TAYLOR'S UNIVERSITY

Wisdom • Integrity • Excellence

Asian Architecture (ARC 2234 / ARC60403)

PROJECT: CASE STUDY PAPER

The Adaptation of Design Features of Traditional Malay Houses to the Traditional Villas of Belum Rainforest Resort in Achieving Thermal Comfort

Name: Tang Kar Jun

Student ID: 0314075

Lecturer: Mr. Koh Jing Hao

The Adaptation of Design Features of Traditional Malay Houses to the Traditional Villas of Belum Rainforest Resort in Achieving Thermal Comfort

Table of Contents **Page**

ABSTRACT

The purpose of doing this case study paper is to investigate the integration of Traditional Malay Houses' design features into Belum Resort's traditional villas in achieving thermal comfort. Looking further into the details would be investigating the design features which consist of the roof structure, choice of material, vegetation and also the ventilation. In assisting the validation research, literature reviews based on traditional Malay houses were conducted to enrich the process. In order to achieve a better understanding of the topic, it is crucial to be able to cross reference both Belum Resort's traditional villas and Traditional Malay Houses' similarities and differences as to show the relation between them. The Belum traditional villas used the same Malay shingles roof and have been a recurring quality of the Malay houses. The gaps at the roof joints also allow cross ventilation at roof level. This ties in with the ventilation as the open ceiling also allows air to circulate and provide free air flow. Hence, good ventilation. Another important factor would be the windows which are full length and allows for cross ventilation. The resort's front elevation is towards the Temenggor Lake and has been shaded by the trees which grow rampantly atop the hill slope. This natural shading device is also the reason whereby the villas are more open air and less susceptible to weather problems. As a result, it is vital to apply proper design features in achieving thermal comfort in this tropical climate. By using traditional Malay houses as reference, the current design features would aid in modernity.

1.0 Introduction

Building sustainability is a highly sought-after design approach for both old and upcoming architects. The main objectives of this are to reduce critical resources which are depleting such as energy, water, and raw materials. Buildings are made with these resources and in turn generate waste which can prove fatally harmful. Therefore, knowledge on the existing local materials and also the passive design strategies would help to reduce the harmful impacts.

Having chosen the Belum Resort Traditional Villas, research on the sustainable features used includes the usage of natural materials and also the very design concept of a traditional Malay house. This has also brought up the next topic whereby the Belum Resort's Traditional Villas have hints of Malay architecture all over it. The Villas all have highly detailed wood carvings, shingle roofs and most importantly the usage of timbers which are what makes up vernacular Malaysian architecture. The villas offer great views and is well situated to have natural ventilation whilst being shaded. However, while the Villas may look like the traditional Malay houses, the question rises; are they the same in functionality and sustainability?

Next would be discussing on how integrating the aforementioned design features will help to achieve thermal comfort in the Belum Resort Traditional Villas. In the resort, the villas were made with very close similarity to traditional Malay houses and can be seen throughout the villas. The villas were also elevated above ground and have stilts to support it much like Malay houses. The villas are also made with materials which are a replicate of the natural, raw materials. The materials are similar in terms of texture and also functionality. This has addressed such questions to light:

Research Question(s):

- What is the design features that can be used to achieve thermal comfort in the Traditional Villas based on Traditional Malay Houses?
- What makes the traditional Malay house a choice of comparison when considering the design concepts when building the Traditional Villas?
- How are the design strategies mentioned above fit into Belum Rainforest Resort's chalets?
- What are the same and different sustainable design strategies between Belum Rainforest Resort's Traditional Villas and traditional Malay houses?
- How will the design strategies used help to achieve thermal comfort?

2.0 Architecture in Achieving Thermal Comfort

Comfort is defined as a state of mind whereby the mind expresses satisfaction with the environment. As such, the indoor environment must be designed in a way that assures the occupants' comfort and health being. In urban designs, both indoor and outdoor climate must be taken into consideration. Thermal comfort and climatic designs relate to each other a lot and should be a matter of attention of modern urbanists.
Architects would need the study the area's climate to be able to brainstorm for ideas. At the same time, they must look at passive heating or cooling strategies which can be considered on site. The first would be to identify the problems faced on site and then having sketch designs which can help rectify those downfall. It is important to create 2D and even 3D models to help discover the best facade which can provide shelter and thermal comfort to the user.

Thermal comfort is significantly influenced by the climate of an area. In Malaysia, the hot and humid climate causes architect to follow a set of designs accordingly. The first solution to that would be the usage of 'light materials', or materials possessing low thermal mass. In addition to that, said materials are also selected from an abundance of that particular material. A good example of that would be timber as Malaysia has a forest cover of 84.46% (Forestry Department Malaysia, 2012) and therefore an ideal choice.

