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Façade Design Strategies in Passive Design Approach for Thermal Comfort in Malay Vernacular Masjids

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ABSTRACT

Contemporary architecture in Malaysia is facing challenges in preserving the built environment, thermal comfort, and even the culture of the community. Adopting foreign or international architectural style is wide spreading. This has become an issue of the local architect's profession. The quest for a sustainable contemporary architectural approach requires research of past achievements. It creates the need to revive traditional Malay architecture and accessing institutions to be evaluated. Malay vernacular masjid architecture is known to adhere to principles in passive design as the key to thermal comfort. Researchers posed questions as to what can be achieved with this style that can convey passive design in the contemporary masjid. The aim is to investigate passive design strategies for thermal comfort adapted in Malay vernacular masjid architecture as an inspiration for future masjids to achieve sustainable building. Qualitative analysis led to the investigation of miracles through research, direct observation and field review. Empirical finding from the evidence will provide understanding on passive design strategies in environmental context and concluded overview styles that could be learned from Malay vernacular masjid architecture. Several criteria support passive design strategies for thermal comfort in Malay vernacular masjids such as design articulation and layout, building height, openings, roof form, serambi / veranda, as well as ventilation ornamentation. It is respect and community with the common living space as a perfect relationship and understanding of the customer's needs. The consequence of a harmony between the material, construction and environment could become a useful rule for what will come.

1. Introduction

Analysts claim that there are certainly benefit that can be gleaned from the Malay vernacular design. Studies have shown the importance of our understanding on vernacular word conventions [1]. Traditional design values have led to the fact that vernacular architecture serves as a benchmark [2]. The Malay vernacular architecture is considered an established reference point and is a mixture of customs and heritage that characterize its identity, which contributes to the preservation of the national personality. In any case, negligence in the phenomenological disposition of vernacular Malay architecture quickly changes the image of contemporary Malay design [3]. One important hypothetical problem that will dominate the field in the coming years is not evaluating the physical and social culture of vernacular Malay design for its natural nature and its role in shaping the built environment. The research provided the initiator of the conversation as what can be gleaned from vernacular Malay architecture that can recommend thermal comfort in contemporary buildings. Malay vernacular architecture defined its social and ecological characters as essential segments in the arrangement of the contemporary design language. Among the other different types of buildings, masjids are exceptional because they have a constant and unremitting basic capacity. It is a place for collective Muslim to worship, while the composition has continued to develop since the earliest Masjid in this nation. The main purpose of this document is to recognize the connection between the design of Malay vernacular masjid building and the state of the local atmosphere. This process of recognizing relationship is critical to understanding the use of passive designs in a warm, humid atmosphere, and to completing diagram styles that can be transformed into contemporary masjid buildings using vernacular Malay masjid architecture.

Throughout history, Malay vernacular architecture has been known to adhere to basic green design standards for energy efficient materials and resources in the presence of site. Malay vernacular architecture is a way of meeting human needs, which is overlooked in all current design reports. Previous researchers [4] said that Masjid's current design faces several difficulties due to population expansion and high demands from open administrations, as well as systems, especially in urban areas. Problem that has been framed is the low production of thermal comfort. Development of buildings that are not efficient can easily create discomfort in interior and exterior areas due to global warming. Current construction of masjids depends more on a technological system to comfort the interior. Consequently, the annual energy usage builds up. An interest in energy consumption is considered essential, especially during the flowering period: the peak time of Zuhur and Asar. At this time of rapid progress in innovation and urbanization, much can be gleaned from conventional information on vernacular construction. The suitability of climate-sensitive design is evident throughout its useful life as the cost of utilities and support is reduced.

2. STUDY AREA

This study focuses on the traditional and regional Malay vernacular masjid architectural timeline that happened before Malaysia's Independence. It started during the era of Malay Sultanate, Portuguese and Dutch subjugation until pre-colonial period (15th – 18th century). This study highlights characteristics and elements in home-grown masjid architecture in Malaysia without foreign influence which happened before the era of the British colonialization.

