Air Temperature and Humidity Outdoor Analysis of Buildings in Panakukang Makassar

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Abstract. This study aims to analyse data and humidity outside. Data retrieval is taken from the HOBO MX2300 tool data recorder for external temperature and humidity. Then the data processing was analysed and analysed using a Microsoft Excel program in the form of graphs / fluctuating images that showed the average value, standard deviation, maximum value, and minimum value. Only from 6:00 to 8:30. On the 15th to the 17th of June the thermal comfort zone only occurs in the morning under 09.00. The highest maximum air temperature occurs on June 15 at 13.01-13.30. The lowest minimum value is on June 15 at 06.00-06.30. The results of the analysis then show the level of suitability of the data with the thermal comfort zone based on SNI (SNI) every day.

1. Introduction
According to Auliciems and Szokolay [1] that is convenience based on factors, air temperature, air movement, radiation, subjective factors, such as materials, clothing, food and drinks, body shape, and gender. Thermal comfort of building users has resulted in many thermal studies in various types of buildings. Thermal comfort refers to a metabolic rate that can be assessed by variables that include activities, clothing resistance, air temperature, relative humidity, velocity of air flow, and light intensity [2].

According to Soegijanto [3], climate factors greatly affect the design of buildings including radiation and sunlight, temperature and humidity, wind direction and speed and sky conditions. Two groups of variables namely (1) personal physiology includes activities / activities and heat resistance of clothing, and 2) climate variables that include air temperature, air velocity, relative humidity and radiation temperature help to define thermal comfort expectations [4].

The state of air temperature at a place on the surface of the earth will be determined by the following factors:

1.1. The duration of sunshine
The longer the sun emits its light in an area, the more heat it receives. The sunny atmosphere of the day will be hotter than if it was cloudy since morning.
1.2. Sunlight tilt
A place where the position of the sun is perpendicular to it, then the solar radiation given will be greater and the temperature at the place will be high, compared to a place with a more tilted sun position.

1.3. Clouds
The presence of clouds in the atmosphere will cause reduced solar radiation received on the earth's surface. Because the radiation that hits the clouds, the water vapor in the clouds will be emitted, reflected and absorbed.

1.4. Surface State of the Earth
Differences in land and sea characteristics will affect the absorption and reflection of solar radiation. The surface of the land will more quickly receive and release the heat of solar radiation energy that is received on the surface of the earth and consequently causes air temperature differences on it.

1.5. Air Temperature
Indonesia is an area with a humid tropical climate with a relatively hot air temperature that reaches an average maximum value of 27°C-32°C, an average minimum air temperature of 20°C-23°C, an average humidity of 75% -80%, a year of rainfall between 1000 -1500 mm, the condition of the sky is generally cloudy between 60% -90%, the average daily global solar radiation is 2-4 w / m², the luminance of the sky covered by thin clouds is quite high reaching more than 7000 candela / m² and covered with thick clouds of 850 candela / m².

The climatic characteristics of the earth's surface differ from one place to another this is influenced by the position relative to the solar path (latitude position), the existence of the oceans, wind patterns, the surface shape of the earth's land, vegetation density. Revolution (revolution) of the earth around the sun and rotation of the earth on its axis causes the entire surface of the earth to alternately receive solar radiation. solar radiation affects the average temperature in each region, the greater the amount of radiation energy received by an area causes the higher surface temperature in the region.

The air temperature will fluctuate markedly every 24 hours. Maximum air temperature is reached sometime after maximum light intensity has been reached when the beam of light falls perpendicularly, i.e., midday [5].

1.6. Thermal Comfort
Thermal comfort can be defined as a state of mind that expresses satisfaction with the thermal environment [6]. ASHRAE (American Society of Heating Refrigerating Air Conditioning Engineer) provides a definition of thermal comfort as a thought condition that expresses a person's level of satisfaction with his thermal environment. So that thermal comfort is a thought condition at the level of one's satisfaction with the thermal environment. Thus, thermal comfort will involve three elements namely physical, physiological and psychological, so that thermal comfort based on a psychological approach is the most complete meaning.

The difficulty of achieving neutral temperatures that correspond to thermal comfort zones is influenced by several factors including the high level of design that causes sunlight radiation [6], air circulation caused by relatively small air speeds [7] and high humidity due to climatic factors (humid tropical).

To create thermal comfort, it is known that there are four factors that affect the ability of the human body to distribute heat [8], namely:

- Temperature / temperature (°C),
- Relative humidity, (%)
- Air Speed (m / sec.),
- Mean Radiant Temperature (MRT).
Thermal comfort consists of: air temperature, humidity, and velocity of air flow. There are several standards relating to thermal comfort including the thermal comfort standards of Indonesia SNI T-14-1993-03, which divides zones into three parts [9], namely:

- Comfortable air condition, 20.5-22.8°C,
- Optimal Comfort 22.8-25.80 C,
- Nearly Convenient 25.80C-27.10C, with relative air humidity of 50% -80%.

