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Awareness of Passive Design on Apartment Façade Designs in Putrajaya, Malaysia

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ABSTRACT

This research conducts a study on sustainability awareness of apartment facade design in Malaysia. The scope of this study limits to a comparative analysis between colonial and vernacular style facade design. Vernacular style is derived from the traditional architecture to the condition of the place and environment in tropical setting. The style is a logical choice in warm and wet climatic conditions, ideal for creating air movement, ventilation and escape of warm air, thus bringing in thermal comfort to the occupants. On the other hand, colonial style is an expression of classical structures and motives. The architecture does not only have dominant classical style's expression from Europe, it also has a mixture with the local style due to adjustment of the classical style to the tropical setting, which can be seen at heritage buildings erected during colonial time in Malaysia. Two contemporary apartments built in Putrajaya are selected in these two case studies; each has a design approach with colonial and vernacular architectural style. A camera device named Fluke® Ti20 Thermal Imager was used to capture a series of thermal images on a surface of the apartment facades. This camera captured photos of the apartment facade in hourly time during the field works. The study finds that the apartment with vernacular style's facade design has higher sustainability awareness than the apartment with colonial style's facade design. In conclusion, by applying vernacular style in apartment design, it provides awareness to the designer and architect to come with traditional passive design elements which are embedded as part and parcel of the design in a context of tropical climate.

1. Introduction

This study focuses on high-rise apartments in Putrajaya. The definition of high-rise building is a tall and multi-story building equipped with elevator (Cheung, Fuller and Luther 2005). In 1930s

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the first high-rise building was constructed in the world in the United State and later in 1950s in the United Kingdom. The first high-rise building in Malaysia was built in 1960s namely Sulaiman Courts in 1657 (Hoffman, 1996). Figure 2 show the percentage of residential building categories in Putrajaya (Department of Statistics Malaysia, 2010).

Figure 1: Views of apartments in Putrajaya.

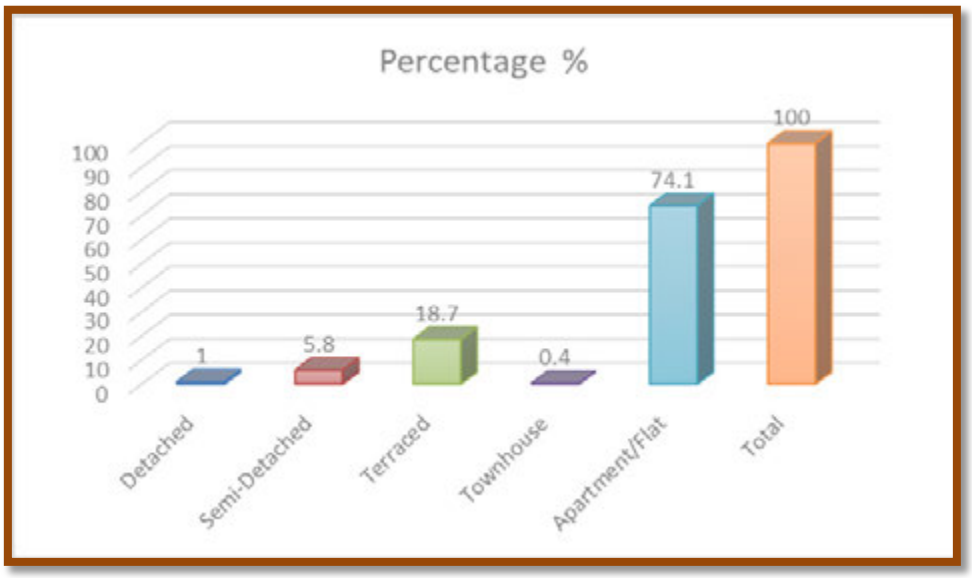

Figure 2: Apartment represents 74.1% of the total units of living quarters in Putrajaya. Source: Department of Statistic Malaysia (2010).

2. Colonial Architectural Style

The colonial architectural style is a reflection of the classical architectural style in the region, a mixture of the colonial and the local style to get a new hybrid with the adaptations to the regional and climate. The colonial architecture style in Malaysia is not only a mixture between the colonial and Malay traditional style, it is also influenced by the Islamic, Indian and Chinese styles. This tuning of eastern and western architecture with local tropical architecture of the Malay traditional building appears with a building design of overhanging roof structures, maximum window openings, cantilevered veranda floor and big roof construction. The concept of traditional Malay building influences the colonial builders which guides them to design building with the tropical climate factors. Yeang (1987; 26) claimed that the roof should act like an umbrella to protect from

the rain and provides shade, on the other hand the building should have maximum openings to maximize the natural ventilation. These features will help the house to reach the thermal comfort and provide better indoor atmosphere.

