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Modular panel house design with prefabricated production technology

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Modular panel house design with prefabricated production technology

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Abstract. The purpose of this study is to get efficient home needs from modular panel houses at low cost and have a comfort factor and describe the design of the modular panel house. This research method used the descriptive quantitative method, with research subjects describing the modular panel house design with its criteria. With the modular panel house building method would be easier with low costs compared to conventional because the industrial process was carried out with prefabrication, and pay attention to ecological factors in the building. Designed houses of modular panel house are built at low cost, taking into account thermal comfort factors and have eco-architectural values so that they can influence people's interest in this type of house.

1. Introduction

Modular house is a form of system that is made using several parts of the module through different methods with old methods that are less effective and efficient [1]. Prefabricated modular panel house building is a method to improve the effectiveness of construction and building quality that has been developed for a long time [2]. Technicians and designers develop innovative ways to improve functionality and minimize environmental impacts and reduce operating costs from development. Performance improvements in buildings are the driving force in buildings using prefabricated concrete panels because energy-related steps can help improve the cost effectiveness of the entire renovation and maintenance process of the building. The need to improve construction in the housing sector needs to be reviewed in the procurement of construction by utilizing the experience of the manufacturing industry to be able to increase efficiency, reduce waste, and make the industry more responsive to development needs [3]. Modular house building components made at the factory after the modular assembly are all complete; then transported to the location to be rebuilt quickly [4]. Modular panels with fabrication methods can allow construction to be constructed up to several levels, with a short time and carried out at the construction site [5]. In order for a product to attract consumer interest, it must pay attention to the benefits aspects, product visualization aspects, and product value aspects [6].

Research conducted by Fred et al. Found that modular panel houses require components that have a degree of adjustment and flexibility in the installation. Component systems on modular panels require more connections and connections with careful installation. Modular constituent components of this panel are fabrication elements such as stairs, ridges, roof truss, wall coverings, wooden equipment, steel frames, and precast concrete. [7] While the research conducted by Ramalhete refers to the development of preparations for modular reinforced concrete panels from local materials, with this new approach there will be potential for the application of preproduction materials to build houses to provide solutions for sustainable development [8]. While research conducted by Vanessa houses with prefabricated



buildings can reduce the impact on the building sector such as reducing energy consumers and the use of large materials, and reducing waste and emissions [9]. BC Housing discusses other influences of modular panel systems on environmental sustainability that are beneficial to human health can also generate financial benefits from investment in housing preparation [10].

From a number of previous studies, it was seen to discuss more about the installation system and its benefits to the environment, so this study was conducted to determine the type and design of modular panel houses that can be desired by the public.

Therefore this study aims to obtain the efficient home with modular panel house to give a low cost and make a comfort factor, and the type of modular panel house. The method used in this research is a descriptive quantitative method, with research subjects describing modular panel house design with its criteria.

2. Method

This research method uses quantitative descriptive methods, based on several references relating to the subject of research, namely making modular panel house designs with several criteria and collecting supporting subjects from research related to the need to build a comfortable and efficient residence.

3. Results and discussion

In a modular panel house design, an analysis of residential building approach to the comfort of the local climate was measured by eco-architecture indicators, such as Inner Room Quality, Water Efficiency, Facilities and Infrastructure, environmental sustainability contribution, Site Selection and Processing, Innovation, Waste Management, Energy Efficiency, Use of Building Materials, Post-Occupancy Design and Evaluation Aspects. The modular panel house building implements a good indoor quality system by designing as efficiently as possible openings in this building to produce the effect of thermal comfort on the space in the building. This building aperture applies the system which is adapted from the house on stilts to produce air flow which is supported by the surrounding vegetation will produce cool and comfortable room temperature. From this, it is obtained a temperature that suits the needs and comfort level of the occupants in it.

Modular panel house building design concept in order to make water efficiency that is utilizing three water sources, namely water coming from a spring source / PDAM which provides water as the main source of clean water availability, the next water source is from the rain harvest reservoir which is stored in the tank as a reserve placed in the building's "panggung", the third source of water is the treatment of waste that is reused from the results of processing by reverse osmosis. The design concept for the criteria of facilities and infrastructure that are accessible to modular panel house buildings is to consider access and achievement that facilitates disability. This design applies the ramp system to the main entrance door. The ramp was applied as an outer link of the building with occupancy to the higher ground of the building (Figure 1).

