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Adaptation of the Omah Jawa to the Magersaren Houses Concept in Boro Sumbersari Hamlet UB Forest, Malang Regency, Indonesia

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ABSTRACT

In the several production forest areas on Java island, there are groups of people who live in these areas. They are known as magersari or magersaren. One of the Magersaren settlements is located at Boro Sumbersari hamlet, Tawangargo village, Karangploso, Malang Regency. The area is specifically located in the UB Forest Education and Training area. Unfortunately, like in other places, the Magersaren there lives in inadequate housing buildings. Several things keep them in this situation. Besides the regulation that applies in this zone, the financial situation also becomes a burden. Thus, a feasible residential design concept is needed following the needs of Magersaren settlers and according to the regulations. This research runs qualitatively with a deductive approach. The design concept used the 'Kampung Srotongan', one of the Javanese house types which have been built long ago in this area. The concept of the houses is designed with a pragmatism paradigm. From the analysis, four models adjusted to the number of magersaren's family members. The model uses a modular house concept that is supported by a semi-permanent structural system. The combination of natural (local) and fabricated materials in the model considered improving the effectiveness and efficiency of the development process, especially in inviting CSR programs to get involved.

Keywords: design, Eco-friendly, housing, Magersaren, modular

1. Introduction

In Indonesia, the ownership and management rights of state-owned production forest land are managed by Perum Perhutani (one of State-owned enterprise of Indonesia government). On the island of Java, in the forest area lives a group of settlers who live from processing forest products. They moved around the residential areas according to the forest land that was being managed. The settler became known as magersari or in Javanese accents called *magersaren*. According to the KBBI, *magersaren* can be interpreted as a person who lives on state-owned land and at the same time works the land. *Magersaren* is taken from the Javanese '*pager*' which means fence or boundary, and '*sari*' which means beautiful, core, or not long [1]. In the social life system of rural Javanese people, *magersaren* is pinned on someone who builds a house and living in someone else's yard. The *magersaren* phenomenon in the forest area is basically closely related to the beginning of the implementation of the intercropping system (*taungnya*) in forest management activities in Java [2].

One of *the magersaren* settlements in Malang Regency is in Boro Sumbersari Hamlet, Tawangargo Village, Karangploso District. They live in a production forest area that is currently managed by UB Forest, a business entity owned by Universitas Brawijaya [3]. Under the applicable law [4][5][6], they cannot erect permanent

buildings for their personal interests. This regulation restricts *magersaren settlers* from developing their home buildings. *Magersaren* settlers in Boro Sumbersari Hamlet live in simple house buildings that have a semi-permanent construction system. The building is made by utilizing natural materials (bamboo and wood) from the surrounding forest area. Along with the development of materials, *magersaren* settlers began to take advantage of fabricated materials to beautify their home. One of them is a calciboard board which is used as a material for the walls of the house.

Unfortunately, their current home can be classified as a less livable house. The statement is based on several conditions, such as damaged structural materials and building cuddles. In addition, the majority of houses owned by *magersaren* settlers are also still grounded without floor covering material. These conditions are influenced by several interrelated reasons, such as the lack of knowledge of *magersaren* settlers about materials, financial limitations, and binding regulations.

The *magersaren* settlers in Boro Sumbersari Hamlet are still part of the Javanese tribe. This indirectly affects them in determining their house style. Their houses tend to use Javanese architectural styles, especially Kampung-type *omah* (*Omah* (Jv.) means house). This can be seen at a glance from the shape of the façade and roof of their house. The architectural form of javanese houses does not have curved lines. The construction system uses supports erected on a umpak. It makes the building is easy to dismantle when it is about to be moved. This system became known by the Javanese people as "*bedhol omah*" or moving houses [7]. Such a system is considered adaptable to the design and construction of semi-permanent residential houses, so that the shape and structure can be adapted to the resident's needs.

This study aims to develop the concept of semi-permanent residential houses for them. The concept of a residential house will be taken from the *Kampung*-type of Javanese house (*omah*) that has long developed in the area. Javanese *omah* will experience a process of adaptation to the needs of residents, regulations, and the environment around the settlement. It aims to improve the inhabited qualities for *magersaren* settlers. The concept will be developed without having to move them from the current location of the settlement. This research is expected to be one of the solutions to problems related to the regulation of ownership and their right to settle well.

2. Method

This research was conducted in Boro Sumbersari Hamlet, Tawangargo, Karangploso, Malang Regency. This area is specifically located within the KHDTK Educational Forest (Special Purpose Forest Area) area owned by UB Forest. The actors in this research are *Magersaren* settlers in Boro Sumbersari hamlet, UB Forest. The group numbered 100 people consisting of the age group of toddlers to the elderly. They live in 29 houses scattered throughout the area (see figure 1). Each house has a varying number of family members. Starting from 1 person to the most 6 people in one house.

(a) (b)

Figure 1 (a) Aerial view of *magersaren* settlers; (b) Common-type of houses in Boro Sumbersari hamlet

This research runs qualitatively with a deductive approach. The concept of residential design will use the paradigm of pragmatism. According to Pawitro [8], the pragmatism design paradigm is a process of designing or creating a three-dimensional form based on a *trial and error* process. The process is carried out by utilizing certain materials in such a way as to achieve certain goals.

The research begins by collecting secondary data from literature and case studies. Literature studies are derived from literature and previous research that is still relevant, such as the activities of Eko Prawoto who rebuilt Ngibikan Hamlet after the Yogyakarta earthquake in 2006 [9]. This stage generates theoretical foundations and research variables. The theoretical foundation provides an understanding of *magersaren* settlers, applicable regulations, Javanese *omah*, adaptive vernacular architecture, and practical materials [10][11][12].

Primary data were collected from the study site using observation, documentation methods, and random interviews with settlers. The data is then analyzed to produce information as the basis for the design concept. The analysis process is in the form of spatial program analysis, regulation, to the mass of the building. Information from the results of the analysis will be developed into several alternative structural models. Each alternative model will be compared with its advantages and disadvantages to each other. The best model is then adjusted and refined again in order to answer the problems in the field.

3. Results and Discussion

Design Concept Analysis

Space Program

This analysis was carried out to determine the space needs of the residential house that corresponded to the needs of the Magersaren settlers. The space program includes several analyses, such as the number of occupants, the activities and needs of the space, the amount of space, and the pattern of space relationships. Based on the analysis of activities and space needs, the majority of Magersaren settlers depend on their lives from the production of forest areas. Their profession did not require a specific type of space in their homes. For Magersaren settlers, the house is a place to rest and chat with family. They only need a simple type of space like a living/family room, warehouse for tools, bedroom, bathroom, and kitchen with a dining room. In the analysis of the space size, the standard of space size is taken from the generalization of 29 houses in Boro Sumbersari, UB Forest. Generalization is carried out to obtain an average spatial size so that the design concept can be applied to all Magersaren homes. Table 1 presents the average space size by room type across all 29 houses, which reveals the standard sizes required for each room to meet the functional needs of the residents.