3. Vernacular Architectural Style

Mohd (1983) defined the vernacular traditional style as the attention to the place conditions, local materials, environment and the traditional habits. The most unique vernacular design elements are raising the floor construction, using the available local rainforest materials, and the flexibility of the spaces in order to cope with the tropical climate. The simple traditional Malay houses were basically built with cut jungle poles, bamboo, rattan ropes and palm trunks and leaves that are gathered around the site and that makes the houses integrated with the surrounding nature. The main structure of the traditional Malay house is timber post and beam with bamboo or wooden wall and large window openings to provide a good natural ventilation (Lim, 1984). And that reflect the large open indoor spaces (Lim 1987). The vernacular buildings designed with concept of nature respect and the ecological balance. Hassan (1998) argued that the local timbers transfer less heat due to the low thermal capacity and the palm leaves can be used as a good thermal insulation material, thus the vernacular style provides comfort against the climate.

4. Passive Design

Having a passive design is having building design that does not require any mechanical heating or cooling systems, and depends on the natural air ventilation, daylight and orientation to reach the thermal comfort (Commonwealth of Australia, 2008). To achieve the thermal comfort, it means that the residents do not feel the temperature too high nor too low, or in other words Cena and Clark (1978) define it as 'an expression of satisfaction' to the thermal environment. This study aims to get better understanding of passive design in the tropical warm and humid climate in the South East Asia with case studies in Putrajaya Malaysia. In the last 25 years, passive thermal design gains the global awareness especially after the Rio Summit in 1992, the conference that set a primary global agenda on sustainable development.

Lim in his research (1987) classified the climate in Malaysia as warm-humid temperature and described the characteristics as the following:

- The average of air temperature is between 22°C and 32°C and seldom to exceed normal body temperature.
- The wind is low-variable speed in general, and usually the strong wind brings rain
- The region humidity is high during the year. Humidity is high throughout the year with almost 75% or more

The building can obtain the thermal comfort in the tropical region based on the following factors:

- In order to achieve the climate comfort there are many factors must be controlled such as: temperature, humidity, glare and solar radiation in the house besides to control the rain which cause floods and sometimes the strong wind.
- In order to reach the thermal comfort, 37°C the human being body temperature should be balanced with the indoor environment reducing the heat gain from the warm air and solar radiation to the minimum amount.
- Providing good natural ventilation based on the air flow or the stack effect help to relieve the climate stress and provide better condition for the residence in hot and humid climate regions like Malaysia.
- The main source of the heat gain is from direct solar radiations. Thus in order to reach the thermal comfort, the designers must take in consideration the building material, and shading elements in order to come out with an efficient façade design.

5. Hypothesis

The research assumes that by applying vernacular style in apartment design, it guides the architects with traditional passive design elements which are embedded as part and parcel of the design in a context of tropical climate.

6. The Case Studies

The two case studies are high-rise apartment buildings located in Putrajaya the capital city of Malaysia, these two case studies are about 800 metres apart from each other. This administrative capital of Malaysia was built after the federal government decision for a new capital city in the early 1990s (Moser, 2009). The city is considered as the newest and most developed city in Malaysia. Most of the buildings were designed with post-modern style which shows the mixture of traditional, modern and colonial styles (Hassan, 2005). The city was designed to be ideal garden and intelligent city with capacity of 250000 people (Scott, 1998). The city is located about 25 km south of Kuala Lumpur along the highway between Kuala Lumpur and the International Airport and this location gave her extra importance and viability as a new capital city (Ariffini, 2003;Hassan, Arab, & Ismail, 2015).

