions over the course of the observation (Figure 5).

The rise in temperature during the midday period reflects the space's response to increased environmental heating. Higher daytime temperatures are a characteristic that warrants attention in houses relying on natural ventilation, as indoor temperature control is heavily influenced by climatic conditions and the building's capacity to facilitate air movement. Research on naturally ventilated houses in Indonesia indicates that air temperature, humidity, and most notably air movement are critical factors influencing occupants' perception of thermal conditions [3].

In this study, the maximum temperature of approximately 34.6°C indicates that the daytime period represented the hottest conditions during the observation. However, this value cannot be directly used to conclude that the occupants experienced thermal discomfort, as the study did not conduct surveys regarding occupant thermal sensation or perception. Instead, the measurement results are best used to characterize the actual thermal environment of the subject property.

Temperature variations between observation points must also be interpreted with the measurement procedure in mind. Since the measuring instrument was moved sequentially from one point to the next, measurements at the five locations were not taken simultaneously. Consequently, the differences in values between points do not indicate temperature distribution uniformity at a single moment in time, but rather reflect temperature trends at the observation sites throughout the study period.

Overall, the measurements show that the air temperature in the wooden house rose from morning to midday and subsequently dropped in the afternoon, peaking at approximately 34.6°C. This pattern requires further analysis in conjunction with relative humidity and air velocity to provide a more comprehensive picture of the indoor thermal conditions.

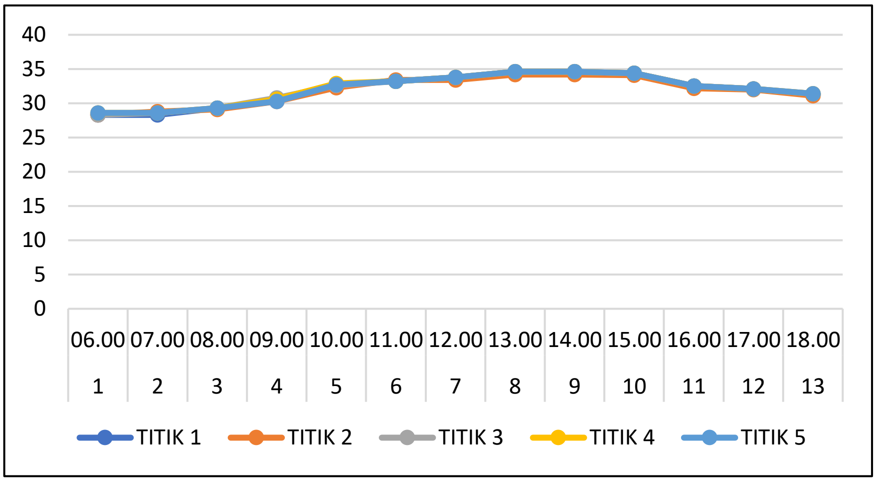

Figure 5. Temperature Measurement Graph

3.2 Relative Humidity

Relative humidity measurements at five observation points revealed a pattern of change that tended to be inversely related to air temperature throughout the observation period. In the morning, relative humidity ranged from 74.7% to 78.5%. These values subsequently declined as air temperature rose, reaching a minimum of approximately 54.1% during the day. As temperatures began to drop in the late afternoon, relative humidity rose again to approximately 73.4%–73.6% by 18:00 WIB (Figure 6).

This pattern of relationship between air temperature and relative humidity is a key characteristic in the assessment of a building's thermal conditions. Research on Indonesian vernacular houses indicates that temperature and humidity are primary parameters for evaluating a building's thermal performance, and both can exhibit varying patterns depending on the time of observation and the building's environmental conditions [4].

In this study, the rise in temperature from morning to midday was accompanied by a decrease in relative humidity. When the temperature reached a maximum of approximately 34.6°C, the relative humidity was lower than it had been in the morning. Conversely, in the afternoon, as the temperature began to drop, the relative humidity rose again. Thus, the changes in these two parameters demonstrated an inverse temporal pattern throughout the observation period.

