Bioclimatic Approach for Designing High School in Hot Humid Climate

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ABSTRACT
Indonesia is a tropical region. Based on weather data in Pecangaan, Jepara. it was observed that Jepara has a tropical climate with the overall environmental conditions being very hot. The average annual temperature is 32 Celcius with a humidity level of 95 percent. This greatly affects community activities, especially school learning activities. Therefore, certain approaches are needed in maintaining thermal comfort. The purpose of the overall design is to implement the principles of bioclimatic design in the design of a vocational high school area in Jepara, Central Java. The method used in this study is to perform design simulations based on parameters related to hot humid climate bioclimatic design. Parameters related to site climatic conditions are implemented to produce a design concept that is implemented into the building.

Keywords: *Bioclimatic, High school, Hot humid climate.*

1. INTRODUCTION

Jepara is one of the districts in Central Java which is located at the northernmost tip of Central Java Province. Jepara's economic data based on PRDB per capita in 2019 reached 24.03 million, an increase of 6.10% from 2018. Jepara's economic growth in 2019 was dominated by the manufacturing sector with 34.64% [1]. The labor force participation rate/TPAK in 2018 was 69.85% [2]. The composition of employment in 2017 was dominated by the industrial sector with 44%, other sectors such as services 12%, agriculture 14%, trade 18%, and the remaining 12% [3]. Most superior industrial sectors are the wood industry and roof tiles because they have the potential to absorb a lot of labor, compared to other economic sectors [4].

One way to develop the community's economic industry is through education. The trick is to instill knowledge and training in accordance with the community work environment. Vocational education maximizes economic development with the surrounding work environment, strives continuously, and optimizes existing government programs [5].

Based on data from the Ministry of Education and Culture, the number of vocational schools in Jepara Regency is arguably still not evenly distributed. In the most populous sub- district, the Tahunan district which has 108,962 there are only 5 private vocational schools and no public vocational schools. In Pecangaan sub-district there are 82,924 people, but there are only 2 private smk, and no state smk [6,7]. From these examples and data, it is necessary to make vocational training facility in the form of smk are needed to absorb the potential of workers to develop the environmental economy of Jepara.

Another factor to consider is that Indonesia is a tropical region. Based on weather data in Pecangaan, Jepara. it was observed that Jepara has a tropical climate with the overall environmental conditions being very hot. The average annual temperature is 32°C with a humidity level of 95% [8]. This greatly affects community activities, especially school learning activities. Therefore, certain approaches are needed in maintaining thermal comfort.

One such approach is to use a bio-climatic approach. In a bio-climatic approach in the form of building features with climatic environmental conditions. This approach aims to increase thermal comfort as well as save energy consumption of buildings [9]. The purpose of the overall design is to implement the principles of bioclimatic design in the design of a vocational high school area in Jepara, Central Java.

2. PARAMETER

2.1. Bioclimatic Architecture

Handoko and Ikaputra [10] concluded that the Bioclimatic Principle for areas with hot humid climate conditions, there are several main principles to respond to environmental conditions, namely:

- Minimize the intensity of solar exposure on the building envelope according to the slope of the angle of incidence of sunlight on the building,
- Minimize the heat gain on the building envelope,
- Minimize the rate of conductive and convective heat gain from the surrounding air, namely by minimizing the heat transfer that occurs in the building envelope, including by selecting the building envelope material,
- Optimizing the potential of buildings to obtain natural ventilation, especially at night and optimizing passive cooling in buildings to increase heat loss in buildings,
- The use of light and thin walls because it is primarily useful for protecting buildings from rainfall and minimizing the risk of tropical storms,
- Protect the building from insects on the walls of the building,
- Provide a semi-outdoor space as a buffer space between indoor and outdoor.

Additionally, Pamungkas and Suryabata [11], concluded that many school children in tropical Indonesia have a standard thermal comfort level in the range of 1°C to 12°C or above the standard thermal size.

3. METHODS

The method used in this study is to perform design simulations based on parameters related to hot humid climate bioclimatic design. Parameters related to site climatic conditions are implemented to produce a design concept that is implemented into the building.

Climate data was taken from weather spark with range of one year. Simulations are carried out using the SketchUp software application to simulate buildings in 3D. To ensure thermal comfort in buildings, the Sefaira plugin is used to see daylight impact.

4. RESULTS AND DISCUSSION

4.1. Site Analyst

4.1.1. Location

The research was conducted by descriptive analysis at a site located in Pulodarat village, with the address Jl. Pecangaan – Batealit RW. II, Pulodarat, Kec. Pecangaan.Kb. Japan. Observations were made on a site area of 6.5 ha. Some of the site land had been used by residents as a place to farm rice, and some are still not used.

4.1.2. Sunpath

Sunrise starts at around 5:09 am, with an average illumination length of about 12.10 hours. From the orientation of the site, the sun rises from the right of the site, towards the left of the site.

4.1.3. Wind Velocity

The dominant wind moves from the southeast to the south. Pecangan area experiences different wind speeds following the annual season. The strongest winds occurred from December 24 to March 4, with an average speed of 12.5 km/hour. Meanwhile, the slowest wind occurs from March 4 to December 24, with a speed of 9.2 km/hour. Wind speeds of 9.2 km/hour to 12.5 km/hour are not too disturbing thermal comfort. To maximize Air Circulation in the Tread, cross-ventilation can be applied.

4.1.4. Humidity

Humidity in Pecangaan is at 95%, with a high of 100% on January 1st. This condition means that daily conditions feel humid to miserable.

4.1.5. Temperature

Based on weatherspark data. Pecangan has an average temperature of 31°C, and has the highest temperature in March with a temperature of 32°C. This temperature condition persists, and does not decrease during the seasons of the year. The Climate data at Pecangaan, Jepara can be seen in Figure 1.

