Prospects of sustainable wood building architecture

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Abstract. The responsibility of an architect as a subject or actor in realizing a work; must consider the conditions and situations of the physical and social environment, taking into account aspects in saving, maintaining and using resources efficiently. To realize the building design requires the selection of material resources that are environmentally responsible, because this will give identity to the architectural work. The role of architects in building architecture is always influenced by the surrounding environment in its era. The history of the wooden building architecture development is inseparable from its surrounding environment condition. Reduced natural resources such as sand, gravel and materials for making cement or iron sand and mining prohibitions that damage the environment will encourage the use of wood as a sustainable material. At first the history of the wooden buildings existence only depends on aspects of a building function alone. Now with technological development innovation, the sustainability of wooden building architecture has three elements, namely: function, strength and aesthetics. In the modern definition, architecture must include functional, aesthetic, and psychological considerations. Meanwhile, the development of various innovative products, for example engineered wood is an effort so that the life span of wood-based products will be utilized longer.

1. Introduction

In terms of scientific taxonomy, the 'design activity' of architecture is basically the estuary of a whole series of architectural planning and design activities which are divided into several domains/fields of work/fields of study (domains) that are inseparable from one another [1]. A theory in architecture is used to look for what actually has to be achieved in architecture and how a good method to process (design) properly in an effort towards an achievement. Theories in architecture are not as precise and detailed as the field of natural science. An important feature of scientific theories that are not found in architecture is detailed proof. This is allegedly due to the value of "quantitative" which is very difficult to be closer to the dose of qualitative values [2]. This is reasonable because architecture is a science of synthesis, derived from the realm of basic sciences, which contextually can be said to be a blend of technique and art [3].

Theories in architecture are hypotheses, expectations and guesses about what will happen if all the elements that make the output are collected in one particular method of thinking. In architectural theory there is no way to predict the fate of its output [4]. Thus the role of architectural theory is basically to provide support: basic knowledge, rules/principles in architectural design to provision in the form of architectural insights in a fundamental and comprehensive manner so that architectural design activities undertaken can run well. Assessment criteria about architectural design are obtained in full through architectural theory, both involving: 'true/false', 'right/not right' or 'suitable /not suitable' or
'comfortable/uncomfortable' until 'beautiful/not beautiful (bad)' criteria about architecture can be had [5]. Reduced natural resources such as sand, gravel and materials for making cement or iron sand and mining prohibitions that damage the environment will encourage the use of wood as a sustainable material. Wood is a forest product that is easily processed to be made into goods in accordance with technological advances. Basically wood is a natural material that has many structural weaknesses, so the use of wood as a structural material needs to pay attention to the properties of the wood [6]. On the other hand, wood has several properties that cannot be emulated by other materials. Traditional houses in Indonesia generally use wood as the main building material, and in the form of wooden structures on stilts. Almost all of the Indonesian archipelago traditional houses which are vernacular architectural heritage have the same shape, both from the shape of the building as well as from the morphological shape of the basic structure. Meanwhile, modern wooden buildings already have three elements in their design, namely: function, strength and aesthetics.

The purpose of this research is to convey the benefits of wood as an environmentally friendly building material. In addition, the production and processing of wood products uses less energy than most other building materials, resulting in less emissions to the atmosphere. Wood is also a building material that is renewable, versatile, durable, easy to use, and has an aesthetic value.

2. Methods and materials
The method used in this research is a literature review that is included in qualitative research (qualitative research), which is based on the issues raised [7]. In this research, the issue analyzed is "wooden building architecture". Data collection was carried out by the method of observation and document analysis. The data obtained is interpreted based on the relationship with the issue of "wooden building architecture" and the environment that affects the issue. Literature review is a complex process that can be defined as an interpretation of the selection of published and / or unpublished documents available from various sources on a particular topic that optimally involves summarization, analysis, evaluation, and synthesis of documents. The analytical method used in this study is the analysis of literature in the study. In its most stringent and comprehensive form, the analysis of literature in studies does not only involve the analysis of the findings of a study or the main premises used in non-empirical work [8].

3. Results and discussion
3.1. Wood building architecture
The writing of this wood building architecture will be discussed on Indonesian vernacular architecture and modern/ post-modern architecture.

