Sustainability in West Java traditional house: A case study from Julang Ngapak House

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Abstract. Bamboo is one of the strongest woody plant species available and is usually found in rural areas. In general, bamboo is widely used in traditional house structures and construction systems because the material is easily available. This study found that the use of local wisdom materials in traditional Julang Ngapak house make the building more durable, environmentally friendly, inexpensive, has aesthetic value, the shape of the roof creates an attic space for thermal comfort, proper cross-ventilation, and a renewable construction system. In addition, the shape of the bamboo house is determined by climate, location, and purpose, building technology, and historical experience. Bamboo is the alternative future construction material for sustainable development.

Keywords: Bamboo, Traditional Julang Ngapak House, Sustainable Development

1. Introduction

The cyclical pattern of the food chain (nutrients) in nature has a closed-loop cycle pattern, where no waste should be formed. This is a real example of the concept of sustainability in our natural environment. Based on this pattern and the system of birth, life, and death, every living being will depend on one another. The principle of sustainable architecture refers to the same cyclical pattern. Sustainable architecture does not only focus on buildings but on the whole process and life cycle of the building itself starting from the early stages of the design process, site selection, material selection, construction, operation, and finally until the building can no longer be used. [1]

In a broader perspective, sustainable architecture is a whole process starting from the building being designed, built, renovated, operated, and/or reused with reference to energy-saving and economical principles. The use of salvaged or recycled materials or low carbon material, rainwater harvesting, the use of energy from sunlight, natural ventilation, and or the use of other environmentally friendly practices in buildings strongly supports the principles of sustainable architecture. [1] In the principle of sustainable buildings, the combination of design and building construction systems in all aspects will affect and be influenced by the surrounding environment. [2]

The main goal of sustainable design is to find solutions to architectural problems that can ensure the welfare and sustainability of inorganic, organic, and human beings. [1] Thus, it can be concluded that
the goal of sustainable architecture is to provide architectural solutions as a response to produce greener and better buildings by reducing the use of natural resources and emissions/pollution. [1]

Traditional architecture is the result of the environment of each area that has variants built in response to existing natural conditions, material availability, climate, and vegetation. In addition, the construction of traditional houses always involves the entire local community in the stage of site selection, selection of building materials to the stage of house construction, and always considers traditions and environmental conditions.

The availability of materials in nature is local wisdom that is continuously protected and maintained by the Cireundeu indigenous people who prioritize the balance of nature. The natural material that is widely used is bamboo, where bamboo is one of the strongest wood-fiber plants and usually grows densely in rural areas. The use of bamboo in traditional houses is common, bamboo is a material that is 100% environmentally friendly because it is easy to obtain, can be used, and is economical. The Julang Ngapak house is one of the traditional houses in West Java with development methods that have been inherited from generation to generation either through legends, pantun, stories, or through an apprenticeship process. using bamboo as a natural material that is environmentally friendly and a solution to sustainable design. This research aims for identifying the interdependencies between local wisdom and the sustainability architecture concept using the traditional house in West Java (Julang Ngapak) as the case study.

Prior research on virtualization of Joglo Cultural Heritage House using CAD contributes to providing digitalization of design elements to manage design data for virtuality in architectural design [3]. This research is complementary research that provides benefits with accomplishing the value of the design elements. Therefore, the virtuality in architectural design can provide digital information in terms of sustainability aspects of design and the value of local wisdom in design

2. Literature Review

2.1. Sustainability aspect

Generally, the word sustainability associate with Sustainability Development Goals (SDGs) which consist of 17 goals category where some of them have direct relationship with Sustainability Architecture Design. According to Sherwin [4], this study argue that sustainability can be achieved by architectural design using at least three principles as follow: (1) design for resource efficiency; (2) design for circularity; and (3) design for social change & equality. Design for efficiency concern with the capability of architectural design to utilize fewer building materials and resources. Secondly, the design for circularity is the strategy by encouraging multiple use of materials in architectural design. Additionally, the design for social change & equality concern with responsible consumption to save the ecosystem. This study assesses how the architectural design of West Java Traditional house concern with sustainability through the aspects of resource efficiency, circularity, including social change & equality.

2.2. Local wisdom aspect

Local wisdom plays important role in creating design uniqueness and believed to be able promoting culture, such as study of Coffee House Design using Gayo nuance as local wisdom to promote Gayo Culture and Tourism [5] and also in study of redesigning Cirebon regent’s office [6]. These studies adopting local wisdom in the elements of architectural design which potentially promoting culture. In this case, local wisdom means the harmonious interaction among human, environment, and nature where most of the time influenced by culture [7]. This research argue that local wisdom that adopting in Wests Java traditional house provide sustainability aspects which exposed through design elements.

