

SUSTAINABLE HOUSE DESIGN IN VERNACULAR HOUSING

Case Study: Dukuh Kampong, West Java¹

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Abstract

Vernacular housings are a sustainable building, which can be proved from social aspects (related to society), environment aspects (related to material used, environment management, and environment impacts control), and economic aspects (construction cost, low cost of construction and environment management, etc). This paper will elaborate one of the vernacular housing in Indonesia, which is vernacular housing in Dukuh Kampong, West Java. The purpose is to prove the sustainable of vernacular housing in Dukuh Kampong with sustainable house design concepts.

Keywords: Vernacular housing, sustainable house design

I. INTRODUCTION

Architecture has developed to fulfill human need and to encourage their live, which make architecture has related with human culture (traditions). According to Rapport (1969), architecture is the result of human tradition by trial and error. In human society, they have had tradition with related to their culture and norm. Human culture and norm are having effect on their environment and their architecture. Norm, culture, climate, and environment are affected to architecture of their building, which resulting vernacular architecture (housing) by trial & error process. These process make vernacular building is different from the others building (non-vernacular), and Gutierrez (2004) said as a unique building. This unique belong to Guitierrez (2004) because of vernakular housings are nonengineered construction and result of ancient tradition, gradually improved along time in response to the needs of their occupants or to their physical environmnet and also accepted by their community. Struggle with their physical environment such as resistance to earthquake, combine with their climate, etcetera which make these building struggle until today, because they are resulted by trial and error process (Rapoport, 1989; Oliver, 1997).

Because of the uniqueness above, Oliver (1997) said that all forms of vernacular architecture are built to meet specific needs, accommodating the values, economies and ways of life of the cultures that produce them. Gutierrez (2004) is also said that the owner is usually an active participant of the building process; he performs a permanent maintenance program, fixing any malfunctioning or replacing any deteriorated component without further delay. He also adapts the building to the expanding needs of

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his family. Building and repair are an everyday affair where impermanent materials and unsettled ways of life demand constant reconstruction and repair; thus, the inadequacy of the building form leads directly to the action.

Based on the explanation above, we can argue that vernacular housing is different from the others building (non vernacular), which make this building is unique because this building have sustainable concepts inside. From social aspect, this building is accepted by their society; from economic aspect, this building is low cost which according to their society economy; from environment aspect, this building is built with some consideration to their climate, environment, etc.

Indonesia has some vernacular housing, such as in West Java, which is vernacular housing in Dukuh Kampong. This paper will elaborate this vernacular housing with sustainable house design concepts.

II. SUSTAINABLE DESIGN HOUSE

2.1 Sustainable concept

Sustainable concept is how to accomadate human need at present without disturbing the human needs in the future (Steele, 1997). Sustainable concept consists 3 aspects (criterias) that has to fulfill, which are:

1. Economic aspects (*economic sustainability*)
2. Environment aspects (*environmental sustainability*)
3. Social aspects (*social sustainability*)

On this paper the sustainable concepts is related to design concepts of housing, which resulting sustainable house design concepts.

2.2 Sustainable House Design

According to UNEP (2007), an important aspect of a sustainable house design is the extent to which the house can accommodate user needs, climate conditions and local natural hazards (e.g. earthquakes, floods, and storms). Well-designed houses minimize environmental impacts and risks, while meeting user needs.

Key sustainable house design recommendations are (UNEP, 2007):

- The solution that are environmentally sustainable and energy efficient.
- Use house designs that are resistant to natural hazard, such as earthquakes and floods.
- When designing a house, consider its whole life cycle (construction, maintenance, reuse, demolition, and recycling phases).
- Consider flexible designs that are easy to upgrade and expand.
- Use designs and materials that allow for easy recycling.
- Simple, low-cost, robust, and practical solutions.
- Ensure easy maintenance through the use of modest and basic house styles. In many cases, maintenance and later renovation turn out to be technically complicated and, therefore, more expensive. Materials and tools needed to work the materials should also be locally available.
- Ensure cost-effectiveness in all construction activities.
- Incorporate the users need and cultural requirements.

Those keys sustainable house design above must be applied to: 1) house shape, construction system, building component, and building materials (UNEP, 2007).

2.2.1 House Shape

The shape of house is crucial to ensuring that it is built sustainable. Certain house shape can better minimize or withstand the impact of earthquakes, flood, and climate conditions. According to UNEP (2007), the checklist below contains the most important points to consider when thinking about sustainable house shape.

1. Environmental technical aspect

The shape of the house has an important effect on its stability. The following rules should be taken into account: a) the most compact the house shape, the better is stability. A square shape is, therefore, better than rectangular one, a circular plan better than a square one, b) L-shaped plans are less stable. An alternative is to separate house parts from each other, c) to accommodate the local climate, such as the house shape should be of open character, allowing airflow through many openings (windows, lovers, and doors).