Relative humidity conditions must also be understood in conjunction with temperature and air movement. In tropical buildings utilizing natural ventilation, fluctuations in ambient temperature and humidity can influence occupants' thermal perception, while increased air movement can serve as a form of adaptation to heat [3].

Nevertheless, the relative humidity value in this study was not used in isolation to determine occupant comfort or discomfort. Research on thermal comfort in vernacular houses indicates that comfort assessments must consider multiple environmental variables and if the aim is to draw conclusions regarding subjective comfort must also take into account occupant responses or perceptions [3].

Since measurements were taken by sequentially moving the instrument from one point to the next, variations in humidity values between points were not used to infer the simultaneous distribution of humidity. The analysis focused instead on trends in relative humidity changes from morning to late afternoon and their relationship with air temperature fluctuations.

Overall, the measurements indicate that relative humidity followed a pattern of being high in the morning, decreasing during the midday period, and rising again in the late afternoon. This pattern reinforces the temperature findings, confirming that the midday period experienced the most significant changes in thermal conditions during the observation.

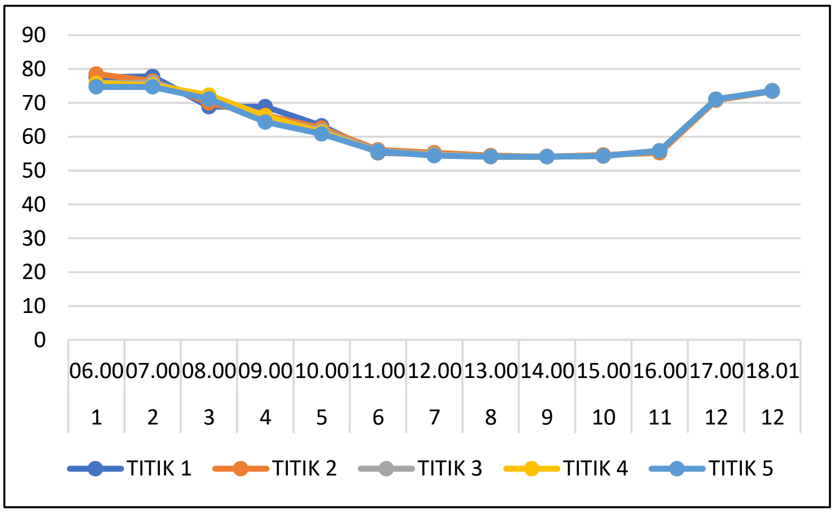

Figure 6. Humidity Measurement Graph

3.3 Air Velocity

Measurement results indicate that the air velocity recorded at the five observation points was 0.0 m/s throughout the observation period. This value appeared consistently across all times and measurement points (Figure 7). In this study, a value of 0.0 m/s is not interpreted as a condition of zero airflow. Direct field observations revealed that air movement was indeed present within the space, but the velocity was insufficient to actuate the fan or mechanical sensor of the measuring instrument used. Consequently, these results are best understood as air velocities falling below the instrument's detection limit.

This limitation is significant, as air movement is a parameter that influences thermal conditions in naturally ventilated buildings. Feriadi and Wong [3], demonstrates that air movement plays a significant role in the thermal perception of occupants in naturally ventilated houses in Indonesia. Therefore, the low air speeds detected in this study need to be considered alongside the high air temperatures observed during the day.

Ventilation characteristics and spatial configuration can also influence air movement within vernacular houses. Research on Malay vernacular houses in Pontianak indicates a relationship between spatial layout, building elements, and natural ventilation [7]. More recent research on Javanese vernacular houses also indicates that natural ventilation strategies are a crucial part of the building's response to local climatic conditions [8]. The open and closed wall configurations of the Taneyan Lanjhang house are related to thermal conditions, assessed through parameters of airflow, temperature, and relative humidity. [9].

In the context of this study, air velocity values falling below the instrument's detection limit indicate that cooling via measurable air movement is relatively limited, particularly when air temperatures reach approximately 34.6°C during the day. However, this study did not measure airflow direction, flow distribution patterns, or air velocity using instruments with higher sensitivity. Consequently, the relationship between house opening characteristics and air velocity could not be quantitatively determined.

