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CLIMATIC RESPONSIVE SPACE IN MELAYU PONTIANAK HOUSE: A PRELIMINARY STUDY

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ABSTRACT

As a building well adapted with climate, traditional houses in Indonesia usually are very suitable to tropical hot humid climate. Almost all parts of the house are constructed in order to respond to the climatic problem of high temperature and air humidity. Layout is one attempt to do so.

Such distinctive layout also appears in melayu Pontianak houses. The living room is located at the front of a large open terrace. Space inside of the house consists of one family room surrounded by bedrooms on each longitudinal side.

The problem of dead space in the middle of the house due to the lack of air flow is solved by row of large doors which behave as openings on the outside wall and inside wall facing each other to provide cross ventilation. Thin elongated shape of building maximizes the performance of cross ventilation. The presence of veranda at the front and at the back of the house helps cooling the air flow through the house.

The air flow of the house increases with the presence of opened back veranda which separates main building and the kitchen. With current airflow, the hot air inside caused by the occupant's activities can be immediately replaced by fresh lower-temperature air.

Keywords : Melayu Pontianak house, climate adaptation, layout

I. INTRODUCTION

The capital of West Kalimantan province, Pontianak, also known as the "Equator City". Pontianak lies on the equator, at 0° 02' 24" north latitude – 0° 01' 37" south latitude and 109° 16' 25" – 109° 23' 04" east longitude.

The daily mean temperature for Pontianak is 29.5°C, the mean minimum temperature is 22.9°C and the mean maximum temperature is 31.05°C. But occasionally the temperature can reach 33.7°C. High rainfall (3,000 mm – 4,000 mm) causes high air humidity as well. Air humidity can reach 99.5% with an average of 80%. This conditions indicate that Pontianak has a hot and humid climate.

Hot and humid condition of Pontianak often leads to uncomfortable condition felt physically by the city residents. Because the air temperature is continually very near to skin temperature, bodily heat loss to the air by convection or conduction is negligible. The main way to improve the thermal environment is by reducing the temperature with air flow (Koenigsberger et al., 1973; Szokolay, 2008). Sufficient air flow will reduce the saturated air envelope which can occur easily in hot humid condition. It will allow the dissipation of heat from the body. The air flow will also allow the body to experience the physiological cooling effect, the cold breeze we feel on our skin.

Mediastika (2002) showed that it is possible to have cooling ventilation in a house in a hot humid tropical environment. Without moving air (wind speed equals 0 m/sec which means the indoor temperature is equal with outdoor temperature, $\Delta t = 0$), cooling ventilation can be achieved when the area of the openings is at least 40% the area of the floor. But to experience the physiological comfort, the occupants must feel the air breeze pass across the body surface of the occupants, resulting in cooling effect.

Traditional and vernacular architecture is known to be well adapted with the environment where it was developed. The adaptation was done with using only natural sources of energy and observed physical phenomena (Hassan, 1986). Similar case can be found at the melayu Pontianak house, particularly from the building shape, the using of lightweight construction (wood) and the interior layout.

The solutions shown by the traditional and vernacular architecture is the passive or non-mechanic strategy which is a sustainable solution. These solutions need to be observed and studied and then to be adapted for new buildings.

Particular study on thermal condition of the built environment in Pontianak has never been done. This study is a preliminary study on how the vernacular melayu Pontianak house adapted with the climate, particularly in how the building's layout optimize the air flow inside the building.

II. METHODOLOGY

This study is a preliminary study to observe how the interior layout of melayu Pontianak house was adapted to optimize the ventilation and the indoor thermal environment.

This study is limited at the melayu Pontianak house which can be considered as the vernacular buildings in Pontianak. The thermal environment factor that will be studied are the indoor layout of the house compared with its possibility of supporting the air flow inside the building as part of natural ventilation.

Methodology used for this study is descriptive explorative by comparing existing field situation with theories. Primary data were collected from field measurement and observation. These data then compiled, redrawn and classified for the purpose of analysis.

Analysis conducted by comparison, reviewing the excellence and the weakness of primary data compared with theories of relevant guidance. The interpretation from the analysis results as the conclusion.