Table 1 Space size average by room type from all 29 houses

No.	Space Type	Space Area (m^2)	
		Analysis Results	**Rounding**
1	Terrace	3,45	3,50
2	Living Room	9,95	10,00
3	Living Room	19,91	20,00
4	Bedroom	7,23	7,50
5	Kitchen + Dining Room	23,86	24,00
6	Bathroom	7,09	7,00
7	Garage + Warehouse	9,92	10,00
Total House Area		81,41	82,00

Based on the analysis of spatial configuration patterns, the *Kampung*-type *omah* generally has a widened shape with a façade on the longest side. Dakung [7] explains that this type is composed of a front room, a living room, and the back room as a chamber (*senthong*) as the highest space hierarchy. The location of the bathroom and kitchen are usually separate from the main building. The central room acts as the center and becomes the link of all spaces.

However, the *magersaren* house has a slightly different configuration pattern. The buildings have diverse configuration patterns and the majority are linear backward, not sideways. There are similarities in forming space hierarchies, such as semi-public spaces (living rooms) are located in the front and private spaces (rooms) are behind them. The service area is usually at the back of the house with a bathroom separated from the main building.

Two alternative spatial configuration patterns can be used in the design concept, that is linear and centralized. First, the linear shape is the most common pattern found in *magersaren* settler houses. Second, is the centralized shape that have found in some houses. Both will have space circulation that merges with the living room, so this space will also act as a link to other space. The living room and family room will be separated to clarify the hierarchy and function of the two rooms. The living room will be the barrier between private space (bedroom) and public space (living room). The service area (kitchen and bathroom) is at the back of the building. However, the linear pattern can be further developed into a building that extends backward, while the center will form a more widened building.

Regulatory Analysis

There are terms and conditions for building structures in the UB Forest area. Until this research is carried out, the applicable guideline is UB Rector's Regulation No. 2 of 2020 concerning Management of Education and Training in UB Forest [6]. Article 25 paragraph 1 explains that buildings built in the area can only be built in a predetermined area. Then in article 25 paragraph 2, it is stated that the total basic area of the building must not exceed than 10% of the forest area, which is 51.4 ha. Article 26 also states that buildings in the UB Forest area should be semi-permanent and environmentally friendly.

In addition, there are additional requirements in managing non-biological sources in the UB Forest area. First, prohibition on reducing vegetation on the land. Second, building requirements include eco-friendly architecture, light and semi-permanent, simple and natural, easy in workmanship and maintenance, space efficiency (multi-function), optimization of natural lighting and scenery, and rainwater harvesting. Third, the use of eco-friendly energy such as solar cells.

In the process of utilizing forest products, *magersaren* settlers are allowed to use pine wood and other decent plants. However, these activities must still be under supervision and permission from UB Forest management. Forest products can be used for the personal benefit of *magersaren* settlers only, not to be traded.

As for building permits, *magersaren* settlers are no longer allowed to build houses on the new site. These 29 houses located in Boro Sumbersari are the maximum number allowed and recognized for their existence by UB Forest management. These houses are entirely their property, but land ownership rights are still held by UB Forest management. *Magersaren* settlers had only the right to borrow land. If any *magersaren* settlers want to build a new house, they will be asked to build it outside the UB Forest area. UB Forest management still allows *magersaren* settlers to carry out renovations, both simple renovations and rebuilding. However, these activities must still be within the knowledge of UB Forest management.

Analyze The Mass of The Building

The physical aspect of the building mass will be associated with regulatory variables [13]. The goal is to show its influence on other variables, such as building materials, structural systems, to the adaptation of the *Kampung*-type *omah* forms. This stage includes the shape and composition of the *Kampung*-type *omah*, materials, structural systems, building enclosures, and utility systems.

In the analysis of forms and compositions, the design concept will adapt the form of the *Kampung*-type *omah*, especially *Srotongan* (see figure 2) with the consideration that this type has long developed in *magersaren* settlements and has a simple shape and accord with the environment. In addition, *srotongan* was chosen as a form of actualization of the local architecture. The adaptation process will not carry out the exploration of new forms and will still maintain the basic shape of the *srotongan*. Adjustments are made to the structural and

material systems. In addition, the shape of the *srotongan* will be adapted to the modular concept. This concept was chosen because it is fast in the construction process, simple structure, and can be built gradually. In addition, modular homes support the concept of a growing house that is adaptive to the needs of its residents over time.

Figure 2 *Kampung-srotongan* type of Javanese *Omah*

(Source: Frick)

In the design concept, the shape of the srotongan will be arranged from modules organized to form a single building. The srotongan is primarily based on the basic form of the Kampung-type omah, with additional space (emper) on both sides. This design uses two types of modules: the basic module (core) and the supporting module (emper). The basic module serves as the main component of the house, supported by four columns (saka), with a roof slope above 30º, and is designed to accommodate communal functions such as living rooms, family rooms, and kitchens. The supporting module, or emper, complements the main module and is smaller in size, with four columns and a roof slope below 30º. This module is intended for more private functions, such as bedrooms and bathrooms, or to fulfill other additional needs, such as terraces, garages, and warehouses.

In material analysis, the building must meet the criteria mentioned in the regulations, such as light, semi-permanent, simple, easy for maintainance [14]. The concept using a combination of natural and fabricated materials in response to these criteria. Pine wood and bamboo are used since it easy found around the area. The fabrication materials used are galvalume, hollow iron, calciboard, fibercement, and paving blocks. This material is used to support the modular home concept while increasing the effectiveness and efficiency in the construction process.

In the analysis of structural systems, the building must have a structure that complies with the regulations, that is, light and semi-permanent. The design concept will adapt the structural system of *bedhol omah* ((Jv.) means dismantling house), but not permanently fastened and easy to disassemble in order to adapt to changing space needs in the future [15].

The existing Magersaren houses use stone foundations (umpak), which comply with regulations but will be enhanced with concrete patch foundations in the design concept. The wooden construction will be replaced with fabricated hollow iron, connected by elbow joints and reinforced with nuts and bolts, to align with the modular house concept. Regarding the floor, while most existing houses have earthen floors or use cement plaster, which raises legal concerns, paving blocks will be used in the new design to ensure compliance and durability. For the building envelopes, materials that are lightweight and easy to disassemble will be utilized. The walls will be constructed with calciboard and bamboo-woven panels (gedhek), which are commonly used in existing structures. Additionally, the clay roof tiles will be replaced with lighter, more durable fiber-cement roofing to enhance the overall efficiency and adaptability of the building.

