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Seri Iskandar Campus, Perak, MALAYSIA

PROCEEDINGS OF THE 16TH REGIONAL SYMPOSIUM OF THE MALAY ARCHIPELAGO

SIMPORA XVI: 2025

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LEARNING FROM THE PAST: SUSTAINABILITY ASPECTS OF DUTCH COLONIAL HOUSING COMPARED TO TRADITIONAL AND MODERN HOUSES IN ACEH

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Abstract: *The Dutch colonisation of Indonesia, which lasted for more than 350 years, left behind a variety of architectural relics, including colonial houses that continue to serve functional purposes until today. In Banda Aceh, several Dutch colonial houses are still occupied, either as private residences or offices managed by the Indonesian military. These houses were designed by adopting architectural features suited to tropical climates, such as large openings, high ceilings, and wooden wall structures that support natural ventilation and thermal comfort. This study analyses the sustainability aspects of three Dutch colonial houses in Banda Aceh by evaluating their spatial design, ventilation strategies, and construction materials. To strengthen the analysis, comparisons are also made with the Acehnese traditional house (Rumoh Aceh), which embodies local wisdom in climatic adaptation, and modern houses that are commonly built in Aceh today. The findings reveal that colonial houses demonstrate strong sustainability performance through passive cooling strategies and the use of locally available materials with low embodied energy. These approaches parallel those of traditional Acehnese houses but differ significantly from modern houses, which rely heavily on energy-intensive materials and mechanical cooling. The study concludes that colonial housing design provides valuable lessons for contemporary sustainable architecture in tropical regions.*

Keywords: *Colonial Housing, Aceh, Sustainability, Tropics*

1. INTRODUCTION

Indonesia was colonized by Dutch for about 350 years. While in Aceh, Dutch came and started the colonialism from 1873-1904 (Hasibuan, et al., 2024). During their residency, Dutch remained their relics such as building for some purposes like office, housings and infrastructures. It is interesting that several buildings are still well standing and claimed as the historical building conservation. Especially the house design, it looks to adopt the characteristics of local old dwellings design which applies the local tropic climate (Pauline, 2013; Kurniawan et al., 2019). In Banda Aceh, there are several colonial houses resided by the military which are still well standing. While some others resided by civils have been renovated or even demolished. Currently, there are not studies performing the colonial housing evaluation in Banda Aceh in term of sustainable building design. Meanwhile, many colonial buildings have been vanished and changed to be the new modern one. This study, therefore, would like to evaluate the sustainability of the colonial houses in Banda Aceh regarding the

house design adopting the local climate. This study will figure out some aspects of the houses which meet the sustainability that can be followed by others to promote environmental-friendly, and energy-saving building design.

1.1 Dutch Colonial House

Dutch colonial architecture in Indonesia was developed into two periods, namely Architecture before the XVIII century and Architecture after XVIII century (Handinoto, 1994). Before the XVIII century, the architectural style was known as the Indische Empire Style. This colonial-style developed in the 18th and 19th centuries, before the "westernization" of Indonesian cities in the early 20th century. The Indische Empire Style Architecture was the result of a mixture of technology, building materials and climate in the Indies developing in France. General characteristics of the Indische Empire Style architectural style are non-storied, shielded roofs, monumental impressions, large courtyards, the mass of buildings divided into mains and supporting buildings connected by porches or gates, symmetrical plans, open front, and back porches, equipped with stone pillars high Greek style (order Coritian, Iconic, Doric), inter-porch connected by a central corridor, the round-roman arch at the entrance or corridor binding between building masses, and the use of classically patterned around the roof. Generally used for public buildings.