III. AIR MOVEMENT AND VENTILATION

Air flows either because of natural convection currents, caused by differences in temperature, or because of differences in pressure. As air hits the windward side of a building, it compresses and creates a positive pressure (+). At the same time, air is sucked away from the leeward side, thus creating a negative pressure (-) (Lechner, 2001).

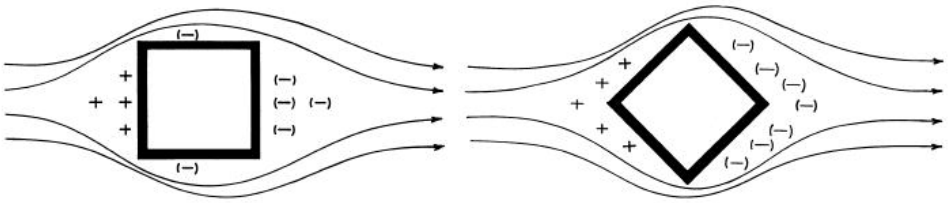

Figure 1. Air flowing around a building will cause uneven positive and negative pressure areas to develop
Source: Lechner, 2001

The Bernoulli effect can also be applied for studying air flow. The Bernoulli effect states that an increase in the velocity of a fluid decreases its static pressure. Because of this phenomenon, there is a negative pressure at the constriction of a venturi tube as seen in Fig. 2 (Lechner, 2001).

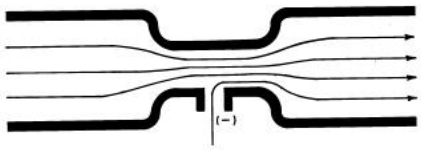

Figure 2. The venturi tube illustrates the Bernoulli effect: As the velocity of air increases, its static pressure decreases.
Source: Lechner, 2001

Air movement and natural ventilation are main tools to sustainably provide the comfortable thermal environment in hot humid climate (Koenigsberger *et al.*, 1973). Adequate ventilation brings in fresh outdoor air then the air is passed over people to increase evaporative cooling on the skin (Lechner, 2001).

Cross ventilation also must be provided to achieve comfort thermal environment. Cross ventilation assures the constant flow or movement of the air inside a building (Koenigsberger *et al*., 1973).

Designers must consider their designs to provide buildings with comfort thermal environment. Different types of climate requires different types of design strategies. Koenigsberger *et al* (1973), Lechner (2001) and Szokolay (2008) have proposed strategies for design, especially related to layout, dealing with hot humid tropical climate. The strategies are:

1. Long thin elongated plan shapes, with a single row of rooms to allow cross ventilation.

2. Elevate main building on stilts to avoid the stagnant or slowly moving air at the ground surface, thus capturing air movements of a higher velocity.

3. With low rise building, orientation for wind is more advisable.

4. Wide big area of openings for natural ventilation, especially for the living aren (up to 2 m above the floor). This condition is suitable for air change as well for air flow which will pass the air over the people to increase evaporative cooling.

5. Spacious veranda covered with roof or shading to lower the outdoor air temperature before entering the building.

IV. MELAYU PONTIANAK HOUSE

Melayu Pontianak house is the dwellings for Pontianak residents which were built and passed down by predecessor. As the history of Pontianak city can be seen from the rising of malay sultanate, Kesultanan Kadriah Pontianak, the architectural style of malay also affected the dwellings, hence the term “melayu Pontianak house”.

Currently, many houses of this style can be found at the region near to The Kadriah Palace Pontianak, especially on Kampung Arab Street or Kampung Beting, Sub-district of North Pontianak. Several other houses can be found scattered around the city area.