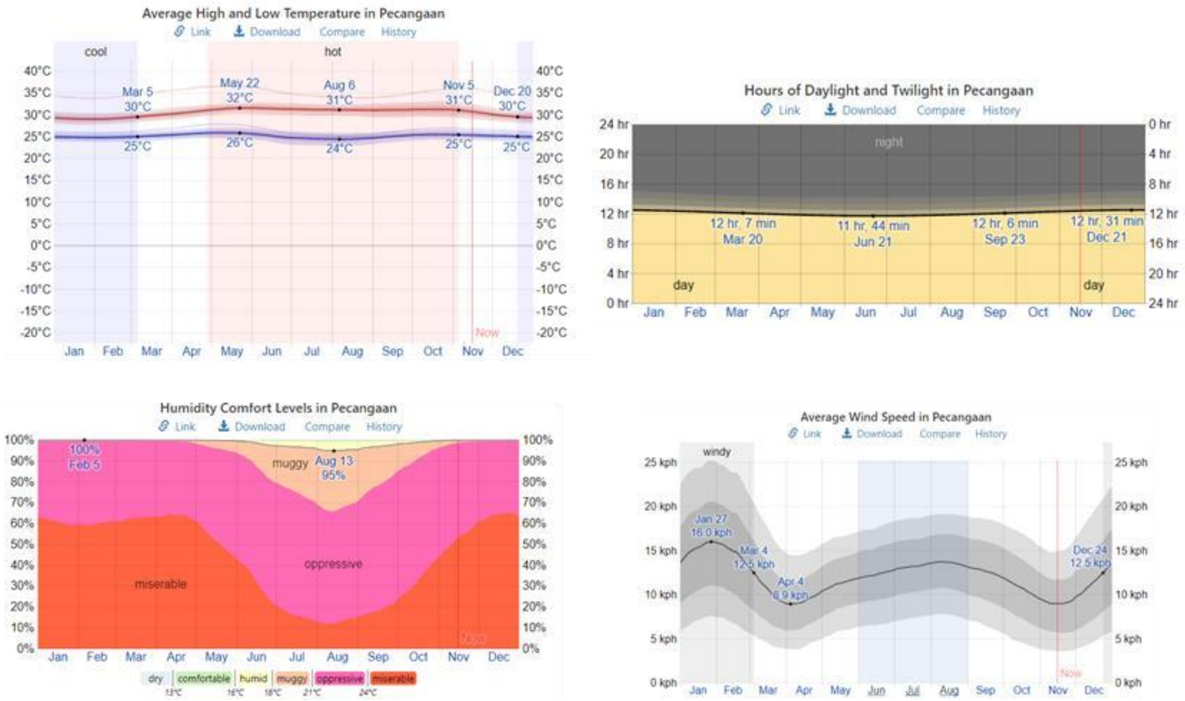

Figure 1 Climate data at Pecangaan, Jepara.

4.2. Design Evaluation Based on Bioclimatic Principle

4.2.1. Windows and Openings

To maximize natural light, the window must be made wider, so that more areas receive natural light. In its use in schools, the window formation should not be too wide because privacy is needed in teaching and learning activities. The use of materials also needs to be considered, a good window for a hot environment can use a type of material that does not absorb too much solar radiation.

In the daylighting simulation using faira, there is a spot that lacks natural lighting, namely in the middle of the room. the lighting from the corridor is less than the lighting from outside the building. This is because there is a distance as wide as the corridor from the space opening to the building site. The corridor gets a high level of lighting.

Judging from the position of the opening, that the opening facing the outside of the building has a more dominant role in daylighting. Therefore, to maximize natural lighting, the openings face the outside of the building site. With a wider opening, light can more easily enter the room. Impact between different size of windows opening facing off site can be seen in Figure 2.

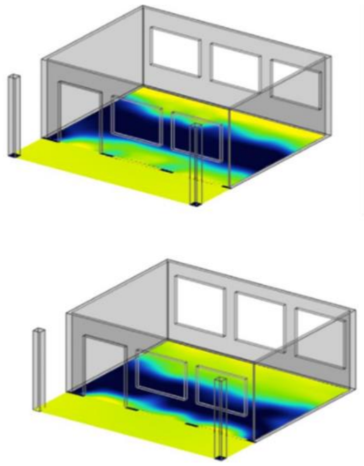

Figure 2 (Top to botton) impact between different size of windows opening facing off site.

4.2.2. Shading

Shading is useful for blocking or reducing the hot sun that falls into the room [12]. a common shading formation is with a horizontal blade formation. Where this formation aims to reduce and dispel incoming solar radiation.

Judging from the first simulation, the corridor section gets a good level of lighting, but it is associated with hot humid climate conditions, the area will feel hot. Shading device was made with formation in the form of a horizontal blade louver, with angle facing the sun So that air can still circulate in the room [13]. Horizontal blade louver placed as shading device for corridor area can be seen in Figure 3.

Figure 3 Horizontal blade louver placed as shading device for corridor area.

4.2.3. Cross Ventilation

Cross ventilation is obtained by utilizing the wind that enters the building through existing openings. Therefore, so that the wind can still enter, the shader formation must be able to let air pass through it, while deflecting solar radiation. Also window openings should be made to be opened and closed, and not fixed into the frame. The direction of the building should also be facing the direction of the wind to maximize the circulation of the incoming wind.

5. CONCLUSION

The application of Bioclimatic in school buildings can be in the form of 1. Application of wide window openings for better daylighting. The opening facing the outside of the building is made wide, while the opening facing the inside of the building should not be wide to maintain privacy. 2. Use of Shading device in the form of a horizontal louver blade. 3. Application of cross ventilation by orienting the building facing the direction of the wind.

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