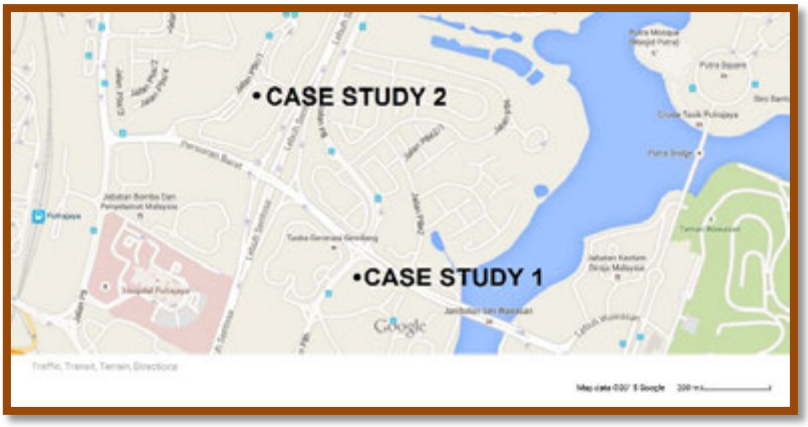

Figure 3: The two case studies location in Putrajaya (source: Google Maps)

The first case study is a thirteen-story apartment building called Block 8R1 located at Jalan P8h, Presint 8, Putrajaya (Figure 3). The building has colonial architectural style like so many other building in the city of Putrajaya. The classical Greek and Roman architectural elements decorated on the building façade with triangular and semi-circular Figure (4). On the other hand the second case study as shown in Figure (5) is a seventeen stories building called Block 9A with vernacular architectural style located at Jalan P9 C/1, Presint 9, Putrajaya. The building is constructed with pyramid and pitch and overhang roofs and other traditional style elements.

Figure 4: The first case study, colonial architectural style apartment.

7. Methodology

This survey is able to detect thermal temperature using a thermal imager device named Fluke Ti20 (Figure 6). The equipment consists of Fluke Thermal Imager device and software. The device helps to get the thermal solution to conduct the thermal survey thorough with accurate inspections

in any climatic environment. From the affordable and easy-to-use Performance Series to the Professional Series, this device offers superior image quality and advanced features, to the Expert Series that gives you a premium viewing experience with highly detailed images, and an extensive feature set. The Fluke built in with the needed Infrared Camera to provide the survey results. The photo images can be stored in one location for comparison and work for approvals or questions for answers without leaving the field, for additional information.

Figure 5: The second case study, vernacular architectural style apartment.

Figure 6: Fluke® Ti20 device.

8. Analytical Software

SmartView® software is used to view, optimize and analyse infrared images and to create a fully customisable and reports. SmartView® software is very easy to use and fits the requirement from the users. It provides the performance specialized thermographers help for advanced report and analysis. Fluke® IR-Fusion technology is a blending of digital and infrared images into a

single image. It delivers strikingly crisp detailed images, making problem detection extremely easy. SmartView® software allows the users to use this technology, to capture and annotate images and quickly import them into the reports.

9. Results of Analysis and Discussions

The survey was taken by taking thermal photo shots for both of the case studies. The device places at the human eye level with a distance at 45 m apart and the photos snapped perpendicular to the building façade. The thermal photo shots were taken hourly from 2:00 pm to 5:00 pm in both of the case studies. The field survey is limited to these durations because of the full cloudy condition and raining weather usually occurred after 5:00 pm, which made the results of the survey inaccurate. It is hard to find the case study at exactly the same building orientation. Both of the case studies are located in orientation with almost the same angles with 35o degree for the first and 33o degree for the second case study. The results as illustrated in the Figures (8 to 11) and Tables (1 to 4). This research will be limited to the average of the selected points in the selected area as shown in Figure 7. The comparison will be between the averages of the points of the last five stories of the two case studies A series, B series, C series, and D series from up to down respectively.

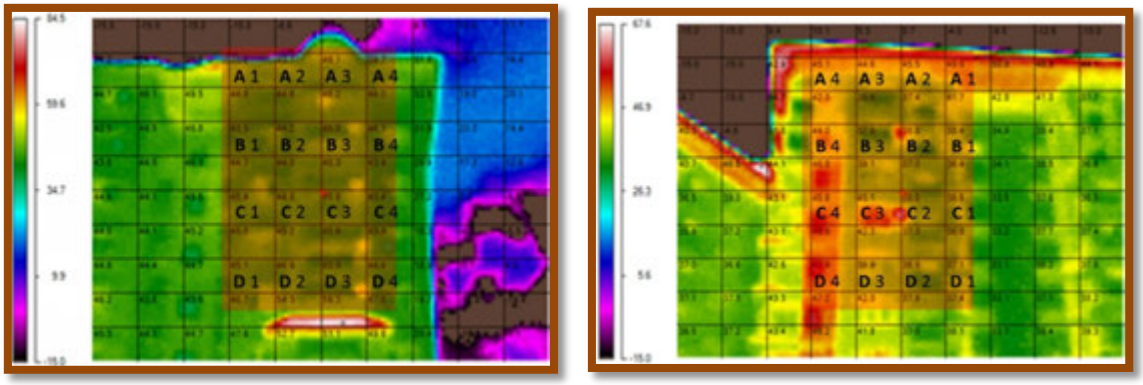

Figure 7: Selected points of case study 1 (left) and case study 2 (right)