In the analysis of utility systems, building utility systems must meet the criteria of eco-friendly energy in accordance with regulations. These criteria are needed to minimize the environmental burden provided by the building of the house. The clean water system will maintain the nearest water source and is supported by a rainwater harvesting system to support the water reserves. Then for the power source, it will utilize the electricity network from PLN (State Electrical Company) and is supported by solar panel system. The sanitation waste will be processed into biogas that can be used as fuel reserves to replace LPG gas and firewood. In addition, the dregs from the processing of biogas can also be used as organic fertilizer.

Design Concept

Alternative Models

There are 3 alternative models developed from the results of the previous analysis. All three are adapted to the shape of the *Kampung*-type *omah* particularly *srotongan* type. Alternative models will be compiled from two types of modules, namely the basic module and *emper*. All three have the same structural system and type of material with differences in the shape and size of the constituent modules (see table 2). This difference will affect the amount of space, price, and efficiency of material use.

Table 2 Alternative model structure

		Alternative Models		
		Alternative 1	**Alternative 2**	**Alternative 3**
Module	**Main**	12 m²	12 m²	9 m²
	Illustration			
	Emper	9 m²	8 m²	6 m²
	Illustration			
Advantage		1. The size is not much different from the existing building. 2. More proportional shape	1.The area of the module is not much different from the existing building house. 2.Less material requirements than alternative 1	1.The price is the cheapest. 2.The most efficient module size with the size of the structural material (hollow iron). 3.The shape is more proportional.
Shortage		1. The price is still relatively expensive. 2. The area of the bathroom is too wide.	1.Prices tend to be expensive, but cheaper than alternative 1 2.The overall shape of the house is less proportional because it tends to be long (flattened).	The size of the module is below the average of the existing *magersaren* settler's house.

Based on the comparison, the third model is the model that best suits to the needs. The third model can maximize the efficiency of the use of structural materials, so as to reduce production costs. Although this module has smaller space size, but it is not much different from other alternative models.

Development of Selected Models

The selected model was developed in 4 models of house buildings (model A – D, see figure 8 – 11). The model is divided based on the needs of the bedrooms of its occupants. The least number of residents is 1 person and at most 6 people. Each occupant needs one bedroom and assuming the couple will sleep in one room.

Each model of the house will feature the same types of spaces, but with varying amounts of space depending on the number of residents. The number and dimensions of each room will be adjusted to accommodate the household size. Each space will be interconnected through a centralized and linear configuration pattern. Model A uses a centralized configuration pattern due to its smaller space, while the other models adopt a linear configuration pattern because they offer more space. In Model A, the living room transforms into a linear

corridor that connects all the spaces. This spatial arrangement ensures a consistent hierarchy across all models: the public spaces are positioned at the front, followed by the private spaces behind them, with the service area (bathroom and kitchen) located at the rear of the building. According to Table 3, the total area for Model A is 70 m², with 7 m² for the terrace, 10 m² for the guest room, 20 m² for the living room, 7.5 m² for Bedroom 1, and 24 m² for the kitchen and dining room, among other dimensions. As the models progress to Model D, the area increases, reflecting the greater number of rooms and space allocated, with a total area of 112 m² in Model D. This pattern of space distribution ensures that each model meets the specific needs of the residents while maintaining a functional and adaptable design.

Table 3 The type, amount, and amount of space on the model

No.	Space Type	Standard Space Quantity ()m^2	The Amount of Space on the Model (m^2)			
			Model A	Model B	Model C	Model D
1	Terrace	3,50	7,00	7,00	7,00	7,00
2	Guest Room	10,00	15,00	15,00	15,00	15,00
3	Living Room	20,00	9,00	18,00	18,00	27,00
4	Bedroom 1	7,50	6,00	6,00	6,00	6,00
5	Bedroom 2		6,00	6,00	6,00	6,00
6	Bedroom 3		-	6,00	6,00	6,00
7	Bedroom 4		-	-	6,00	6,00
8	Bedroom 5		-	-	-	6,00
9	Kitchen + Dining Room	24,00	15,00	15,00	15,00	15,00
10	Bathroom	7,00	6,00	6,00	6,00	6,00
11	Garage + Warehouse	10,00	6,00	6,00	6,00	12,00
Total Area			70,00	85,00	91,00	112,00

The overall shape of the house model is arranged from two types of modules, namely the main module (9 m²) and the emper module (6 m²). The module's form is generally adapted from the basic srotongan style. The design concept will combine the main module with the emper module on both sides. These modules will be arranged side by side repeatedly to form a cohesive structure. Where the main module and emper module meet, there is an adjustment system for the structural elements, ensuring the integration of both parts. The two types of modules will be subdivided into several sub-types, with reductions in the column and beam sections to optimize the material usage. As shown in Figure 3, the illustration of the arrangement of modules forming the Kampung Srotongan type, the layout emphasizes the modular nature of the design, allowing for flexibility in the construction process while maintaining structural integrity. The alignment of columns and beams is systematically organized to support the modular concept while ensuring stability and efficiency.

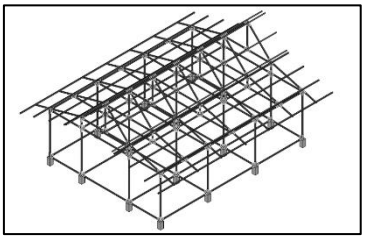


Figure 3 Illustration of the arrangement of modules that form Kampung *Srotongan* type

Figure 4. Module Type illustrates the basic structural components of the house models, with (a) showing the A-C basic module and (b) displaying the A-C emper module. The basic module, which serves as the core unit of the structure, measures 9 m² and houses essential communal functions such as living rooms, family rooms, and kitchens. This module is designed with a steeper roof slope, typically above 30°, and is supported by four vertical columns (saka). The emper module, smaller in size at 6 m², complements the basic module and is used for more private spaces such as bedrooms, bathrooms, or additional functional areas like terraces or warehouses. It has a less steep roof slope, typically below 30°. The design integrates these two modules, with

the basic module forming the central structure and the emper modules flanking it on both sides. The arrangement of these modules allows flexibility in spatial configurations, adjusting to the needs of different family sizes while maintaining a semi-permanent, modular, and adaptable structure.