3. METHODOLOGY

The qualitative method of this analysis was performed to examine the phenomenon. Evidence has been aggregated through various analyzes and evaluations of the thermal performance status during the field review as a means to support the claim. Furthermore, direct observation that depends on the author's perception as a result of the general description of the field has led to a strengthening of the data. Ideally, a precise understanding of the evidence discussed will have the option of providing a better understanding of the suitability of thermal comfort in an ecological setting and ending with a striking description of the contemporary nature of the style that could be derived from Malay vernacular masjid architecture.

4. RESEARCH BACKGROUND

A. *Thermal Performance in Passive Design*

The coordination of passive systems in the design process requires numerous considerations at all levels of the design phase. Passive system displays generally depend on common natural components such as sun, wind, land and water. It is therefore important to investigate and examine how passive systems interact with regular components and their relationship to a construction site. However, it is essential to understand the needs of the selected remote systems and determine the right options when and where to coordinate them within the design process. This study presents context analyzes and examples for the combination of gadgets and activities in building planning.

B. *Typological Development of Malay Vernacular Masjid*

The historical background of Malay vernacular architecture has been established in a complex manner due to different individuals and the social associations. Subsequently, the form of Malay vernacular architecture improved through the social ethnicity trade [3]. The vernacular masjid has been structured with a deep understanding and respect for nature, reflecting the characteristics of traditional Malay houses that are influenced by their environment and culture [5] and [6]. For a tropical country, such as Malaysia, where significant rainfall and thermal sunlight occur throughout the year, the construction of vernacular masjids reflects vast majority of traditional Malay house attributes. The compositional style of vernacular masjids is influenced by four central points, including weather conditions, accessibility of building materials, crafts, and ethnicity. Examples of some building highlights that have been processed due to warm and humid weather conditions include pitched roofs that allow rainwater to drain quickly, stilts to lift masjids above the floor

to prevent flooding and numerous openings, including louvered windows, fanlights and carving panels to allow natural air cross ventilation. Building materials such as wood, bamboo, blocks, stone, earthenware and *attap* are generally used in local masjids because they are effectively accessible locally. Like Malay traditional houses, vernacular masjids display a high level of craftsmanship. This can be found on windows, fanlights, carving wall panels, fascia boards as well as intricate flower motifs at a well-designed mimbar.

Numerous researchers [6], [7] and [12] grouped vernacular masjid architectural styles into two classes, particularly the traditional and regional influence. The traditional vernacular masjids largely reflect the solid effects of Malaysian houses, their lifestyle and environment. Alter vernacularly, regional vernacular masjid can be recognized for their multi-tiered roofs with decorated roof ridges and tiles, octagonal minarets, and square-shaped building form. Unlike several researchers, [9] and [11] suggested that there are seven types of masjid architectural language in Malaysia. They are the traditional vernacular, Sino Eclectic (Pre-colonial), Colonial, North Indian, Modern Vernacular, Modernistic Expressionism and Post-Modern Revivalism.

- **Traditional Malay Vernacular Masjid**

All masjids in traditional vernacular style are made of wood. These masjids initially have no *serambi* area. They came later after the design process ends. All masjids show single space layout and no indication of subdivision can be found. Because a large number of masjids were built near a stream for ablution purpose, some of the masjids have wells to prepare for supplication. There is no evidence that these early masjids were fenced off and separated from the cities. These masjids use conventional timber post and beam system except in Masjid Kampung Tuan, Kemaman, Terengganu (1830). Another fascinating part of these masjids is the way they are not equipped with a minaret. In masjids form before the 18th century, this was considered unnecessary, since the *azan* decree should be possible by staying under the roof on the ceded stages. The requirement that the *azan* be heard has led to the presentation of minarets. The minarets were later extended to the design of the masjid and as such were regularly found to be separate from the main building. In Masjid Kampung Laut Nilam Puri, Kelantan (1730), Masjid Tinggi Bagan Serai, Perak (before the 19th century) and Surau Tok Janggut, Kedah (before the 19th century), the minarets were designed to reflect the vernacular design and despite being free standing structures, they relate to the main building through their design, material and proportion. The various examples of vernacular masjids with traditional influences are Masjid Langgar, Kota Bharu, Kelantan (1871), Masjid Papan, Papan, Perak (1888), Masjid Lengeng, Lengeng, Negeri Sembilan, Masjid Paloh, Ipoh, Perak (1912) and Masjid Kampung Raja, Seremban, Negeri Sembilan (1924).