3.1.1. Vernacular/traditional architecture. Indonesian traditional houses are generally built using materials that are in nature and shaped on stilts. Traditional house architecture is also a cultural element that grows and develops together with the cultural development of a community, tribe or nation. In this case the basic elements persist for a long period of time and remain in accordance with the development and growth of the culture of a society, tribe, or nation concerned. Therefore, vernacular architecture, especially traditional house architecture is one of the identities as supporting the culture of the community, tribe, or nation [9]. Traditional houses can be interpreted as houses that have been built and used in the same way for generations. Tradition is not something that is sustainable, but continues to experience change/ transformation. Traditional buildings as a mirror of cultural values are reflected in the embodiment of its shape, structure, spatial layout and decoration. The physical form of a traditional house, although not ignoring a sense of beauty (aesthetic), is still bound by cultural values prevailing in community.

The structure and morphological features of Indonesian traditional houses consist of two types, namely traditional houses built based on typical principles of the ancient Austronesian architectural tradition, namely: a box structure erected on a wooden foundation pillar, can be planted into the ground or placed on the ground surface with stone foundations, stage floors, sloping roofs with extended jurai
and inclined roof front sticking out. While in the eastern part of the Indonesian archipelago many types of traditional houses are classified as part of the vernacular architectural tradition, which in the form of the building usually has; circular floor and high cone roof structure such as wasp nest or elliptical dome-shaped roof structure. Generally these wooden buildings, whether in the form of monuments or public buildings, hold an invaluable cultural heritage. Not only in terms of architectural embodiment, but also in terms of the wealth of building construction knowledge. The resilience of wooden buildings in Indonesia has been tested by natural challenges for hundreds of years (see figure 1) [10].

![Figure 1. Kampung Naga traditional house.](source: Terry E., http://blog.negerisendiri.com/blogpage.php?judul=19, accessed on November 25, 2019).

Traditional houses in Indonesia are also often seen as a place where ancestors live and are used as a place of rituals and ceremonies to honor them, and are also used as a storage place for ancestral heirlooms. Another important general characteristic is the use of various types of polar opposition in space, such as front and back, east and west, left and right, as well as inside and outside which are adapted to class distinctions among various social groups of tribal communities in general.

3.1.2. Postmodern architecture. This postmodern architecture was born because the syntax of buildings in modern architecture must follow one way and the 'words' in the building are arranged in the same format, if not false. Though architecture is a mixture of art, history and technology. In this paper two examples of postmodern architecture from wooden buildings will be discussed, namely the Novotel Hotel in Lombok (Indonesia) and the Roof of the Pompidou Center Museum Building in Metz (France).

3.1.2.1. Novotel hotel (Lombok). The architecture of Lombok's typical building with coconut wood dominance seems to be an option for some people in Lombok Island, West Nusa Tenggara Province. The use of wood species named latín Cocos nucifera, in addition to strong also gives a natural impression. Coconut wood is not only used only in residential homes, but also become the main building material at Novotel Lombok Hotel in Mandalika beach resort, Central Lombok (figure 2) [11].

The hotel building and interior are designed as a Sasak traditional house architecture reflection which is supported by a unique and thick landscape with a rural feel. Building materials from coconut wood are the hallmark of this four-star hotel. The alang-alang roof enriches the concept of the rural nature of the hotel building and its overall building materials from nature such as coconut wood, rattan, earthenware and terrazzo, thus giving a natural impression. The exterior of the hotel starting from the sills, doors, cabinets and furniture fixtures and the hotel building floor which is located on the coast of Mandalika are all made from coconut wood, so it is really thick with a rural feel.
Coconut wood as a building material has indeed become an alternative choice for the community when the price of forest wood is increasing or jungle wood is increasing lately. In addition, coconut wood is more durable, not easily weathered and resistant to termite attack; and the price is affordable compared to wood from fast-growing trees or wood from natural forests. Building materials from old coconut wood can last for decades. Coconut wood can be used as door frames, windows and rafters (rib roof frames), and even many who use coconut wood for door leaf. The color of the fiber from black coconut wood looks attractive, especially if you use wood fiber varnish will be brighter.

Figure 2. Novotel hotel in Lombok with coconut wood architecture. (source: https://mataram.antaranews.com/berita/24146/kayu-kelapa-dalam-arsitektur-bangunan-tradisional-lombok, accessed on November 21, 2019).