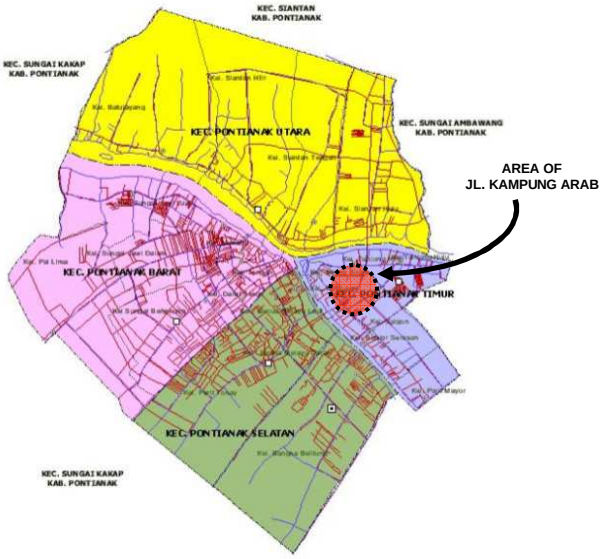

Figure 3. Administrative map for Kota Pontianak
Source: RTRW Kota Pontianak, 2001 – 2011

Main structure of melayu Pontianak house is from wood with elevated floor on stilts. Main frame of the building uses iron wood, a very strong waterproof kind of wood found in Kalimantan. The foundation uses wood pile foundation called "*alas-laci*" foundation. The wall constructed from wooden board. The original material for the roof was thin sliced wooden bar (called "*sirap*") or pile of leaves (called "*rumbia*"). Due to the age of the materials, many of the original roofs were replaced by zinc sheet roof.

Opening in the form of windows and doors can be found almost at every interior rooms. Each window and door also have ventilation opening above it. The window's shape is casement windows, but it was found that at several houses the original windows have been replaced by louvered glass windows.

Interior layout of melayu Pontianak house can be divided into two main part, the main house and the kitchen. The two parts are separated by slight lower level of open space called "*pelataran*" or in this article will be revered as *back veranda*. The back veranda is open, means it is not covered with roof or shading.

Front area of the main house always has front veranda covered with roof which acts as sun shading. After the veranda, the interior room begins with a spacious living room. Behind this living room are two rows of bedrooms, facing each other at the left side and right side of the house. These rows surround an alley at the center of the house, occasionally functioned as the family room.

After the main house is an open space or back veranda which connects the main house with the kitchen and toilet. This veranda is at the same level or sometimes at one step lower level as the main house, therefore the occupant does not have to go down to the ground to move from main house to the kitchen. This back veranda also used for kitchen activity when the family holds social or community events which require more cooking space.

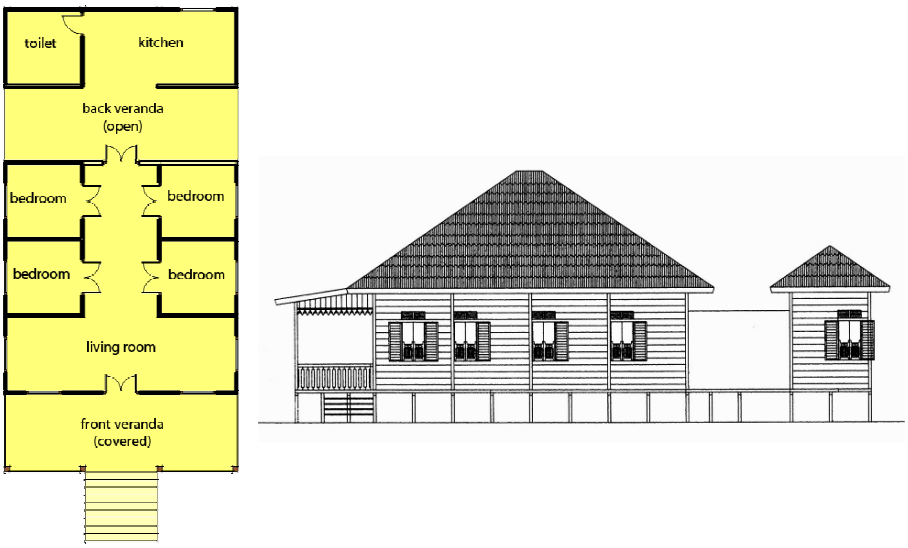

Figure 4. Typical plan and side elevation view of melayu Pontianak house
Source: field observation

Figure 5. Front view of one of the melayu Pontianak house
Source: field observation

Figure 6. View of back veranda (“pelataran”)
Source: field observation

V. ANALYSIS

Melayu Pontianak house is well adapted with hot humid climate. Comparing the guidance and the internal layout, the house adapts with climate in ways of:

1. Thin elongated plan with row of bedrooms allows a good condition for cross ventilation.

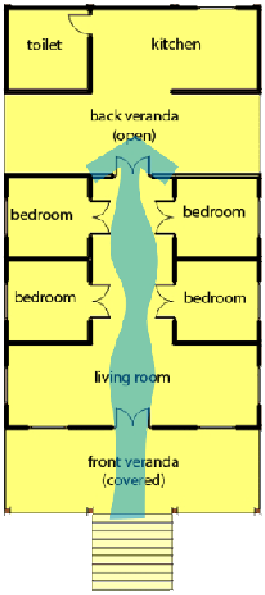

Figure 7. Thin elongated plan allows an adequate cross ventilation.
Source: analysis

2. Almost all rooms has big wide openings at human level (up to 2.1 m), windows and doors, therefore the air flow can move pass over the occupants and generate the physiological cooling (Fig. 8).
3. Main building is elevated on stilts, this will avoid the stagnant or slowly moving air at the ground surface, thus capturing air movements of a higher velocity. High humidity near the ground will also can be eliminated by the air movement below the building. It will take the water vapor as it flow (Fig. 8).

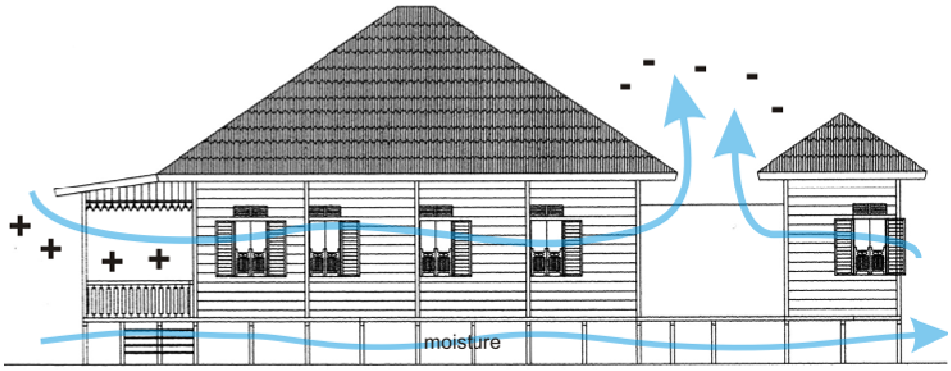

Figure 8. Higher level was made for capturing air movements of a higher velocity and humidity on the ground can be eliminated by air movement below the building.
Source: analysis

4. Cooking activities in the kitchen produce heat. The separation between main building and the kitchen can avoid the heat from entering the main building. Excessive heat can be easily eliminated by the air movement and wind collected by the open back veranda.

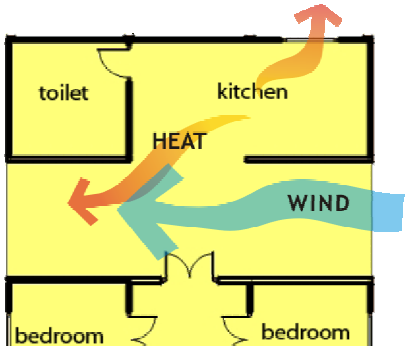

Figure 9. Heat produced by kitchen's activities can be eliminated by natural ventilation with large openings and open (outdoor-connected) back veranda.
Source: analysis

5. Front veranda covered with overhang and shading helps reducing the hot outdoor air before entering the building thus raising the air pressure at this area which can help air to flow into the building.
6. Rows of rooms facing each other at the center of the house may give the effect of wind funnel. Wind funnel can help increasing the speed of the air flow thus help the effectiveness of ventilation for each room.