- **Regional Malay Vernacular Masjid**

Although many researchers [6], [7], [8], [12] perceived that some vernacular masjids belonged to the regional influence category, they were also known as Sino-Eclectic style in Malaysia's masjid architecture as proposed by [9] and

[11]. The term Sino-Eclectic comes from two sources. Chinese word Sino shows a Chinese influence and Eclectic means a mixture of at least two influences of architectural language. This is due to discussions about the impact on the Islamic appearance on this region and its impact to masjid architectural form. Although architectural design of masjids in Malaysia is a result from many repercussions, much of its influences date back to the country's verifiable occasions, which were largely responsible for the adjustments in Malaysia's vernacular masjids. The focus of Islam that was spreading at the time did not lead to the presentation of any other type of Islamic architecture that was not vernacular to this region. It rather creates the transformation of existing architectural form which was later interpreted according to Islamic representation and usage. As a result, it saw the early evolution in Malaysia identity for home-grown masjid architecture. For an example, Masjid Tengker, Melaka (1728) has a three-tiered pyramid-shaped roof, a square layout, and generally reflect typical traditional timber masjid, while the decoration of the roof ridges and pagoda inspired minaret show Chinese influences. The columns, arched doorways and balustrades follow western design styles. In order to study the architectural foundations of masjids in Malaysia, it would be essential to highlight the scope of study to Peninsular Malaysia with its history of Islamization and the early role of the Malay Sultanate of Melaka.

In the early-15th century, merchants from different parts of the world were drawn by the rich trading in the state of Melaka, including Muslim businessmen from the Middle East, the Indian subcontinent, and Indonesia. The settlement of these ethnic groups led to the formation of masjids in Malaysia (previously known as *Tanah Melayu* at that time). Such examples are the Acehnese Muslim ethnic group in Penang, while various settlements of Indian, Pakistani, Javanese and Arab starting points can also be discovered across the country. These settlements displayed distinctive styles in their masjids, adjusting Malaysian attitudes to specific materials, culture, as well as existing structural buildings. Similarly, during the Portuguese, Dutch, and British periods before the independence of Malaysia, the colonial period had a major impact on architectural styles as they brought with them new social and technological ideas that influenced the construction and presentation of buildings. During the British colonial period, the tides of Indian immigrants were at the forefront, and comparatively add more different style. A real case of these effects are the Masjid Kampung Hulu (1728) and the Masjid Kampung Keling, Melaka (1748) in Melaka, which were built by Indian Muslim merchants. The building is a mix of Malay, Chinese, Hindu and Sumatran influences [11]. Other examples of regional vernacular masjids are Masjid Lebu Aceh, Georgetown, Penang (1808), the old Masjid de Kampung Masjid Tinggi, Bagan Serai, Perak (1929), Masjid Tanjung Keling, Melaka (1930) and Masjid Dato ' Undang Kamat. Simoang, Negeri Sembilan.

C. Malay Vernacular Architectural Concept in Malaysia Modern Masjids

Following the values of masjid architecture of a particular culture or nation is important in order to understand the evolution of the cultural paradigm. The development of Islamic approaches in the Malay world in the early 14th century was associated with the presence of masjids in the region. Despite Melaka's prosperity in the 15th century as an Islamic kingdom, there is no archaeological evidence from that period. This is probably due to the fact that the masjid was being built using timber construction at this time and its lifespan rarely goes more than 200 years. The earliest masjid which survived is the 18th century masjids in Melaka and the Kampung Laut Masjid in Kelantan.

