

Permaculture Building for Porang Plant in Pontianak by Emphasizing on Envelope System Design

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Final Architectural Design Studio Entitled:

DESIGN OF PORANG CULTURE BUILDING

**PERMACULTURE BUILDING FOR PORANG PLANT IN PONTIANAK BY EMPHASIZING ON ENVELOPE SYSTEM
DESIGN**

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01

Design Premise

Chapter 1: Introduction	10
1.1 Background	11
1.1.1 Porang Plant Production and Export Target	11
1.1.2 Pontianak Soil and Climate Condition for Porang Plant	12
1.1.3 Permaculture Building as Commercial Crop Product	13
1.2 Architectural Problem Statements and Goals	14
1.2.1 General Architectural Problem Statement	14
1.2.2 Specific Architectural Problem Statement	14
1.2.3 Goals	14
1.2.4 Benefit	14
1.2.5 Scope of Limitation	14
1.3 Design Method	15
1.4.1 Primary Data Collection Method	15
1.4.2 Secondary Data Collection Method	15
1.4.3 Design Approach Method	15
1.4 Thought Process	16
1.5 Originality and Novelty	17

02

Chapter 2: Design Study	18
2.1 Preliminary Study of Design Theme	19
2.1.1 Porang Planting Characteristics and the Criteria for Growing	19
2.1.1.1 Morphology Description	19
2.1.1.2 Requirement For Growing Porang plants	20
2.1.1.3 Porang Plant Propagation and Growth Phase	21
2.1.1.4 Porang Plant Cultivation Technology and Procedure	22
2.1.1.5 Advice and Strategies for Porang Cultivation	24
2.1.1.6 The Whole Porang Plant Production Process	24
2.1.2 Pontianak Soil and Climate Condition for Porang Plant	25
2.1.2.1 Soil Condition in Pontianak City for Porang Plants	25
2.1.2.2 Climatic Conditions in Pontianak City in Terms of Growing Porang Plants	25
2.1.2.3 Land type categories in Pontianak based on the Table of Land Suitability Criteria for Porang Plants	26
2.1.2.4 Conclusion Table of Pontianak Soil and Climatic Condition Data for Porang	27
2.1.2.5 Design Criteria for Porang Based on the Conclusion Data	28
2.1.2.6 Design Criteria for Porang Based on Each Stage of Porang Growth	29
2.1.3 Permaculture Building for Porang Plant	30
2.1.3.1 Permaculture Approach	30
2.1.3.2 Zone of Use for Porang Permaculture Building	31
2.2 Context Site Study	33
2.2.1 Site Location Selection	33
2.2.2 Site Condition	33
2.2.2.1 Road Conditions Around the Site	33
2.2.2.2 Site Size and Site Condition	33
2.2.3 Pontianak Climate Data	34

Table of contents

2.2.3.1 Air Temperature.....	34
2.2.3.2 Humidity	34
2.2.3.3 Sunlight Intensity	34
2.2.3.4 Rainfall.....	35
2.2.3.5 Wind Rose and Wind Velocity	35
2.2.3.6 Sun Chart.....	35
2.2.4 Map of Facilities and Infrastructure	36
2.2.5 Land Use and Regulations	36
2.3 Early Studies of Typology and Similar Precedent	38
2.3.1 Home Farm (by Sparks).....	38
2.3.2 Farmsphere (urban farming center) in Thailand.....	39
2.3.3 The Havana Food Port's Urban Agriculture	40
Chapter 3: Design Concepts (Concept Design Guideline)	41
3.1 Permaculture Building for Site Plan Design Concept.....	43
3.1.1 Situation and Existing Condition on Site Location	43
3.1.2 Zone Division Analysis Based on Permaculture Building Activities on Site Plan Design.....	44
3.1.3 Zone and Access Plotting Design Analysis on Site Plan for Permaculture Building.....	45
3.2 Permaculture Building for Building Mass Design Concept	47
3.2.1 Analysis of Appropriate Building Mass Orientation for Planting and Processing Area	47
3.2.2 Analysis of Appropriate Building Mass Forms for Planting and Processing Areas	48
3.3 Permaculture Building for Building Room Space Concept.....	53
3.3.1 User Activity Analysis	53
3.3.1.1 Analysis of Porang Agricultural Activities	53
3.3.1.2 Analysis of Porang Manager Activities.....	53
3.3.2 Space Requirements Analysis for Permaculture Building.....	53
3.3.3 Spatial Relations and Spatial Organization	54
3.3.3.1 Spatial Relationships (Bubble Diagrams).....	54
3.3.3.2 Spatial organization in Porang Permaculture Building with permaculture zoning approach (Zoning Diagrams).....	54
3.3.4 Development on Plotting Design for Room Space in Building.....	55
3.3.5 Initial design of building mass and site plan	56
3.4 Permaculture Building for Building System Concept (Building Utility System Analysis)	57
3.4.1 Utility Systems for Porang Plant Nutrition and Water Requirements in Porang Culture Buildings.....	57
3.4.1.1 Water Needs Fulfillment System in Porang Permaculture Building.....	57
3.4.1.2 Gray Water Treatment System in Porang Permaculture Building	57
3.4.1.3 Plant Nutrition System	57
3.4.1.4 Spatial Planning for Porang Planting Media	59
3.5 Permaculture Building for Building Envelope Design Concept	60
3.5.1 Design Concept for the Shape of the Roof in Accordance with the Needs of Each Function of the Building	60
3.6 Building Skin Technology for Room Space Design Concept.....	62
3.6.1 The division of each building facade design for each room function.....	62
3.6.2 Façade design for Porang Planting Area.....	63

04

3.6.2.1 Facade design for North and South directions for Porang Planting Area.....	63
3.6.2.2 Facade design for East and West directions for Porang Planting Area.....	65
3.7 Building Skin Technology for Building System Concept	68
3.7.1 Building Skin Technology for Building System Concept in each rooms.....	68
3.7.1.1 Building System Concept for natural lighting systems and air ventilation in building.	68
3.7.1.2 Concept of the building system in the facade design 1, 2, and 3.	69
Chapter 4: Design Development	71
4.1 Site Plan Design for Permaculture Building	72
4.1.1 Site Plan Design Response on Situation and Existing Condition on Site Location	72
4.1.2 Zoning division on Site Plan Design	72
4.1.3 Distribution of Access and Placement of Building Mass in Site Plan Design.....	73
4.2 Building Mass Design for Permaculture Building	75
4.2.1 Proper Building Mass Orientation Design for Planting and Processing Areas.....	75
4.2.2 Proper Building Mass Forms Design for Planting and Processing Areas.	76
4.3 Room Space Design for Permaculture Building	79
4.3.1 Plotting Design for Room Space in Buildings based on Functions, Activities, and Relationships Between Spaces.	79
4.4 Room Space Design for Building Skin Technology	81
4.4.1 The division of each building facade design for each room function.....	81
4.5 Building System Design for Permaculture Building	84
4.5.1 Water System Needs Fulfillment Design in Porang Permaculture Building.....	84
4.5.2 Porang Plant Nutrition System Design	84
4.5.3 Design of Spatial Planning for Porang Planting Media	85
4.6 Building System Design for Building Skin Technology	86
4.6.1 Building Skin Technology design in each Room Space based on the function of the room.....	86
4.6.1.1 Building Skin Technology design on the facade design 1.....	86
4.6.1.2 Building Skin Technology design on the facade design 2.....	86
4.6.1.3 Building Skin Technology design on the facade design 3.....	87
4.6.1.4 Building Skin Technology design on the facade design 4.....	87
4.7 Building Envelope for Permaculture Building	88
4.7.1 Design the appropriate roof shape for the Porang planting area.....	88
4.7.2 Building Skin Technology design on the facade design for the Porang planting room.....	89
4.7.2.1 North and south facade designs for the Porang planting room.....	89
4.7.2.2 East and west facade designs for the Porang planting room.....	91
4.7.2.3 Facade designs for the Heating/drying room.....	91

05

Chapter 5: Design Testing	93
5.1 Determining What Porang's Growth Factors Will Do To Test The Design.....	94
5.1.1 Design testing on the sunlight intensity factor with SunTool simulation	95
5.1.1.1 Design testing on the north and south facades of the Porang planting room	95
5.1.1.2 Design testing on the east and west facades of the Porang planting room	98
5.1.1 Design testing on the sunlight intensity factor with Velux simulation	101

06

Chapter 6: Evaluation of Design Results.....	103
6.1 Conclusion Evaluation from Supervisor and Examiner Lecturer.....	104
6.1.1 Supervisor.....	104
6.1.2 Examiner Lecturer.....	104

Reference	119
------------------------	------------

Attachments	120
--------------------------	------------

01

Figure 1 – 7

02

Figure 8 – 45

03

Figure 46 – 110

04

Figure 111 – 158

05

Figure 159 – 162

01

-

02

Table 1 – 14

03

Table 15 – 23

04

-

05

Table 24

Design

Premise

Design Premise/Abstract

In Pontianak City, the production of Porang is still very low and rare, due to the fact that the type of soil in Pontianak is dominated by peat soil which has a high acid level. This land is not suitable for growing agricultural crops including Porang. Considering that the criteria for planting Porang plants have not been sufficiently met for the Pontianak area, especially because the type of land and the climate requires a little adjustment to the conditions for growing Porang plants, special treatment is needed so that Porang plants can continue to grow. In the city of Pontianak itself, the Porang farming community already exists but the Porang farmers in Pontianak have difficulty producing this type of plant due to several obstacles, such as the condition of the soil whose PH level must be modified first to make it neutral. With this project, it is hoped that the government can provide a pilot project to the people of Pontianak and the Porang farming community in West Kalimantan, so that they can provide education in improvising themselves on how to grow Porang indoors. On the other hand, the Porang plant itself is a plant that has a very high selling value when exported to neighboring countries such as Malaysia which is one of the third largest Porang export market shares which is directly adjacent to the West Kalimantan region, Pontianak. Pontianak as an area that is not possible to plant Porang plants has potential and challenges to the design of agricultural building development plans. To overcome this, the architectural design and design method obtained a concept with a permaculture approach by emphasizing the building envelope system, so it's able to regenerate itself within the environmental scope contained in the permaculture farming system. Permaculture building for Porang plants requires special handling in creating an artificial climate inside of the building that adapts to the growing conditions for Porang plants, so that the performance and modification of the building envelope design as the most important element of the building is highly emphasized. Architectural issues that will be resolved in this design case include the need for the appropriate intensity of sunlight, humidity, temperature, and water distribution systems in the building. By considering these aspects, it is expected to be able to increase the productivity of Porang plants.

Keyword: permaculture building, porang planting, Pontianak climate, building envelope system



Chapter

01

Introduction

1.1 Background

1.1.1 Porang Plant Production and Export Target



Figure 1. Image of Porang Plant
Source: m.tribunnews.com

The trend of farming Porang plants has recently become a prima donna among Indonesian farmers, as well as export materials and domestic manufacturers. This plant is one of the promising food ingredients and has a high value. Porang plants are root crops of the species *Amorphophallus muelleri*. This plant is a type of tuber plant. This plant is a shrub (herb) that can be found growing in tropical and sub-tropical areas (Dewanto and Purnomo, 2009). Porang can grow in the shadow, therefore it can be used as an intercrop between different types of woody plants or trees in an agroforestry system. Meanwhile, ecologically, this type of plant grows sporadically in the forest as a wild plant. Porang plants grow well at an altitude of 100-600 m above sea level. Porang growth can grow on all types of soil at a pH of 6 - 7 (neutral), and grows well on loose soil and is not waterlogged. The environmental conditions needed for Porang plants to grow are temperatures of 25-35 °C, and rainfall between 1000-1500 mm/year. Jansen, et al. (1996) in Purwanto (2014) explain that Porang plants also require shade, which is about 40-60% light intensity. So that the designed building envelope must be designed to suit the growing conditions of the Porang plant.

National Porang tuber production until 2020 is still 19,950 ha equivalent to 200,000 tons. Meanwhile, Indonesia's Porang exports in 2020 were recorded at 8,570 tons with a total value of US\$19,645,620 from an export market opportunity of 13.28 million tons or 300 thousand hectares of Porang plantations were needed and following up on the direction of the Indonesian President Joko Widodo at the Limited Meeting on the Development of Bird's Nest Cultivation. Swallow and Porang Plants. The Ministry of Agriculture through a 300% export increase program, to increase the country's foreign exchange during the COVID-19 pandemic, was issued Minister

of Agriculture Decree No. 104/ KPTS/HK.140/M/2/2020, Porang plant is one of the targeted commodities from the Directorate General of Food Crops from the type of nuts and tubers (Budiono, 2021). Therefore, the government's effort as a solution to help achieve the target and increase the production of Porang plants is to apply alternative options by designing agricultural buildings in areas where the type of land does not allow agricultural crops to be planted, such as in West Kalimantan, Pontianak.

The Indonesian porang export market is dominated by three major countries, one of which is Malaysia. Malaysia, which is a country directly adjacent to West Kalimantan, is the country that receives the third largest export of Porang plants out of a total of ten Porang export destinations. So that the city of Pontianak as a trading city center and the capital city of West Kalimantan has the opportunity and potential to be used as a strategic Porang plant production center by providing Permaculture building facilities.