As for a building form which can help thermal comfort, it is advised to study on the site context such as sun path, wind analysis and even hydrology analysis. This is to help in creating a form which is functional and aesthetic at the same time. Malaysia having both sun and rain all year round is best paired with a pitched roof and also having it slightly elevated from the ground to prevent flood water.

3.0 The Traditional Malay House as the Ideal Method of Achieving Thermal Comfort

The Malay Traditional house has been greatly influenced throughout the years by many factors including the surroundings, the owner's lifestyle, economic status as well as climatic features. This paper discusses on how the given design features present in Traditional Malay houses will aid in achieving thermal comfort.

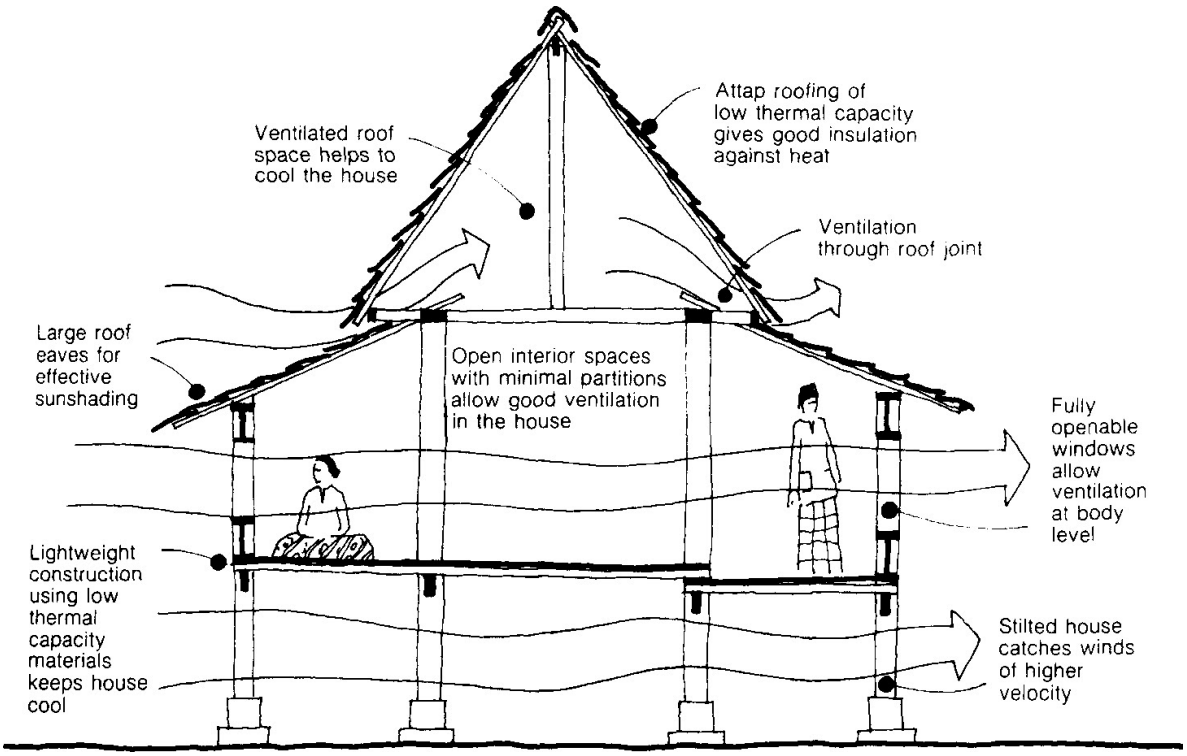

Figure 1: Climatic Design of the Malay house (Source: Lim, 1987)

For a traditional Malay house, the climate plays a huge role to determine the form and can be seen from the figure above. In order to adapt to Malaysia's hot and humid weather, these houses are built on stilts to raise the floors above ground. By doing so, this severely reduces the effect of dampness from the ground and creates airflow beneath the

house. During any rainy season, the house is well above the ground and also protected from flood.

The floors and walls are made with either bamboo or timber with gaps in between for ventilation. The roof are sloped to roughly 45 degrees and helps to prevent rainwater absorption, leakage and even leaks. The roof overhangs and eaves acts as a shading device for the home. The area underneath the roof overhang is an opening which allows ventilation so the house is always ventilated. The roofs of the traditional houses really contribute a lot to the thermal comfort in the house. Most of the time, the roof is usually made of palm leaves which are found in the vicinity.