Traditional and regional Malay vernacular masjid architectural timeline happened before independence of Malaysia. It started during the era of Malay Sultanate, Portuguese and Dutch subjugation until the pre-colonial era (15th – 18th century). This study highlights characteristics and elements in home-grown masjid architecture in Malaysia without foreign influence which happened before the era of the British colonialization. According to [8] and [12], the British were not interested in Malay state's affairs and there were no events of building developments took place. However, towards the end of the 20th century, when tin mining and rubber became the nation's main exports, they began to show interest then describe their position and strength through the development of amenities and buildings. The colonials also worked on the royal masjids, which was another jargon of design and special taste. Structurally, it is not the same as local masjids in terms of size and scope, construction, reflections, and building materials. Reference [13] pointed out that for geopolitical reasons, the British helped to build masjids that looked great and were more like a castle than a religious center. It is to maintain their reputation as well as to satisfy the local ruler. Colonials then built masjids as an image to present Islam but at the same time are isolated from the real Islamic lifestyle [10]. Nowadays Malaysia is facing various challenges and difficulties pertaining to build environment, be it social, environment, thermal or even technical. Building collapses, land slide, flash flood, architectural style that is unpleasant to the eyes, problems on thermal comfort, and the list goes on. Any design approach related to the understanding of local context such as climate and socio-culture is done with less consideration and thinking. One of the issues is architect's profession being criticized for imitating foreign architectural style, thus the need to revive traditional Malay architecture and heritage.

Studying within the limits of art and architecture of a masjid is a highlight and popular topics with researchers today. Various processes were obtained and important data was collected and used for modernization and development of Muslim religious buildings. Today's social problems are fluctuating and complex. The urban population in particular faces increasing physical, social and financial problems due to the increasing degree of urbanization and population development. The need to reach out to urban institution, such as masjids, must be assessed in today's environment.

The mission of a deeper contemporary design methodology for nature eventually obscures the achievements of the past. Vernacular architecture is the most integrated design building in community with the land by aim and structure. Two important indicators for vernacular design can be resources for contemporary architecture. It is the deep respect and ideal community with the indigenous living space, as well as the ideal connection and the ideal understanding of the client's needs. The aftermath of a complicated harmony between the material, the shape and the regular environment could make Malay vernacular architecture an incredibly useful motivational model for the present.

Early Malay vernacular design is concerned with the legacy of the human psyche from early ascension to the present and future generation yet to come. Masjid architecture is certainly not a static wonder. It progresses from time to time. This shows that masjid design is an image of Islam and the Muslim mindset, constantly thinking, moving, and far from static. According to [9], the term modern vernacular is used today to refer to buildings that were built using practice, accessibility of materials and development processes which are gradually becoming the new standard in this nation. Another example is concerning earlier Malay vernacular masjids which were built by a river bank. Ablution water is taken from the stream and collected in a pool, thereby reducing water waste during ablution. In modern masjids, tap water is structured with high levels of innovation today. Some advanced massages naturally deliver and stop water using an infrared touch probe thus achieve the similar result.

5. ANALYSIS AND FINDING

Malaysia's rich and authentic foundation has created exceptional local architecture that shows amazing and powerful variations and effects. The connection between peoples and their environment are important segments in the arrangement of the architectural heritage [14]. It captures various designs that respond to the social and ecological environment as a practical tool to get contemporary design to use the latest knowledge. Therefore, create a new pattern for building ideas.

Vernacular architecture is a building style that is tailored to local needs, accessibility of development materials, handicrafts, innovation and local convention. On the other hand, passive design approach includes daylighting, natural ventilation and solar advantages to keep the building comfortable. Passive design is important as it is the way to build sustainably. It responds to the local atmosphere and site conditions to improve the comfort and well-being of the occupants while reducing the energy usage. The aim of this analysis is to investigate passive design strategies adapted in Malay vernacular masjid architecture as an inspiration for future modern and contemporary masjids to achieve sustainable building.

The development of materials and technological strategies has expanded the possibility in building form and style options in masjid architecture. The need to develop a responsible architecture and human appreciation towards the environment sees the fundamental union of passive design strategies with vernacular practices that have somehow been overlooked in the days of innovation and globalization. As a result, passive design is the common factor for sustainable architecture. It is compatible with a relationship of harmony and balance between human beings, the building form and existing environment that is receptive to its geology, social and worldly embrace, which will ultimately be beneficial to the presence of all. As already mentioned by [15], the use of traditional vernacular as a store for passive environment strategies is important, which were created to connect between the exterior surrounding and the interior spaces, as a requirement for contemporary design. Table 1 indicates the elements of passive design in Malay vernacular masjid architecture promises to offer in the contemporary times.

