

SUSTAINABLE MATERIALS FOR BIOCLIMATIC DESIGN IN DAYAK TRADITIONAL LONGHOUSE

Janet Victoria Stia^{1*} and Siti Akhtar Mahayuddin²

¹ Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia.

² Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, Malaysia.
janetvic55@gmail.com *

Abstract - Traditional longhouse is a heritage dwelling of the Dayak people in Sarawak Malaysia. Traditional longhouse is unique in term of layout design with apartments of the families in the longhouse stacked side by side under one roof. In front of the row of apartments is an open common space for social activities. Basically, traditional longhouse is built from sustainable local materials such as timber, bamboo, palm tree, palm leaves and rattan. The local materials are environmentally friendly and act as the passive elements that supported the bioclimatic design of the longhouse. In this study, 15 Dayak traditional longhouses in Sarawak were surveyed for the presence of local sustainable materials. Condition survey had been conducted to these longhouses. This study found that, timber has the highest potential to be conserved as compared to bamboo, palm tree, palm leaves and rattan. The situation might due to preferences of longhouse dwellers on modern materials such as bricks, concrete, metal roofing and processed timber products such as plywood which are widely available in the market. Action need to be taken by related bodies and authorities in order to conserve the longhouse with the traditional materials.

Keywords - Sustainable, Materials, Longhouse, Heritage, Bioclimatic

1 INTRODUCTION

Traditional longhouse is one of the precious heritages of the Dayak people in Sarawak, Malaysia. Dayak people in Malaysia comprised of the Iban, Bidayuh and Orang Ulu group (Leigh, 2002). Orang Ulu group can be further divided into few ethnics such as the Kayan, Kenyah, Kajang, Lun Bawang and Kelabit. Not only in Sarawak, Malaysia the Dayak people also can be found in Brunei and Kalimantan, Indonesia. Some of the ethnics of the Dayak group still practicing longhouse lifestyle while the others already abandon it (Ting, 2005; Chang, 2004; Winzeler, 2004). Bidayuh and Melanau people willingly to abandon the longhouse lifestyle and choose to live in the single dwelling due to preference for privacy (Chang, 2002; Morris, 1991). Modernization influence and improvement in term of economics motivate the longhouse dwellers to accept modern lifestyle over the traditional one thus leads to the abandonment of traditional longhouse. In this modern time once cannot escape from modern influence as long as everyone have accessibility to it. Modern influence affects the design of the traditional longhouse especially in the selection of materials to repair the existing longhouse or build a new one. The availability of modern materials such as bricks, concrete and metal roofing in the market cause the longhouse dwellers choose it over traditional materials. The lots of labour and time to process the traditional materials cause the longhouse dwellers to choose modern materials.

Traditional local materials are known to be sustainable and environmentally friendly as compared to modern materials (Tomovska & Radivojevic, 2017). This is the reason for the traditional longhouse can be considered as bioclimatic structure due to the passive function of the building materials to provide thermal comfort in the longhouse. Traditional longhouse in the past does not have any mechanical ventilation and air conditioning system due to lack of technology thus local materials need to be able in providing thermal comfort for the dwellers. Nowadays traditional longhouse is threatened by the availability of modern materials thus study need to be done to determine the availability of sustainable local materials in the traditional longhouse so that preservation and conservation works can be done. Not only that by learning from the past on sustainable construction can lead to solutions that can be adapted in this modern time especially on the building materials selection (Eiraji & Namdar 2011). Traditional longhouse can be a model of large and long dwellings that practicing sustainable construction for future generation. Lastly, the aim of the study is to

determine the availability of sustainable materials for bioclimatic design in the Dayak traditional longhouse.

2 CONCEPTS OF SUSTAINABILITY

Issues on global warming, ozone depletion and pollution urge us to find sustainable solutions in building construction. Nowadays building design is more focus on function-shape concept as compared to building in the past that focus on shape-energy concept (Manzano-Agugliaro et.al., 2015). Building in this modern time more focus on function and maximising the usage of space which is more beneficial in term of monetary. Thus, the application of sustainable features which might costly is need to put aside to put construction cost low. Different from modern house, traditional house put priority on materials and passive design that can give comfort to the dwellers due to lack of technology in the past.