3.1.2.2. The roof of the Museum Pompidou Center, Metz (France)

The roof of the Pompidou Center Museum building in the city of Metz, France is very unique (figure 3). Museum roof made with wood frame wrapped with fiberglass and Teflon is a work of art architectural achievement. The roof of the building is supported by external pillars, the roof hangs over the building without touching the top edge of the wall, allowing outside air to flow inward. Japanese architect Shigeru Ban, in collaboration with French architect Jean de Gastines, based the roof truss on bamboo woven patterns on Chinese conical hats.

Figure 3. Roof of the Museum Building Pompidou Center, Metz (France). (source: https://www.archdaily.com/490141/centre-pompidou-metz-shigeru-ban-architects, accessed on November 21, 2019)

This building is structured using the concept of a wooden structure which has a height of up to 77 meters, which is a symbol of the first year the building was opened in 1977. This building is a two-curvebuilding...
with a wooden beam assembly forming a hexagonal module and supported by a central metal tower and four cone-shaped pillars. Materials made for the structure are laminated bamboo, Teflon and wood made prefabricated with modular geometry (hexagon) components. Also add transparent glass membrane which is attached to the roof structure module. This waterproof material can create a natural climate, helping to meet the demands of building energy needs and ensuring that works of art are well known and preserved in the best conditions [12].

3.2. Sustainable architecture
The current architectural design needs to consider the sustainability of the building itself proportionally and the building user. Architectural works need to follow the development of building material technology and the application of building technology. This is a standard requirement in quantitative architectural design. Sustainable architecture is an architectural philosophy that promotes harmony between human habitation and nature through a design that harmoniously approaches building locations, furniture, and the environment to be part of a composition, united and interconnected. The ecological approach to architectural design is not a specific hi-tech building concept, but a building design concept that emphasizes an awareness and courage to decide on a building design concept that respects the importance of ecosystem sustainability in nature [13].

Sustainable architecture also contains dimensions of time, nature, socio-cultural, space and building techniques. Alignment with natural behavior, can be achieved with the concept of sustainable architectural design that is contextual, namely the processing of site designs and buildings that are in line with local potential, including topography, vegetation and other natural conditions [14]. The material chosen must save energy from utilization as natural resources to use in buildings and allow recycling (sustainable) and waste that can be in accordance with the cycle in nature. Conservation of natural resources and the continuation of eco-system cycles in nature, the selection and use of building materials with an emphasis on recycling, occupant health and its impact on nature, energy efficient, and maintaining local potential.

Wood is one of the sustainable building materials. The availability of wood from natural forests has been reduced, so it is necessary to plant timber of lower quality. Thus, wood from industrial forest plantations must be processed into value-added products [15]. At present engineering experts have added designs for disassembly or designs that can be disassembled, designs for recycling or designs that can be recycled, and designs for the environment or designs that take environmental aspects into account in their treasury. Meanwhile, a wood used as structural elements can be either solid wood or engineered wood. Engineered wood such as glulam, cross laminated timber and others are made to meet the needs of strength and dimensions of large wood. Besides green and sustainable, wood has a strength / mass ratio greater than concrete and steel materials [16].

Engineering for the development of various innovative products, for example engineered wood by means of composite wood waste with non-wood waste is an effort so that the lifetime or lifetime of wood-based products will be utilized longer. Engineered wood has been very advanced and is widely used in countries such as Canada, Australia, New Zealand, the United States and many countries in Europe. Up to 10 storey buildings which are widely used as apartments using engineered wood have become common in some of these countries.

4. Conclusions
Architectural theory in architectural design activities is as the main basic knowledge or insight that functions as initial knowledge supporting architectural design activities. Theories in architecture are hypotheses, hopes and guesses about what will happen if all the elements that make an output are collected in one particular method of thinking.

The vernacular architecture of a traditional house is one of the cultural elements that grows and develops together with the growth and development of the culture of a society, tribe or nation whose basic elements persist for a long period of time and remain in accordance with the development and growth of the culture of a community, tribe, or the nation concerned.
The tradition of postmodern architecture can be said to prioritize theory first then practice. Postmodern architecture is better known as an architecture that 'marries' two codes or styles or styles. For example, between the antique and modern, between masculine (buildings with more dominant structures) and feminine (dominant exterior beauty), between western and eastern, and so on.

The prospect of wooden building in Indonesia is very dependent on our knowledge and policies from the government. Reduced natural resources such as sand, gravel and materials for making cement or iron sand and mining prohibitions that damage the environment will encourage the use of wood material as a sustainable material. Engineered wood needs to be prepared or engineered wood as a substitute for solid wood and other building materials, so as to realize sustainable wood building architecture.

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