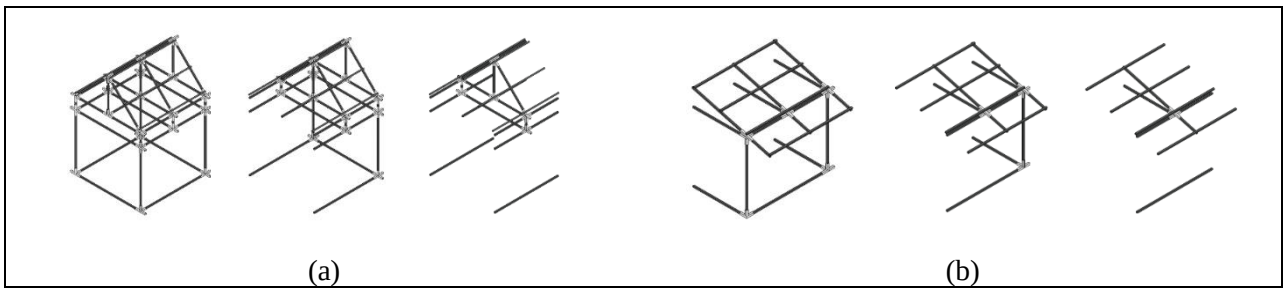


Figure 4 Module Type ((a) A-C basic module; (b) A-C *emper* module)

The structural system of the Magersaren house design is based on a modular approach that combines traditional techniques with modern materials, ensuring adaptability and stability. As shown in Figure 5, the foundation consists of a concrete umpak (stone base) combined with hollow iron (4x4 cm, 1.7 mm thickness). This combination provides strength while maintaining the flexibility necessary for modular and semi-permanent structures. The vertical hollow iron ties the foundation with the upper structural systems, which is crucial for the stability of modular houses that require flexibility. The concrete foundation guarantees durability, even though it is not meant to be permanent, while the iron plate below the umpak ensures fast setting of the concrete mixture, providing a stable base. For the columns and beams, hollow iron (4x4 cm, 1.7 mm thickness) is used, forming the modular frame that can be scaled to accommodate various module types. This flexible design ensures that the structure remains strong enough to meet the specific load requirements of each house. The roof frame, also made of hollow iron (4x4 cm, 1.7 mm thickness) for the ridge, and a thicker steel frame (4x4.5 cm, 0.45 mm thickness) for the batten, ensures roof stability while allowing for easy adaptation to different roof configurations, as shown in Figure 5(c).

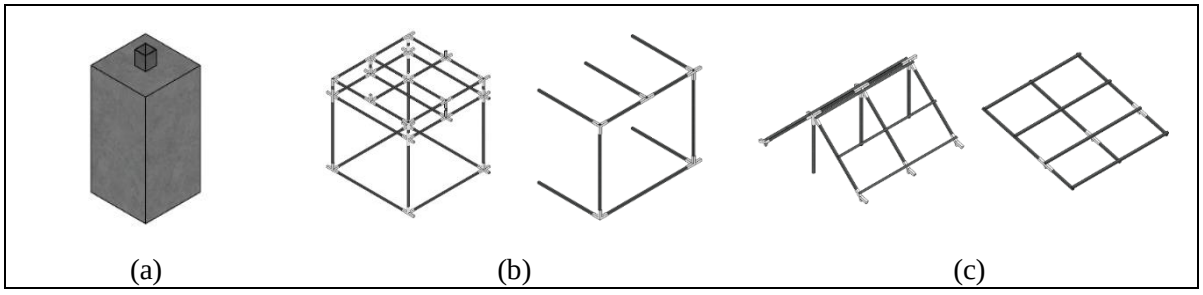


Figure 5 Structural system on module ((a) Foundation; (b) Columns and beams; (c) Roof frame)

The connections between structural components, shown in Figure 6, are made using elbow joints crafted from hollow iron (5x5 cm, 1.7 mm thickness), welded together to ensure strong and secure links between the elements. The use of hexagonal bolts, SDS screws, and GRC screws further enhances the structural integrity, ensuring the frame remains securely fastened while allowing for disassembly when needed. These fastening techniques are vital for maintaining the semi-permanent nature of the housing system, supporting modularity and the potential for future expansions or adjustments.

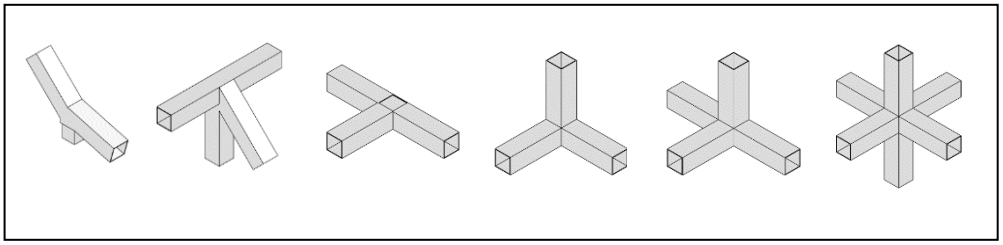


Figure 6 Some types of elbow joints

The materials used reflect an adaptive approach, with both natural (bamboo, pine wood) and fabricated materials (hollow iron, calciboard, fibercement) chosen for their lightness, availability, and compliance with semi-permanent housing standards. This material flexibility allows for a balance between sustainability and practicality, taking into account local resources and regulations. The modular design also enables gradual development, providing flexibility for the Magersaren settlers to expand or modify their homes according to their needs and financial capabilities.

In terms of structural integrity, the elbow joints, bolts, and screws offer a reliable system that facilitates easy disassembly and reassembly. This ensures that the housing remains functional as a modular system, in line with the semi-permanent design ethos, where structures must be adaptable without compromising safety. However, for further clarification, it would be helpful to provide more details on how load is distributed across the modular units, especially with the combination of natural and fabricated materials. Additionally, considering Indonesia's seismic activity, an analysis of how the joints and materials address seismic forces would be beneficial to enhance the design's resilience. A strategy for maintaining the materials, particularly the hollow iron or fibercement roof, in harsh environmental conditions would also help clarify the long-term sustainability of the housing system. In conclusion, the integration of traditional building techniques with modern, flexible materials offers an innovative and practical solution for the Magersaren settlers. The combination of semi-permanent materials and the modular system ensures that the houses can adapt to future needs, while also adhering to the regulatory and financial constraints faced by the settlers.

The building envelopes in the model will be composed of material panels that are easily disassembled, with each part (floor, wall, and roof) customized to meet the specific needs of the module, whether it's for the main module or the emper. The floor will feature various types of paving blocks arranged into panels of different styles and areas, ensuring flexibility. The walls will be structured in panels combining covering materials such as pine-wood planks, gedhek (woven bamboo), and calciboard, supported by mild steel frames. Doors and windows will be made from pine wood, with hollow iron frames for added durability. The roof will be constructed from fibercement panels, grouped based on the size of the module, with the roof type determined by the specific house model. This design, as shown in Figure 7, integrates the floor panels (paving blocks), wall panels (combinations of pine-wood, gedhek, and calciboard), and roof panels (fibercement), ensuring a modular, sustainable housing solution that can adapt to the settlers' needs.