Besides the form of the traditional Malay house, the site context greatly affects the thermal comfort of the house. Examples of that would be the surrounding vegetation such as palm trees which shade the building naturally due to its enormous height. Tall trees also do not obstruct wind movement and thus allows airflow into and out of the houses.

4.0 Analysis of The Adaptation of Design Features of Traditional Malay Houses to the Traditional Villas of Belum Rainforest Resort in Achieving Thermal Comfort

Figure 2: Overview of Traditional Villas at Belum Rainforest Resort

While conducting researches and interviews at the Belum Rainforest Resort, it was mentioned that the Resorts were all built with the same intention *'to be built with nature'*. Through this statement, it is safe to assume that the buildings were made to be sustainable before investigating its actual performance. However, a sustainable building might not necessarily be made to help achieve the best and optimal thermal comfort. Though it seems impossible to state the amount of thermal comfort from the site, the resort was analyzed in comparison to the Traditional Malay houses based on the following factors:

- Orientation - Sun Path Analysis & Wind Analysis
- Ventilation - Fenestrations Analysis & Cross-Ventilation Analysis
- Context
- Layout
- Materials Analysis

4.1 Orientation

A vast majority of a building's performance is hugely dependant on the orientation of the building itself. This way, it is possible to determine the sun path of the site and how it will interact with the building. Next is also the wind analysis from which can be done at the site to obtain data on the ventilations as well.

4.1.1 Sun Path Analysis

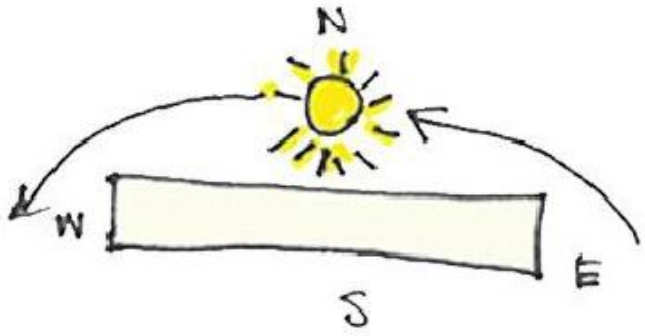

Figure 3: Proposed orientation of buildings to minimize heat gain (Source: Munirah, Z. 2014)

In clause 4.3 of MS 1525 (Department of Standards Malaysia, 2007), it is stated that "For climatic zones near the equator, the best orientation for buildings is with the long directional axis of buildings facing North-South, minimizing the East-West orientation." It is also best to minimize the amount of openings in a building facing the East and West side. This is to reduce the amount of openings in the building facing those facades.

The villa resorts in Belum all has different openings in the buildings and is shown in the plan drawings. Although the resorts has fenestrations, the positions of them serve two purposes; one to help ventilate the building and keeping the temperature to room level and the other to serve aesthetically.

Figure 4: Orientation of Traditional Houses at Belum Rainforest Resort

Based on the above diagram, it's shown that the villas are not arranged linearly but instead are curved. This has caused different openings in the three different chalet types. In the 1-bedroom traditional house, the North-West facade has the most openings while the 2-bedroom villa's South-West facade has the most openings. The 3-bedroom villa has the most openings on the South-East facade. The difference in fenestrations may serve to relate to its site context and also aesthetics purposes. These openings are also more responsive to the wind movement as compared to the sun path.

Out of all three traditional villa, the 3-bedroom villa responds to the sun path data the most. As mentioned, to build thermal comfort, it is best to place the longer facade facing North and South and minimum openings on the East and West. The mentioned properties are met by the 3-bedroom villa. The remaining two villas does not meet the requirement and instead is opposing the ideal orientation and opening locations.