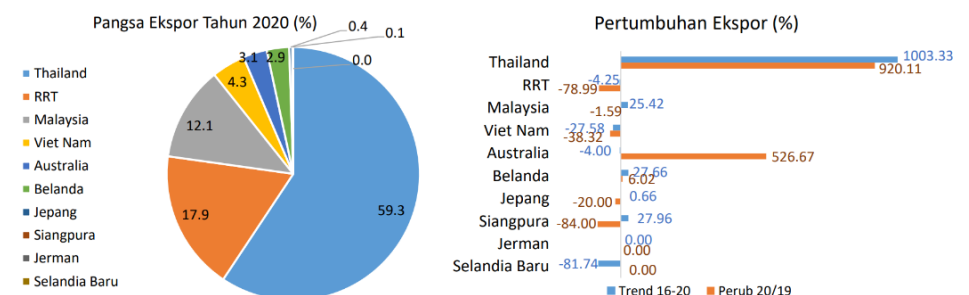


Figure 2. Chart of Indonesian Porang Export by Destination Country
Source: Trademap KBRI Tokyo, 2021

When viewed from the export capability of Indonesian Porang products, Indonesia's exports in 2020 only reached USD 3.1 million, or decreased by 12,7% compared to its exports in 2019. Nevertheless, export growth during 2016-2020 experienced a significant upward trend of 18,4% per year. The Indonesian Porang export market is dominated by Thailand with a share of 59,3% of Indonesia's total Porang exports in 2020, followed by China with an export share of 17,9%, Malaysia at 12,1%, Vietnam at 4,3% and Australia by 3,1%. Exports of Porang plants from Indonesia to Malaysia increased by 25,42% (Trademap KBRI Tokyo, 2021). So that the value of export growth is expected to provide opportunities to increase market demand for Porang production in Malaysia by exporting directly from the West Kalimantan region, Pontianak City.



Figure 3. Porang culture building project
Source: author

Ownership of the Porang Culture Building project is the Department of Agriculture and Food of the City of Pontianak, and the People of Pontianak City especially Porang farmer in Pontianak who will manage the project. Determination of ownership is done because the emergence of Porang farming communities in Pontianak as a result of the trend of planting Porang which provides a lot of benefits. On the other side, it provides the potential to export processed Porang products to neighboring Malaysia, due the location of the project is directly adjacent to the State of Malaysia, so that the export process is much more potential and profitable.

1.1.2 Pontianak Soil and Climate Condition for Porang Plant

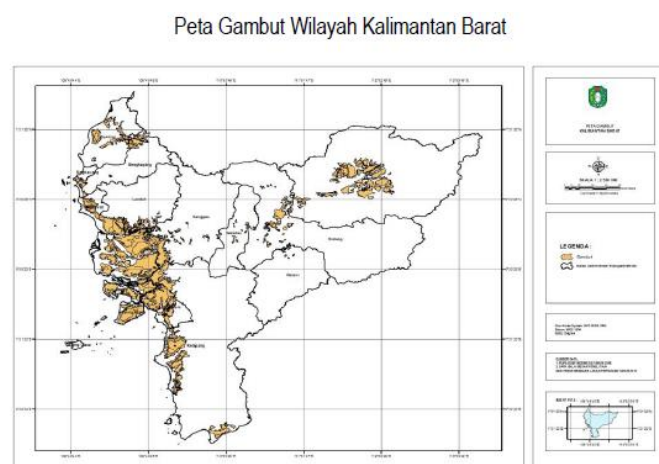


Figure 4. Image of West Kalimantan peatland map
Source: West Kalimantan Province Government

This plant has various benefits and its derivative materials can be used to produce various industry products. So that Porang plant are widely exported to foreign markets in several countries. In the city of Pontianak itself, Porang plants are still relatively scarce and poor in production. In fact, it is nearly hard to plant Porang plants in the area, because the

geological conditions in Pontianak City are included in the category of penepanting areas and alluvial sediments which are physically a type of clay.

This type of soil is in the form of peat, former mud from the Kapuas river. Under these conditions, the existing soil is very unstable and has a very low bearing capacity. Then the soil types in Pontianak City consist of Organosol, Gley, Humus and Alluvial soil types with different characteristics from each other. In areas of peat soil, the thickness of peat can reach 1-6 meters, causing poor soil bearing capacity if it is intended to construct large buildings or to use it as agricultural land (BAPPEDA Pontianak City).

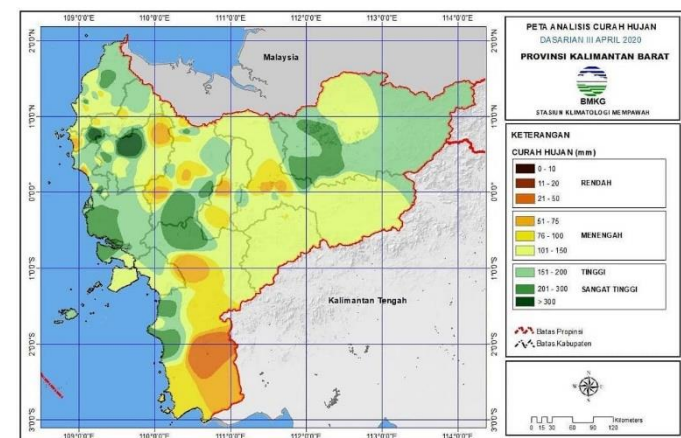


Figure 5. Image of West Kalimantan Province Rainfall Analysis Map
Source: BMKG Mempawah

Considering that the criteria for planting Porang plants in the Pontianak area are not met. In particular, the type of soil in Pontianak is characterized by peat soil, where the peat soil itself has an acidic pH level, so agricultural crops cannot be grown in this location (BAPPEDA Pontianak City). Meanwhile, the temperature in Pontianak City has a temperature ranging from 28 - 32°C which is sufficient to meet the requirements for growing Porang plants. But there must still be a building envelope arrangement in agricultural buildings so that the temperature inside the building remains stable to grow Porang plants. In addition, the setting of the building envelope design must also pay attention to the level of intensity of sunlight, considering the intensity of sunlight needed is around 40-60%, while in Pontianak, the intensity of sunlight is very high and hot. Then in Pontianak, the rainfall rate is between 3000 - 4000 mm/year, so it is not suitable for Porang plants whose habitat has a rainfall rate of around 1000-1500 mm/year (Sari and Suhartati, 2015). For this reason, it is necessary to evaluate the water distribution performance system in agricultural buildings so that the volume of water in the soil does not affect the productivity of the Porang plant. Pontianak City, as an unlikely

place to cultivate Porang plants, has both possibilities and challenges in terms of agricultural building design. This indicates the need to complete an agricultural system that is able to regenerate itself within the environmental scope contained in the permaculture farming system.

1.1.3 Permaculture Building as Commercial Crop Product



Figure 6. Image of indoor plant growing system with temperature control inside
Source: hortamericas.com

Permaculture is a movement aimed at facilitating many aspects of human life through technological innovation. Permaculture aims to keep humans from being greedy in their exploration of natural resources while also paying regard to the environment's sustainability (Ward, 2017). The concept of permaculture has been widely utilized in various design facilities in multiple related research. The study's design facilities, on the other hand, focused on the application of the permaculture idea in the tourism sector. Few people describe how to apply permaculture principles to agriculture. Permaculture, on the other hand, is a notion that emerged from the agricultural system itself. As a result, the permaculture concept is applied to the Porang agricultural building in this design, which is a permanent area for Porang plant production in a location where Porang plants cannot be grown on that land type, which is located in Pontianak, West Kalimantan.

A Porang agricultural building's design considers not only how to organize the agricultural area that will be developed, but also how to place the necessary agricultural buildings in the facility so that they may function as a unit that is integrated. Buildings on this agricultural land must be designed in such a way that they do not degrade the current conditions of the chosen site, preserving the authenticity of the built environment's appearance. This is consistent with Bill Mollison's (1979) comment in his book on the design of permaculture

applications. As a result, permaculture principles must be used to guide the design of this institution, both in terms of site and building layout.

The permaculture concept will be applied to the design of Porang agricultural buildings in Pontianak, putting more focus on zoning. Furthermore, the zoning will be linked to the concept's use in outer space as well as the building's appearance in terms of design function. As a result, it appears that using the concept of permaculture, both outdoor space and infrastructure in the form of buildings can be connected to one other. The application of the permaculture concept relies heavily on zoning. This is because permaculture zoning theory divides it into various pieces to make the planning and layout process easier.

For this regard, Permaculture Building for Porang plants is needed in order to meet the target of the Indonesian government to export Porang plants to foreign markets, especially in this case is to expand Porang export market share to Malaysia through the Porang production center in Pontianak City, West Kalimantan. So that the government's export target is met and the export process of Porang from Indonesia to Malaysia becomes easier, faster, efficient and sustainable. Then considering the soil and climatic conditions in Pontianak City which are not sufficient to allow planting, this facility requires special treatment in terms of design planning to achieve this target. Permaculture building for Porang plants requires special handling in creating an artificial climate inside of the building that adapts to the growing conditions for Porang plants, so that the performance and modification of the building envelope design as the most important element of the building is highly emphasized. Architectural issues that will be resolved in this design case include the need for the appropriate intensity of sunlight, humidity, temperature, and water distribution systems in the building.

1.2 Architectural Problem Statements and Goals

1.2.1 General Architectural Problem Statement:

- How to design a Porang agricultural building that is able to regenerate itself within the environmental scope in Pontianak contained in the permaculture farming system?

1.2.2 Specific Architectural Problem Statement:

- How to design an integrated Porang permaculture building in response to the physical and climatic conditions in Pontianak?
- How to arrange the building envelope for porang cultivation in the building to create an artificial climate that is suitable for the growing conditions of the Porang plant?

1.2.3 Goals:

- To design a permaculture building for Porang plant in response to the physical and climatic conditions in Pontianak.
- To arrange the appropriate building envelope for Porang plant inside of the building by adjusting the need to grow Porang plant.

1.2.4 Benefit:

With the Permaculture Building Porang Design, it is hoped that it will expand the potential of architects to develop agricultural buildings in areas where it is not possible to plant certain crops; provide benefits and pilot projects for the farming community in Pontianak; and achieve the export target of Porang plants set by the Indonesian government, so that it can help improve Indonesia's economy and food security that is reliable and sustainable in the future. As well as creating an agricultural building that can increase human awareness about the importance of the natural environment by applying the Permaculture design approach to design as an effort to strengthen the relationship between humans and nature.

1.2.5 Scope of Limitation:

• Porang plant

The design of this permaculture building will focus on the need for Porang growth in the building, as well as propagation in the production of Porang tubers as the main export raw material and processed products, such as flour and porang rice.

• Building envelope

The design of the building envelope in this case must be in accordance with the requirements for growing porang plants

which include architectural issues in the form of the need for the appropriate intensity of sunlight, humidity, temperature, and water distribution systems in the building.

1.3 Design Method

To collect information and data related to the problems to be analyzed, two design methods are used, namely primary and secondary methods.

1.4.1 Primary Data Collection Method

This method was used to find and analyze data directly from the results of survey activities, observations, questionnaires, and personal interviews with data in the field. This primary data collection includes site location data in Pontianak City, West Kalimantan which has been evaluated previously. This primary data will be used as a reference in designing and looking for design problems to be solved. Primary data taken is climate data in Pontianak which consists of temperature, humidity, precipitation, and lighting level.

1.4.2 Secondary Data Collection Method

The secondary data collection method was carried out by taking data and documents from several sources indirectly from previous parties and then re-examining them, namely in the form of theories related to the concept of Permaculture and specifications of peatlands through literature references, journals, articles, and related precedents. In addition, studies related to planting and the criteria for planting Porang plants were also carried out to provide data and information in matching and processing information in designing agricultural buildings according to the criteria for planting Porang plants. The data obtained were then analyzed by determining a design solution based on the permaculture concept.

1.4.3 Design Approach Method

The use of architectural design and planning methods will focus on applying the concept of Permaculture in the design of agricultural buildings which are motivated by the export of Indonesian Porang agricultural materials and agricultural problems that are not suitable for planting Porang plants on peat land types and the climate, namely in Pontianak City, West Kalimantan. This study also refers to applied research as a research study with the aim of producing applicable actions for solving certain problems (Putryana et al., 2020) in (Saputro, 2018). The ideas of ecological thinking are applied in the permaculture design approach, and spatial reasoning procedures are used to examine site characteristics (Ferguson, 2013). The emphasis on site uniqueness (reaction to

the microclimate), interactions between components (connected to zoning), and spatial design are the most distinguishing features of permaculture. The zoning part of permaculture design is the point at which the link between space functions is determined. The emphasis on site uniqueness (reaction to the microclimate), interactions between components (connected to zoning), and spatial design are the most distinguishing features of permaculture. The zoning part of permaculture design is the point at which the link between space functions is determined.