- Results analyzing at 2:00 pm: The thermal Images

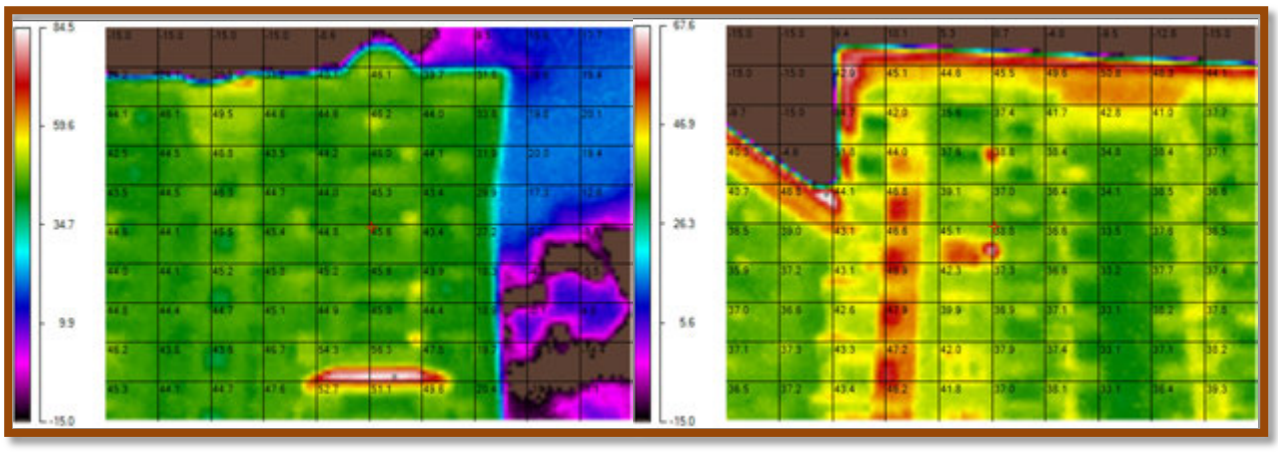

Figure 8: Thermal images for both case studies colonial style (left) and vernacular style (right) at 2:00 pm

- Results analyzing at 3:00 pm

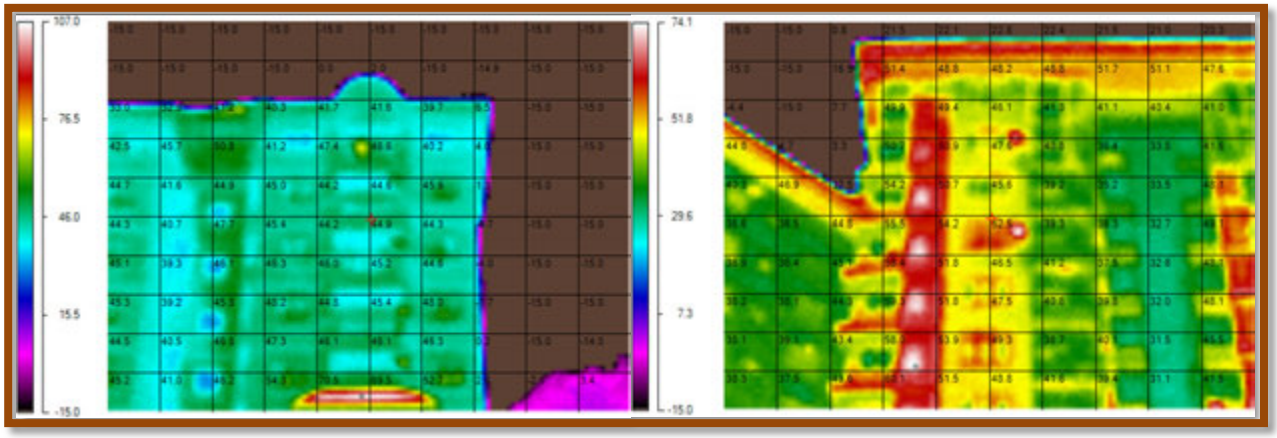

Figure 9: The thermal image for both case studies colonial style (left) vernacular style (right) at 3:00 pm