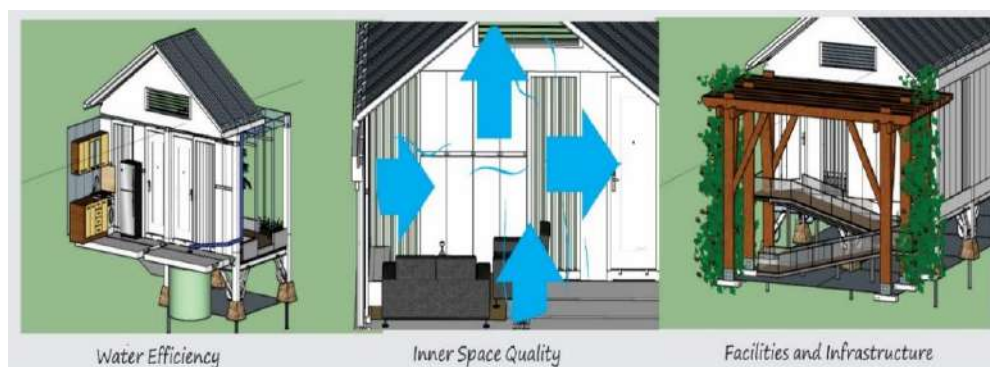


Figure 1. Modular panel house building design concept.

The application of the concept to the contribution of environmental sustainability is the application of paving material to the building landscape. This material is used to be able to reduce the overflow of rainwater into drainage directly. It expected that with the application of paving as a pavement this building could be better able to function as a recharge so that water can be absorbed directly into the soil. In the vegetation area around the building, it is also covered with biopori installation so that the water is more absorbent and does not flow into the drainage channel. Biopori in modular house panel buildings acts as infiltration wells to be able to preserve the environment against reserves of water resources.

Modular panel house design is placed in populist areas by residential development regulations. This is to provide a model and change the pattern or attitude of the behaviour of the surrounding community towards environmental conservation in the dwelling by arranging the pedestrian environment around the dwelling so that the pedestrian aspect can be more considered. In this development location, it is necessary to arrange vegetation in the surrounding environment, especially in residential buildings with green areas that are inadequate for the provision of green open space and investment in water sources.

The innovation worked on the design of the house panel implemented a garbage collection system. Garbage is divided into organic and inorganic types. In the organic waste section, waste is collected and collected in tanks or special containers that will later be used as compost fertilizer. This compost can be used for plant nutrition and other vegetation needs. The compost container is placed in the utility room (kitchen) in a continuous modular panel house into the waste room so that the placement of this space is more efficient and facilitates processing and sorting waste. The waste processing concept in the house panel is a treatment of waste sourced from water use, which is carried out by the osmosis reaver process so that the former use of water (grey water) can be processed and reused as a function for watering plant vegetation. This waste treatment can reduce the amount of water needed by this building.

Designing the design of the panel house uses material with the amount of material all the energy needed to produce goods (low energy embody). The material on the wall and other building components are attempted to use wood/bamboo so that aside from renewable materials, the material acquisition process is easily obtained and imported because the material used is predominantly local material. Other influences of this local material are transportation expenditure, and the length of travel in bringing in the material will be more efficient (Figure 2).