Furthermore, since measurements were taken sequentially at different locations, the results from individual points cannot be considered simultaneous measurements. The analysis focused on trends in air conditions during the observation period rather than on mapping the spatial distribution of air velocity.

Overall, the measurement results indicate that air velocities fell below the instrument's detection limit, even though visual and field observations confirmed the presence of air movement. These findings highlight the need to use higher-sensitivity instruments in future research to measure airflow velocity more accurately.

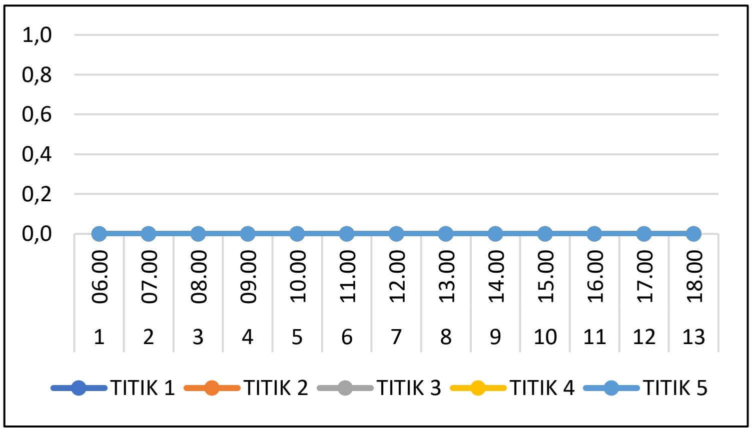

Figure 7. Wind Speed Measurement Graph

3.4 Integrated Discussion of Thermal Conditions

Measurement results indicate that the thermal conditions of the wooden house fluctuated throughout the observation period. The three observed parameters air temperature, relative humidity, and air velocity exhibited interrelated characteristics. Air temperature rose from morning to midday, reaching a maximum of approximately 34.6°C, while relative humidity showed a downward trend, dropping to around 54.1%. Concurrently, air velocity was recorded at 0.0 m/s; in this study, this value is interpreted as being below the instrument's detection limit.

The rise in temperature during the midday period indicates that the house was subjected to a greater heat load compared to the morning and afternoon. For houses relying on natural ventilation, this condition is significant because heat dissipation capacity is heavily influenced by air movement. Feriadi and Wong demonstrated that occupants of naturally ventilated houses in Indonesia exhibit adaptive responses to heat and tend to desire higher air velocities when environmental conditions become hot [3].

The characteristics of wooden houses also need to be considered when interpreting these results. Research by Shofie and Prianto [5] A study on wooden-walled vernacular houses in Slagi Village, Jepara, demonstrates that the thermal performance of wooden wall facades can elicit varying responses to indoor temperature and humidity conditions. Utilizing in-situ measurements with data loggers, the study found that the thermal performance regarding temperature and humidity requires separate analysis.

Beyond the materials used, natural ventilation strategies constitute a crucial aspect. Research by Muqoffa et al. on Javanese vernacular houses indicates that spatial characteristics, openings, and traditional architectural elements play a significant role in natural ventilation strategies and adaptation to local climatic conditions [8]. This provides a basis for understanding that the low air velocity conditions observed in this study should not be viewed merely as numerical measurement results; rather, they must be considered in relation to the configuration of openings and the spatial layout of the houses.

Nugroho's research on Samin vernacular houses in Blora Regency also highlights the importance of passive design strategies in shaping the thermal conditions of the homes. That study utilized one month of field measurements and revealed a difference in temperature performance between traditional and modern Samin houses [10]. These findings serve as a relevant regional benchmark because both Blora and Grobogan are located in Central Java, although Nugroho's study utilized a longer measurement period.

In this study, daytime hours can be considered the most critical period, as air temperatures peaked while air velocity fell below the instruments' detection limits. This combination suggests a potential reduction in heat dissipation via air movement, yet it is insufficient to draw definitive conclusions regarding the occupants' thermal comfort. A more robust assessment of thermal comfort would require measuring occupants' subjective responses and accounting for additional variables such as mean radiant temperature, activity levels, clothing, and adaptive behaviors.