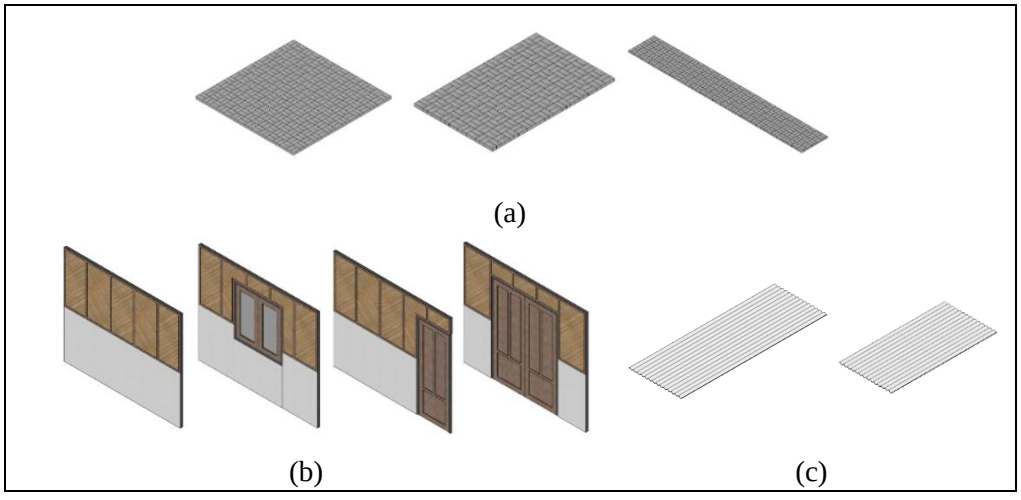


Figure 7 House envelope panels ((a) Floor panels (paving block); (b) wall panels (combinations of pine-wood, *gedhek* and calciboard); (c) roof panels (fibercement roof))

The utility system in the model integrates eco-friendly energy concepts in compliance with regulations. The water system draws from the nearest available source and a rainwater harvesting system, with water flowing by gravity directly to the houses, relying on the hamlet reservoir. The harvested rainwater is stored in a reservoir on elevated ground for toilet flushing and plant irrigation, with horizontal pipelines under the floor and vertical pipes clamped on exterior walls. The electricity supply comes from two sources: the PLN network

and solar panels. The solar panels, installed on the roof, are connected to an inverter in the service area to convert solar energy into electricity. For sanitation, the settlers are encouraged to use the Home Biogas Program (BIRU), converting waste such as sanitation, food scraps, and animal manure into biogas through a reactor. This biogas system, designed to service 2-3 houses, includes two pipelines—one for transporting biogas from the bathroom and the other for distribution to the homes. The integration of these systems ensures sustainable energy use and waste management in line with environmental regulations.

The Schematic Design of The Model

Model A is designed to accommodate 1-3 people using an efficient centralized configuration pattern, as seen in Figure 8 (a) for the plan and (b) for the side view and section. The house consists of 3 main modules, each measuring 9 m², and 6 emper modules, each measuring 6 m², which are arranged modularly to form the entire structure. This centralized pattern allows for more compact and efficient use of space, while still maintaining the basic form of the traditional Kampung Srotongan house type. In the plan, public spaces like the living room are centrally located, flanked by private spaces and service areas such as the bathroom and kitchen. The side view and section show a simple structural composition with a semi-permanent building system that is easy to assemble, using natural materials like bamboo and fabricated materials like calciboard. This model is also designed to meet environmental needs and regulations, with flexibility for future development, in line with the eco-friendly principles applied in the UB Forest area.

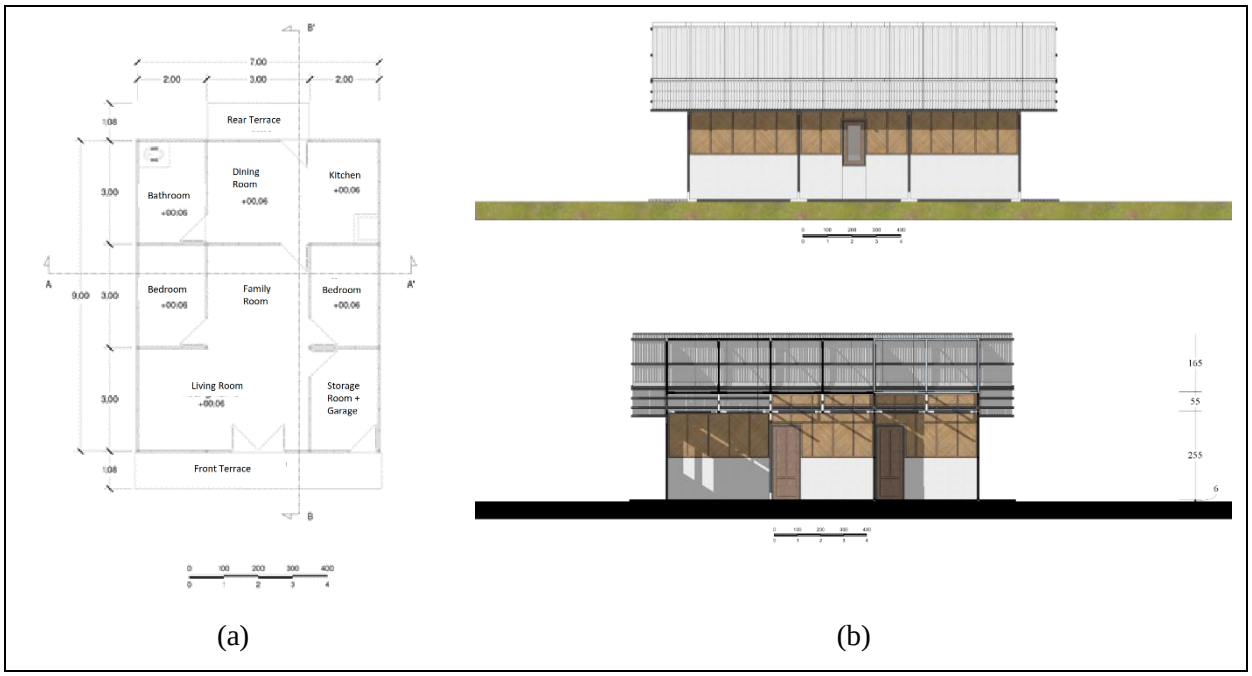


Figure 8 Model A ((a) plan; (b) side view and section)

Model B, designed for 3-4 people, is structured using a modular system to optimize space usage while maintaining a balance between functionality and flexibility. As illustrated in Figure 9 (a) for the plan and (b) for the side view and section, this model consists of 4 main modules (each measuring 9 m²) and 7 emper modules (each measuring 6 m²). The plan adopts a linear configuration pattern, which is more appropriate for a slightly larger space, offering a clear separation between public, private, and service areas. The living room, as a central public space, is positioned at the front, leading to the private spaces such as bedrooms at the back. The service area, including the kitchen and bathroom, is located at the far end of the house, ensuring a practical layout for daily activities. The side view and section reveal the structural components of Model B, showcasing a semi-permanent structural system that is easy to assemble and disassemble, in line with the bedhol omah tradition. The use of lightweight materials such as bamboo and fabricated materials like calciboard and fibercement roof allows for easy construction and maintenance, while ensuring sustainability and eco-friendliness, which are crucial for this model. The modularity of this design allows future adaptations, catering to the evolving needs of the occupants. Overall, Model B offers

a scalable solution for small families or households with 3-4 people, combining simplicity, practicality, and environmental responsibility.