<p>ROOF DESIGN</p>	<ul style="list-style-type: none"> • Ventilated roof space helps to cool the house • Ventilation through roof joint • Roof material use low thermal capacity that gives good insulation against heat • Large roof eaves for effective sun shading • Steep roof angle is used to quickly drain off any rain falling onto the roof surface.
<p>BUILDING LAYOUT</p>	<ul style="list-style-type: none"> • Open interior spaces with minimal partitions that allow good air circulation in the house
<p>FAÇADE DESIGN</p>	<ul style="list-style-type: none"> • Fully openable openings allow ventilation at body level • Decorated non-structural

	building components are fitted to allow cross ventilation <ul style="list-style-type: none"> • The building is oriented in respond to sun direction
BUILDING TECHNOLOGY	<ul style="list-style-type: none"> • Lightweight construction using low thermal capacity materials to keep building cool • Stilted building form that catch winds of higher velocity

Table 1: Elements of passive design in Malay vernacular masjid architecture

A. *Design Articulation and Layout*

According to [16], there are several compositional highlights of a vernacular masjid, which can have an effect on indoor thermal comfort, sunlight, and power usage such as building shape, orientation, wall structure and indoor partitioning of the building, window size, cladding material, and shading. Architects may have used building form as a shading device to shade exterior surface, window, and coated areas.

The reference [17] expressed that the building structure and orientation during the design process could have a major impact on the use of vitality, lighting, cooling and heat stress. During congregational prayers, the *imam* led in front of the *ma'mum* (followers). As the *ma'mum* should stay in continuous lines with no gasps in between, the praying area is expected to be in minimum physical obstruction which might break the *saf* (line) and offer solar and ventilation advantages. These design requirements are met by vernacular masjids like Masjid Tinggi Bagan Serai, Perak.

The building form assumes a key task in the outdoor area, which therefore decides on the balance of vitality and, therefore, on the cooling load. Building orientation can also reduce cooling loads by limiting heat gain through windows, walls, partitions and roofs, depending on the climate. In reference [18] it was noted that the decision of a suitable building orientation in relation to source of wind can also maximise cross ventilation, which is mainly suitable for buildings in hot and humid areas. The open plan layout of vernacular Malaysian masjids also allow air intake and provide excellent cross ventilation. Only limited number of insignificant internal partition that restricts air movement is positioned in the masjid.

For any architect, orientating the masjid building is its necessity to be toward Qibla (the heading to Kaba, inside the Holy Masjid in Mecca) which is in an east-west bearing. The east-west direction limit zones exposed to sun radiation. Notwithstanding, there is a likelihood to change the direction of the entire building aside from the praying area. It isn't fundamental but since the *saf* is fixed, while the building could be properly arranged according to the climate passive design strategy.

For instance, in hot and humid climate condition, glazing on the west façade should be minimized. It is preferably to orientate the building according to the east-west bearing to minimize solar heat gain on the façade. [19].

B. Building Height

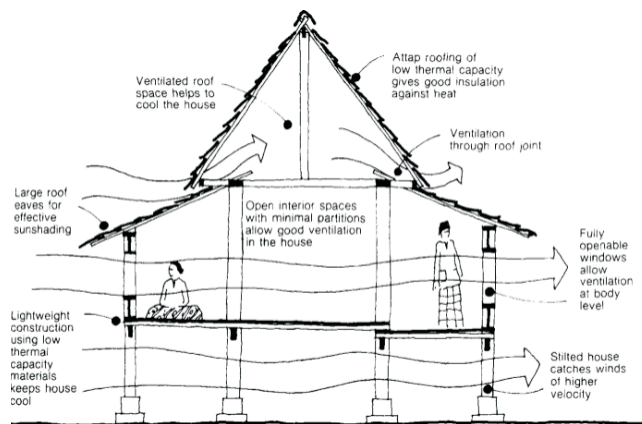


Fig. 1: Climatic Design of the Malay House

Source: Yuan, 1987



Fig. 2: Ventilation Openings in the Roof of Traditional Malay House

The wind speed increases with altitude. The uniqueness of the traditional Malay vernacular masjids inspired by traditional Malay house is that they are based on stilts. This methodology has several advantages from a thermal, functional and safety perspective. The raised floor, which is made higher than the ground, can capture stronger winds as in Fig. 1 [20] and offers a phenomenal underfloor ventilation system. This is particularly important in regions where plants multiply in the soil, which limits air movement. The use of wooden planks with gaps in between can bring air into the interior. [21] suggests that wet ground requires more sunlight to dry, and a raised floor is one of the solutions.