1.4 Thought Process

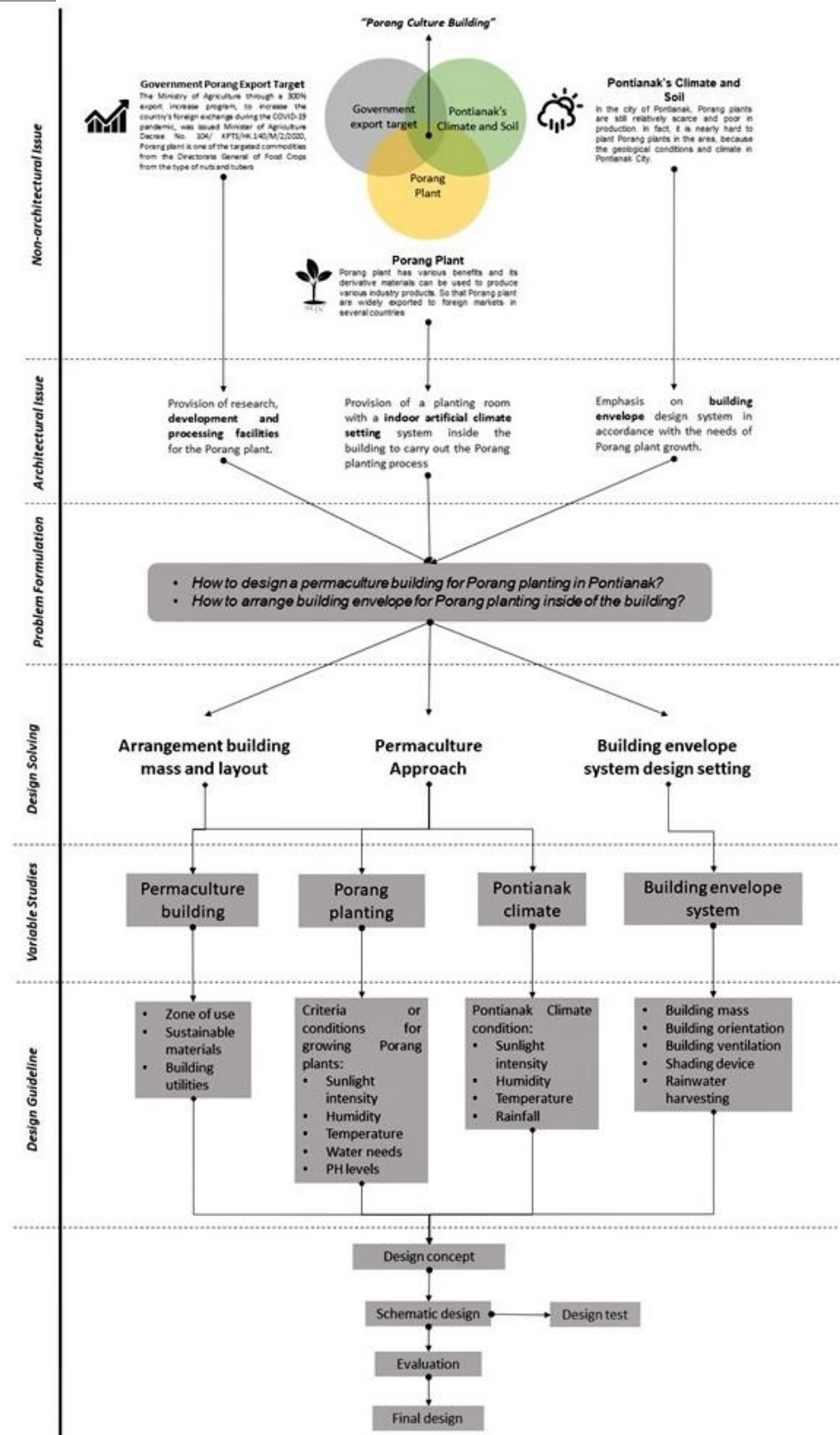


Figure 7. Design framework thinking
Source: author

1.5 Originality and Novelty

1.5.1 Bangunan Pengolahan Hasil Produksi Pertanian Kota Batu by Raka Dewangga (Universitas Brawijaya, 2013)

Discussion: In the final project, Raka Dewangga took the concept of applying natural materials in industrial buildings. What is meant by natural materials here are natural building materials which are the potential of the local area which are adapted to the needs and material requirements of an industrial building.

Knowledge renewal: the function of the building prioritizes the processing performance of agricultural production in general. not as specific as in certain agricultural buildings to produce Porang.

1.5.2 Pasar Pertanian di Area Perkotaan dengan Penerapan Vertical Farming dan Sustainable Material: Baciro Agri-Market by ZHAFIRA RIZQA BENNARADICTA (Universitas Islam Indonesia, 2015)

Discussion: In the final project, Zhafira Rizqa discusses how to design an agricultural market building with good internal layout and external that can provide comfort for space users and can meet the requirements of growing plants with an approach to the use of sustainable building materials.

Knowledge renewal: The projects have the same standard requirements for growing plants in buildings, but have differences in using a design approach, namely the Porang Culture Building applying a permaculture approach.

1.5.3 AgriStruktur: Konsep Arsitektur Tumbuh untuk Pertanian Kota by Agus Dwi Riswanto (Universitas Islam Indonesia, 2015)

Discussion: In this final project, Agus Dwi designed a building that functions as an urban farm consisting of agriculture and agribusiness, with a solid structure and the application of the concept of growing architecture in buildings to address the increasing food demand in urban areas.

Knowledge renewal: the project focuses on a modern agricultural system that emphasizes the building structure system which is part of the growing architectural concept.

Meanwhile, this project will focus on emphasizing the envelope building system.

Chapter

02

Design Study

2.1 Preliminary Study of Design Theme

2.1.1 Porang Planting Characteristics and the Criteria for Growing



Figure 8. Porang plant
Source: porang.co.id

Porang (*Amorphophallus oncophyllus* Prain.) or often referred to as *iles-iles* belongs to the *Araceae* family and is one of the biological richness of Indonesian tubers. As a plant that produces carbohydrates, fats, proteins, minerals, vitamins, and dietary fiber, porang plants have long been used as food ingredients and exported as industrial raw materials. However, the plant has not been widely cultivated (Porang Agricultural Research and Development Agency, 2015). Especially in Pontianak, Kalimantan, where the soil type does not allow Porang to be planted.

2.1.1.1 Morphology Description

The description of the porang plant (*A. oncophyllus*) has been clearly described by Sumarwoto (2005) and Perhutani (2013), among others.

a) Trunk. Stems grow erect, soft, smooth, green or black with white stripes growing on the sweet potato in the ground. The stem is actually a single and false stem, 5-50 mm in diameter depending on the age/period of plant growth, splitting into three secondary stems and then splitting again into leaf stalks. Stem measuring 40-180 cm x 1-5 cm, smooth, green to brownish green with a number of greenish-white (pale green) stripes. When entering the dry season, the porang stems begin to wither and fall to the ground as an early symptom of dormancy, then during the rainy season they will grow back. Depending on the level of soil fertility and climate, porang plant height can reach 1.5 m. Leaf.

b) Porang leaves include compound leaves and are divided into several leaves (*menjari*), light green to dark green. The leaf blade is elliptical in shape with a pointed leaf tip, the leaf surface is smooth and wavy. The color of the leaf margins varies from light purple (on young leaves), green (on medium-aged leaves), and yellow (on older leaves). In normal growth, each plant stem has 4 compound leaves and each compound leaf has about 10 leaves. The width of the leaf canopy can reach 25-150 cm, depending on the age of the plant.



Figure 9. Bulbil Porang, asexual (without mating) plant propagation method.
Source: pinterest.com

c) Bulbil/frog. At each meeting of the secondary stem and leaf axils a symmetrical round nodule will grow, with a diameter of 1045 mm called bulbil/frog, which is a generative tuber that can be used as seed. The size of the bulbil depends on the age of the plant. The outside of the bulbil is brownish yellow while the inside is yellow to brownish yellow. The presence of bulbil/frog distinguishes porang plants from other *Amorphophallus* species. The number of bulbils depends on the branching segments of the leaves, usually ranging from 4-15 bulbils per tree.

d) Tubers. Porang tubers are single tubers because each porang tree only produces one tuber. Porang tuber diameter can reach 28 cm with a weight of 3 kg, the outer surface of the tuber is dark brown and the inside is yellow-brown. Slightly oval round shape, fibrous roots. Bulb weight varies between 50-200 g in one growing period, 250-1350 g in two growing periods, and 450-3350 g in three growing periods. Based on the observations of Perhutani (2013), if the planted tubers weigh 200 to 250 g, the tuber yield can reach 2-3 kg/tree per growing season. Meanwhile, when using bulbil/frog seeds, the tuber yields ranged from 100-200 g/tree.

e) Flowers. Porang plant flowers will grow during the rainy season from tubers that do not experience leaf growth (*flush*). Flowers are composed of a flower sheath, pistil, and stamens. The flower sheath is slightly rounded, slightly erect, 20-28 cm high, purplish-green underside with white spots, orange with white spots on the top. The pistil is red heart (maroon). The

stamen is located above the pistil, consisting of fertile stamens (below) and sterile stamens (above). The flower stalks are 25-45 cm long, 16-28 mm in diameter, light green to dark green with greenish-white spots, and a smooth and slippery surface. The shape of the flower is like the tip of a blunt spear, with a diameter of 4-7 cm, height 10-20 cm.

f) **Fruits/seeds.** Including fleshy and compound fruit, light green in color when young, turning greenish yellow when ripe and orange-red when ripe. Fruit bunches are oval, tapering to the base, 10-22 cm high. Each bunch has 100-450 seeds (average 300 seeds), oval in shape. Each fruit contains 2 seeds. Age from flowering (when the flowers come out) until the ripe seeds reach 8-9 months. Seeds have dormancy for 1-2 months.

g) **Root.** Porang plants only have primary roots that grow from the base of the stem and some grow around the tubers. In general, before the seedlings grow leaves, it is preceded by rapid root growth within 7-14 days then new shoots grow. So the porang plant does not have a taproot.

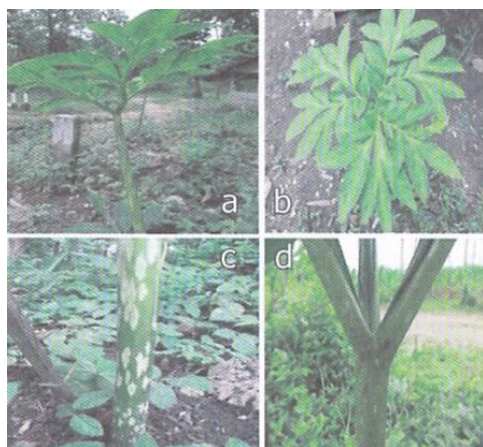


Figure 10. Picture of. a, b. Porang plants with leaf crowns, pointed leaf tips; c. pseudo-smooth stems are light green in color with pale greenish white stripes; d. Stem branching.
Source: Porang Agricultural Research and Development Agency, 2015.

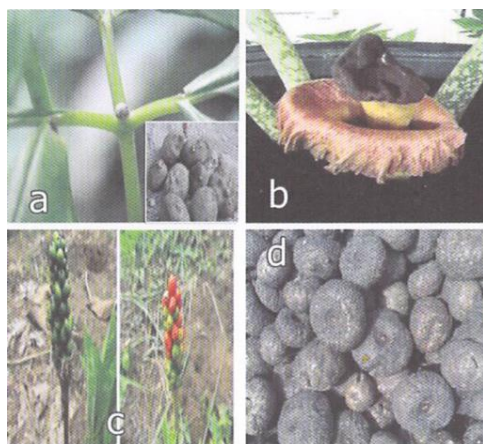


Figure 11. Picture of. Picture. a. Frog bulbs (bulbil) at the meeting of the base of the leaves; b. Flower; c. Young and ripe fruit, seeds; d. sweet potato.
Source: Porang Agricultural Research and Development Agency, 2015.

Porang plants have two growth phases that appear alternately, namely the vegetative phase and the generative phase. In the vegetative phase, the pseudo leaves and stems grow, after some time, the vegetative organs wither and the sweet potato is dormant. When all the leaves have died, there is still food reserves in the sweet potato and if the growing environment supports it, compound flowers will grow. Flowers emit an unpleasant smell like rotting flesh which attracts flies and beetles to help pollinate them. If fertilization occurs during the blooming period, it will form a fruit that is initially green when it is still young, then turns red with seeds at the former base of the flower.