Consequently, the results of this study are best characterized as a preliminary evaluation of the thermal environment within wooden houses rather than a definitive assessment of occupant thermal comfort. While single-day measurements provide an overview of fluctuations in temperature, relative humidity, and air velocity, further research involving extended measurement periods is necessary to determine the consistency of these patterns.

Beyond material properties and ventilation, the thermal conditions of vernacular houses are also influenced by the relationship between building elements and the external environment. Hermawan and Švajlenka have demonstrated that the architectural elements of vernacular houses including the building envelope and environmental characteristics play a significant role in how the structure responds to tropical climatic conditions [11]. These findings reinforce the conclusion that evaluating the thermal conditions of a house cannot rely solely on indoor air temperature; rather, it requires consideration of the architectural characteristics that shape the thermal environment.

In vernacular houses, the building envelope is a key element in regulating heat transfer between the external environment and the interior space. A study of Betawi houses by Hidayat and Suhendar demonstrates that the materials and elements of the building envelopesuch as the roof, walls, windows, and floors can influence indoor temperature conditions [4]. Therefore, regarding wooden houses in Grobogan Regency, the material and construction characteristics are factors that must be considered when interpreting the temperature changes observed during the study.

Other research on Indonesian vernacular houses also indicates that thermal responses can vary between rooms, even within the same building. Bassaleng et al. found that in vernacular stilt houses in Palu, room temperatures varied, and these differences were linked to ceiling height, roof shape, opening sizes, spatial layout, and room orientation [12]. These findings are relevant to the present study because measurements were also taken at multiple spatial points. However, since the measurements in the Grobogan study were conducted sequentially, differences between points cannot be regarded as simultaneous variations.

Studies on the thermal comfort of traditional Indonesian houses also indicate that vernacular architectural principles do not automatically guarantee comfortable conditions. Thermal performance is influenced by a combination of climate, materials, ventilation, roof form, transitional spaces, and the occupants' capacity for adaptation [13]. Latif et al. emphasize that the evaluation of vernacular houses should consider air movement, humidity, radiant heat, and occupant response, rather than relying solely on air temperature.

This aspect is significant in the present study. A maximum temperature of approximately 34.6°C and a relative humidity dropping to around 54.1% indicate that daytime hours represented the hottest environmental conditions during the observation period. Although air speed was recorded as 0.0 m/s, this value is understood to fall below the instrument's detection limit. Consequently, the study's findings cannot definitively establish that the occupants experienced discomfort.

Research on traditional houses in Indonesia's warm-humid climate also demonstrates that traditional architectural strategies can respond to climatic conditions through various building elements [1]. In their study of various traditional Indonesian houses, Hildegardis et al. found that architectural elements such as roofs, openings, and building characteristics play a role in shaping a building's thermal performance.

Accordingly, the study of wooden houses in Grobogan Regency indicates a potential for unfavorable thermal conditions during the day, primarily because air temperatures rise while air speeds fall below the detection threshold of the instruments used. However, these conditions should be understood as a snapshot of the thermal environment at the time of measurement rather than a subjective assessment of occupant comfort.

These findings can also be compared with research on thermal comfort in traditional houses that employed direct measurement of environmental parameters. Suwantara, Nugrahaeni, and Suprijanto conducted measurements at the Sao Pu'u traditional house in Wogo, East Nusa Tenggara, using instruments to monitor thermal conditions and an anemometer to measure wind speed. Their research demonstrated that thermal comfort conditions in traditional houses are linked to the occupants' adaptive responses to environmental conditions [14].

These findings demonstrate that measuring environmental parameters alone does not fully capture the occupants' thermal comfort. In the Sao Pu'u study, environmental parameters were linked to the occupants' thermal preferences and acceptance. In contrast, the study on wooden houses in Grobogan Regency evaluated environmental conditions solely based on air temperature, relative humidity, and air velocity. Therefore, the results of the Grobogan study are more accurately described as an evaluation of environmental thermal conditions rather than a measurement of subjective thermal comfort.