Basically, sustainability has four main principles namely environmental, ecological economical and societal (Glavic & Lukman, 2007). While according to Cuadrado et.al. (2015), the pillars of sustainability are including environmental economic and societal. Environmental principle related to waste control so that it will not harm the environment and cause pollution. Ecological principle based on the efficient usage of natural resources to avoid wastage. Economical principle is about the ability to reduce cost and effective usage of resources with increase in quality and lower the negative impact to the environment. This can be described as maximizing the usage of available resources which not involving hike in cost but at the same time achieve the best quality and less threat to environment. In term of societal principle is on the role of the society to protect the environment.

Traditional longhouse design basically is an environmentally friendly as compared to modern buildings. The harmonious relationship of the traditional longhouse with the environment can be described in term of passive design and sustainable local materials. In term of environmental and ecological principle, the components of the building that made from durable local materials can be recycled to build the new one (Tomovska & Radivojevic, 2017; Cuadrado et.al., 2015). For example, the durable ironwood beams and columns that still in good condition can be used to build new longhouse. This will reduce materials wastage which deplete it resources. Not only that the local natural materials are biodegradable and will not polute the environment. The characteristics of the local materials which is nontoxic will not polute the environment as compared to manmade materials (Tomovska & Radivojevic, 2017).

2.1 Bioclimatic Design

Bioclimatic design approach applied passive building function to provide comfort for the building dwellers (Mazano-Agugliaro et.al., 2015). South East Asia including Malaysia is known to experience hot and humid climate. The design of the building in the region must be able to provide comfort to the dwellers with the lack of technology in the past. For example, the design of traditional house in the South East Asian that built on high stilts. The velocity of wind is higher on high ground as compared to low ground (Kristianto et.al., 2014). Thus, by elevating the height of the house allow maximum velocity of wind to cool down the longhouse. Not only that South East Asian architecture is known to have large and high roof. The large and high roof functioned to prevent heat directly transferred to the living area of the dwellers. Selection of building materials also important for the bioclimatic design to function well. The materials selected must be able to absorb heat and allow natural ventilation. For example, split bamboo that allow air to move in between the spaces which in turn help to cool the building interior.

3 SUSTAINABLE MATERIALS

Building materials are one of the important elements in the construction of a building. Thus, building materials also play an important role in order to reduce negative impact to the environment together with energy used by the building and the spaces (Eiraji & Namdar, 2011). Traditional longhouse was built from local materials that available in the surroudings. Sarawak is known to be rich in timber ranged from hardwood to softwood species. The thick jungle of Sarawak is one of the Malaysian precious natural resources. Thus, mainly Sarawakian traditional houses are built from timber and other plants such as bamboo and palm tree that widely available in the jungle (Winzeler,

2004). The timber, bamboo and palm tree are natural and organic materials thus known to be environmentally friendly. The natural materials do not trap much carbon dioxide especially the bamboo materials (Escamilla & Wohlmuth, 2016). As compare to building from timber and bamboo, concrete building trap heat and carbon dioxide more due to its compact nature and this will create greenhouse effect if the concrete building built around together. Passively building made from timber and bamboo does not allow heat to trap in and around the building. So that the reason for less of pollution in the past as compare to modern time where the concrete housing and building dominated the development area.

Local materials such as wood and bamboo have low embodied energy (Tomovska & Radivojevic, 2017). Low embodied energy means the total energy consume during the production process. Traditional processing of wood and bamboo is not complicated as compared to modern materials thus have low embodied energy. Less or even no harmful gas is emission during bamboo and tree processing activity especially by the traditional method. Besides that, bamboo and wood can be replanted to replace the one that already cut.