2.1.1.2 Requirement For Growing Porang plants

Porang plants are generally cultivated as secondary crops, intercropped under forest stands (teak, mahogany, sengon) or under shade at the edge of community forests and shrubs. In order to grow and produce sweet potatoes optimally, porang plants require the following growing requirements.

a) **high place.** Porang is generally found on dry land at an altitude of up to 800 m above sea level (asl), but what is good is an area with a height of 100-600 m above sea level. For its growth requires a temperature of 25-35 ° C, and rainfall of 1000-1500 mm / year and spread evenly throughout the year. At temperatures above 35 °C, the plant leaves will burn, while at low temperatures, the plant is dormant. Warm and moist conditions are required for leaf growth, while dry conditions are necessary for potato development.

b) **Soil texture.** Like other sweet potato plants, porang will grow and produce good sweet potatoes on light to medium textured soil, loose, fertile, and the content of organic matter is quite high because porang plants require soil with good air aeration (Ermiati and Laksmanahardja, 1996). Although quite tolerant of inundation, long standing conditions can cause plants to die from rot. According to Jansen et al. (1996 cit. Flach and Rumawas 1996) in porang cultivation requires a good drainage system so that water does not stagnate. Porang plants grow well in soils with a neutral pH (pH: 6-7).

c) **Shade.** Porang plants have special properties, namely tolerance to shade between 40%-60%, therefore they can be intercropped with perennials (trees). In Indonesia, porang grows wild in the yard or on the outskirts of the forest, under the shade of other trees. In the Perum Perhutani Units I and II areas in Central and East Java, porang plants are developed in industrial

forest areas under stands of teak, rosewood, or mahogany trees. In India, the suweg plant, which is a close relative and similar to the porang plant, is mostly cultivated in monoculture on open land or under stands of coconut, papaya, guava, mango or lychee plantations (Jata et al. 2009). In this intercropping condition, the recommended spacing is 90 cm x 90 cm, so the population is around 5,000-9,000 plants/ha, depending on the spacing of the main plants and the level of canopy cover.

There are differences of opinion about the effect of shade intensity on sweet potato productivity. Wijayanto and Pratiwi (2011) reported that the growth of porang plants under sengon trees with 30% shade was better than under 80% shade conditions. The opposite was previously reported by Santosa et al. (2006) that the biomass of fresh cassava increases with decreasing irradiation intensity. At 75% shade conditions will produce the highest sweet potato, conversely at 0% shade it produces the lowest sweet potato. At full irradiation, necrosis occurred and the leaf edges rolled up to the leaf tips, which resulted in a decrease in sweet potato yields of up to 25%. The leaf damage/symptoms did not occur at 25%, 50% and 75% shade. Shade conditions will significantly reduce the number of leaves, petiole length and rachis.

d) Soil moisture. Soil moisture did not affect the germination (sprouting) of sweet potatoes, but it did affect the growth and development of shoots. If soil moisture is sufficient throughout the growth period, porang plants will produce large sweet potatoes. According to Jansen et al. (1996) rainfall between 1000-1500 mm/year is optimal for porang plant growth. In areas with a rainy season of less than four months, to produce sweet potatoes optimally, additional irrigation water is needed. According to Santosa et al. (2004) frequent and regular irrigation will produce large leaves and a longer life span than in conditions of limited watering. The decrease in dry weight of sweet potato seedlings was greater in conditions of frequent watering than in conditions that were not irrigated, this indicates that the carbohydrate supply in sweet potato seeds is not easily utilized in metabolic processes in conditions of limited water supply. The ratio of dry weight of sweet potato saplings to sweet potato seedlings at intervals of 1, 3, 5, 7 and 15 days, respectively, was 6.1, 1, 1, 0.6, 0.4, and 0.2. The ratio between dry weight of sweet potato seedlings and sweet potato seeds in conditions of frequent irrigation proves that the availability of ground water affects not only the use of dry matter of sweet potato seeds but also on the production and translocation of photosynthetic assimilate to sweet potato seedlings (Sugiyama and Santosa 2008).

The results of research Santosa et al. (2004) showed that if the water content is less than 40% of the field capacity, the roots will dry faster than under normal conditions. Plants can still tolerate stress conditions of lack of water for 30-60 days, but if it is longer than this period, it will reduce the yield of sweet potatoes. Moisture conservation by means of mulching, encourages the germination of sweet potato seeds, the formation of a larger canopy, plant height, and higher sweet potato yields. The yield of porang tubers under surface irrigation conditions reached 40 t/ha, while in rainfed conditions it was only 25 t/ha.

2.1.1.3 Porang Plant Propagation and Growth Phase

Propagation of porang can be done vegetatively using plant material in the form of stem tubers, leaf tubers (bulbil) or often called frogs and leaves (leaf bone crosses), and generatively using seeds (Sumarwoto 2012, Perhutani 2013). Reproduction with tubers can be done in two ways, namely taking small tubers and dividing large tubers with pieces of at least 100 g each to achieve good growth and yields. To avoid rot/mildew attack, it is better to give the tuber ash or fungicide, then drain it until it sprouts (approximately 1 month), then it can be planted in the field.

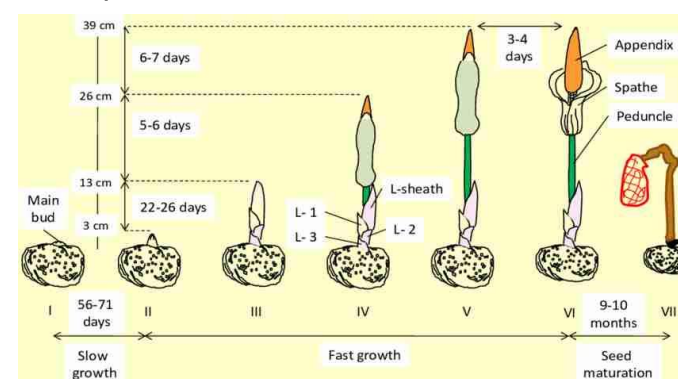


Figure 12. Vegetative propagation of porang through the tubers that have been cut and processed.

Source: porang.tv

Frog bulbs/bubil/leaf bulbs were collected at harvest and only healthy bulbs were selected and stored in a shady and dry place. In 1 kg of seeds contains approximately 100 grains of frog/bubil bulbs. These frog tubers can be planted directly on the prepared land at the beginning of the rainy season. Santosa and Wirnas (2009) reported that to multiply planting material quickly, bulbil and tuber slices could be used. However, if the slices are too small, they will rot and not be able to germinate.

Porang plants can reproduce by seeds. In general, it will flower at the age of 3-4 years (Santosa et al. 2006 b). When it is fruitful, then from each fruit cob will produce

250 seeds. Before planting in the field, the seeds must be washed to remove the mucus that covers them. After cleaning, the seeds are soaked in water and discarded seeds that float on the surface of the water. Seed first before planting in a nursery with sand media in a shady place.

2.1.1.4 Porang Plant Cultivation Technology and Procedure

In recent years, porang plants have become popular because they are shade tolerant, easy to cultivate, have high productivity, relatively few pests/diseases attack, good market demand and high economic value. From the aspect of cultivation, to get optimal growth and yields, optimal growing environmental conditions are also needed.

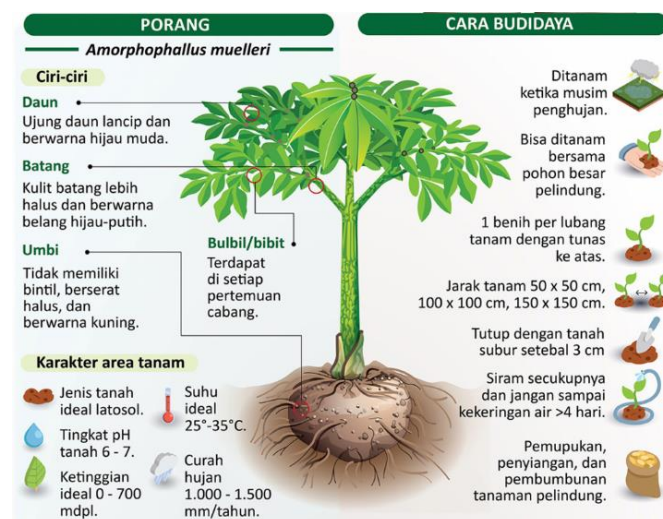


Figure 13. Characteristics of porang and how to cultivate it.

Source: antaranews

a. Soil tillage/land preparation

Like other root crops whose tubers are in the ground, porang wants loose and fertile soil. There are two ways to prepare the land for planting, depending on the seeds used. If the seeds come from tubers, it is necessary to make planting holes with a size of 60 x 60 x 45 cm, the distance between the planting holes is 90 x 90 cm. If the porang plant is designed to produce small-medium sized tubers, the distance between the planting holes is reduced to 60 x 60 cm. Before planting, the planting hole is covered with topsoil and organic fertilizer (compost or manure). As for the seeds from bubil/frog, bunds were made after intensively cultivating the soil with a distance of 90 cm between the bunds and the bulbs were planted in bunds with a distance of 90 cm.

In practice, porang plants are planted under the shade of stands of other plants, for example under stands of teak, sengon, or mahogany trees.



Figure 14. The size of the planting hole for porang plants with a depth of 45 cm and a width of 60 cm.

Source: author modification

b. Seeds and Nursery

Propagation by using seeds in the form of stem tubers or tubers that have a growing point (apical meristem) is the most common method. Bulbs/tuber pieces used as seeds should be large enough, because if they are too small, to grow and produce large tubers requires 2-3 growing seasons. According to Mondal and Sen (2004), a high percentage of seed germination (98%) if the seeds were obtained from the top half of the tuber, while from the bottom half of the sweet potato, would result in lower germination. The bottom part of the tuber is generally not good for use as seeds.

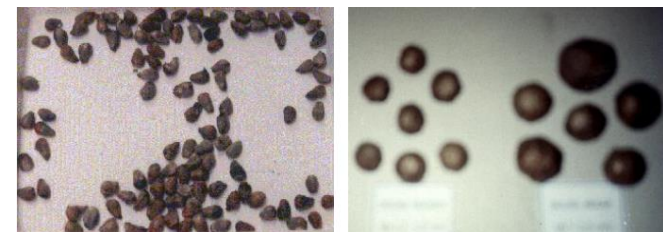


Figure 15. Seed (left); bulbil (leaf bulb) of Porang (right).

Source: Sumarwoto (2005)



Figure 16. Seeds in the nursery.

Source: Sumarwoto (2005)



Figure 17. 2 month old porang seeds in polybags (left); adult porang plant (right).

Source: Sumarwoto (2005)

According to Santosa et al. (2006a), seedlings with intact apical buds germinated faster and produced larger plants than seedlings with split apical buds or seedlings without apical buds. Cutting the apical buds encourages the growth of lateral shoots which will delay germination.

Mohankumar and Ravi (2001) also reported that smoking whole tubers for 6 hours/day for six weeks increased seed germination by 58.4% compared to no smoking. Similar results were obtained by exposing sweet potato seeds to a temperature of 45 °C for 6 hours/day for three weeks, increasing seedling germination by 83.3%. It was also concluded that the heating treatment at 32 °C and the immersion treatment in thiourea solution for 20-30 minutes had a significant effect on breaking seed dormancy. Dark conditions had a negative effect on seed germination.

The size of the tubers or pieces of tubers that are used as seeds affect plant productivity. The larger the pieces of tubers used as seeds, the higher the plant height (pseudo stems) and tuber yields. Using seeds in the form of whole tubers also produced tubers 45% higher than when using seeds in the form of pieces of tubers even though they had almost the same weight.

In general, seedlings weighing 500 g, planted with a spacing of 90 x 90 cm are ideal conditions for producing porang sweet potatoes. Bulbs or tuber pieces measuring 200 g are quite suitable as seeds, which are planted at a distance of 30 x 30 cm and produce bulbs weighing 500 g. It takes 2-3 years to produce larger tubers. This is done by taking the tubers carefully and replanting them in the next growing season. Porang tubers are generally planted as deep as 10-15 cm.

In addition to tubers, porang can also be propagated using frog tubers (bulbil). Bulbil can be planted directly in the field. According to Sumarwoto and Maryana (2011), medium-sized (5 g) and large (10 g) bulbils are equally good when used as seeds, while small bulbils (1.5 g) can be used as seedlings if they have undergone special maintenance first. Porang can also be propagated by using seeds. Seeds are taken from ripe fruit. Seeds are spread evenly in the nursery with a planting medium of sand or crumbly and fine soil, protected from direct sunlight and kept moist by watering. When the seedlings have grown and reach a height of 10-15 cm, the seedlings are ready to be transferred to the field. Bulbs harvested from seed seedlings, are not large enough and not yet suitable for harvesting. The seed nursery is intended to prepare the seeds for the next season.

c. Spacing

The spacing used is determined by the desired harvest age. If it will be harvested at the age of the first 8 months, then a spacing of 30 cm x 30 cm is sufficient. But when harvested in the second year of harvest period, a spacing of 45 cm x 45 cm is used. When harvested in the third year of harvesting, a wider spacing of 60 cm x 60 cm is needed. According to Jata et al. (2009) using 500 g of seedlings will give the highest yields when planted at a distance of 90 cm x 90 cm.