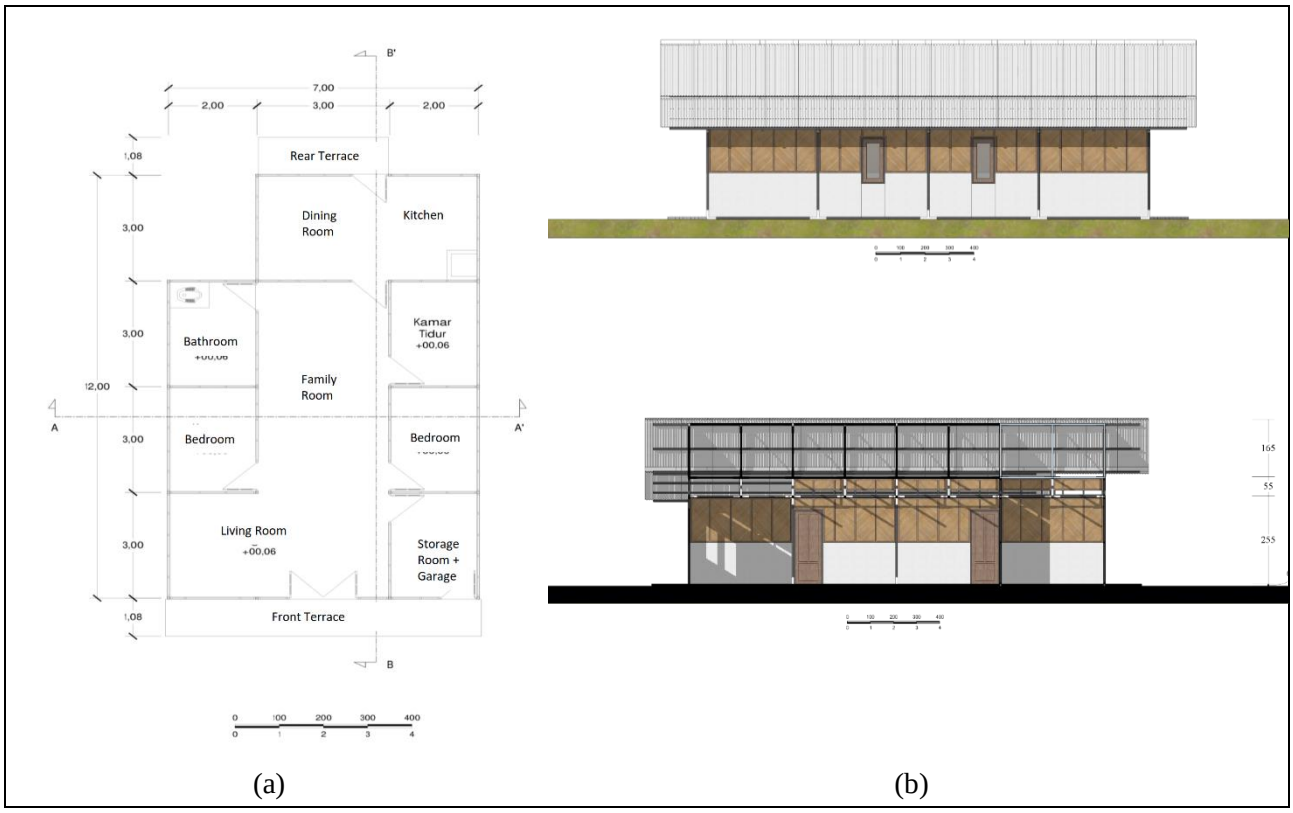


Figure 9 Model B ((a) plan; (b) side view and section)

Model C, designed for 4-5 people, is an evolution of the modular housing concept, providing more space while maintaining efficiency and adaptability. As shown in Figure 10 (a) for the plan and (b) for the side view and section, this model consists of 4 main modules (each 9 m²) and 8 emper modules (each 6 m²). The layout adopts a linear configuration pattern, which works well with the larger space requirements of this model, ensuring a practical flow between the public, private, and service areas. The living room, as a communal space, is located at the front, followed by bedrooms and private areas, with the service spaces—kitchen and bathroom—positioned at the rear of the house. This layout is designed to accommodate a family with 4-5 people, providing adequate space for privacy and communal living. The side view and section further detail the structural aspects of Model C, highlighting the semi- permanent construction system based on the bedhol omah design. The use of lightweight materials, such as bamboo and fabricated materials like calciboard, allows for a robust yet flexible structure. The system is designed to be simple, easy to assemble, and disassemble, aligning with the principles of eco-friendly construction. These materials contribute to the durability and ease of maintenance of the house while also meeting the regulatory requirements for sustainability. The design also allows for future extensions, making it adaptable to the needs of the occupants as their family grows. Model C, therefore, provides a balanced solution for families requiring more space, maintaining functionality, sustainability, and scalability.