Nugroho's research on Bugis vernacular houses also provides an important point of comparison, as it utilized visual observations as well as temperature and humidity measurements at the Jida and Lammada houses [15]. Research findings indicate that bioclimatic elements such as roof volume and slope, wall type and material, floor height, and shading vegetation are linked to the thermal environmental performance of houses.

Similarly, the study of wooden houses in Grobogan Regency demonstrates that thermal conditions are inseparable from the building's physical characteristics. However, this study did not conduct quantitative measurements or analyses regarding building orientation, opening size, roofing material, ceiling height, or shading elements. Consequently, these factors cannot be definitively cited as the direct causes of the observed temperature and humidity patterns.

Based on the overall results and comparisons with previous studies, it is evident that vernacular houses offer distinct passive design potential depending on their environmental and construction characteristics. For the wooden houses in Grobogan Regency, daytime hours presented the most critical conditions during the observation period: temperatures reached approximately 34.6°C, relative humidity was around 54.1%, and air velocity fell below the instruments' detection limits. While these findings suggest potentially unfavorable thermal conditions during the day, they are insufficient to determine the occupants' subjective level of comfort. These results also align with research by Kusyanto, Triyadi, and Wonorahardjo, which utilized air temperature, relative humidity, and airflow velocity parameters to evaluate indoor thermal conditions. Their findings indicate that the position and size of openings, as well as surrounding environmental conditions, influence airflow patterns and relative humidity within the building [16].

4. Conclusions

Based on measurements taken in a wooden house in Grobogan Regency, the indoor thermal conditions showed distinct changes throughout the observation period from 06:00 to 18:00 WIB. Air temperature rose from approximately 28.3–28.6°C in the morning to a peak of around 34.6°C between 13:00 and 14:00 WIB, before declining in the late afternoon. Relative humidity exhibited a trend inverse to that of temperature: it was relatively high in the morning, dropped to about 54.1% during midday, and rose again in the late afternoon.

Air velocity was recorded at 0.0 m/s at all measurement points and times. However, this value does not imply a complete absence of airflow; field observations indicated the presence of air movement, albeit insufficient to actuate the fans or mechanical sensors of the measuring instruments. Consequently, the air velocity in this study fell below the detection threshold of the equipment used.

Overall, the midday period presented the hottest thermal conditions, characterized by high air temperatures, lower relative humidity, and air velocities undetectable by the instruments. These conditions suggest a potential for thermal discomfort, particularly during the day. However, as this study did not assess the occupants' thermal perceptions or sensations, the level of subjective thermal comfort could not be determined.

The findings indicate that enhancing natural ventilation effectiveness and optimizing opening configurations are strategies worth considering to improve airflow within the wooden house. Further research incorporating longer measurement periods, higher-sensitivity instruments to measure air direction and velocity, and assessments of occupant thermal responses is required to obtain a more comprehensive evaluation of thermal comfort.

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References

[1] N. K. A. Hildegardis, C., Saraswati, A. A. O., & Dewi, "Review of thermal comfort in warm humid climate for traditional architecture in Indonesia," *KnE Soc. Sci.*, vol. 2019, pp. 151–166, 2019, doi: 10.18502/kss.v3i21.4965.

[2] S. N. I. Hafizha, F., & Jairina, "Study of bioclimatic architecture methods in the traditional house of Banjar Gajah Baliku," *Civ. Eng. Archit.*, vol. 11, no. 5A, pp. 2857–2868, 2023, doi: https://doi.org/10.13189/cea.2023.110801.

[3] N. H. Feriadi, H., & Wong, "hermal comfort for naturally ventilated houses in Indonesia," *Energy Build.*, vol. 36, no. 7, 2004, doi: https://doi.org/10.1016/j.enbuild.2004.01.011.

[4] J. Hermawan, H., & Švajlenka, "The connection between architectural elements and adaptive thermal comfort of tropical vernacular houses in mountain and beach locations," *Energies*, vol. 14, no. 21, p. 7427, 2021, doi: https://doi.org/10.3390/en14217427.