2. Method
The research method uses quantitative analysis. The data source is obtained from the MX2300 data loggers HOBO tool. The computer as the recipient of data transmission from the logger box, equipped with a special program, namely the Logger Net [10]. The data collected is then inputted, processed and analysed using Microsoft Excel programs in the form of graphs / fluctuating images.

3. Results and Discussion
Data obtained from the Logger are arranged based on time intervals every 30 minutes, from intervals of minutes to thirty minutes, and per day, in June 2018. This study aims to analyse data on temperature and humidity of the air outside the building. The amount of data recorded in 2018 in June is 3 days, with a total of 3 days of measurement days.

The data are arranged in table form in the order: average value, amount of data, maximum value, minimum value and standard deviation equipped with graph / image fluctuations.

This study is limited to the analysis of air temperature and humidity. The results showed that the maximum air temperature was highest on June 15, 2018 with a temperature (25.45°C-34.89°C) and the lowest minimum on June 17, 2018 (23.98°C-34.51°C). Daily average value for temperature for 3 days that enters the SNI standard thermal comfort zone (20.5°C-27.1°C) for three measurement days, the first day is only 6:00 a.m. to 07:30 p.m., the second day at 6:00 p.m. to 08:00 p.m., third day from 06.00 to 08.30.

The daily data for the maximum relative humidity for the three days recorded by the tool is around (41.64% - 87.90%), the highest occurs on the first day of measurement, namely 87.90% and the lowest on the third day (38.55%). Minimum air relative humidity between (38.55% -76.93%). Minimum is highest on the first and lowest day on the third day of June 17, 2018. Daily average value for daily relative humidity in the thermal comfort zone according to the SNI standard (50% -80%) is around 22% on the first day that is included in Indonesian National Standards.

Table 1 shows the value of air temperature on the first day is the highest and lowest temperature on the third day of measurement. Among the three days, the daily average value from 00.06-18.00 is in the range (31.06°C-31.88°C), the maximum temperature is (31.65°C-32.49°C) and the minimum (30.47°C-31.26°C). 08.00-18.00 daily average value is above the thermal comfort standard (28,23°C-31,20°C). Air temperature and thermal comfort zones can be seen in figure 1.
Table 1. Average Value, Maximum and Minimum Air Temperature on the First Day

| TIME          | AVERAGE | STDV | DATA | MAX  | MIN  |
|---------------|---------|------|------|------|------|
| 06.00-06.30   | 25.45   | 0.09 | 30   | 25.6 | 25.24|
| 06.31-07.00   | 25.63   | 0.08 | 30   | 25.82| 25.56|
| 07.01-07.30   | 26.29   | 0.29 | 30   | 26.75| 25.85|
| 07.31-08.00   | 27.39   | 0.32 | 30   | 27.78| 26.8 |
| 08.01-08.30   | 28.23   | 0.29 | 30   | 28.85| 27.73|
| 08.31-09.00   | 29.76   | 0.4  | 30   | 30.38| 28.95|
| 09.01-09.30   | 30.69   | 0.38 | 30   | 31.44| 30.17|
| 09.31-10.00   | 31.38   | 0.18 | 30   | 31.67| 31.06|
| 10.01-10.30   | 31.64   | 0.17 | 30   | 31.9 | 31.24|
| 10.31-11.00   | 32.08   | 0.29 | 30   | 32.52| 31.49|
| 11.01-11.30   | 33.02   | 0.26 | 30   | 33.53| 32.36|
| 11.31-12.00   | 33.68   | 0.28 | 30   | 34.21| 33.19|
| 12.01-12.30   | 34.7    | 0.5  | 30   | 35.73| 34.13|
| 12.31-13.00   | 35.67   | 0.7  | 30   | 36.67| 34.53|
| 13.01-13.30   | 36.66   | 0.42 | 30   | 37.38| 35.4 |
| 13.31-14.00   | 35.24   | 0.4  | 30   | 35.81| 34.53|
| 14.01-14.30   | 34.89   | 0.53 | 30   | 35.86| 33.97|
| 14.31-15.00   | 34.74   | 0.32 | 30   | 35.32| 34.13|
| 15.01-15.30   | 34.64   | 0.44 | 30   | 35.51| 34   |
| 15.31-16.00   | 33.63   | 0.59 | 30   | 35.16| 32.7 |
| 16.01-16.30   | 32.5    | 0.22 | 30   | 32.96| 32.11|
| 16.31-17.00   | 33.19   | 0.44 | 30   | 33.58| 32.31|
| 17.01-17.30   | 32.69   | 0.36 | 30   | 33.32| 32.16|
| 17.31-18.00   | 31.2    | 0.44 | 30   | 32.08| 30.53|

Figure 1. Fluctuations in External Environmental Temperature Air Temperature: Air Temperature and Thermal Comfort Zone (SNI standard: 20.50°C-27.10°C).
For the air relative humidity, the second day can be seen in table 2, where the average humidity value at 06:01 - 18:00 ranged from 42.14% - 77.26%, the maximum humidity between 42.22% - 78.00%, and a minimum of around 39.60% - 75.15%.