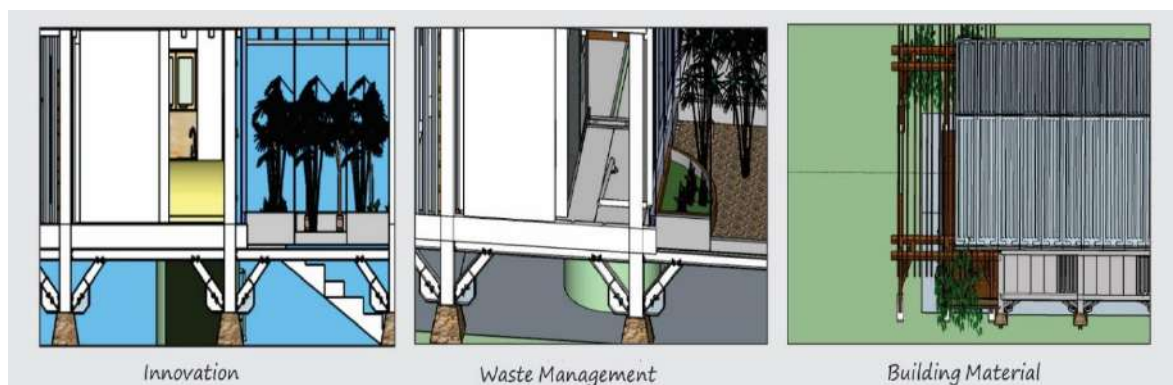


Figure 2. Embody energy.

The application of the concept of energy efficiency in this modular panel house uses alternative energy as an additional supply in the use of electricity. Alternative energy is obtained from solar energy as additional energy that is renewable and environmentally friendly so that the use of energy in the design of this building becomes more efficient. Natural alternative energy in the design of residential buildings also uses it as lighting, so the use of electrical energy as lighting can be reduced (Figure 3).

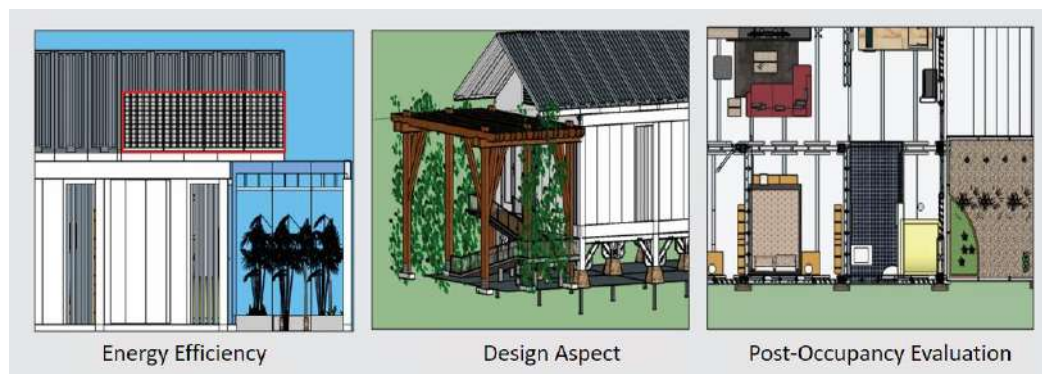


Figure 3. The application of the concept of energy efficiency.

The application of the modular panel house design is to strive to reduce indoor heat gain. This is achieved by the application of pergola on the front porch of the building with the roof of vines, this is useful for the comfort of the temperature produced naturally by plants, the use of crops that can be harvested, as well as vegetation media for the application of waste compost and limiting as a provision of green space. The draft concept of this residential building in terms of post-occupancy related to the evaluation that will be done later, the building needs to be assessed from the implementation of corrective actions later by the results of the evaluation of the building that is proven in the form of documents. In the post-occupancy action later, such as utility rooms (water tank, compost area) can be converted again. This evaluation is carried out in the form of the transfer of residential buildings (not demolition).

Aside from the concept of the components of the modular panel house above, there are also ideas for joint and connection in prefabricated modular panel house designs. The connection used in the modular design of this panel house uses the DOVE TAIL system, which is the installation of flip-flops. Each component is connected to the connection and then locked, almost similar to a wooden bed connection. Between material connections are only paired with other connections; the rest is welded and bolted to the steel frame (Figure 4).