- Results analyzing at 4:00 pm

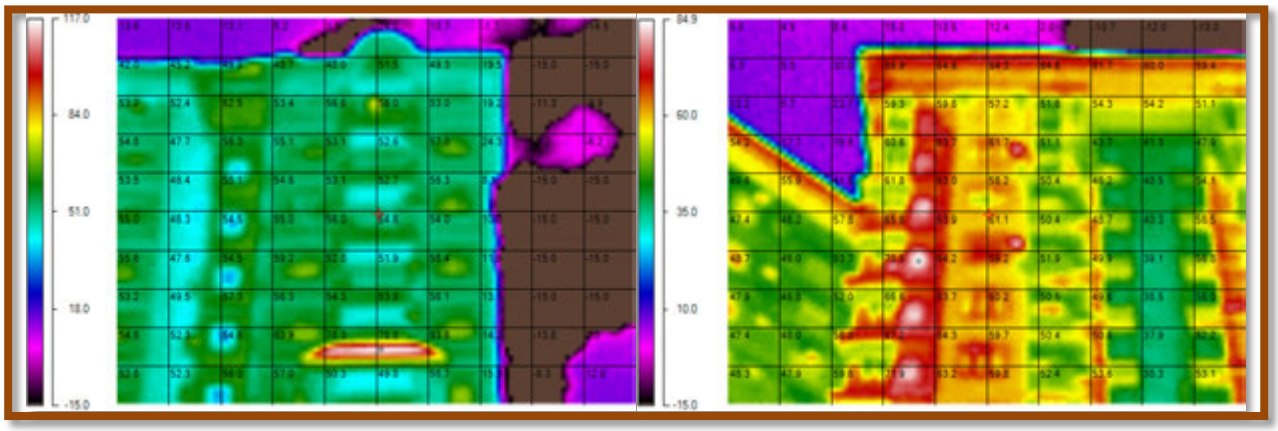

Figure 10: The thermal image for both case studies colonial style (left) vernacular style (right) at 4:00 pm

- Results analyzing at 5:00 pm

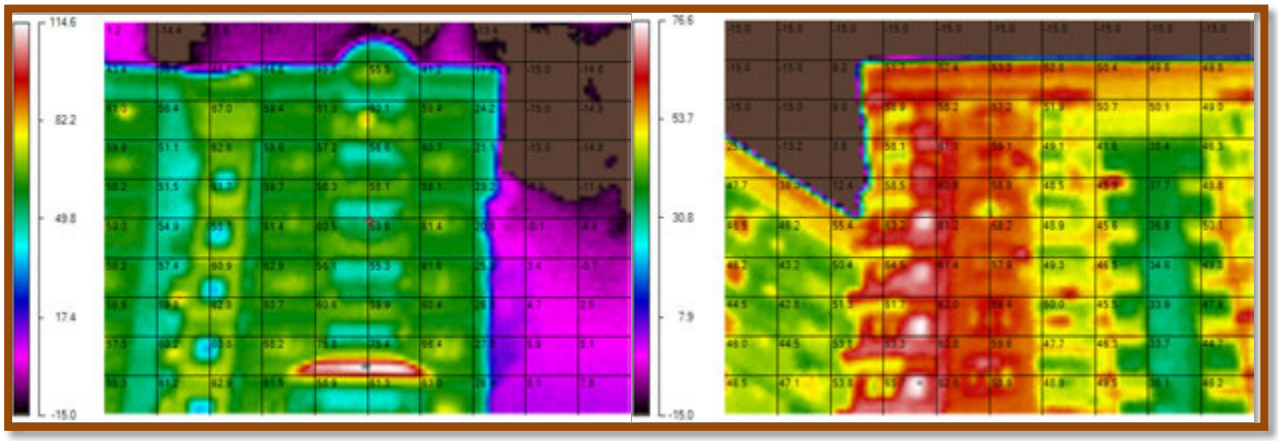

Figure 11 Thermal image for both case studies colonial style (left) vernacular style (right) at 5:00 pm

Table 1: The results (temperature point A) for both case studies.

Temperature	Case 1 Colonial style					Case 2 Vernacular Style				
Time	A1	A2	A3	A4	Average	A1	A2	A3	A4	Average
2:00 PM	44.6	44.6	46.2	44	44.85	41.7	37.4	35.6	42	39.175
3:00 PM	41.2	47.4	46.6	40.2	43.85	41.1	41.3	46.1	49.4	44.475
4:00 PM	53.4	56.6	58	53	55.25	54.3	51.6	57.2	59.8	55.725
5:00 PM	59.4	61	60.1	59.4	59.975	50.7	51.9	57.2	58.2	54.5
Average of A1, A2, A3 and A4				50.98		Average of A1, A2, A3 and A4				48.47

Table 2: The results (temperature point B) for both case studies.