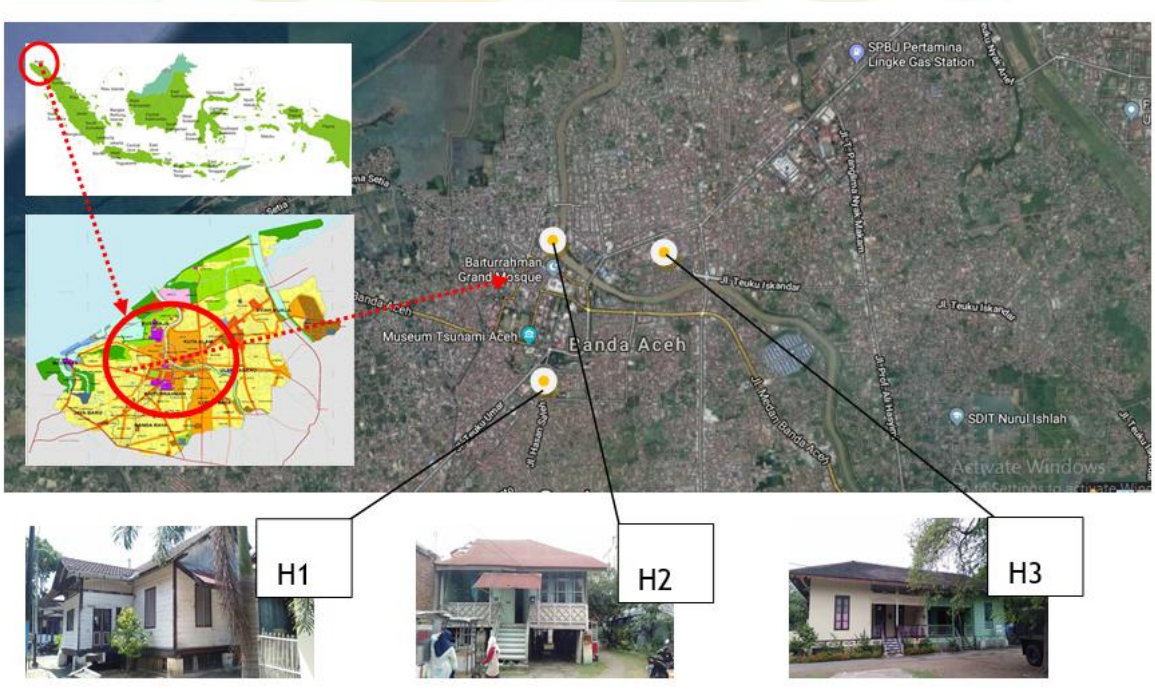


Figure 1: The location of the three colonial houses surveyed in this study

After the 18th century, the Dutch achieved their colonial power. In this period The Dutch made a total renewal of the architectural model that previously had the "Indische Empire"

style, underwent a change in the style of modern colonial architecture that was adapted to the local climate. The Dutch military was well aware of the local climate, so they named the complex "Tropen Kampementen" (tropical military complex). The colonial house is much different from the nowadays house in Indonesia. The house has been transformed to be grounded, made from concrete, metal roof and utilized with air conditioners. The typical standard house in Aceh comprises two bedrooms, a living room and a small kitchen near the toilet at the rear built-in one united roof. Perhaps, due to the high price of land, the houses are built on a small plot without any outdoor hallway like in colonial houses.

2. MATERIALS AND METHODS

This study is qualitative which obtain data through observations, field measurement, and interviews. Three colonial houses in Banda Aceh were selected representing the typical house design built in the Dutch colonial period. House H1 and H3 are located in the Baiturrahman sub-district , while H2 is located in the Kuta Alam sub-district. The three houses are compared with an Acehnese traditional house and modern typical house in Banda Aceh.

3. RESULTS AND DISCUSSION

H1 is occupied by a family who is working in a military hospital. H2 is occupied by a family who inherited the house from their parents. While H3 is functioned as a barrack for the military troops. H1 and H3 look to be well maintained, and no significant modifications have been carried out. While H2 has been majorly modified. Half part of the house couple has been demolished due to the different ownership. The study analyses the sustainability aspects through house design, ventilation and material, and resource.

3.1 House design

In general, the houses are stilt yet with various height from the ground. Based on the observation the closer the house to the river the higher the stilt. The three houses shows that House H2 which is the closest one to the big river stands on the higher stilt which is about 1.50 meter above the ground. While House H1 and H3 which are located 50 m and 200m from the river slightly smaller are 1.0 m 0.8 and respectively above the ground. The stilt is reinforced brickwork which supports the wooden house. This design shows that the Dutch concerned about the building design that is adaptive to the surroundings. It also works well in mitigating the flooding risks. H1 is bungalow while H2 and H3 are semi detach. All the house types have two zones i.e main and service area (table 1). The three houses show the typical layout plan. The main area which is located at the front has several rooms such as front and rear terrace, two bedrooms, and a living room. While the service area which is at the rear is connected to the main zone by a long open-air corridor (house H1 and H3). We observe that the rear part of house H2 has a different design from H and H3 where no long corridor connects the service area to the main part.