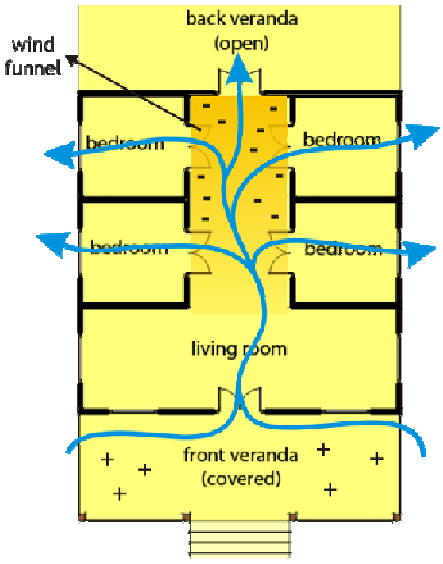

Figure 10. The "wind funnel" increases the effectiveness of cross ventilation for the rooms.
Source: analysis

7. Back veranda offers a good sample of the Bernoulli effect for the air flow. The open back veranda allow outdoor wind, which most likely has higher speed, to flow along the back veranda. In this case, the back veranda acts as the venturi tube. The main building door opened to the back veranda acts as the constriction. The air pressure around the door will be reduced and the indoor air will be sucked out the back veranda. The main building has constant air flow thus natural and cross ventilation of the house is improved.

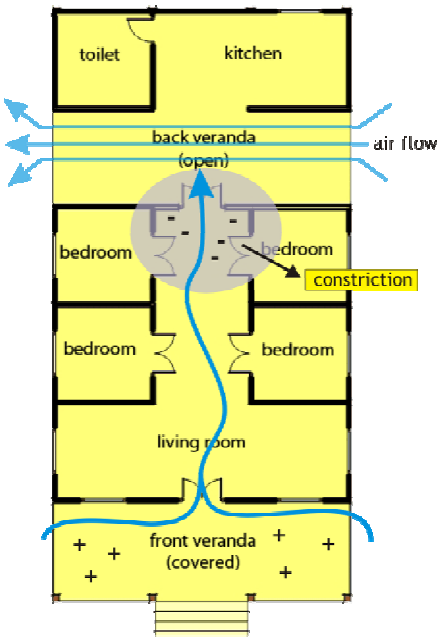

Figure 11. The back veranda acts as venturi tube and main building opening acts as the constriction, which will allow indoor air flows and give accepted natural ventilation for the house.
Source: analysis

VI. CONCLUSION

Vernacular buildings, as a result of hereditary tradition, has excellent design strategies in adapting to the local climate. These strategies is often overlooked by designers of new buildings in order to pursue more attractive building's shape and appearance.

The space layout at the melayu Pontianak house has been composed carefully to adapt with the climate of Pontianak. Spacious and covered front veranda will reduce the temperature of outdoor air before entering the building and it will also increase the air pressure. The open back veranda is also a distinctive feature found. When the outdoor air flows in the open back veranda, it will act as venturi tube and suck the indoor air from the main house. This combination will provide the house with well and adequate cross ventilation.

Other thing to consider is that air movement and wind speed very much depends on site climate condition. The melayu Pontianak houses studied here still have green vegetative surrounding and sufficient space between houses, a good environment condition to gain desired temperature of outdoor air and air movement. This condition should be provided prior to implementing the design strategies in new buildings.

This study is only a preliminary study to learn about the climatic response by local genius. Further empirical studies are required to invest more about dimensions of space and openings and which is the best layout configuration to achieve comfort thermal environment. Other elements of buildings, such as building form, building materials, etc. also need to be investigated to support comfort thermal environment on the climate of Pontianak.

REFERENCES

Fathy, Hassan (1986). *Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates*. Chicago: The University of Chicago Press.

Koenigsberger, O.H.; Ingersoll, T.G.; Mayhew, Alan; Szokolay, S.V. (1973). *Manual of Tropical Housing and Building, Part One: Climatic Design*. London: Longman Group Limited.

Lechner, Norbert (2001). *Heating, Cooling, Lighting: Design Methods for Architects*. New York: John Wiley & Sons, Inc.

Mediastika, Christina E., (Juli 2002) Desain Jendela Bangunan Domestik Untuk Mencapai 'Cooling Ventilation'. In *Jurnal Dimensi Teknik Arsitektur, Vol. 30, No. 1*. Surabaya: Universitas Kristen Petra.

Szokolay, Steven V. (2008). *Introduction to Architectural Science: The Basis of Sustainable Design*. Oxford: Elsevier.