Temperature	Case 1 Colonial style					Case 2 Vernacular Style				
Time	B1	B2	B3	B4	Average	B1	B2	B3	B4	Average
2:00 PM	44.7	44	45.3	43.4	44.35	36.4	37	39.1	46.8	39.825
3:00 PM	45.4	44.2	44.9	44.3	44.7	35.2	39.2	45.6	50.7	42.675
4:00 PM	54.6	53.1	52.7	56.3	54.175	46.2	50.4	58.2	63	54.45
5:00 PM	59.7	58.3	58.1	59.1	58.8	45.3	48.5	56.8	60.8	52.85
Average of A1, A2, A3 and A4				50.5		Average of A1, A2, A3 and A4				47.45

Table 3: The results (temperature point C) for both case studies.

Temperature	Case 1 Colonial style					Case 2 Vernacular Style				
Time	C1	C2	C3	C4	Average	C1	C2	C3	C4	Average
2:00 PM	45.8	45.2	45.6	43.9	45.125	36.8	37.3	42.3	46.9	40.825
3:00 PM	48.2	44.8	45.4	48	46.6	37.5	41.2	46.5	51.8	44.25
4:00 PM	59.2	52.8	51.9	58.4	55.575	49.9	51.9	59.2	64.2	56.3
5:00 PM	62.9	56.1	55.3	61.6	58.975	46.5	49.3	57.4	61.4	53.65
Average of A1, A2, A3 and A4				51.57		Average of A1, A2, A3 and A4				48.76

Table 4 The results (temperature point D) for both case studies.

Temperature	Case 1 Colonial style					Case 2 Vernacular Style				
Time	D1	D2	D3	D4	Average	D1	D2	D3	D4	Average
2:00 PM	46.7	54.3	56.3	47.8	51.275	37.4	37.9	42	47.2	41.125
3:00 PM	54.3	70.5	69.5	52.7	61.75	40.1	38.7	49.3	53.9	45.5
4:00 PM	63.9	78.3	78.8	63.8	71.2	50.6	50.4	59.7	64.3	56.25
5:00 PM	68.2	75.8	75.4	66.4	71.45	46.3	47.7	59.6	62.8	54.1
Average of A1, A2, A3 and A4				63.92		Average of A1, A2, A3 and A4				49.24

From the results, some notice points are

- The highest temperature in averages in case 1 recorded at 5:00 pm with 71.45 °C at point D, while it was 56.3°C at point C in the case study 2 at 4:00 pm.
- The least temperature in the first case study was 43.85 °C point A at 3:00 pm, whereas it was 39.19 °C point A in the second case study at 2:00pm.
- The lowest temperature in average was 47.45°C at 3:00 pm in the colonial style followed by 50.98, 51.57 and 93.92 °C respectively at 2:00, 4:00 and 5:00 pm.
- The lowest temperature in average in the vernacular style follows the same behavior

with 47.45, 48.47, 48.76 and 49.24°C at 3:00, 2:00, 4:00 and 5:00 pm respectively.

- The highest record in average was at 5:00 pm in the colonial style with 63.92 °C, while the highest record in the vernacular style was at 5:00 pm with 49.24°C.
- In average all hours shows lower temperature in vernacular style than the colonial style.

10. Conclusion

The study finds that by applying the vernacular style on the second case study, the designer manages to reduce the façade surface temperature in all of the analyzing point between 3 to 15 degrees in the afternoon and evening hours comparing with the colonial style. The traditional design components and shading elements provide a slightly good sunlight shading façade performance compared to that of the colonial style's apartment which helps to prevent the unnecessary sunlight from penetrate inside the house, thus lead to reduce solar radiation to the indoor air temperature. In other words, applying the vernacular architecture style for the second case study helps to reach the indoor thermal comfort. The study can be used as a guide for the architects and designer to apply the passive design element for their future projects. This study also finds that colonial style's apartment has a façade design integrated with shading design similar to that of the traditional architecture like recessed wall, balcony and roof overhang. This design adjustment is inherited from the colonial architecture introduced by the architects and builders during the colonial times to cope the European styles to the tropical climatic contexts.

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