C. Openings

The local climate gives direct impact on the layout of vernacular masjids. Openings, such as windows, panels and grills, are an essential element of ventilation, contributing to thermal comfort. The ceiling void compared to mass on the floor and verticality of the vernacular Malay design offers satisfactory vertical and transverse ventilation [20]. Consequently, Malay vernacular masjids respond appropriately to natural factors. Openings, such as windows, panels, and doorways, are an essential ventilation element that aids in human tilt. Both categories of Malay vernacular masjid permits ventilation through plenty of full-length windows and doors at the body level [20].

The roof space in Malay vernacular building is adequately ventilated by the arrangement of joints and ventilation panels in the roof design. Fig. 2 below shows the roof opening on both sides that permit air movement into the building [21]. As one of the indigenous materials, the *attap* rooftop utilized in Malay houses has a low thermal capacity. This material doesn't hold warmth and cools right away.

D. Roof Form

The design of vernacular masjids with a passive approach requires the unification of numerous variables, such as orientation, ventilation, shading devices and building design that able to reduce the use of vitality in a building. It is important to provide these masjids with a proper shading design that would provide interior spaces with thermal comfort by controlling solar heat gains and reducing glare while maintaining the initial purposes of large glazed surfaces for external views and sufficient daylighting. Roof is one of the main building enclosures giving form to a building and directly influenced thermal comfort.

The roof is one of the basic buildings that are fenced in areas that allow the construction of a building and directly affect thermal comfort. As mentioned by [22], roofing system covers 70% of the total heat gain in a building. Numerous analysts carried out analyzes of the relationships between shading devices in order to optimize their performance, save vitality and achieve the greatest thermal comfort. Studies have shown that shading devices can help save vitality and improve the thermal load on the building. Studies on traditional Malay vernacular masjid of Masjid Lama Kampung Laut and regional Malay vernacular masjid of Masjid Tengkeru by [23] and [24] concluded that the roof

design of the vernacular masjid promotes passive design. In addition, roof's visual and aesthetic significance with its extensions in relation to the building facade make it an invaluable part of the masjid's morphological properties.

There are three types of roof form in traditional Malay vernacular masjid from both traditional and regional category. The first is the three-tier pyramidal rooftop building as in that of Masjid Kampung Laut (Fig. 3) and Masjid Kampung Tuan believed to be constructed between sixteenth and seventeenth century. From the tip of the pyramid to the base of the sections, the masjids can be engraved into a practically immaculate solid shape. The subsequent type is the two-tier pyramidal rooftop buildings, for example, Masjid Papan (Fig. 4) and Masjid Lengeng. The third type is the gable rooftop building which is likely to Malay traditional houses (Fig. 5).



Fig. 3: Masjid Kampung Laut, Kelantan



Fig. 4: Masjid Papan, Perak



Fig. 5: Masjid Langgar, Kelantan

All multi-tiered types of pyramidal roofs are square in shape. Masjid Lama Kampung Laut, Kelantan (built in 1676) is considered as the oldest vernacular masjid in Malaysia, displaying the pragmatic approach to timber construction in its tiered roof construction, scale and forms [25]. Masjid Lama Kampung Laut illustrates the tiered roof construction in providing comfort to the occupants of vernacular masjids in Malaysia [27]. The roof creates segments in between the roof layer resulted in window openings or clerestory window which normally related to louvered openings to permit wind movement [23]. It is a passive design approach important for buildings in tropical climate especially public building like masjids that accommodate a large number of occupants at one time. These windows do not function like ordinary windows at floor level, but they improve the stacking effect, which draws warm air flow from the upper roof windows and is replaced by cool air from the ground. Tiered pyramidal roof system was intended for articulation of different volume to the interior of the building, since the height, scale, and extent of roof ventilation influence the ventilation rate of the building [23]. Large overhangs and low exposed vertical (windows and walls) offer a high level of protection against rain, act as a shading device, and allow windows to remain open for natural ventilation [20]. Additionally, the cantilever reduces glare from the sky as well as immediate sunlight and converted into a moderate amount of light. Regardless of this, a distinction was made that 1200mm overhang is unable to effectively shade roof windows and praying area from low angle when the sun is below 30°C. Meanwhile, the short span overhangs need louvers as part of opening to provide effective shading. Nevertheless, the impact of the low angle sunlight is lower compared to high angle sunlight impacts. Moreover, the steep roof angle is used to quickly dissipate any rain that falls on the roof surface [28]. In reference [23], the 45°C tilt point is recognized as the best roof form that stimulates a smooth flow of water from the roof to the floor.