4.1.2 Wind Analysis

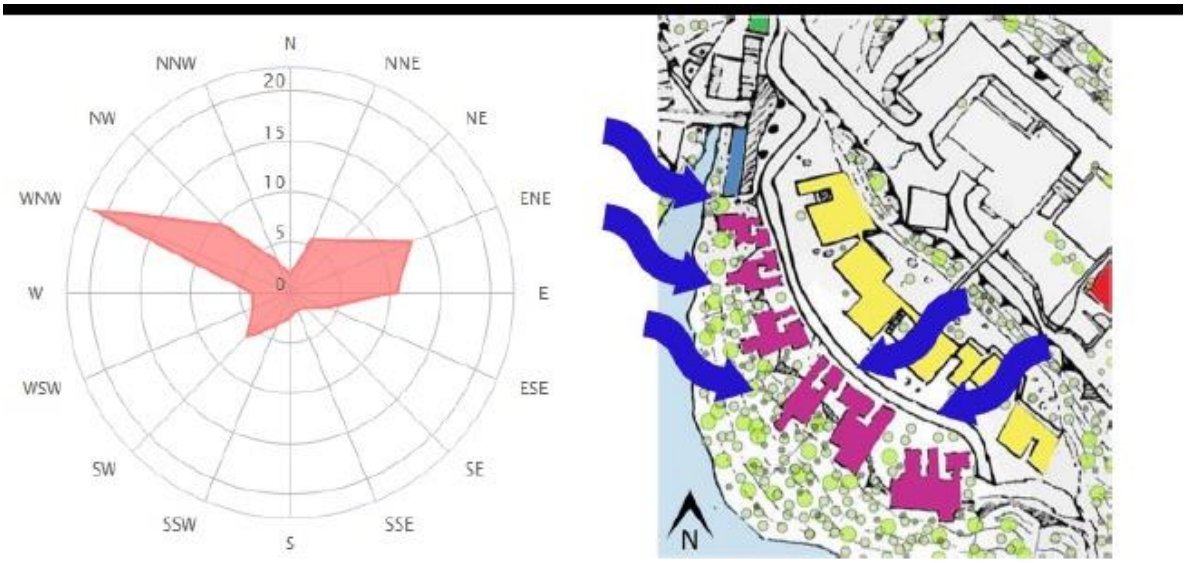

Figure 5 & 6: Wind Rose Diagram and Wind Path (Source: Munirah, Z. 2014)

The wind-rose diagram of Gerik (Figure 5) illustrates that prevailing winds come from the East-Northeast and West-Northwest directions. The above can be curbed by orientating the building to maximize surface exposure to such prevailing winds. With the above data, it is safe to assume the best placements of openings mainly on the North-West and North-West facades. And as such, the openings can be used to help circulate air into the resorts without actually needing the usage of air-conditioners or fans.

Figure 7: Orientation of Chalets at Belum Rainforest Resort

As mentioned in the above section under the sun path analysis, the traditional villas are oriented in accordance with the direction of prevailing winds, which comes from the West-Northwest direction. This is further explained by looking at how the villas are ventilated.

4.2 Ventilation

Ventilation is analyzed from the wind analysis and also been investigated more thoroughly. As such, there are two such properties of the chalets which affect the thermal comfort of the user within the space. The usage of fenestrations as well as the positions of the openings plays a role in the ventilation. This has created cross-ventilation within the building and helps to circulate the hot air out. Besides that, there are other areas to look at such as the roof and stilts of the traditional houses compared to that of the Malay houses.

Figure 8: Back Elevation of Traditional Villa (Pulai)

By looking at the traditional villa's roofs, they are pitched but not to the extent of a 45 degree Malay house. It is also not high above the house which reduces ventilation space. The design of the Belum Rainforest resort is not properly ventilated using the ventilation joints. While it does not function half as good as a traditional Malay house, it can still offer thermal comfort to the users within.

Figure 9: Section of 1-Bedroom Chalet (Source: Munirah, Z. 2014)

Based on the sectional diagram of the resort chalet, it is shown that the stilts of the villas are much shorter compared to that of a traditional Malay house. This severely reduces the building's ability to catch winds of higher velocity as there are not enough space below the house for the function. That said, the resort may not be as windy as a traditional Malay house.

4.2.1 Fenestrations Analysis

The reason to why traditional Malay houses are so successful in applying natural ventilation is due to their full length windows and doors.

Figure 10: Fenestration

As seen in the above picture, the fenestration promotes ventilation and a huge portion of that is from the full length windows. This means that when wind were to blow in, the whole room will be chilled. The above picture applies to a majority of the chalets as some of the villas orientation is slightly tilted.

To determine the amount of ventilation received by the respective chalets, the area of openings is calculated over the total wall area, as seen in Table 1.

	1-Bedroom	2-Bedroom	3-Bedroom
Total exterior wall area (m^2)	26.15	27.54	29.84
Area of Openings/Wall Area (%)	56.8	59.8	38.6

Table 1: Percentage of Openings over Total Wall Area

The data above shows that all three villas have a high percentage of openings over wall area, indicating that the villas do promote ventilation. The 1-bedroom and 2-bedroom villas have openings which cover more than half of their respective total wall areas (Munirah Zazarin, 2014). The 3-bedroom differs in its low percentage of openings per total wall area. When comparing the three, the 3-bedroom villa is the most related to sun path but it shows its flaws as it is unable to allow a lot of wind in. Through this table, the results are that the 1-bedroom and 2-bedroom villas give more thermal comfort compared to the last villa. Next, investigation of the cross-ventilation is conducted to discover the efficiency of the villa openings.