4 RESEARCH METHODOLOGY

The study on the sustainable materials used in traditional longhouse construction had been done to fifteen longhouses. Five longhouses belong to the Iban community, eight from the Bidayuh people while another two are longhouses of the Orang Ulu people. The Iban longhouses are located in Bintulu and Saratok area. The Bidayuh longhouses are the nearest which located around Kuching and Serian area while Orang Ulu longhouses are the farthest which located in the Sungai Asap, Belaga, Kapit. Inspection had been done on the traditional longhouses to determine the availability of sustainable local materials. The elements of inspection focus on the main building elements that still exhibit the sustainable local materials. The building elements inspected including roof, floor, wall, beam-column and stilts. The findings are recorded in a record card with few photos of the building elements with the materials for re-examination. The collection of photos is important in order to re-examine the availability of the local materials. The limitation of the research based on the availability of the sustainable local materials and availability of the traditional longhouses.

5 AVAILABILITY OF SUSTAINABLE MATERIALS IN TRADITIONAL LONGHOUSES

Sustainable local materials that used in traditional longhouse construction including bamboo, palm tree, ironwood and timber from various species such as selangan batu, meranti, chengal and engkabang (Winzeler, 2004). Bamboo used to construct wall, floor, supporting columns, beams and stilts of the traditional longhouse. Full size bamboo is used to construct stilts, supporting columns and beams. While split bamboo is used for wall and floor. Palm trunk from pinang palm tree of areca catechu species usually used for the floor construction while palm leaves from sago palm tree used for roof coverings and exterior wall. Ironwood in the form of timber shingles was used as the roof coverings for the longhouse. Ironwood also used for beam, column, wall and floor. Table 1 shows the availability of local materials in existing traditional longhouses.

Table 1 Availability of the Sustainable Local Materials in Each Longhouses

Materials Longhouse ID	Various Timber	Ironwood	Bamboo	Palm Trunk	Timber Shingles	Palm Thatches
LH001MU	X	X	X			
LH002PG	X	X	X			
LH003RA	X	X		X		
LH004AR	X	X	X			
LH005BE	X	X	X	X		
LH006SB	X	X			X	X
LH007MO	X	X	X			
LH008PR	X	X				
LH009RJ	X	X				

LH010RM	X	X				
LH012UK	X	X				
LH013UB	X	X				
LH014RMA	X	X			X	
LH015RAS	X	X			X	
LH016RR	X	X				
Availability (%)	100%	100%	33%	13%	20%	7%

Timber from various species is the local material that mostly used in traditional longhouse construction followed by ironwood. All the longhouses studied are still using timber and ironwood as main materials for beams, columns, stilts, floor and wall. Timber also used to replace bamboo as the materials for wall and floor in some existing traditional longhouse. Bamboo and palm are the lowest to be used in the existing traditional longhouses. About 33% of the longhouses still using bamboo as one of the materials while only 13% still using palm trunk. The bamboo and palm materials either being replaced with timber or modern materials such as bricks, concrete and metals. Most of longhouses already changed the roof coverings from timber shingles and palm thatches to metal roof coverings. Only 20% of the longhouses still using timber shingles as roof coverings. Only partial of the roof area still using the timber shingles and, in some part, already replaced with metal roof coverings. Only one longhouse still using palm thatches as wall but only on top part of the longhouse. Figure 1 shows traditional longhouse plan and the traditional materials that still be used in the longhouse.