The resider of House H2 is civil where many modifications have been applied to the house. The resider used the entire service zone as storage and the little part at the front as the toilet. We suspect that the service zone had been modified because the wooden material and building structure is not the same as the main building. The land plot is still large where bush grows tightly which can be previously utilized to allocate the long corridor connected to the service zone built resembling H1 and H3. H1 and H3 have a service area comprising kitchen, toilets, washing area and maid rooms. The idea to separate the two zones is adaptive to the tropic climate where air circulation is essential to reduce the high relative humidity to create the indoor thermal comfort. All the service rooms are related to outdoor directly which also gives sufficient daylight into all rooms.

3.2 Colonial house compared to Acehnese traditional house and Typical Modern House

The houseThe house layout shows the transformation of the Acehnese traditional house where the bedrooms were located similarly to the colonial house. However, there are two living rooms in Acehnese traditional house which are larger and have different functions.

Figure 2: The underneath of the Acehnese traditional house

The front living room accommodates males and females (called seuramo keue). While the rear living room called suramo likot is for females only which is connected to the kitchen at the back. The Acehnese house has two bedrooms known as rumoh inong (a bedroom for parents) and rumah anjong (a bedroom for daughters). There is a living room in between the two-bedroom, there is spacious corridor that also functions as a transitional living room for connecting the front and rear living room. The Acehnese traditional house creates shades through the stilt which is up to 1,5-3 meters above the ground. The raised floor allows the air from beneath the floor to circulate throughout the house. The space beneath the floor is also functioned to socialize with others, outdoor living rooms, carport and storage spaces (figure 2). While in a colonial house, the stilt is not too high which is explained in figure 3.

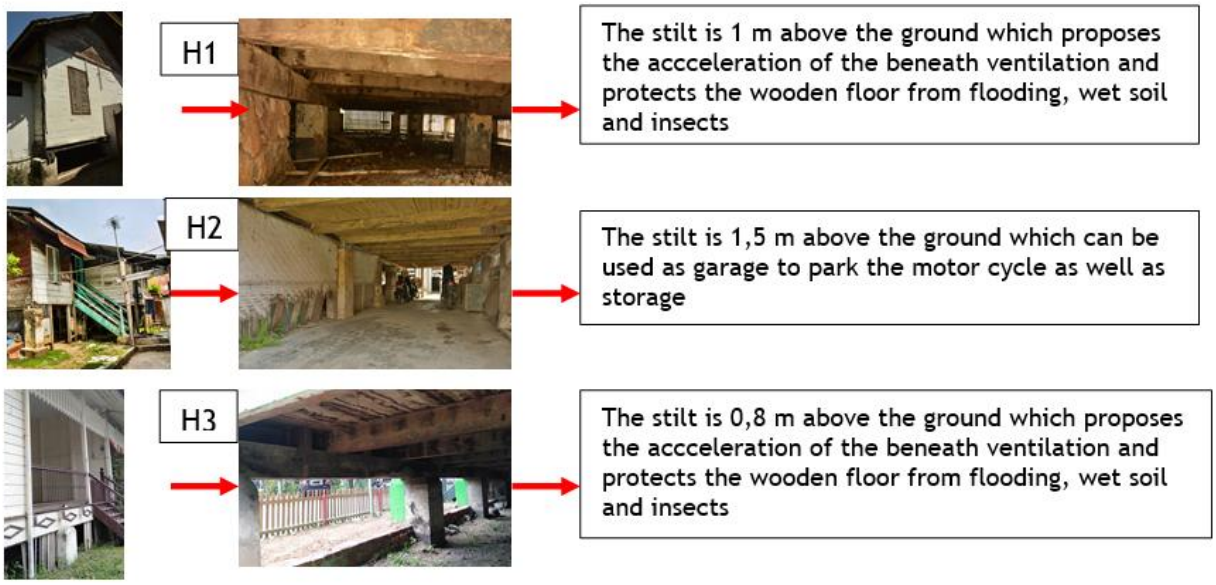
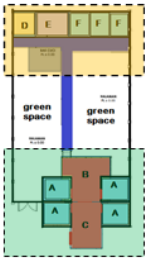
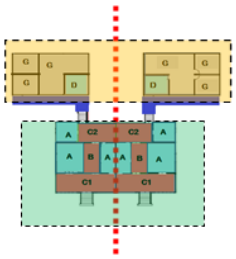
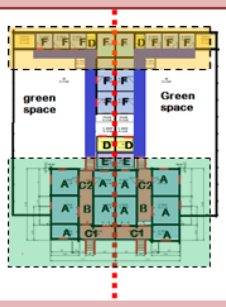
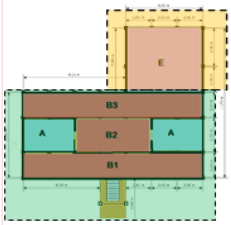
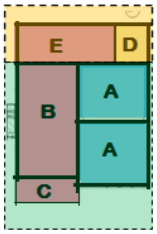
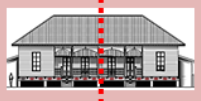