4.2.2 Cross-Ventilation Analysis

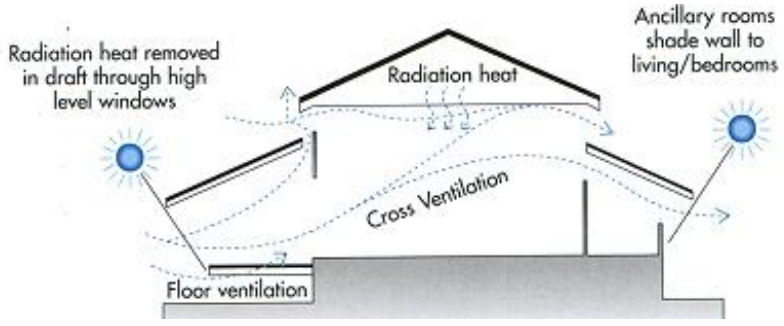

Figure 11: Cross-ventilation

By checking the buildings' openings, it can be assumed that there are cross-ventilation occurring when wind blows as there are openings on both opposite sides when one looks at the plan drawings.

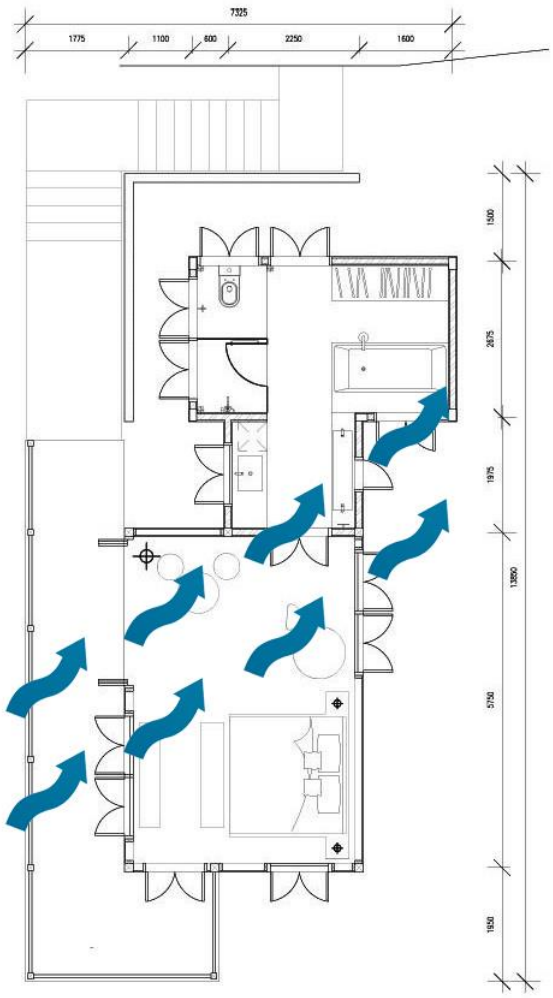

Figure 12: Cross-Ventilation Diagram of the 1-Bedroom Villa (Source: Belum Rainforest Resort Official Site, n.d. & edited by the author)