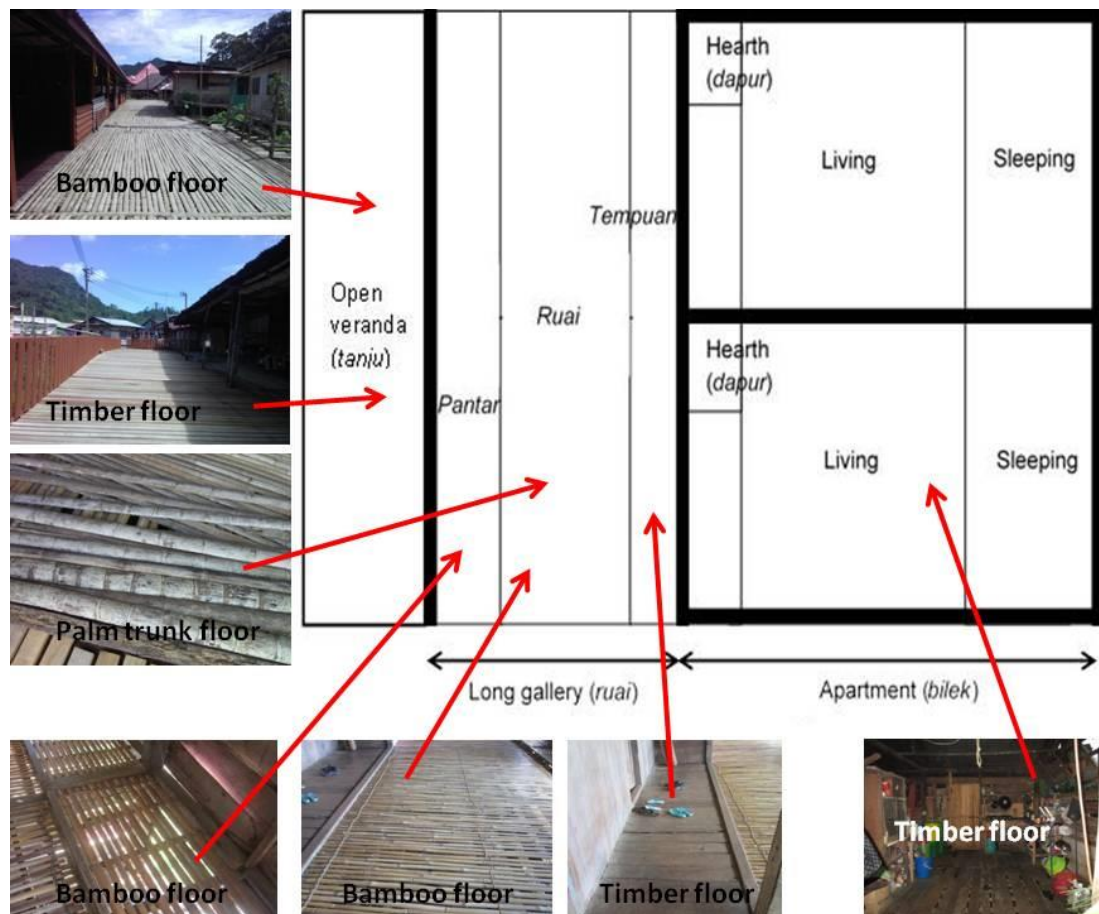


Figure 1 Traditional longhouse plan and materials used in the longhouse section.

Tanju (open veranda) originally built from bamboo for the floor components but nowadays the bamboo floor replaced with timber or concrete floor. The *ruai* (long gallery) floor and wall are either

built from split bamboo or timber especially from the ironwood species. Sometimes palm trunk also used for the *ruai* floor. The *ruai* is divided into three sub-elements namely *pantar* (seating area), *ruai* main body and *tempuan* (walkway). The floor of *pantar* and *ruai* main body built from split bamboo or timber while *tempuan* floor built from timber. But nowadays some traditional longhouses replaced the timber and split bamboo building elements to the one built from concrete. For the *bilek* (apartment) floor is built from split bamboo and timber while wall from timber, tree bark, fine split bamboo or palm thatches. Nowadays *bilek* is the most affected by modernization where this section renovated using modern materials to suit the dwellers taste.

Figure 2 shows traditional longhouse section and the materials used. Stilts are built from timber or ironwood which are durable, high in strength and long lasting. But in some Bidayuh longhouse the stilts are also built from rigid bamboo from the species that high in strength. Longhouse roof in the past was built from timber shingles or palm thatches but nowadays is replaced by metal roofing.