Figure 3: The underneath of colonial houses

Table 1: Floor plan and house facade of colonial house compared with that of Acehnese traditional house

House element	H1	H2	H3	Acehnese traditional house	Modern house
Floor plan					
Front facade					

= Service zone

= Main zone

Notes of table 1:

A. Bedroom

B. Living room

B1. Front living room (for female and male)

B2. Transitional living room

C/C1. Front terrace

C2. Rear terrace

D. Toilet/ bath room

E. Kitchen

F. Maidroom

Colonial Colonial house provides the shade through the large veranda and outdoor shaded corridor connecting the main area and the service zone (figure 4). The separation of zone works to provide the optimal provision of daylight in the house. Such design also performs the courtyard which creates shades to emerge the passive cooling strategy. These are contradicting to the modern houses where the house is much smaller may be due to the high price of the land. The house is grounded. The terrace is also small which also lack of shades.

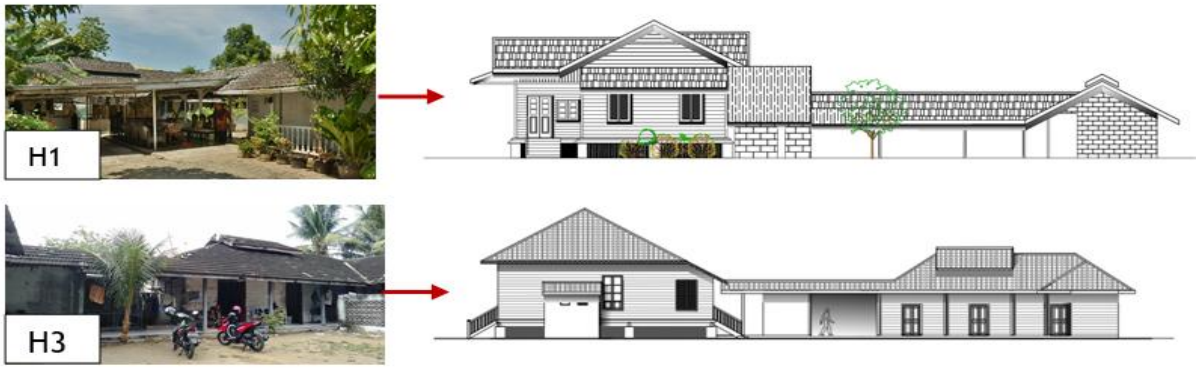


Figure 4: outdoor shaded corridor

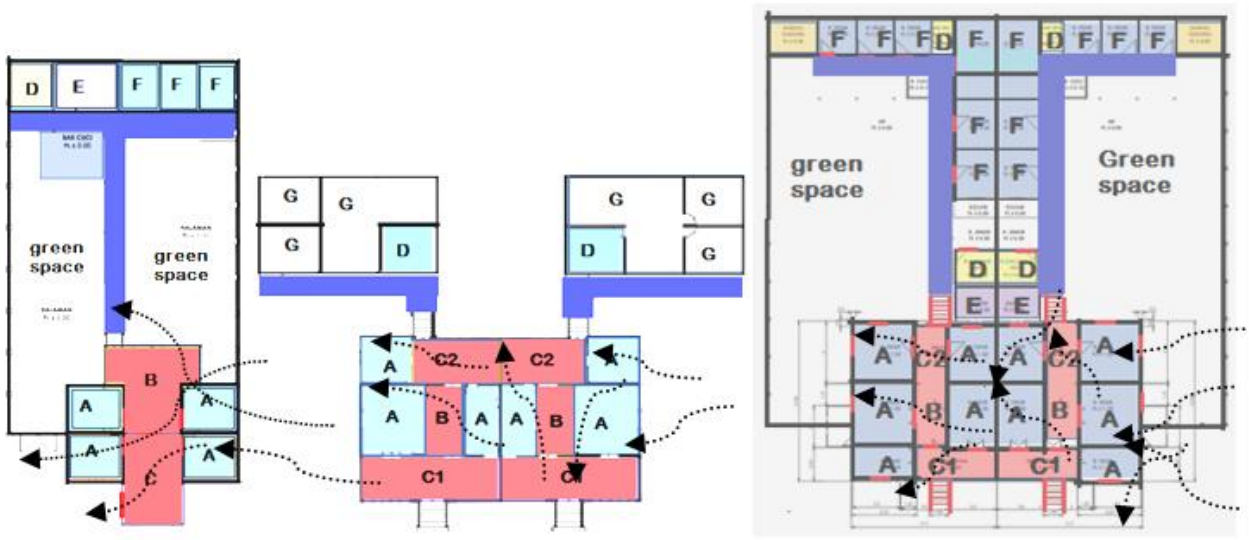


Figure 5. Cross ventilation across the rooms

3.3 Ventilation and window type

The colonial house applied cross ventilation through the rooms to allow the air breeze to run across the rooms. Cross ventilation is achieved using windows on both sides of the room,

creating a current of air across the room (Kosutova et.al, 2019). The windows are casement i.e jalousie and glass window type. The ceiling which is up to 4 meters high also shows how the Dutch design the air circulating space to avoid the excessive heat that may be transferred through the roof as the main surface radiated directly by the sun. The casement window in the jalousie type is similar to the window of the Acehnese traditional house. Yet, the Acehnese consistently allocated the apertures throughout the northern and southern wall which allows the presence of optimum daylight without excessive solar heat (Salsabilsa et al., 2024). While the colonial house orients the window to all sides with shaded terrace or canopy on the eastern and western sides.

Figure 6. Window type in colonial house

Figure 7. Kitchen roof design Window type in collonial house