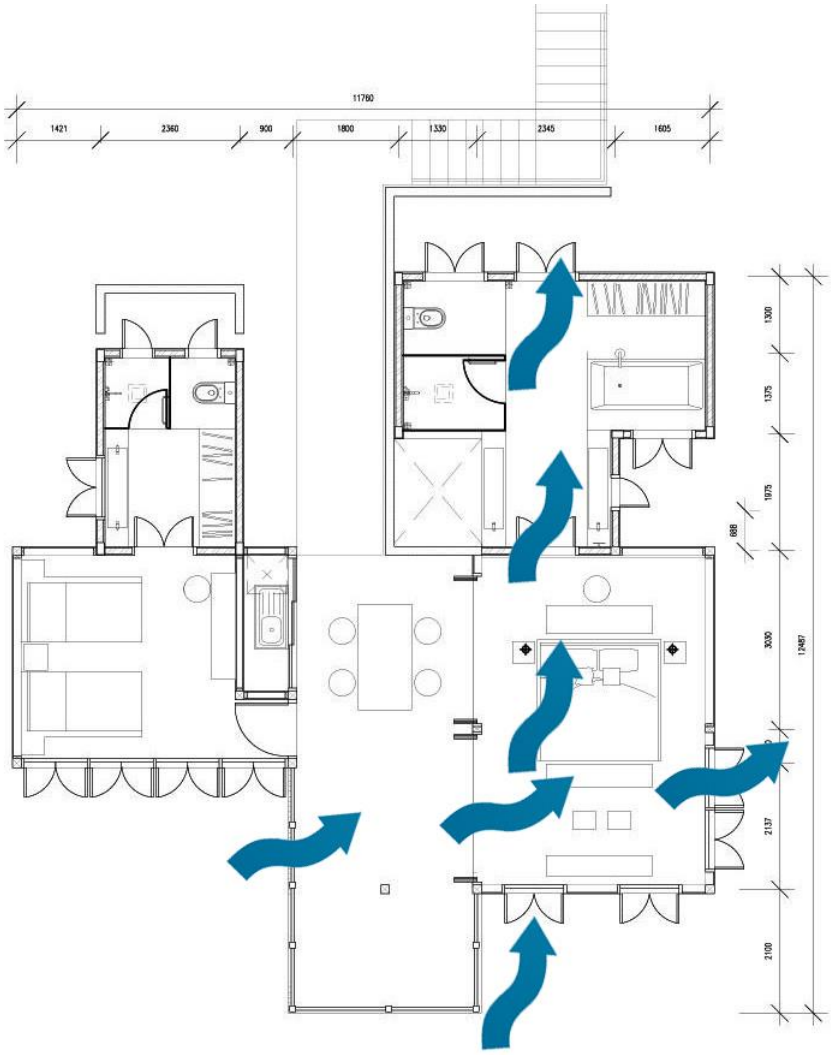

Figure 13: Cross-Ventilation Diagram of the 2-Bedroom Villa (Source: Belum Rainforest Resort Official Site, n.d. & edited by the author)

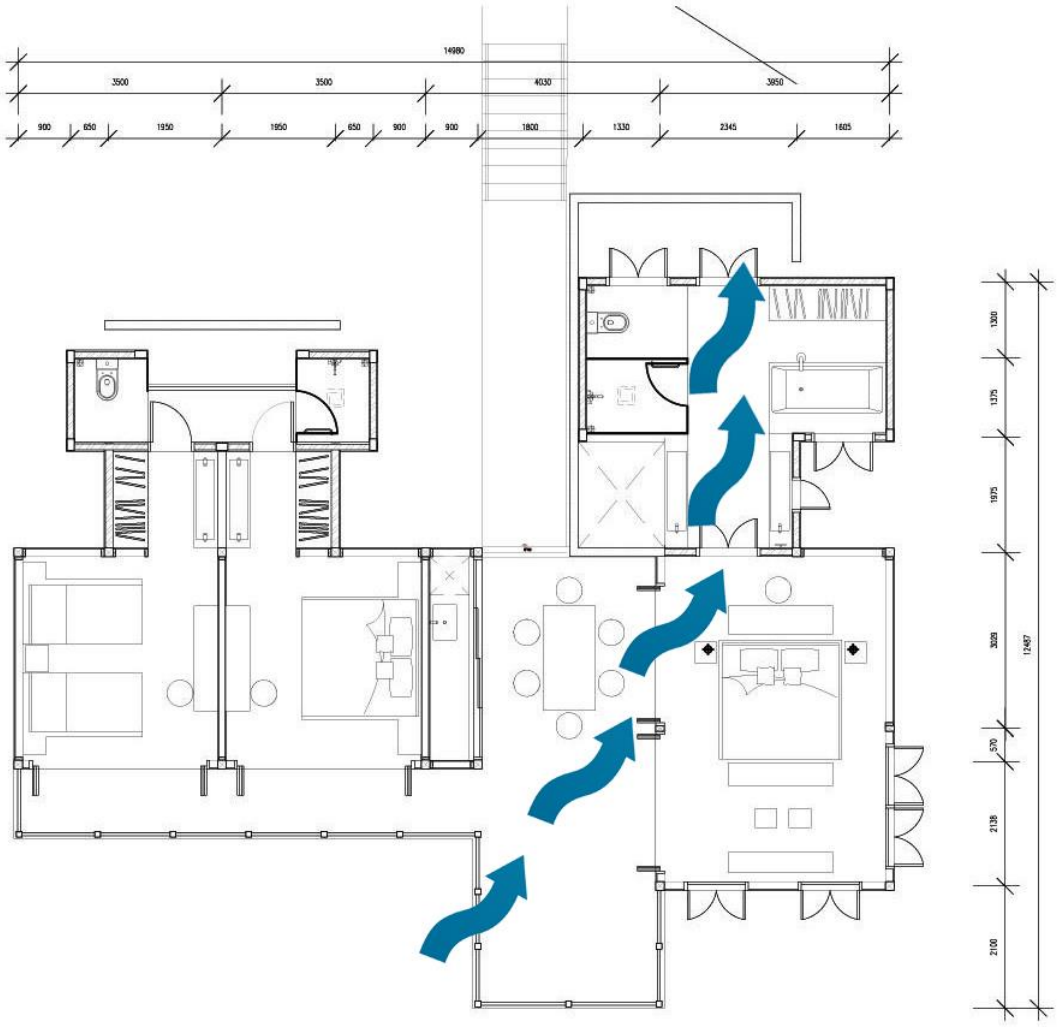

Figure 14: Cross-Ventilation Diagram of the 3-Bedroom Villa (Source: Belum Rainforest Resort Official Site, n.d. & edited by the author)