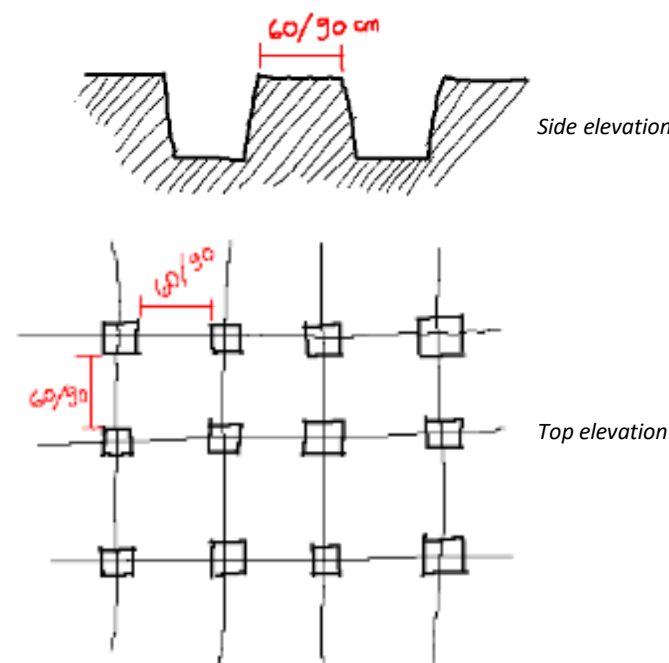


Figure 18. The distance between porang plants is about 60-90 cm depending on the final result of the desired tuber size.

Source: author modification

d. Depth of planting

Planting depth affects the growth and yield of tubers. In general, the deeper the seeds are planted, the more inhibited the growth of tuber seedlings will be. At a depth of 30 cm, most of the tubers will elongate to become pyriform. In general, according to Sugiyama and Santosa (2008), a planting depth of about 10 cm from the soil surface is quite ideal for planting porang. However, according to Sumarwoto (2012), the depth of planting is largely determined by the type and size of the seeds used. If the material planted is in the form of frog tubers (bulbil), then the planting depth is about 5 cm. If using seeds in the form of small bulbs (200 g) then planting them at a depth of 10 cm, and seeds in the form of larger bulbs, planting at a depth of approximately 15 cm.

g. Water management

Porang plants are generally cultivated on dry land. However, to be able to produce optimal tubers, soil with sufficient moisture is needed, especially at the beginning of plant growth. The results

of research Santosa et al. (2004) showed that if the water content is less than 40% of the field water capacity, the roots will dry faster than under normal conditions. Plants can still tolerate stress conditions of lack of water for 30-60 days, but more than this period will reduce tuber yields. According to Santosa et al. (2004) frequent and regular irrigation will produce large leaves and a longer life span than in conditions of limited watering.

e. Fertilization

Porang plants need to be fertilized with manure (5 t/ha) to get optimal results. Tubers yields of 39.6 and 98.9 t/ha could be obtained from the application of 100-200 kg N and 100-150 kg K O/ha, respectively. The application of manure as much as 30 t/ha can increase the weight of fresh tubers by 15%, while the use of N fertilizer as much as 150 kg/ha increases the yield of sweet potatoes by 16.5%.

f. Weeding

Weeding is mainly done at the beginning of plant growth before the canopy closes, generally done manually at the age of 30, 60, and 90 days after planting. While loosening the soil around the plant. In addition to manually, in large-scale farming weeding can be done by spraying herbicides.

h. Harvest

The signs that porang plants are ready to be harvested are when the leaves have dried and fallen to the ground. In Indonesia, harvesting should be done in the dry season around May to June. If the harvest is carried out in the second year of harvesting, each tree can produce yams weighing 0.5-3.0 kg, so that with a population of about 60,000 plants/ha, 40 tons of fresh tubers can be produced. Harvesting needs to be done carefully to avoid injury to the tubers, done by digging the soil around the new plant to take the tubers.

i. Storage

After harvesting, porang tubers need to be cleaned and stored in a well-ventilated room at a cool temperature (about 10 °C). In this condition the tubers can be stored for months. However, if stored at a temperature of around 27 °C in the first month of storage, it will lose weight about 25%. If the tubers are going to be processed into products, they should be stored in the form of chips (thin slices) or dry flour. Because when stored in the form of fresh tubers with a high water content (70-80%), the sweet potato is often damaged by enzyme activity.

2.1.1.5 Advice and Strategies for Porang Cultivation

According to Sumarwoto (2012) in porang cultivation, it is recommended that land use be separated or serial planting is carried out on available land areas with different designations, namely part of the land for own nurseries, separated from land for enlargement (production), so that harvesting arrangements can be done regularly.

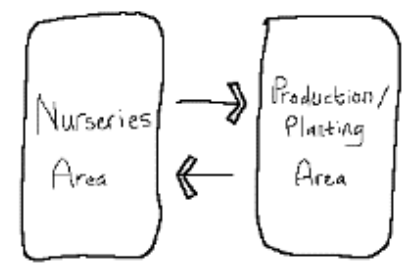


Figure 19. It is recommended that the nursery and production areas be separated so that harvesting arrangements can be carried out regularly.
Source: author modification

2.1.1.6 The Whole Porang Plant Production Process

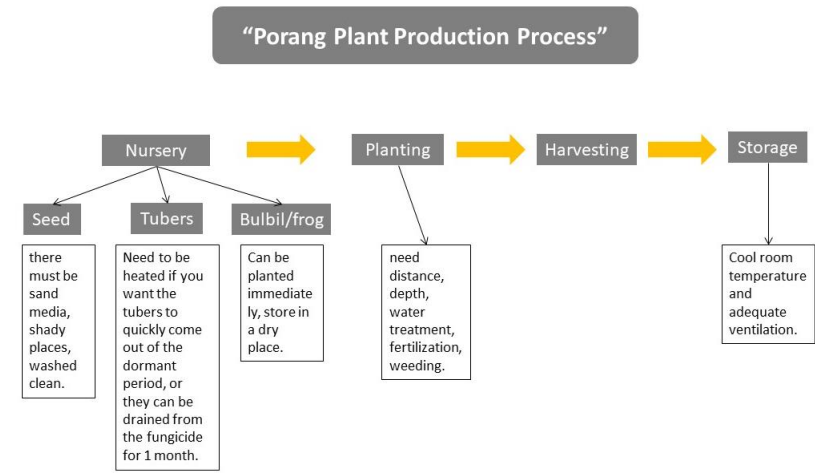


Figure 20. The whole Porang Plant production process.
Source: author modification

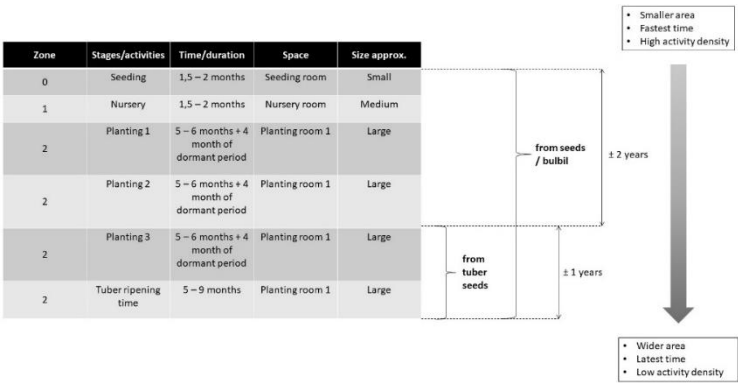


Figure 20. The whole Porang Plant production process based on activity variables, duration, and the approximate size of the space.
Source: author analysis

2.1.2 Pontianak Soil and Climate Condition for Porang Plant

2.1.2.1 Soil Condition in Pontianak City for Porang Plants

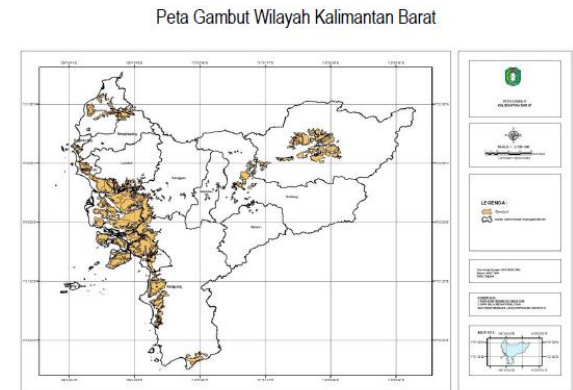


Figure 21. Image of West Kalimantan peatland map
Source: West Kalimantan Province Government



Figure 22. Peat soil texture in West Kalimantan.
Source: 99.co

Porang plants are still hard to come by in Pontianak, and they're not very productive. Because the geological conditions or soil structure in the city of Pontianak is included in the peneplant area and alluvial sediment, which is physically a type of clay, this type of soil is in the form of peat from the mud of the Kapuas river, it is nearly impossible to plant Porang plants in the area. Because the conditions for planting Porang plants in the Pontianak area have not been met. Pontianak's soil is characterized by peat soil, which has an acidic pH level, making it impossible to cultivate agricultural crops there (BAPPEDA Pontianak City). While the conditions for growing Porang plants are that the soil acidity level must be neutral or PH around 6-7. On average, peat soils in Indonesia are mostly acidic to very acidic with a pH < 4.0, including areas in Kalimantan. Peat soil is also the result of incomplete decomposition of soil in areas that are always flooded, such as swamps. This land is not good for agriculture because it is less fertile and always waterlogged. Especially with the condition that the Porang plant grows which is a tuber plant that requires a type of soil that is fertile, loose, has a good level of soil aeration, soil that is not waterlogged but dry and the humidity is

maintained. From this regard, the design of agricultural buildings for Porang is needed as a medium for replacing land for planting Porang.

2.1.2.2 Climatic Conditions in Pontianak City in Terms of Growing Porang Plants

a) Temperature

Bulan	Suhu Udara (Derajat Celcius)																							
	Minimum								Maksimum								Rata-rata							
	2020	2019	2018	2017	2016	2015	2014	2020	2019	2018	2017	2016	2015	2014	2020	2019	2018	2017	2016	2015	2014			
Januari	24.0	23.2	24.4	22.6	24.0	22.2	24.7	33.1	34.1	31.5	35.2	32.6	32.8	33.1	27.1	27.2	27.0	27.8	27.5	26.5	28.0			
Februari	23.6	23.2	24.2	22.8	24.4	22.4	24.3	33.2	34.0	32.8	35.2	32.4	33.6	30.1	27.3	27.2	27.3	27.1	27.3	26.7	27.3			
Maret	23.4	23.3	24.3	23.0	24.7	21.8	24.7	35.0	35.7	33.1	35.4	33.7	35.2	34.3	27.9	28.2	27.7	27.6	28.2	27.6	28.5			
April	24.3	23.0	24.7	23.6	24.8	22.5	24.4	35.2	36.4	33.6	35.4	33.8	35.5	34.0	28.1	28.2	28.0	28.0	28.4	27.9	27.9			
Mei	24.0	23.0	24.4	23.4	24.7	22.8	24.6	35.4	37.1	33.2	36.2	33.9	36.0	32.9	28.3	28.9	28.3	28.1	28.0	28.2	27.9			
Juni	23.6	22.9	24.4	23.1	24.3	23.0	25.1	35.4	37.0	33.6	36.4	33.9	36.7	35.2	27.2	28.0	28.0	28.4	28.2	28.5	29.1			
Juli	22.4	22.8	25.2	23.2	24.7	22.2	23.9	34.5	35.6	34.5	36.1	34.4	36.8	33.4	27.7	28.3	28.8	27.8	28.5	28.7	27.5			
Agustus	23.1	22.2	24.0	22.4	25.1	22.6	24.3	35.2	36.6	35.0	35.8	35.8	36.2	34.0	27.7	28.4	28.9	27.7	29.5	28.8	28.0			
September	22.9	23.2	24.3	23.3	24.5	23.8	24.3	35.1	35.8	34.0	36.2	34.4	36.0	33.4	27.0	27.9	27.8	27.9	28.5	28.7	27.9			
Oktober	23.5	22.0	24.0	23.9	24.4	21.3	24.6	35.2	34.3	32.4	35.7	33.4	35.5	33.4	27.5	26.9	27.0	27.8	27.8	28.1	27.8			
November	23.6	23.2	24.3	22.7	24.4	23.0	24.0	34.3	35.1	32.2	34.4	32.5	34.0	32.2	27.1	27.4	27.1	27.4	27.1	27.1	27.5			
Desember	23.6	23.6	24.1	23.2	24.2	22.6	24.0	34.2	32.8	31.7	34.2	31.7	34.8	31.0	27.3	26.9	26.8	27.4	27.3	27.6	26.8			
Jumlah	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Rata-Rata	23.5	23.0	24.4	23.1	24.5	22.5	24.4	34.7	35.4	33.1	35.5	33.5	35.3	33.1	27.6	27.8	27.7	27.7	28.0	27.9	27.9			

Table 1. Table of temperature data in Pontianak for the period 2014-2020
Source: BPS Pontianak City

In general, the Equator is the hottest area because it receives the most solar radiation. The air temperature in Pontianak City is relatively hot, namely the average air temperature reaches 28 - 32°C but sufficient to meet the requirements for growing Porang plants. However, there must still be a building envelope arrangement in agricultural buildings so that the temperature inside the building remains stable to grow Porang plants.

b) Humidity

Bulan	Rata-rata Kelembaban (Persen)						
	2020	2019	2018	2017	2016	2015	2014
Januari	86.0	84.0	85.0	81.0	83.7	85.0	79.0
Februari	83.0	84.0	82.0	81.0	85.3	83.0	84.0
Maret	81.0	79.0	82.0	82.0	81.6	80.0	79.0
April	82.0	81.0	82.0	81.0	81.3	81.0	82.0
Mei	82.0	79.0	84.0	83.0	83.8	81.0	83.0
Juni	81.0	82.0	82.0	79.0	79.8	79.0	74.0
Juli	83.0	75.0	76.0	80.0	78.6	75.0	80.0
Agustus	82.0	75.0	75.0	82.0	72.8	76.0	78.0
September	83.0	79.0	80.0	81.0	77.5	80.0	81.0
Oktober	82.0	87.0	85.0	83.0	81.4	82.0	80.0
November	85.0	84.0	85.0	85.0	85.7	86.0	83.0
Desember	83.0	86.0	85.0	84.0	84.3	82.0	86.0
Jumlah	-	-	-	-	-	-	-
Rata-Rata	82.8	81.3	81.9	81.8	81.3	80.8	80.8

Table 2. Table of humidity data in Pontianak for the period 2014-2020
Source: BPS Pontianak City

In addition, the air temperature in Pontianak City is relatively hot, which is followed by high humidity, with air humidity ranging from 86%-92%. While porang plants require moist conditions only for leaf growth, while dry conditions are required for porang tuber development (Porang Agricultural Research and Development Agency, 2015).