The ventilation also works in the kitchen, where the aperture at the roof is applied to induce the hot air blowing out from the kitchen to outside. In this case, the stack effect and the wind effect work together to naturally circulate air. When hot air rises, the stack effect works and causes a higher pressure at high points in the attic (Salsabilsa et al., 2024). Hot air that escapes is known as exhaust. However, this hot air cannot escape without an inlet for cooler, low-pressure air. Cool air that enters is referred to as intake. When the wind blows against the outside of a roof and increases the volume of intake and exhaust, it is known as the wind effect. Intake and exhaust generate the natural flow of air to create a well-vented

attic (Sukawi et.al, 2015). This design is similar to the Acehnese traditional house , where the ventilation is applied in the entire kitchen including roof, wall and floor (figure 7). Whereas the modern house also has windows yet mostly fixed glass windows with fewer shades. This causes the high indoor temperature throughout the day due to the radiated heat trapped by the glass.

3.4 Material resource and cycle

The overall building materials of the colonial house (H1, H2, H3) such as floor, wall, are made from wood. In term of thermal comfort, timber is an isolator which is significant in rejecting the heat transfer through the timber. The roof type of the three houses is a pitched roof that is made from clay tile produced in Netherland.The clay tile roof is still good where the brand name is still clearly printed on it. Clay roof works well in reducing the mean radiant temperature due to the lower surface temperature of the clay compared with metal roof (Anumah and Anumah, 2018). The foundation is made from plastered brickwork. Just a small part of the window is glass.

In this study, the embodied energy of the building materials is considered to obtain the level of building sustainability. Embodied energy (MJ/kg) is the energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery (Renping, 2006). This study figures out the embodied energy of the colonial house compared with Acehnese traditional house, and current modern houses in Indonesia. Table 2 shows the materials usually constructed into the buildings.