Cross-ventilation helps to moderate internal temperatures and as such achieve thermal comfort. This ventilation can reduce the accumulation of moisture, odors and other gases that can build up during occupied periods. By having such openings, it creates air movement which improves the comfort of occupants.

Comparing all three floor plans, cross-ventilation is present in each villa. However, the many window openings are not fully utilized. In the 3-bedroom chalet, for instance, cross-ventilation is not used much (Munirah Zazarin, 2014). The many openings aren't even parallel or facing each other. Through the previous study on the percentage of openings over total wall area, it is known that the 3-bedroom villa has lesser ventilated space. But through the plan drawings, the window openings are not up to its full potential to help bring thermal comfort to the user. Another flaw is that the building failed to follow MS1525; to have equal numbers of inlets and outlets. In between the windows also seems

to have a lot of obstruction going about which may decrease the efficiency of cross-ventilation. The next flaw is in the building's orientation which should be facing the North and South direction to maximize wind flow.

4.3 Context

Figure 15 & 16: Traditional Villas being shaded by the trees (front & back)

In reference to Malay traditional houses, trees are arranged distantly as to allow the air flow between them and thus an effective circulation. However, the Belum Resort Traditional Villas has them all jam packed at the back but distantly from the front. The resort has so many trees surrounding it that the building almost seems to be drowning in the greeneries. By having such arrangement of trees, it could be using elements of the Traditional Malay house but also has the site into consideration whereby the area with more trees can help shield against strong wind, hot sun or even aesthetics. The building does get its shade because of nature acting as a natural shading device but this does not maximize the air flow movement.

Figure 17: Helicopter view of Belum Rainforest Resort

From the above site plan picture, the Belum Rainforest Resort is surrounded by lush greeneries. The resort is almost enveloped by the nature even. Similar to traditional Malay houses having coconut trees, the traditional villas at Belum has huge trees to act as a natural shading device. However, in reference to a traditional Malay house context, trees are mainly arranged at quite a distance from each other. That allows space for wind to travel between the trees, resulting in an effective ventilation. According to Gut & Ackerknecht, vegetation at a site should be arranged in a way that it does not impede air circulation (1993).

When viewed from afar, the villas are almost non-existent as they blend in with the surrounding nature. The threes around the villas are quite densely laid out which provides

good shading but also creates obstruction for wind. While this design may impede on wind movement and is not maximizing the wind flow to its full potential, it is still a great design in achieving thermal comfort.