In Pontianak City, the evaporation that occurs is large and will result in the absolute humidity being relatively high. To overcome high humidity, it can be done by orienting the building perpendicular to the direction of the wind, providing protection against rain, ventilation to circulate air continuously, and making the plaster thickness ± 2 cm (Audian, 2002).

c) Sunlight Intensity

The amount of solar radiation and sunlight intensity that reaches the surface depends on the topography of the earth. The equatorial region receives more radiation and sunlight intensity than other regions because throughout the year the position of the sun with respect to latitude is never more than 23° N and 23° South Latitude. In Pontianak City, the duration of sunshine is around 34–78% (BAPPEDA Pontianak City). Meanwhile, Porang plants need shade around 40-60%, so they need shading against openings, the color of building materials that tend to be bright, and coating materials that do not absorb heat.

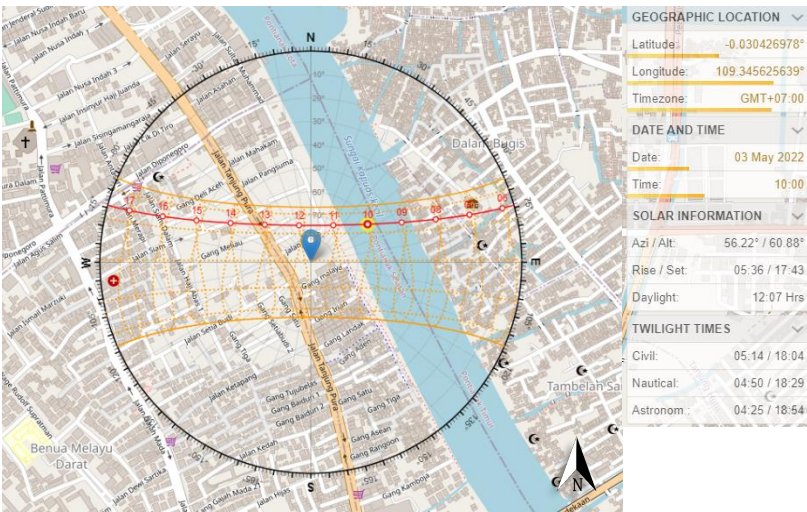


Figure 23. Site location crossed by the equator line.
Source: PD: Sun-Path Map

d) Rainfall

Due to the geographical position of Pontianak City which is located on the equator, the climate in Pontianak is Tropical Climate with 2 (two) seasons, namely summer and rainy season. Under normal conditions, the dry season occurs from May to July, while the rainy season occurs from September to December. From the table of rainfall data in the city of

Pontianak, it shows that the average rainfall is around 3000 - 4000 mm/year.

Bulan	Curah Hujan (mm)					
	2019	2018	2017	2016	2015	2014
Januari	201.8	402.0	144.2	433.3	290.8	73.8
Februari	302.2	105.0	278.7	343.1	214.4	40.2
Maret	83.7	231.0	340.4	231.6	220.9	249.6
April	299.9	346.0	110.9	359.9	226.2	198.6
Mei	276.8	552.8	327.8	403.1	436.5	270.2
Juni	506.3	400.0	226.3	290.8	284.5	254.1
Juli	227.6	51.0	315.2	264.2	257.0	104.6
Agustus	73.0	73.0	514.5	35.3	113.7	460.8
September	58.1	257.0	200.7	211.2	19.5	202.8
Oktober	579.4	517.4	143.1	217.5	286.2	269.1
November	371.5	429.8	234.3	301.2	298.0	518.2
Desember	635.8	449.0	243.5	298.0	205.4	213.2

Table 3. Table of rainfall data in Pontianak for the period 2014-2019
Source: BPS Pontianak City

2.1.2.3 Land type categories in Pontianak based on the Table of Land Suitability Criteria for Porang Plants

In addition to data on physical and climatic conditions in Pontianak and data on criteria for growing Porang plants, comparisons between data are also determined using a data table for Land Suitability Criteria for Porang Plants (Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016) following. So which factors must be handled specifically if a discrepancy is found in the conditions for growing Porang in the Pontianak area by solving problems within the architectural scope.

Persyaratan penggunaan/ karakteristik lahan	Kelas kesesuaian lahan			
	S1	S2	S3	N
Temperatur (tc)				
Temperatur rerata (°C)	23 - 25	20 - 23	18 - 20	< 18
		25 - 28	28 - 32	> 32
Ketersediaan air (wa)				
Curah hujan (mm) pada masa pertumbuhan	1200 - 2000	400 - < 1200	< 400	
		> 2000 - 2800		
Kelembaban (%)				
	24 - 80	20 - 24	< 20	
		80 - 85	> 85	
Ketersediaan oksigen (oa)				
Drainase	baik, agak terhambat	agak cepat, sedang	terhambat	sangat terhambat, cepat
Media perakaran (rc)				
Tekstur	halus, agak halus, sedang		agak kasar	kasar
Bahan kasar (%)	< 15	15-35	35 - 55	> 55
Kedalaman tanah (cm)	> 75	50-75	20 - 50	< 20
Retensi hara (nr)				
KTK liat (cmol)	> 16	≤ 16		
Kejujuran basa (%)	> 35	20 - 35	< 20	
pH H ₂ O	5,5 - 7,5	5,0 - 5,5	< 5,0	
		7,5 - 7,8	> 7,8	
C-organik (%)	> 1,2	0,8 - 1,2	< 0,8	
Bahaya erosi (eh)				
Lereng (%)	<8	8-16	16-30	> 30
Bahaya erosi	sangat rendah	rendah - sedang	berat	sangat berat

Information:
S1 = very suitable
S2 = suitable
S3 = marginal fit
N = not suitable

Table 4. Table of Land Suitability Criteria for Porang Plants
Source: Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016.

Parameters	Pontianak Data	Porang requirements	Category
Temperature	28 - 32°C	28 - 32°C	S3
Rainfall	3000 – 4000 mm/year	>2000 – 2800 mm/years	S2
Humidity	86-92%	>85%	S3

Table 5. Table of analysis Pontianak data and Porang requirement data.
Source: author analysis

As shown in the table, there are categories S1 (very suitable), S2 (suitable), S3 (marginally appropriate), and N (not suitable). The parameters for Porang plant growth conditions that will be analyzed in the following table consist of temperature, humidity, and rainfall. In the Table of analysis of Pontianak data and Porang requirement data, it can be seen that the land category for temperature and humidity is categorized into S3, which means marginal fit. Namely land conditions suitable enough and have little effect on Porang growth or low land potential.

So for the temperature factor it is necessary to modify the design such as setting the orientation of the building to reduce the absorption of solar heat, laying ventilation and opening in buildings facing the wind source, the required ventilation size, the application of the stuck effect in the building, and the use of shading devices to reduce heat from altitude. sun to be avoided.

As for the humidity factor, humidity is not really needed on the tubers, but is needed on the leaves and stems (Porang Agricultural Research and Development Agency, 2015). So that design modifications such as proper ventilation arrangements for the Porang plant zone are emphasized on the soil part compared to the Porang stems and leaves, and create a drainage system on the soil so that water does not stagnate and cause tubers to rot.

In the Table of analysis of Pontianak data and Porang requirements data, it can also be seen that rainfall is categorized into S2, which means suitable. So that the arrangement of the watering system in the building can be

adjusted to the needs of the Porang plant according to the watering schedule. And design modifications can be applied to the shape and arrangement of the Porang planting media, and the utility system for using recycled water for the Porang plant.

2.1.2.4 Conclusion Table of Pontianak Soil and Climatic Condition Data for Porang

Parameters	Porang plant	Pontianak condition	Results
PH of soil	6-7 (PH neutral)	PH <4.0 (acidic)	X (N)
Temperature	23 - 25°C (most optimal)	28 - 32°C	V (S3)
Humidity	24 - 80% (optimally) (Porang plants require moist conditions only for leaf growth, while dry conditions are required for porang tuber development.)	86 – 92% (air temperature)	V (S3)
Sunlight intensity	40 - 60% (most optimal)	34 - 78%	X (N)
Rainfall	1200 – 2000 mm/year (most optimal)	3000 – 4000 mm/year	V (S2)

Information:
S1 = very suitable
S2 = suitable
S3 = marginal fit
N = not suitable

Information:
V= suitable (suitable, or even though the potential is small).
X= not suitable

Table 6. Table of Pontianak Soil and Climatic Condition Data for Porang
Source: author analysis

Based on the Conclusion Table of Pontianak Soil and Climate Conditions for Porang above, it can be concluded that the soil pH, and the intensity of sunlight in Pontianak City show category N (not suitable) or do not meet the requirements for growing Porang plants. So that it is necessary to arrange the design for the permaculture porang building, especially in the building envelope system.

Meanwhile, the temperature, humidity, and rainfall in Pontianak are categorized into S3 (marginal fit) and S2 (suitable), which means that they are suitable and meet the requirements for growing porang plants, although the temperature and humidity factors have a small potential (S3).

So that these three factors need to be adjusted to the building design to increase the number to be optimal or meet the Porang planting criteria to be more suitable than before with an emphasis on the building envelope.

2.1.2.5 Design Criteria for Porang Based on the Conclusion Data

So the architectural problem that must be solved is in category N (not suitable), namely sunlight intensity. As well as the S3 category (marginal fit), which requires a little adjustment to increase the number to be more optimal (more suitable) for the conditions for growing Porang plants, that consists of Temperature and Humidity.

Meanwhile, soil pH is not included in architectural problems, but it can be done by providing Porang planting media. For the rainfall factor, architectural problem solving is not really needed, because the plant watering system is carried out inside the building.

Design criteria in category N (not suitable):

1. Arch issue: Sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">• The roof can use a massive material or an ordinary roof.• Sufficient light comes from windows, etc.• Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">• The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.• Avoid the sun's altitude point which has a high level of solar radiation.• Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).• Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).• Must use transparent roofing material but have a louver.• Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">• Use transparent materials so that sunlight can be transmitted into the building 100%.• Avoid using shading devices, etc.• Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table 7. Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

Design criteria in category S3 (marginal fit):

1. Arch issue: temperature

Design criteria	Problem solving
All stages of Porang growth require air temperatures that are not hot (most optimal 23 - 25°C).	<ul style="list-style-type: none">• The orientation of the building faces south and north, so that the large facade area does not absorb too much solar heat.• The shape of the building mass extends to the west and east to avoid absorption of solar radiation. or you can design a solid void building mass to create a shaded area on the facade.• The use of shading devices to avoid the sun's altitude point which has a high level of sunlight intensity (the more perpendicular the sun's position, the higher the level of sunlight intensity).
Except for the break dormancy stage, seedlings in the form of tubers require a temperature of 45°C (drying/drying in the sun for 6 hours/day).	<ul style="list-style-type: none">• The use of transparent materials, so that sunlight can be transmitted 100% (sunlight intensity 100%).• Does not require a shading device.

Table 8. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

2. Arch issue: humidity

Design criteria	Problem solving
The nursery stage of frogs/bulbills requires sufficient humidity/not dry (most optimal 24-80%).	<ul style="list-style-type: none">• The composition of the building mass can use a single banked room so that air movement is evenly distributed.• Ventilation can use the stuck effect.• Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Porang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none">• Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Porang.• Use cross section ventilation.• Make openings / ventilation in the roof to reduce excess moisture.

Table 9. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

2.1.2.6 Design Criteria for Porang Based on Each Stage of Porang Growth

Each stage of Porang plant growth has its own design criteria according to its growth needs. The stages start from the nursery stage of the frog/bulbil and seeds, the tuber seedling stage, the break dormancy stage, the tuber ripening stage, and the last on is the storage stage for the ripe Porang bulbs.