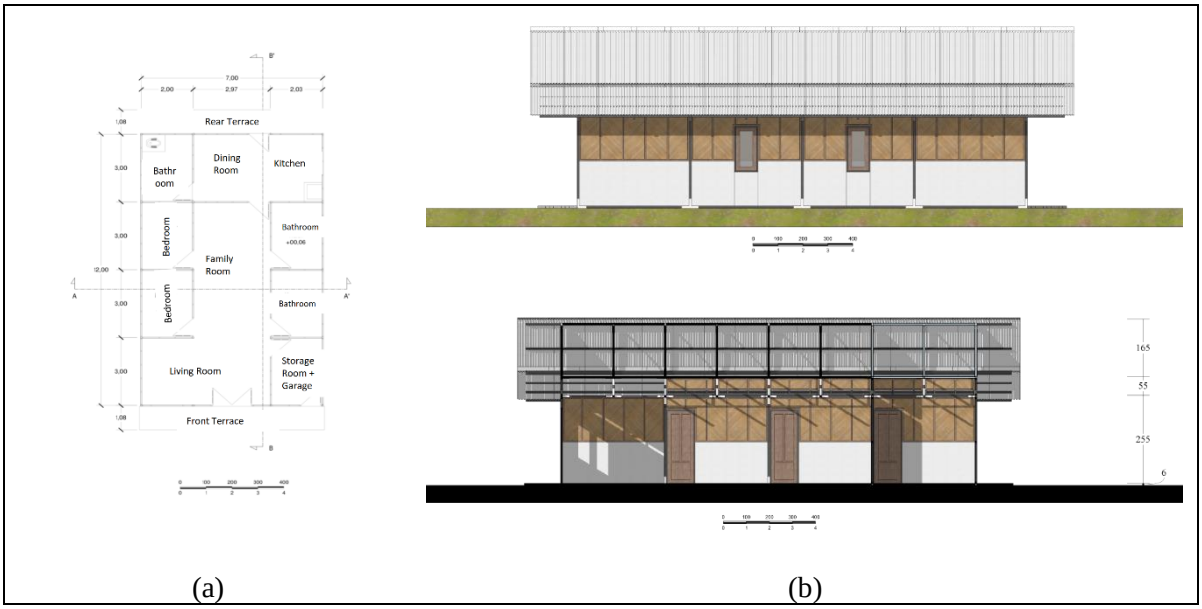


Figure 10 Model C ((a) plan; (b) Side view and section)

Model D, designed to accommodate 5-6 people, offers the most expansive design in the modular housing series, providing ample space for larger families while maintaining efficiency and adaptability. As depicted in Figure 11 (a) for the plan and (b) for the side view and section, Model D consists of 5 main modules (each 9 m²) and 10 emper modules (each 6 m²). The layout employs a linear configuration pattern, which efficiently organizes the space, ensuring a clear division between public, private, and service areas. The living room serves as the central public space, located at the front of the house, followed by the private areas, including the bedrooms, and the service spaces, such as the kitchen and bathroom, which are situated at the rear of the building. The side view and section diagrams illustrate the semi-permanent structural system, which is designed based on the bedhol omah principle, offering flexibility and ease of construction and deconstruction. This approach aligns with the need for a modular, eco-friendly structure that uses lightweight materials, such as bamboo, alongside fabricated materials like calciboard and fibercement for the roof. These materials are chosen for their practicality, ease of maintenance, and sustainability, meeting the environmental requirements outlined in the design regulations. Model D is adaptable, allowing for future extensions or adjustments as the family's needs evolve, ensuring it can continue to serve as a functional and sustainable living space for a growing family. Overall, Model D offers a spacious, scalable, and eco-conscious housing solution for larger households, combining comfort, efficiency, and flexibility.

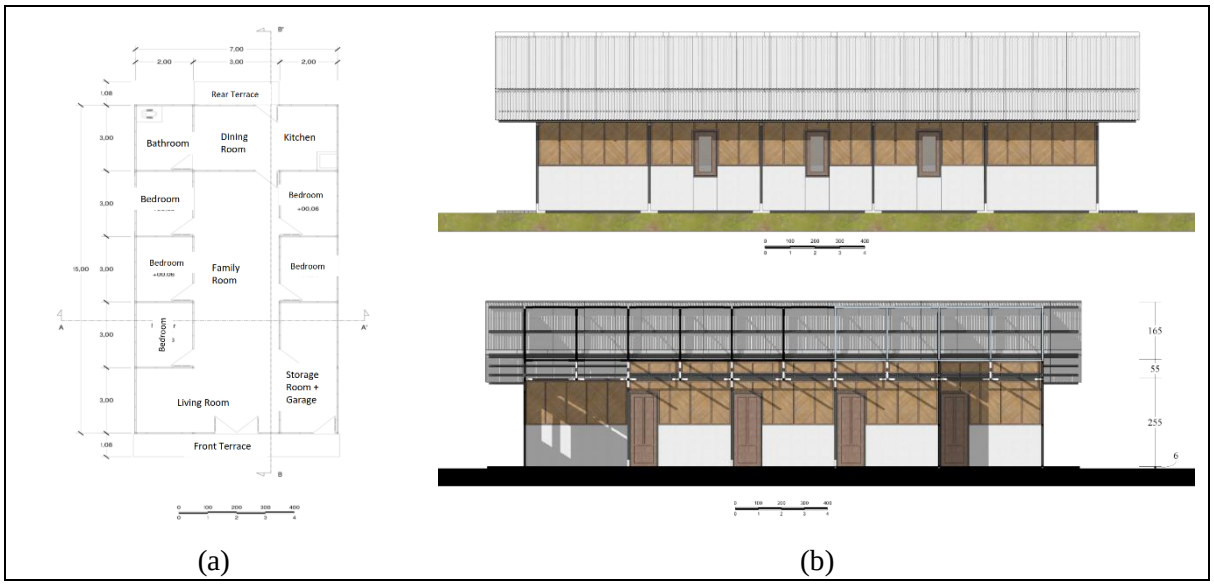
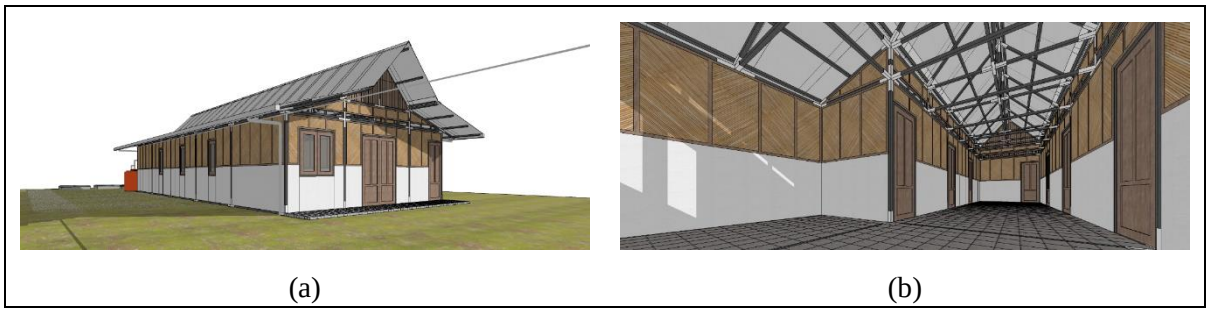


Figure 11 Model D ((a) plan; (b) side view and section)