4.4 Layout

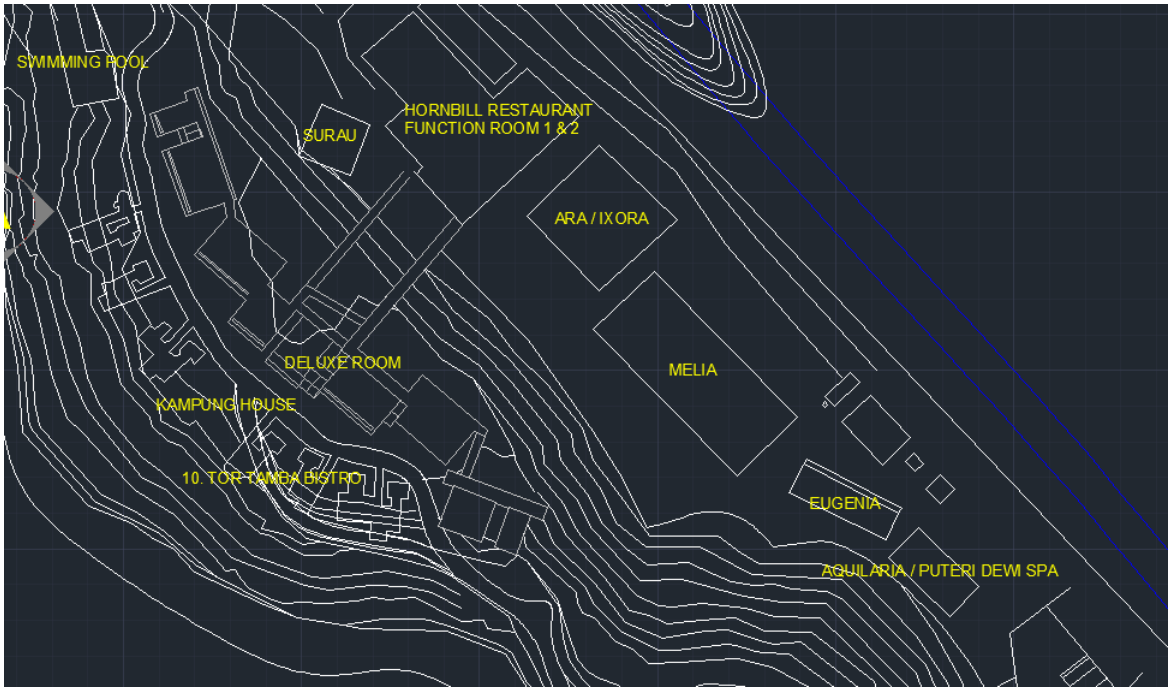

Figure 18: Plan drawing of site

As seen in the plan layout, the buildings are arranged in quite an orderly manner whereby they are alligned with the site contour. Each villa is also within walking distance to the next villa. Just by this site plan, it's known that the layout differs from the random arrangement of the traditional Malay houses which are also further apart.

4.5 Materials Analysis

Figure 19: Wood panel (Timber)

- Hardwood timber: Resistance to weight of occupants
- Low embodied energy as acquired from local forestry.
- Sanded surface for smooth touch.

Figure 20: Cement fiber board

- Containing fibrous material which increases its structural integrity.

- Short discrete fibers that is uniformly distributed and randomly oriented.
- Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers.
- To control cracking due to plastic shrinkage and to drying shrinkage.

Figure 21: Rammed Earth Concrete

- Providing excellent protection from extremes in climate.
- In this case, it served as the natural aesthetic purpose
- Recycle the use of soil & lower the use of embodied energy aka the total processing energy used.

Figure 22: Interior of Traditional Resort using Meranti wood

The Traditional resort and the Malay houses both use wood and timbers in the construction and shows many similar materiality. This material can keep the room cool as the materials do not absorb heat as much as compared to that of concrete.

5.0 Conclusion

Having analyzed the many different properties of the Belum Rainforest Resort's traditional villas thermal comfort factors, the conclusion of it would be that the resort is definitely lacking behind in many terms which has many opportunities to be improved. The villas are the Resort's latest addition and built to reference the local, traditional Malay

houses, it would definitely score on its looks. However, the functions and designs of it are almost too different and has caused their response to thermal conditions less effective. As a well-known resort, it is difficult to put a number as to how successful the villas are. Nevertheless, by looking at the discussed elements, it's response to those factors clearly show that they are lacking. It's response to the sun path was not successful due to its' contour orientation. In terms of wind response, the openings are placed on the façade with the prevailing wind and offers natural ventilation. However, its response to cross-ventilation was poor which is also due to the villas placement. The site is covered in an abundant amount of nature which are compact that helps in sun shading but foregone the wind movement. The villas did manage to capture the materials used and even had its' own mix into it. The usage of natural materials found on site helps create low cost, sustainable performance and providing thermal comfort.

6.0 References

Annotated Bibliography:

- Sustainable. (2014, August 25). Retrieved September 24, 2015, from https://www.wbdg.org/design/sustainable.php#top
- Wan. H., Abdul Halim. N. (2011). The Traditional Malay House. Kuala Lumpur: FajarBakti.
- Malaysia Resorts | Belum Rainforest Resort | Banding Island | Official Site. (n.d).Retrieved September 26, 2015, from http://www.belumresort.com/
- Toosi, N. (2014, June 12). Transcript of the effective implementation of sustainable building material. Retrieved September 15, 27, from https://prezi.com/andfje00avod/the-effective-implementation-of-sustainable-building-materia/
- Lim. J. Y. (1987). The Malay House: Rediscovering Malaysia's Indigenous ShelterSystem. Kuala Lumpur: Institut Masyarakat.
- Zazarin, M. (2014, June 12). The Adaptation of the Sustainable Features of Vernacular Architecture at the Phase II Chalets of Belum Rainforest Resort. Retrieved November 3, 2015, from http://www.scribd.com/doc/233759731/The-Adaptation-of-the-Sustainable-Features-of-Vernacular-Architecture-at-the-Phase-II-Chalets-of-Belum-Rainforest-Resort#scribd