Design criteria for Porang planting growing media (nursery stage of katak/bulbil and seeds):

- The soil and the shoot area need the same moisture (20-80%).
- Lighting is not very necessary for nurseries and seeding (sunlight intensity <50%).
- The depth of the soil if the seeds planted are in the form of katak tubers (bulbil), then the planting depth is about 5 cm.

Design criteria for Porang planting growing media (tuber ripening stage and tuber seedling stage):

- The soil area should not be very moist.
- The soil area should not be waterlogged, as this will cause the tubers to rot.
- The hole depth is about 45 cm and the width is 60 cm (this is for the maximum size of tubers produced, which is 2-3 kg).
- Soil depth if using seeds in the form of small tubers (200 g) then plant at a depth of 10 cm, and seeds in the form of large tubers, plant at a depth of approximately 15 cm.
- The ideal distance between Porang plants is 60 cm.
- The area of the stems and leaves requires a fairly high humidity (20-80%).
- Sunlight intensity must be around 40-60%.
- Porang growth require air temperatures that are not hot (most optimal 23 - 25°C).

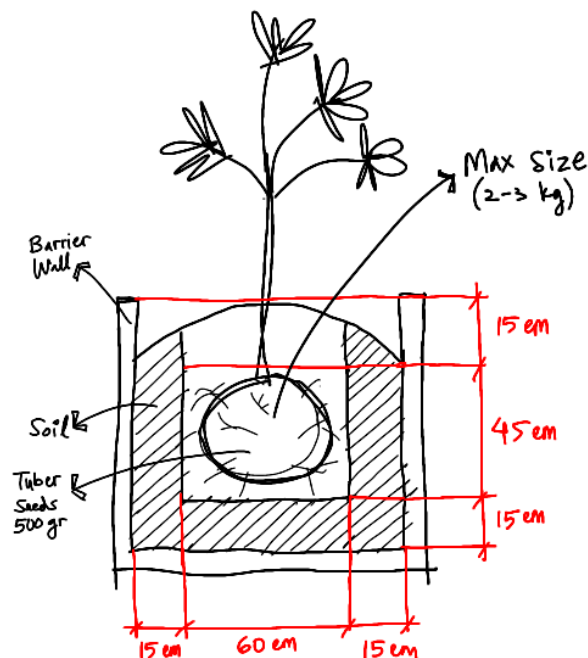


Figure 24. Image of section drawing for porang growing media in tubers ripening stage.
Source: author analysis

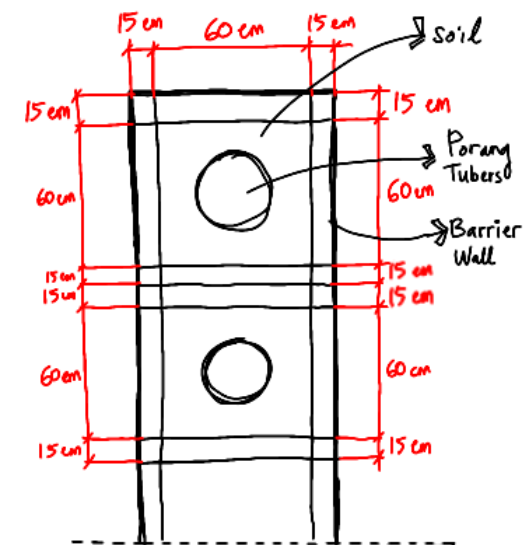


Figure 25. Image of top view drawing for porang growing media in tubers ripening stage.
Source: author analysis

Design criteria for the stage of breaking the dormancy period of Porang tuber seeds:

- Requires 100% sunlight intensity.
- Requires a temperature of 45°C so that the seed dormancy period ends quickly and can be replanted for the tuber ripening stage (drying/drying in the sun for 6 hours/day).

Design criteria for Porang Storage:

- A room that has a cold temperature, so that the Porang tubers are durable, not sprouting, and rotting.
- Have a good ventilation system.

2.1.3 Permaculture Building for Porang Plant

2.1.3.1 Permaculture Approach

Permaculture is an uptake word adapted from English, namely Permaculture, as an abbreviation of permanent agriculture. That is, agriculture with a sustainable, continuous, and permanent life order. Therefore, permaculture upholds the principle of balance and sustainability (Caritra, 2017). Permaculture is a movement towards the phenomenon of technological advancement that facilitates many things in human life. Permaculture is aimed at keeping humans from being greedy in exploring natural resources and paying attention to the sustainability of nature (Ward, 2017). Permaculture offers techniques and ideas that help us towards a healthy environment, culture and society. It is based on ethical steps and principles of responsibility for our own lives, our environment and the future (Stevan, Ratna, & Mira, 2014). In simple terms, permaculture is an effort to organize a sustainable life through agricultural activities. This is based on ethics that build balance and preserve nature.

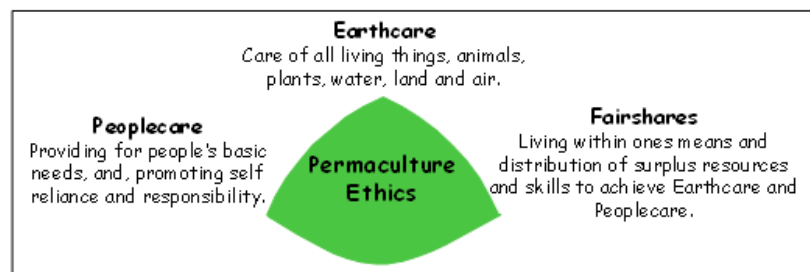


Figure 26. Permaculture ethics consist of three pillars, namely earth care, people care, and fair share.

Source: gaia education

The ethical basis of Permaculture, namely (1) Care for the earth: how we provide all living systems (life and death elements) to be sustainable and increase, (2) Care for humans: how we expand access to resources needed for human survival, and (3) Setting limits on consumption and population: how we regulate how much we need ourselves, so that we can set aside resources for the future (Caritra, 2017). According to Vivi Apanti, SP., in (Apanti, 2019), Permaculture has the principle of combining various plants that are mutually beneficial so they will have a beneficial relationship, also and can support the natural conditions needed to keep growing and living healthy. Friendly Plants (Companion Plants) is a term for plants that have beneficial relationships. In permaculture, each plant has its own function in the ecosystem, the concept is planting the plants that have mutual benefit/ symbiosis by maximizing the nutrients in the soil and mutually avoiding pests or disturbances by other insects. Supporting Plants (Perennial plant) is a term for plants that longlasting. Plants that have a long life will support the stability of soil nutrients and stability of

water in the soil.

a. Earth Care

The basic principle of this ethics is to care for and protect nature, both its soil, water, climate, and other aspects. Even so, the vision that originally aimed to protect and care for all living and nonliving things has now developed and also accommodates a comprehensive and in-depth understanding of the decisions that humans make in their daily lives. Those decisions are largely related to human consumption patterns, such as the clothes we wear and the food we eat. No, permaculture does not require everyone to grow their own food and build their own dream home, but it is important to remember that we have both responsibility and power as consumers/buyers. Therefore, use that power well and be a wise consumer.

b. People Care (Caring for Individuals and Communities)

This principle emphasizes that basic human needs must be met, starting from food, shelter, education, work, and healthy human relationships. In addition, after completing the business of meeting the basic needs of life, the next focus is to realize and empower the strengths of the community. If only one individual can make changes, then imagine what bigger changes can be achieved by a strong and empowered community. In both urban and rural areas, one can benefit from empowering and giving back to their local community.

Like neighbors who help each other, a strong community can be the beginning of social transformation that starts from grassroots movements.

c. Fair Share

Last but not least, ethics has to do with understanding that we only have one earth, and we must share this one living space with all the living things that live on it, as well as for future generations. In other words, it is not enough if we only design spaces or landscapes that benefit ourselves and our communities, while in other parts of the world there are still many people who have to struggle to fulfill their basic needs and rights to life, such as clean water, shelter, etc. The harsh reality that we have to accept now is that the developed countries use the resources equivalent to 3 earths! While on the other hand, many developing countries still have to struggle with hunger and poverty. This is what the Fair Shares ethic is trying to raise: that there are deep disparities and inequalities among the world's people, which then requires us to limit consumption (especially natural resources) in developed countries. Permaculture

fundamentally rejects the industrial growth model of developed countries and aspires to design a more equitable and just system, which takes into account the boundaries of the planet and the needs of all living things on it. The concept of permaculture can be used not only to design garden landscapes and plants, but also in our daily lives so that we can live a more mindful and harmonious life with nature.

2.1.3.2 Zone of Use for Porang Permaculture Building

Permaculture zones of use are both an organizing force and a management tool during the design phase. They directly support our efforts by providing a simple but effective logic for placing design elements throughout the system. The closer an element is near the center of human activity, the greater attention it might attract compared to elements further away. This is due to the fact that the amount of time and energy spent traveling increases with distance. Because time and energy are finite resources, we will have less of both once we arrive at our destination if we waste them merely going from point A to point B (Permaculture Research Institute). As a result, zones of use can be said to reflect the intersection of spatial relationships, energy use, and time.

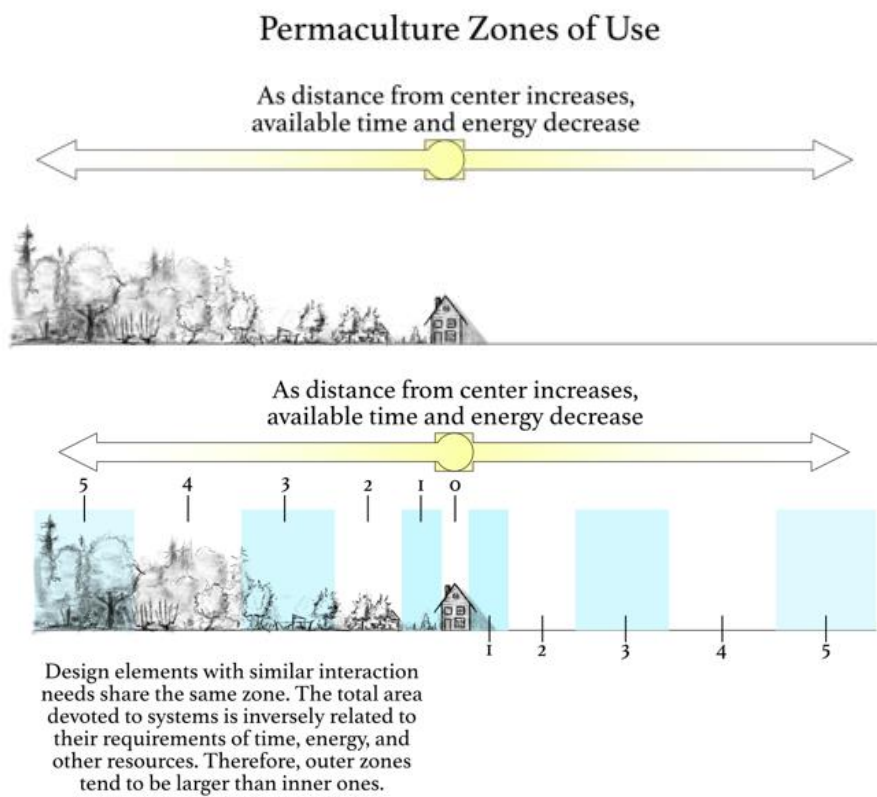


Figure 27. Permaculture zones of use can be said to reflect the intersection of spatial relationships, energy use, and time.
Source: permaculturenews

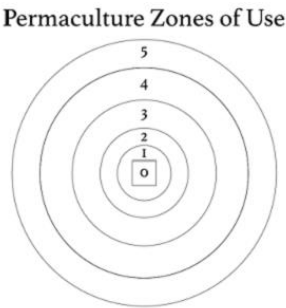


Figure 28. In the concept of permaculture zones of use, the zone is divided into 5 areas, where the outer zone is wider.
Source: permaculturenews

Just as in designing a permaculture landscape, designing a porang permaculture building will also apply the concept of permaculture zones of use which consists of three main element systems that will be taken into consideration in creating an integrated porang permaculture building design, namely the intersection of spatial relationships, time, and energy use.

a. Spatial relationships

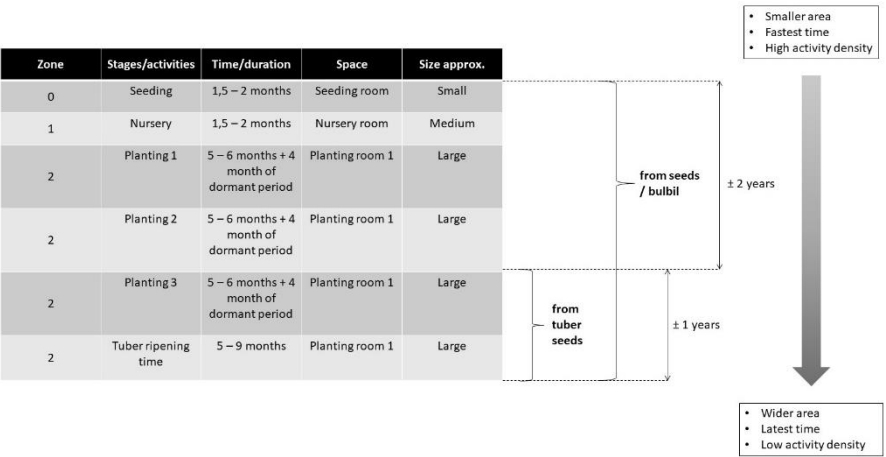
Place each related element or space as well as the type and duration of activity so that they can be mutually beneficial. For example, store tools in a place close to where they are used.

b. Time

Most materials can be used in a variety of ways and for a variety of functions. One rule of thumb in permaculture is to try to design three functions for each element of the system. This will save space, time and cost.

c. Energy use

Placement of elements as best as possible to save energy (including fertilizer, water and human labor). Such as making a framework or SOP to carry out each activity (fertilizing, watering, making compost, etc.) so that it can be measured and efficient in the process.