The exterior and interior perspectives of the model, as illustrated in Figure 12 (a) for the exterior and (b) for the interior, provide a comprehensive view of the design's aesthetic and functional aspects, offering insight into how the structure integrates with its environment and meets the needs of the occupants. In the exterior perspective (Figure 12a), the design emphasizes simplicity and adaptability, reflecting the traditional Kampung Srotongan style, with a modern twist that utilizes modular components. The house features clean lines and a straightforward form, built with a combination of natural materials, such as bamboo, and fabricated materials, like calciboard and fibercement, ensuring durability while maintaining an eco-friendly approach. The exterior showcases the semi-permanent structural system, which allows for ease of construction and disassembly, adhering to the requirements for sustainability and flexibility. The design ensures a balance between functionality and visual appeal, blending with the natural surroundings while offering an adaptable and scalable housing solution for the settlers. In the interior perspective (Figure 12b), the space is organized to optimize the living experience for the inhabitants, offering a functional layout that separates the communal and private areas. The central space, which serves as the living room, is spacious and connects seamlessly with the other rooms, allowing for fluid movement throughout the house. The use of natural light is maximized, thanks to the open plan and the modular nature of the design, which enables easy adjustments to the layout as needed. The interior also emphasizes practicality, with space-efficient storage and multi-purpose areas that cater to the everyday activities of the residents. The interior is simple yet functional, providing comfort and adaptability while maintaining the principles of sustainable and eco-friendly design. Overall, the perspectives highlight the model's ability to offer a flexible, functional, and aesthetically pleasing living space, suitable for the evolving needs of the settlers.



(a) (b)

Figure 12 Model perspective ((a) exterior; (b) interior)

Technics and Development Methods

In the building process, the model will be built in several stages. This approach is carried out so that the *magersaren* settlers can still live in the old house buildings, when the model construction process is in progress. They can arrange the process and complete it according to their needs and financial capabilities.

The development stage is divided into 2, namely the planning and implementation stages. The planning stage begins with determining the model of the building that suits the needs of the *magersaren* settlers. The plan of the selected model will be adapted to the conditions of their site. These adjustments include determining the foundation point, the location of the utility system, and the order in which the parts of the existing house will be dismantled first. They are recommended to sequentially disassemble from the service area, the central part of the house, to the façade.

The implementation stage begins with preparing construction materials and equipment. This stage is assumed that each part of the module has been prepared according to the specified size and quantity. *Magersaren* settlers can build their own houses in mutual aid. The construction of the module does not require special skills. The assemble process is easy and only requires the cohesiveness and cooperation between the *magersaren* settlers. The process begins with preparing the condition of the site. After that, the modules of the structure are arranged sequentially from the foundation, columns, beams, to the roof frame. Installation of the utility system will be carried out simultaneously with the preparation of the structure modules. The last stage is the installation of the enclosing panels of the building, that is the floor, walls, and roof.

Built Model Development Project (Grow House)

The concept of growing and modular houses gives *magersaren* settlers the opportunity to develop their homes after the first construction. This concept gives them a chance to develop their homes according to their needs and funds. However, there are some notes and recommendations so that the building remains relevant and able to meet the needs of its residents.

First, *magersaren* settlers can develop their homes according to the recommended plan. Basically, model A can be developed into model B and so on. Second, they can explore forms and designs beyond recommendations. Building modules and enclosing panels give occupants the freedom to choose, arrange, and swap the positions. But on condition that the size of the panels and structure modules remains in accordance with each other.

However, *magersaren* settlers can still develop their house without using modules from the design concept. They are advised to keep using semi-permanent materials in order to remain in accordance with regulations. As for the connection part between the module and the new building, they are advised to use bolted and screw joints. Such materials can help maintain the flexibility of the module structure.

Cost Budget Plan (BOQ)

The compiled Bill of Quantities (BOQ) presented in the document covers material prices in Malang Regency for September-October 2021. It is important to note that the cost of construction services is excluded, as it is assumed that the construction process will be carried out by the settlers themselves through a mutual aid system. Additionally, the BOQ does not include utility costs, such as the installation of solar panels, cable networks, latrines, bathtubs, and other similar fixtures. The table in Table 4 provides a detailed breakdown of the costs required to build each of the models resulting from the schematic design. The costs vary depending on the number of modules and the total area of the house. For example, Model A, which consists of 3 main modules and 6 emper modules, has a total area of 70 m² and costs IDR 49,063,060 to build. In contrast, Model D, the largest model with 5 main modules and 10 emper modules, has a total area of 112 m² and costs IDR 75,679,661. These figures reflect the materials required for each model but do not account for labor or utility installations, offering a clear overview of the material costs involved in constructing the houses based on the schematic design.

Table 4. The BOQ of all models

No.	Model	Number of Modules	Total Area ()m^2	Total Model Price
1	A	3 main, 6 *emper*	70	IDR 49,063,060
2	B	4 main, 7 *emper*	85	IDR 58,766,119
3	C	4 main, 8 *emper*	91	IDR 62,710,964
4	D	5 main, 10 *emper*	112	IDR 75,679,661

4. Conclusion

The *magersaren* settlers in Boro Sumbersari, UB Forest needed a decent house to live in. However, the house must still be in accordance with applicable regulations, such as being semi-permanent and implementing eco-friendly construction. This research created a house design concept adapted from the Javanese *omah* type (*Kampung srotongan* style). From the analysis, finally decided the basic shape of the building consist of two basic modules, namely the main module (3x3 m) and the *emper* (2x3 m). The modular concept allows *magersaren* settlers to build their houses in several stages according to the needs and financial capabilities. The structural system in the design concept is semi-permanent which is adapted from the concept of *bedhol omah* as the response to applicable regulations. The structural system is composed of hollow iron frames connected by elbow joints, bolts and screws. In addition, the design concept uses a combination of natural (pine wood and bamboo) and fabricated materials (paving block, fibercement, calciboard, and hollow iron) to

optimize the potential of resources around the region, while increasing effectiveness and efficiency in the construction process.

The design concept resulted in 4 models of houses adapted to the number of the *magersaren* family in each house. Model A (2 rooms) consists of 3 main modules and 6 *emper* modules. The building has a total area of 70 m2 and can be inhabited by 1-3 people. Model B (3 rooms) consists of 4 main modules and 7 *emper* modules. Model B has a total area of 85 m^2 and can be inhabited by 3-4 *magersaren* settlers. Model C (4 rooms) consists of 4 main modules and 8 *emper* modules. The building has a total area of 91 m^2 and can be inhabited by 4-5 people. Model D (5 rooms) consists of 5 main modules and 10 *emper* modules. The model has a total area of 112 m^2 and can be inhabited by 5-6 people.

5. Acknowledgments

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6. Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article. The research conducted for the design and analysis of the Magersaren housing models in Boro Sumbersari Hamlet, UB Forest, was independent and free from any financial or personal relationships that could have influenced the outcomes of the study. The funding for this research was supported by the Professorship Acceleration Grant of the Faculty of Engineering, Universitas Brawijaya, and there were no external sponsors or parties involved in the design or decision-making process of the study.

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