2. Economic aspect

Construction cost can be minimized by using simple shapes without numerous and complicated angle. Sophisticated house shapes are normally more labour and material intensive.

3. Social aspect

To ensure a socially, aesthetically and culturally appropriate house design consult with the house future residents regarding which build form and lay out will be suit their needs and fit with their customs.

2.2.2 Building Method (construction system)

Sustainable construction practices are low cost, practical and environmentally appropriate, such as the availability of building material and skilled workers.

2.2.3 Building Components

The main building components are the foundation, supporting frames, floor, walls (with door and window), ceiling and roof. Simple building techniques help to ensure sustainable reconstruction.

2.2.4 Building Materials

Building materials are either made from naturally available sources like inorganic materials or from organic raw materials (wood). The appropriateness of a particular building material can never be generalized. Whether a specific building material is sustainable or not, depends on the local context.

III. VERNACULAR HOUSING IN DUKUH KAMPONG

3.1 Vernacular Housing

Vernacular housings are a unic buildings which radically differentiate from the other buildings. According to Rapoport (1969), vernacular housing have characteristics, which are: 1) without supported by theory or building principle, 2) tuned with their climate and environment, 3) respectful with society and environment, 4) with some ornaments as a

symbol of their society or their occupants, 5) open-ended with site (material resource come from their environment) and accepting changes by their built environment.

3.2 Vernacular Housing in Dukuh Kampong

In generally, vernacular housing in Dukuh Kampong have identities, which are:

1. Raised box frame

Vernacular housing in Dukuh Kampong used raised box frame which raising floor from ground surface (± 60 cm) (figure 1). The main structure of housing is wood, the wall from bundled of bamboo and roof cover is sugar palm's and rumbia (*imperata cylindrical*). This building is using stone foundation which column in the surface of the stone.



Figure 1: Raised box frame on vernacular housing in Dukuh Kampong

2. Light, Elastic, and Ductile Structures

Vernacular housing in Dukuh Kampong is using light, elastic, and ductile structure which shown from material properties, such as wood, bambo, ijuk, rumbia. Wood is using for column, roof frame (tie beam, ring beam, king post, purlin), wall frame, and floor frame. Bamboo is using for roof frame (ridge purlin, rafter (*kaso*), ceiling frame, wall frame, wall enclosure, floor enclosure (figure 2). Bamboo for roof element are bound together with bamboo skin and assembled transversely in layers to cover the roof.



Figure 2: Wood and bamboo as a material of building

3. Box Frame

Building frame is a box, which has related each of components that make building rigid and solid. The rigid of box frame is not because of columns, ring beam, and floor beam, but also wall frame which support structure systems and combine with box frame. Columns beside is bounded by ring beam and floor beam and also bounded by floor frame (figure 3).



Figure 3: Perspective section of box frame

4. Roof

Roof of vernacular housing in Dukuh Kampong is gabled roof with addition in one side. The roof cover is the trunk of the sugar palm (*arenga saccharifera*), used in buddle as a roof materials which consist in their surrounding environment.

5. Connection and joint

Joint system used by this vernacular house is pivot (*pasak*) (figure 4). In several roof structures, bamboo or palm's trunk tie system also used. Bamboo for rafter, roof battens, and roof coverings are tied with sheered bamboo.



Figure 4: Connection and joint system in vernacular housing of Dukuh Kampong

IV. SUSTAINABLE DESIGN HOUSES OF VERNACULAR HOUSING IN DUKUH KAMPONG

Based on sustainable design house from UNEP, we are assessing vernacular housing in Dukuh Kampong to know how far its sustainability. The assessment of sustainability design house concepts of vernacular housing in Dukuh Kampong is based on 4 elements,

which are: from house shape, building materials, building method, and building components.

4.1.1 House shape

- **House shape**

The House shape is square with dimension 4,3 m x 5,8 m (figure 5). Based on sustainable house design (UNEP, 2007) from environmental technical aspect, this house is a good shape.

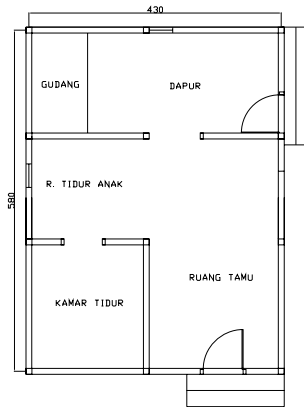


Figure 5: Plan of vernacular housing in Dukuh Kampong

- **Accommodate the local climate**

Vernacular housing in Dukuh Kampong has considered the climate (hot humid climate). This house is used window, door, wall to flow fresh air for reducing heat and humidity inside of building. This house is also using elevated floor to reduce humidity from under the floor. With the holes in the gable end of roof is make air flow in the roof, which can reduce heat inside of roof space and also in building as a whole.