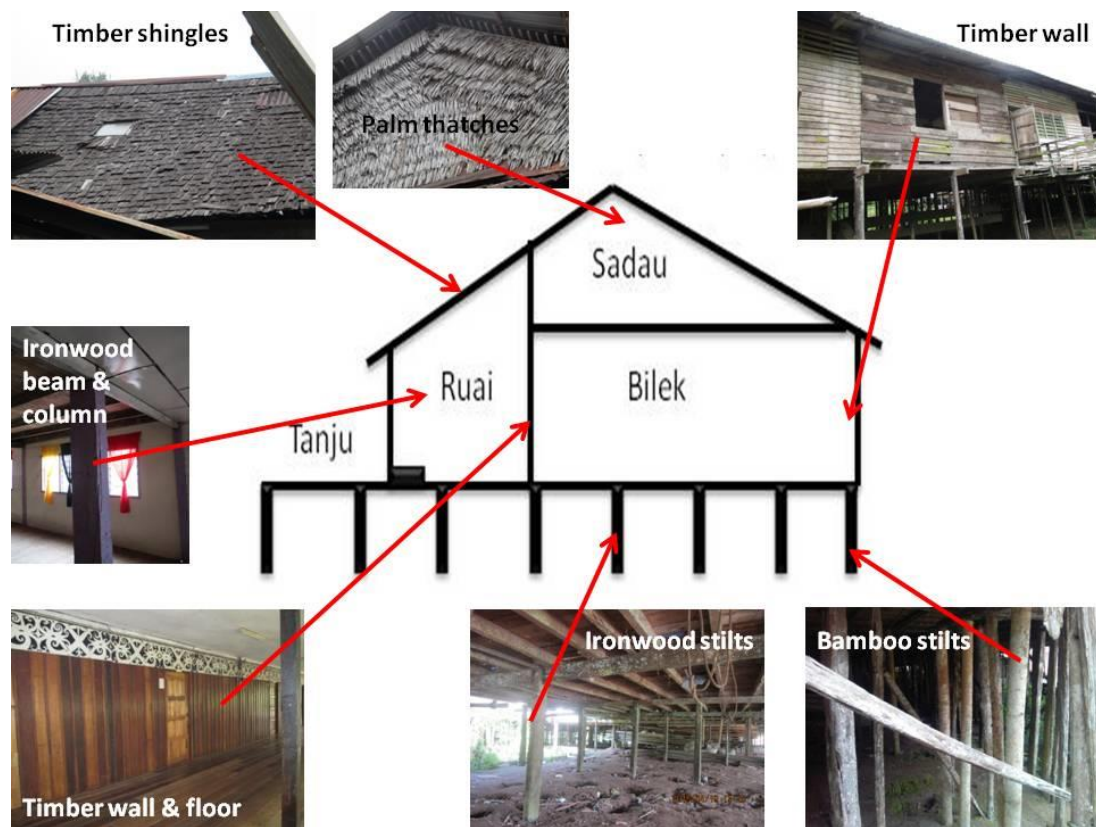


Figure 2 Longhouse section plan and traditional materials used.

The reason for the traditional materials especially bamboo and palm tree no more to be used due to maintenance issue where the materials need to be frequently changed especially when it exposed to weather. The availability of modern materials which is long lasting replace bamboo and palm tree. Not only that, new longhouses not constructed with timber, ironwood and bamboo due to improvement of economics for the Dayak society. The Dayak people willingly to choose a more modern design for any new longhouses which allow them to show their economic status. Existing traditional longhouses also gradually renovated using modern materials. This trend will slowly diminish the use of traditional materials to construct the traditional longhouse. Traditional longhouse will no more becoming a sustainable construction model. Thus, by determining the materials that threaten by modernization will help to formulate preservation and conservation strategy for the traditional materials.

4. CONCLUSIONS

As a conclusion, traditional longhouse is threatening by modernization especially in the selection of new materials to replace the traditional materials. Existing traditional longhouse renovated with modern materials that degraded its sustainability value and authenticity. Timber and ironwood are still widely used due to the durability and strength but gradually replaced by concrete and bricks especially in the new construction. Bamboo, palm trunk and thatches are the most affected and less being used due to durability issue, maintenance and contrast with modern lifestyle. Action need to be taken to preserve and conserve the sustainable traditional materials in longhouse construction so that it can be a model for sustainable construction. Before all the existing traditional longhouses demolished and replaced with modern concrete longhouse, solutions need to be formulated to save the heritage for future generation. Reconstruction of traditional longhouse from traditional materials can be done and the longhouse can be used as a tourism product. New resorts and private villa building can be constructed based on the original design and materials of the traditional longhouse to promote sustainable construction from the past.

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