The third type is the long rectangular roof which can be divided into two different types: gable and hip roof. Gable roof form has a long straight rooftop with single ridge and two panels that creates gable end wall, similar to traditional Malay house roof form which is appropriately ventilated by the arrangement of ventilation joints and panels in the rooftop development [20] and [29]. They are mostly found in the East Coast locale of Malaysia. Fig. 2 shows the rooftop's opening on both sides to permit air movement into the house [21]. The chosen materials utilized for rooftop construction doesn't hold warmth and cools right away. In the meantime, the rooftop angle for both types ranges from 30° to 60°.

E. Serambi / Veranda

This element is one of the basic building components in regional Malay vernacular masjid due to adequate social diversity. In hot and humid climate, *serambi* is always presented as an outdoor shaded area to cool off before entering the building. Regional Malay vernacular masjid includes *serambi* as one of its main segments in its building. It acts as the transitional space between the entrances to the other parts of the masjid. In addition, it acts as a

venue for informal religious classes or informal meeting places. *Serambi* also can be converted as an extra praying area and when the need arises, similar to the function of courtyards.

F. Ventilation Carvings and Decorations

Like the Malay houses, the vernacular masjids portray a high level of craftsmanship. This can be found in the non-structural components such as louvered windows, fanlights, carving wall panels and fascia boards for the floors, walls, stairs, and roofs that are fitted between the frames to allow natural cross ventilation of air.

Window segments can be divided into three operable sections; the top, middle and bottom. The top section, which is called an ornament, is the fixed ventilation plates and are usually heavily decorated and carved. A vernacular Malay masjid also allows ventilation by having some full-length windows and doorways at body level. Reference [30] suggests that the huge number of windows and openings supported by ornamentation at the perimeter walls can support the cross ventilation process similar to the climatic design of a Malay house (Fig. 6). However, further analysis based on reference [30] shows those large openings on Malay traditional house walls create high air intakes outside to reduce the performance of the stack effect.

CONCLUSIONS

Masjids speak of an incredible place of importance and function for the Muslim community. Occupants need to feel thermally comfortable and relaxed in the masjids. Masjids built in traditional and regional Malay vernacular architectural style offered original solutions to the design challenges posed by the masjid as a community and cultural center. It is passive design form embodied in the technology, culture, and economy of that time. The signatures of Malay vernacular architecture deem to be another indication of honesty in design values of contemporary architecture. Responding to the climatic factors in a variety aspect as vernacular Malay architecture does can take into account of considerable design successes. Sharing the similarity among the passive design approach in Malay vernacular masjids and contemporary style possibly would have ended up with the best architecture produced by our community filled with its own inspiration and local spirit. Therefore, the Malay history and architecture should remain in continuity but with a careful reanalysis and reinterpretation of its deep meaning.

For architects to successfully apply the principles of sustainable design, they need to question the impact of each decision they make when designing a building and adopt a long-term view by focusing on sustainability rather than the aesthetical building form. This paper recommends that new masjid designs should move towards adaptation and interpretation of vernacular architecture whilst being suited with the contemporary context and technology. Malay vernacular identity in any modern designed buildings especially masjids can be considered as a challenging task in architecture. However, referring to climatic characteristics and elements of thermal comfort in Malay vernacular masjid,

modern building designs in Malaysia should be able to optimize thermal comfort by fulfilling all these major factors. The architecture and Malay culture exist as a symbiosis which is united to accentuate its unique identity.



Fig. 6: The Non-Structural Components of Traditional Malay House similar to Vernacular Masjid building facade

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