Figure 6: The holes in the gable end of roof

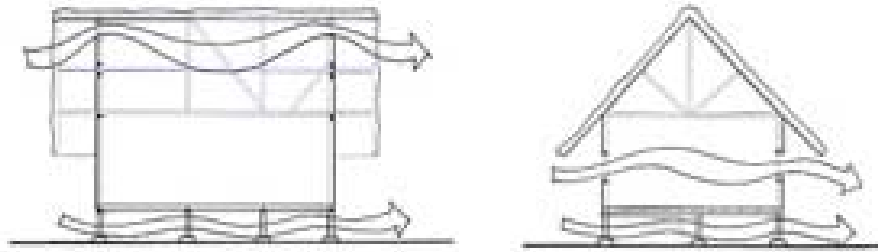


Figure 7: The air flow inside of building through roof, windows, wall, doors and also from under the floor

- **Large overhanging roof**

The large of overhanging roof is 80 cm, which provide good shading and protection against heavy rains (figure 8).



Figure 8: Overhanging roof of vernacular housing in Dukuh Kampong

4.1.2 Building Methods

Vernacular housings in Dukuh Kampong are built together by local people. Materials used for the building were taken from forest around the village. Materials include bamboo for roof battens, rafter, and sometimes the upper purlin. Walls covering are made of whickered bamboo made by the house's owner and some of his neighbors. Roof coverings materials such as bamboo and sugar palm's trunk are also taken from the forest and processed by the locals themselves.

The people are easily bond together in such fellowship because they come from same ancestor, which have strong lineage. Knowledge about building technology derived from ancestor and passed on from time to time. When asked, today's locals did not quite understand why the joint have to be like that or why such materials used. They only follow what they called tradition in building vernacular housings.

- **Low cost**
With using local materials around the kampong such as wood, bamboo, sugar palm, etc. which making the cost of building is low. Local people are using local technology to construct their vernacular housing, such as knock down system and tie system with bamboo or palm's trunk.
- **Practical and environmentally appropriate**
Indigenous knowledge's of construction teams are appropriate with physical of vernacular housing because it have been developed in years with trial & error process to their environmental physics.

- Availability building material
Availability of building materials is enough to fulfill their need to construct the new house. The head of kampong with supporting of his society is managing the usage of forest.
- Availability skilled worker
Housings in Dukuh Kampong are built together by local people, which have skilled to construct the house. The skill came from their parents which developed by local people time by time.



Figure 9: Local peoples construct their house

4.1.3 Building Materials

- Foundation
The foundation is stone foundation which column in the surface of the stone. The material of foundation is getting from the river which closed to their kampong.



Figure 10: Stone foundation in Dukuh Kampong

- Supporting frame
The material of supporting frame is wood. They are choosing the appropriate wood such as rasamala, jeunjing, jamuju, etc, which consist and able to get in their forest. The frame system is a box frame with bracing in the corner of box to make rigid frame.
- Floors
Vernacular housing in Dukuh Kampong is used elevated floor from ground surface (± 60 cm) to get the air flow from under the floor. This concept is appropriate with

hot & humid climate. They are using bamboo which specific construction and arrangement.

- Walls, windows and doors

The wall in Dukuh Kampong is using bamboo bundled, which is been tied and connected to building frame. The construction technology of the wall is simple, with using the trunk of the sugar palm (*arenga saccharifera*) as a rope. The window and the door are been made from wood with knock down construction. They are using bamboo or rattan as a cover of window to get air flow to inside of building.

- Roof

The truss frame of roof is made from wood which connected to frame of building. This concept is made the building more rigid and solid. The roof cover is the trunk of the sugar palm (*arenga saccharifera*), used in buddle as a roof materials which consist in their surrounding environment. The trunk of the sugar palm have a minus which easy to burn but it so light and easy to get in the forest.

4.1.4 Building Materials

The building material is using local material which has been explained above. This local materials come from their forest which been controlled by head of kampong. The forest is managed by local people with continuous.

V. CONCLUSIONS

Vernacular housing in Dukuh Kampong based on sustainable house design concept of UNEP (2007) is a sustainable building. Based on criteria of house shape, building method, building component, and building material, vernacular housing in Dukuh Kampong has fulfilled all the criteria's. Nevertheless, vernacular housing in Dukuh Kampong has had minus from building material aspect, which is the usage of ijuk as a material (easy to burn).

This papers is showing how sustain of vernacular housing in Dukuh Kampong. We can learn from this building and to teach the society about sustainability of vernacular building, especially for people around the kampong.

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