[5] E. Shofie, A. M. T., & Prianto, "Kinerja termal fasad dinding kayu pada rumah vernakular Desa Slagi, Kota Jepara," *Vitr. J. Arsitektur, Bangunan dan Lingkung.*, vol. 14, no. 2, pp. 121–128, 2024, doi: https://doi.org/10.22441/vitruvian.2024.v14i2.06.

[6] E. Susilo, A., & Prianto, "Analisa termal jendela tingkap bangunan vernakular-Pekanbaru. Langkau Betang," *J. Arsit.*, vol. 10, no. 1, 2023, doi: https://doi.org/10.26418/lantang.v10i1.54890.

[7] T. W. Caesariadi, "Pengaruh tata ruang pada penghawaan alami rumah vernakular Melayu Pontianak. Langkau Betang," *J. Arsitektu*, vol. 6, no. 1, 2019, doi: https://doi.org/10.26418/lantang.v6i1.33160.

[8] & B. Muqoffa, M., Suyitno, Yaningsih, I., Rachmanto, R. A., Himawan, K., Caroko, N.,

"Exploring natural ventilation strategies in Javanese vernacular houses for sustainable design," *J. Asian Archit. Build. Eng.*, vol. 24, no. 6, pp. 4985–5004, 2025, doi: https://doi.org/10.1080/13467581.2024.2439348.

[9] A. D. Bastedo, A., Larasati Z., M. M., & Hariyanto, "Influence of traditional wall façade from Taneyan Lanjhang house to thermal sensation," *Arsitektura J. Ilm. Arsit. dan Lingkung. Binaan*, vol. 22, no. 2, pp. 185–192, 2024, doi: https://doi.org/10.20961/arst.v22i2.80329.

[10] A. M. Nugroho, "Passive design strategy in vernacular house of Samin, Indonesia. DIMENSI: Journal of Architecture and Built Environment," *J. Archit. Built Environ.*, vol. 51, no. 1, pp. 17–27, 2024, doi: https://doi.org/10.9744/dimensi.51.1.17-27.

[11] J. Hermawan, H., & Švajlenka, "Building envelope and the outdoor microclimate variable of vernacular houses: Analysis on the environmental elements in tropical coastal and mountain areas of Indonesia," *Sustainability*, vol. 14, no. 3, p. 1818, 2022, doi: https://doi.org/10.3390/su14031818.

[12] R. Bassaleng, A. J. R., Fitriaty, P., Burhany, N. R., Zubaidi, F., & Arifin, "Thermal performance of vernacular stilt house in Palu City," *Inj. Interdiciplinary J. Hummanity*, vol. 3, no. 2, 2024, doi: https://doi.org/10.58631/injurity.v3i2.180.

[13] & R. Latif, Abdullah, Amin, Abdullah, "Thermal Comfort in Indonesian Vernacular Houses," *Sinektika*, vol. 23, no. 2, pp. 217–226, 2026, doi: 10.23917/sinektika.v23i2.17452.

[14] I. Suwantara, I. K., Nugrahaeni, R., & Suprijanto, "Adaptive thermal comfort on Sao Pu'u traditional house in Wogo Village, East Nusa Tenggara," *Widyarise*, vol. 15, no. 2, pp. 425–436, 2012, doi: http://dx.doi.org/10.14203/widyariset.15.2.2012.425–436.

[15] A. M. Nugroho, "Performance of bioclimatic architecture in Bugis vernacular housing: A case study of Jida and Lammada houses," *Dimens. J. Archit. Built Environ.*, vol. 48, no. 2, pp. 131–140, 2021, doi: https://doi.org/10.9744/dimensi.48.2.131-140.

[16] M. Kusyanto, S. Triyadi, and S. Wonorahardjo, "Kualitas Ruang Masjid Berkubah yang Dibangun Masyarakat Secara Swadaya dari Aspek Kenyamanan Termal di Kabupaten Demak," *J. Lingkung. Binaan Indones.*, vol. 6, no. 3, pp. 134–143, 2017, doi: 10.32315/jlbi.6.3.178.