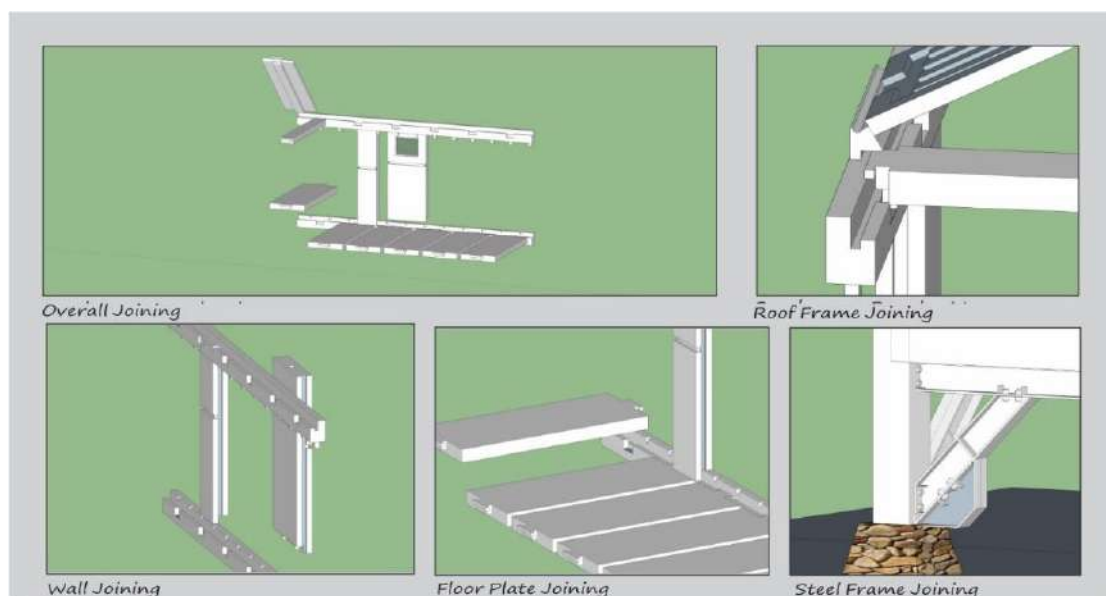


Figure 4. The concept of the components.

The application of cables on modular panel houses has been designed notches for cable and electrical channels, in addition to water pipelines. Each module on this panel has a continuous notch for the connection and power plug holder. This cable is connected from a home miniature circuit breaker (MCB) panel divided into each space. The cable can be channeled horizontally for electrical plugs, or vertically for lights. The distribution of cables in this panel will pay attention to the safety factor because the cable installed in this modular panel house is planted in the panel module so that it is safe against the danger of weak current contact which can cause a fire (Figure 5).



Figure 5. The application of cables on modular panel houses.

The Sanitary channel pipe is placed on the panel module notch. Panel modules are manufactured with factory supplies for sanitary and electrical manufacturers. The water in sanitary is sourced from blue tank water reservoirs (reservoir, rain harvest, PAM) which are distributed by the pump to each tap. The sanitary piping utility network in this modular panel house is relatively simple, and installation is easy.

Planning the application of the material used in this modular house panel using materials with a composition of 70% cement, 30% fiber. The mixture of material composition can form a good module material. The material is also quite resistant to heat and fire, so it is safe and durable to use as a modular panel house material. From these concepts and ideas, the appearance of a space-forming composition with the module system. This module can be developed by the needs and application in the field. The module applied was a simple house module design with type 21 which was developed into three different building units (Figure 6).



Figure 6. Variant unit.

Unit 1 is the standard type 21. This unit is a basic modular for the development of other types of housing units. The structure module used is 3 meters x 3 meters; this is adjusted to the size of a square multiplication that is easy in the division of space. As in the living room which combines two room modules, obtained 4 meters of living room, 1.5 meters of circulation, 0.5 meters of space which is emptied. This module can be developed based on needs in the construction of module houses. Unit 2 is a type 21 unit with vertical upward development (two levels). The module used is a unit 1 type module with the addition of a floor up. With the same module, you will get a living room with sufficient circulation plus the right and comfortable stair access to connect to the upper floor. Additions to this unit are upstairs rooms, balconies, and wider sanitation rooms. Unit 3 has the same modular system as the derivative type. Unit 3 is a home development with a wide landform. In this type, the composition of the house mass is more sideways. The difference in this type is that the house is shorter but wide. The roof system uses a butterfly roof system so that it is more efficient in utilizing rain harvest, while the greenhouse is located next to the front of the building.

4. Conclusion

The modular panel house design was designed through the Architecture and Environment also Climate approaches to Buildings. The concept and idea efforts were raised to produce an efficient and effective house, namely used prefabricated production technology. Several aspects were involved in the design, such as eco-architectural factors and thermal comfort aspects so that in the modular panel house production could pay more attention to the comfort of the surrounding microclimate so that it could have a direct effect in increasing the interest of the community in supporting comfortable residential needs.

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