![Humidity Data Fluctuation](image)

**Figure 2.** Thermal environmental conditions: relative air humidity and thermal comfort zone (SNI standard: 50% - 80%).

In figure 2, the condition of relative air humidity during the day between 09:31 - 11:00 has decreased to below the minimum comfort limit or less than 50%, because the condition of air temperature has increased due to sunlight radiation.

On the third day the average value of humidity starting at 09:31-18:00 is the value entered in the comfort zone. The average daily value of air relative humidity for three days no one entered the comfort zone of 100%.

The highest temperature on June 15 at 13.01-13.30 is 36.66°C while the lowest temperature occurs on June 15 at 06.00-06.30 which is 25.45°C. The temperature difference does not experience a significant difference every day as shown in table 2.
Table 2. Maximum and minimum values, mean and standard deviation of air relative humidity on June 16, 2018.

| TIME     | AVERAGE | STDV | DATA | MAX   | MIN   |
|----------|---------|------|------|-------|-------|
| 06.00-6.30 | 83.14   | 0.28 | 30   | 25.90 | 25.09 |
| 06.31-07.00 | 80.71   | 0.08 | 30   | 25.73 | 25.48 |
| 07.01-07.30 | 75.82   | 0.04 | 30   | 25.87 | 25.70 |
| 07.31-08.00 | 73.22   | 0.38 | 30   | 27.19 | 25.99 |
| 08.01-08.30 | 69.84   | 0.46 | 30   | 28.65 | 27.19 |
| 08.31-09.00 | 63.22   | 0.35 | 30   | 30.00 | 28.72 |
| 09.01-09.30 | 56.53   | 0.4  | 30   | 31.11 | 30.02 |
| 09.31-10.00 | 50.29   | 0.41 | 30   | 32.75 | 31.24 |
| 10.01-10.30 | 48.22   | 0.15 | 30   | 33.19 | 32.70 |
| 10.31-11.00 | 48.78   | 0.34 | 30   | 33.56 | 32.60 |
| 11.01-11.30 | 53.59   | 0.42 | 30   | 32.91 | 31.29 |
| 11.31-12.00 | 56.90   | 0.21 | 30   | 31.52 | 30.65 |
| 12.01-12.30 | 53.46   | 0.33 | 30   | 32.67 | 31.42 |
| 12.31-13.00 | 51.73   | 0.27 | 30   | 33.71 | 32.52 |
| 13.01-13.30 | 50.24   | 0.37 | 30   | 33.82 | 32.49 |
| 13.31-14.00 | 47.03   | 0.15 | 30   | 34.77 | 33.69 |
| 14.01-14.30 | 44.92   | 0.23 | 30   | 35.08 | 34.26 |
| 14.31-15.00 | 44.08   | 0.51 | 30   | 35.59 | 33.84 |
| 15.01-15.30 | 44.42   | 0.37 | 30   | 35.08 | 33.74 |
| 15.31-16.00 | 43.04   | 0.31 | 30   | 35.24 | 34.19 |
| 16.01-16.30 | 44.86   | 0.21 | 30   | 34.55 | 33.87 |
| 16.31-17.00 | 48.90   | 0.4  | 30   | 33.97 | 32.57 |
| 17.01-17.30 | 51.71   | 0.18 | 30   | 32.57 | 31.85 |
| 17.31-18.00 | 60.07   | 0.65 | 30   | 31.82 | 30.02 |
Figure 3. The position of the sun's trajectory at Perummas Housing Panakukang from the East to West which is dominant in the North and South latitudes.

Table 3. Temperature Recapitulation at Three Days of Measurement.

| Date         | Time          | Highest temperature °C |
|--------------|---------------|------------------------|
| 15 June 2018 | 13.01-13.30   | 36.66                  |
| 16 June 2018 | 14.31-15.00   | 24.86                  |
| 17 June 2018 | 16.01-16.30   | 34.51                  |

| Date         | Time          | Lowest temperature °C |
|--------------|---------------|-----------------------|
| 15 June 2018 | 06.00-06.30   | 25.45                 |
| 16 June 2018 | 06.00-06.30   | 25.51                 |
| 17 June 2018 | 06.00-06.30   | 23.98                 |

4. Conclusion
Data obtained from measurements at Perummas Housing Panakukang Makassar were processed and analysed the air temperature outside the building. Processing and presenting data are done using Microsoft Excel programs. Presentation in the form of data tables: daily. The data is arranged based on: time interval every 30 minutes. Other forms are shown in graphs / images of fluctuations that show the average values, standard deviations, maximum values, and minimum values.

Based on the results of the study, that the condition of temperature and relative humidity of the air in the outer space of the housing of Housing Housing Panakukang not every day can support the application of the system for thermal comfort in the room.
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