2.3. Traditional House

Traditional houses are houses built based on heritage knowledge from generation to generation even to the selection of building materials that use local materials, where these materials are very easy to find
around the settlement and are built using the same method from generation to generation and without or little changes. \[8\]

Traditional houses are the work of traditional architecture \[9\], where the structure and construction system of the house is compiled not from the results of mechanical calculations but based on trial and error that last for many years. Therefore, traditional houses can last up to tens of years and even hundreds of years and are very suitable for climatic conditions, ways of life and geographical conditions of the archipelago. In addition, the traditional house is a physical component that reflects the culture and social life that is formed from traditions in society \[5\]

2.4. Structure of Bamboo House
Bamboo is a plant that can be a source of sustainable material and easily grown in rural areas so that it can be used for house construction.

2.4.1. Bamboo floor. In traditional houses to avoid animals and flood swamp areas, the house is built with a raised skeletons and bamboo plinth as the floor.

2.4.2. Bamboo wall. In traditional houses, the walls of the bamboo house will have bamboo mat walls with bamboo or wooden structure. Bamboo as a local wisdom material, especially bamboo mat walls, if treated or treated, will not last more than 4-5 years as an exterior wall, but if given maintenance it will last 15-20 years. Local treatment of bamboo mat walls can be done with bitumen, oil and so on and can be done using a chemical mixture with the following mixture composition: Copper Sulphate 4%, Sodium Dichromate 4%, Boric Acid 2%, Water 90%. \[11\]

2.4.3. Bamboo roof. Bamboo is usually used for the structure and construction of roofing houses, where to strengthen and improve stability cross-reinforcement is carried out with pieces of bamboo. The split part of the bamboo used for cross supports must be treated with chemical preservatives so that they do not rot and lose strength. To tie the structure, burlap or coir ropes are used. Cavities in the roof area can be used for storage and allow airflow for cross ventilation.

3. Methods
The study was conducted using exploration approach, where the data search method is carried out through literature studies, field measurements and interviews, which are expected to collect and identify data about one of the traditional houses of Julang Ngapak in the West Java area, especially in Kampung Cireundeu, Cimahi. and useful input can be obtained regarding the use of bamboo material as one of the sustainable materials.

4. Result & Discussion
4.1. Floor Plan
In general, the arrangement of space in the traditional Julang Ngapak house consists of five (5) category as listed in Table 1 and describe in Figure 1.
4.2. Structure and Building Materials
The structure and building materials of this traditional house are made of a frame structure consisting of frames and beams made of wood and bamboo. For the floor of the building using material from bamboo which is split and then shaped into sheets that are arranged in such a way and then installed as a building floor with reinforced support from wooden and bamboo beams. The connection system uses ropes and nails. Overall, the building materials used to make this traditional house use natural materials from the surrounding environment such as wood, bamboo, stone and so on. The traditional house building structure is divided into three main parts, namely: Sub Structure, Middle Structure, and upper structure.

4.2.1. Sub Structure. Umpak, serves as the foundation of traditional house buildings, usually made of mountain rock. However, due to the use of new materials such as bricks and cement, the use of this rock is rarely used. But it was replaced by an arrangement of bricks covered with cement.
4.2.2. Middle Structure, incorporates four (4) part of structures as follow: palupuh, tihang, the bilik including doors and windows. Palupuh (talupuh), is a building floor made of bamboo which is split into sheets that are assembled in such a way that it is ready to be installed as a building floor covering. Tihang, serves as the framework of the house that supports the roof of the building and is usually made of bamboo or wood. The Bilik is a wall covering or also functions as a building divider that protects the occupants of the house from wind, heat, and rain. Made from bamboo fibres woven in such a way, where there are three types of woven known namely braid, sasag and gedeg. Doors and windows, usually made of wood or bamboo.

4.2.3. Upper Structure. Roof, it is the cover of the upper building and in this research area the roof shape used is Julang Ngapak.
5. Discussion
The study concluded that the use of local wisdom materials in traditional Julang Ngapak house made traditional home buildings more durable, environmentally friendly, inexpensive, has aesthetic value, roof shape creates loft space for thermal comfort, proper cross ventilation, and renewable construction systems from traditional bamboo houses. In addition, the shape of bamboo houses has been determined by climate, location, and purpose, technological building, and historical experience. Bamboo is one of the alternatives to future construction materials for sustainable development. These findings also relevant with prior discovery in applying local wisdom philosophy in architectural design as mentioned in research of coffee house design inspired by Gayo culture [5] and regent’s Cirebon’s office design [6] which Julang Ngapak House was built based on the needs of Cirende community culture. Therefore, local wisdom that could inspired from Julang Ngapak house can be categorized in four aspects: (1) building structure, (2) material used, and (3) design of room layout. Julang Ngapak house also provide insights in term sustainability according to bamboo as major building materials. Consider that Indonesia has more than 160 bamboo species among around 1200 species worldwide [12], it can be confirmed that bamboo is part of local wisdom in building surounding Cirende community. Utilization of bamboo as material building is part of SDGs where sustainability aspects can be fulfilled.

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