Table 2: Embodied energy of three type of houses

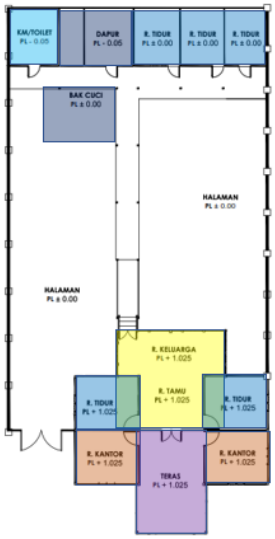
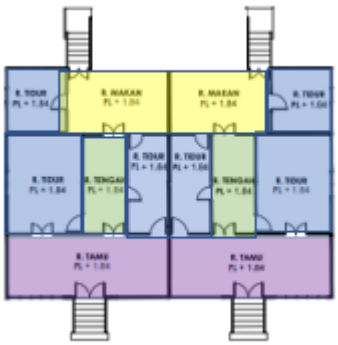
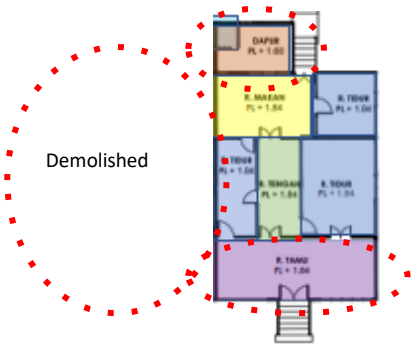
House element	Colonial housing 		Acehnese traditional house 		Modern house 	
	material	Embodied Energy (MJ/kg)	material	Embodied Energy (MJ/kg)	material	Embodied Energy (MJ/kg)
Wall	Timber	3,5	Timber	3,5	Brick	0,97
Floor	Timber	3,5	Timber	3,5	Ceramic	2,5
Roof	Clay tile	0,81	Sagoo leaf	0,24	Zinc sheet	51
Foundation	Brick	0,97	Timber	3,5	Concrete	1,3
Window	Timber	3,5	Timber	3,5	Glass	15,9

Table 2 shows that the colonial house is able to meet the low value of the embodied energy as well as a traditional house. While the modern house has the highest embodied energy due to the use of zinc sheets and glass as the building material . The thermal mass used as wall material in modern house also creates higher indoor air temperature throughout the day and night. It causes the use of air conditioner which is not saving energy and can harm the environment.

3.5 House modifications

The colonial houses perform several modifications from their initial design. H3 performs the least modification by replacing some jalousie windows with the glass. Some jalousie windows had also been covered with plastic sheets from the inner side to get the room cooled by the air condition air.

Table 3: House modifications of H1 and H2

House	Initial design	Modification
H1		
H2		

We suspect that H1 had been modified through the change of function of the front terrace to be a living room. The front terrace was installed with a timber wall as well as a glass window. A new toilet was built attached to the bedroom. Another bedroom was also built connected to the living room at the back. Outside, the modification is performed through the new open carport and outdoor sitting area roofed by zinc construction. While While H2 performs the modifications through the installation of the glassy window at the front and rear terrace to form the new living rooms. The service zone had been demolished and changed with the new one. However, the building material does not look thorough and even more look like the temporary material such as zinc sheet utilized as the overall building materials of the service zone. At the rear side of the house, a kitchen was built attached to the living room at the back. The clay roof tile had been replaced with a zinc sheet. Due to these replacements, the interior is dark and felt hot during the day.

The modification causes the poor performance of air circulation where some inlets or the outlets of airflow are distracted by the additional new rooms. The use of glass as the wall along the terrace is good for creating a more private room as well as good daylight provision. However, the glass creates a higher indoor air temperature during the day. Solar gain through glazing can be as high as 85% of the incident radiation (Sayed and Fikry, 2019) due to the glass characteristic of trapping the transmitted heat.

4. CONCLUSION

This study presents the evaluation of three colonial houses in Banda Aceh regarding with the house design adopting the local climate. In running the analysis, the writer compares the design to the traditional and typical modern house as well as the supporting literature. Initial design performs the typical separation of main and service zone which provides sufficient ventilation. The jalousie window type as the common aperture of the colonial houses maximizes the cross ventilation to flow the air movement. The position of the bedrooms and living rooms looks to be similar to the Acehnese traditional house. The roof ventilation at the kitchen also performs the same design as in traditional one which flows the hot air out of the kitchen. In terms of building material, colonial housing has low embodied energy value as well as the traditional house which meets the standard of sustainability. While the modern house has high embodied energy due to the massive use of zinc sheets and glass as the building envelope. However, the initial design of the colonial house shows the sustainability by adopting the passive strategy in cooling the house and the local wisdom strategy such as also applied in traditional house design.

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