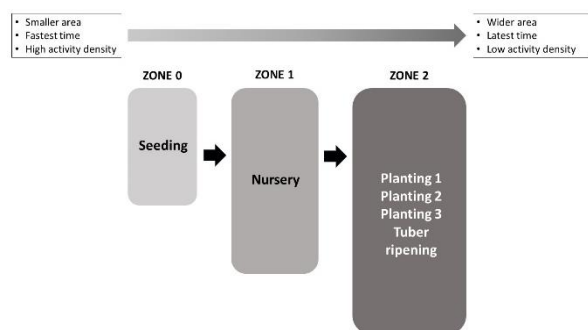


Figure 29. The division of zones based on activity variables, duration, and the approximate size of the space.
Source: author analysis

2.2 Context Site Study

2.2.1 Site Location Selection

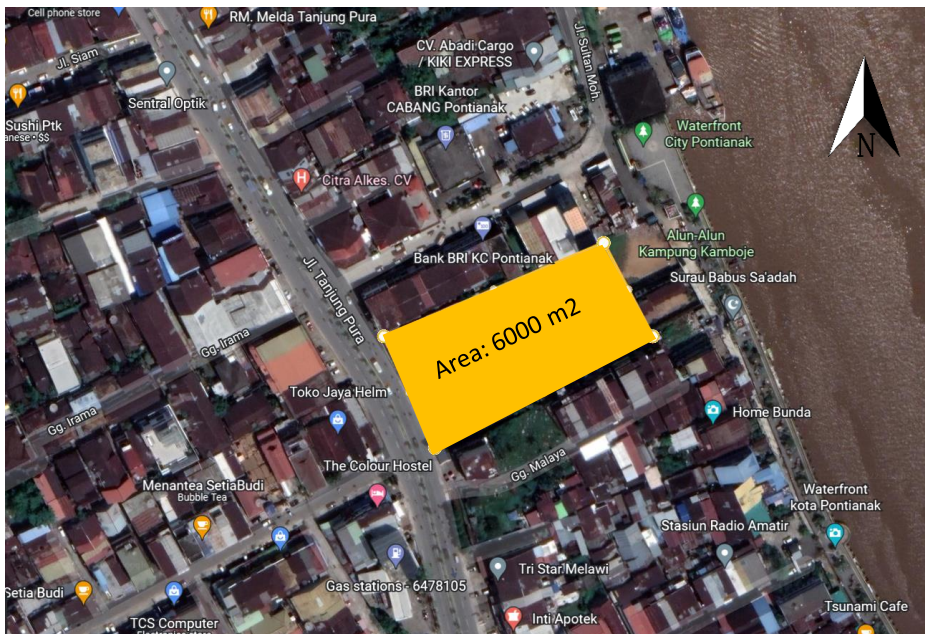


Figure 30. Site location
Source: maps google, author modification

The location of the selected site is located at Jalan Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Pontianak City, West Kalimantan. The reason for choosing the site is due to its strategic location not far from the ship port where the commodity export process can be carried out more efficiently and effectively, so that this also affects the environmental impact of reducing carbon footprint on the environment. In addition, easy access to public vehicles is located right on the front or southwest side of the site. This area is also an industrial and warehousing area of Pontianak City, which is located on the outskirts or outside of a residential area of a city. The location of the site is also located on the banks of the Kapuas River, this is intended as good transportation access and can be used as a source of water for this agricultural building project.

Address: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243

Coordinated point: 0°01'49.9"S 109°20'42.7"E (-0.030526, 109.345182)

Site area: 6000 m2

SWOT Analysis:

- Strength: industry area, near to the river
- Weakness: the soil is not suitable for high-rise buildings
- Opportunity: located in suburban area, easy access to sea and land transportation
- Threats: land subsidence

2.2.2 Site Condition

2.2.2.1 Road Conditions Around the Site



Figure 31. Site situation
Source: maps google, author modification

The site is located on Jalan Tanjung Pura, which is a 2-way road with a width of ± 10 m. The intensity of vehicles on this road tends to be moderate to high.

2.2.2.2 Site Size and Site Condition



Figure 32. Site existing
Source: maps google, author modification

2.2.3 Pontianak Climate Data

2.2.3.1 Air Temperature

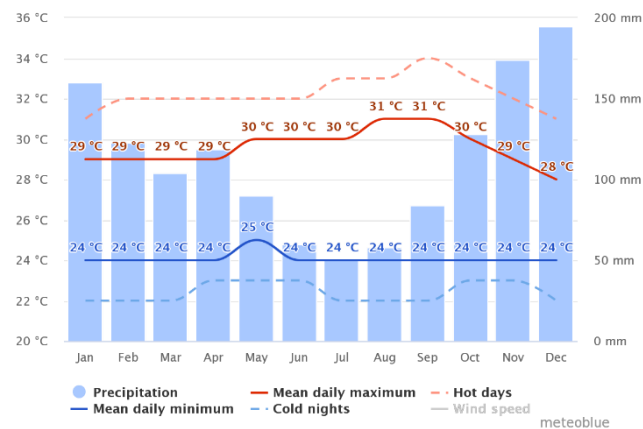


Figure 33. Chart of temperature data in Pontianak throughout the year

Source: meteoblue

Bulan	Suhu Udara (Derajat Celcius)																							
	Minimum							Maksimum							Rata-rata									
	2020	2019	2018	2017	2016	2015	2014	2020	2019	2018	2017	2016	2015	2014	2020	2019	2018	2017	2016	2015	2014			
Januari	24.0	23.2	24.4	22.6	24.0	22.2	24.7	33.1	34.1	31.5	35.2	32.6	32.8	33.1	27.1	27.2	27.0	27.8	27.5	26.5	28.0			
Februari	23.6	23.2	24.2	22.8	24.4	22.4	24.3	33.2	34.0	32.8	35.2	32.4	33.6	30.1	27.3	27.2	27.3	27.1	27.3	26.7	27.3			
Maret	23.4	23.3	24.3	23.0	24.7	21.8	24.7	35.0	35.7	33.1	35.4	33.7	35.2	34.3	27.9	28.2	27.7	27.6	28.2	27.6	28.5			
April	24.3	23.0	24.7	23.6	24.8	22.5	24.4	35.2	36.4	33.6	35.4	33.8	35.5	34.0	28.1	28.2	28.0	28.0	28.4	27.9	27.9			
Mei	24.0	23.0	24.4	23.4	24.7	22.8	24.6	35.4	37.1	33.2	36.2	33.9	36.0	32.9	28.3	28.9	28.3	28.1	28.0	28.2	27.9			
Juni	23.6	22.9	24.4	23.1	24.3	23.0	25.1	35.4	37.0	33.6	36.4	33.9	36.7	35.2	27.2	28.0	28.0	28.4	28.2	28.5	29.1			
Juli	22.4	22.8	25.2	23.2	24.7	22.2	23.9	34.5	35.6	34.5	36.1	34.4	36.8	33.4	27.7	28.3	28.8	27.8	28.5	28.7	27.5			
Agustus	23.1	22.2	24.0	22.4	25.1	22.6	24.3	35.2	36.6	35.0	35.8	35.8	36.2	34.0	27.7	28.4	28.9	27.7	29.5	28.8	28.0			
September	22.9	23.2	24.3	23.3	24.5	23.8	24.3	35.1	35.8	34.0	36.2	34.4	36.0	33.4	27.0	27.9	27.8	27.9	28.5	28.7	27.9			
Oktober	23.5	22.0	24.0	23.9	24.4	21.3	24.6	35.2	34.3	32.4	35.7	33.4	35.5	33.4	27.5	26.9	27.0	27.8	27.8	28.1	27.8			
November	23.6	23.2	24.3	22.7	24.4	23.0	24.0	34.3	35.1	32.2	34.4	32.5	34.0	32.2	27.1	27.4	27.1	27.4	27.1	27.1	27.5			
Desember	23.6	23.6	24.1	23.2	24.2	22.6	24.0	34.2	32.8	31.7	34.2	31.7	34.8	31.0	27.3	26.9	26.8	27.4	27.3	27.6	26.8			
Jumlah	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Rata-Rata	23.5	23.0	24.4	23.1	24.5	22.5	24.4	34.7	35.4	33.1	35.5	33.5	35.3	33.1	27.6	27.8	27.7	27.7	28.0	27.9	27.9			

Table 10. Table of temperature data in Pontianak for the period 2014-2020

Source: BPS Pontianak City

In the data chart of temperature data in Pontianak, it can be seen that the min and max temperatures in Pontianak City are on average the same every month and do not experience a significant difference, namely the min temperature between 24-25°C and the max temperature between 28-32°C. The highest max temperature occurs in August and September. then the lowest min temperature in July.

2.2.3.2 Humidity

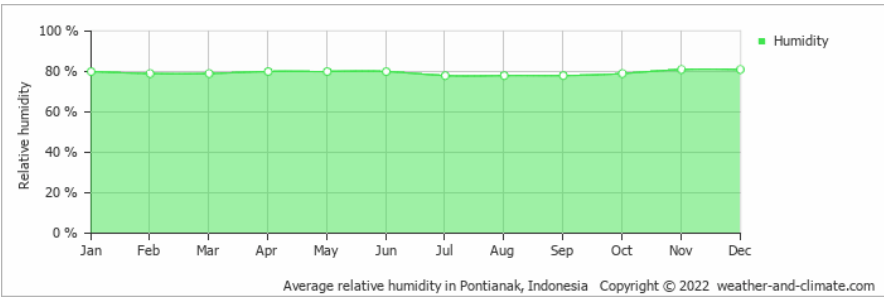


Figure 34. Average relative humidity throughout the year in Pontianak.

Source: weather and climate

Bulan	Rata-rata Kelembaban (Persen)						
	2020	2019	2018	2017	2016	2015	2014
Januari	86.0	84.0	85.0	81.0	83.7	85.0	79.0
Februari	83.0	84.0	82.0	81.0	85.3	83.0	84.0
Maret	81.0	79.0	82.0	82.0	81.6	80.0	79.0
April	82.0	81.0	82.0	81.0	81.3	81.0	82.0
Mei	82.0	79.0	84.0	83.0	83.8	81.0	83.0
Juni	81.0	82.0	82.0	79.0	79.8	79.0	74.0
Juli	83.0	75.0	76.0	80.0	78.6	75.0	80.0
Agustus	82.0	75.0	75.0	82.0	72.8	76.0	78.0
September	83.0	79.0	80.0	81.0	77.5	80.0	81.0
Oktober	82.0	87.0	85.0	83.0	81.4	82.0	80.0
November	85.0	84.0	85.0	85.0	85.7	86.0	83.0
Desember	83.0	86.0	85.0	84.0	84.3	82.0	86.0
Jumlah	-	-	-	-	-	-	-
Rata-Rata	82.8	81.3	81.9	81.8	81.3	80.8	80.8

Table 11. Table of humidity data in Pontianak for the period 2014-2020

Source: BPS Pontianak City

In the data chart and table of humidity data in Pontianak, it can be seen that the city of Pontianak has an average humidity of around 81%. then the lowest air humidity occurred in July, namely 76%. while the lowest humidity occurs in November, which is around 86%.

2.2.3.3 Sunlight Intensity

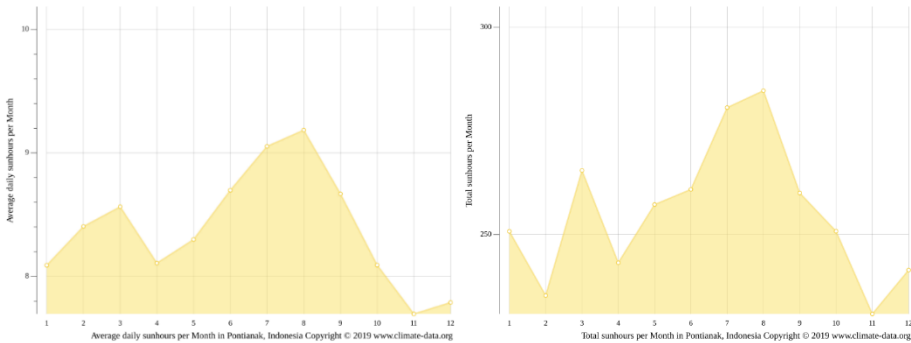


Figure 35. Average daily sunhours and total sunhours per Month in Pontianak.

Source: climate data org

. In Pontianak City, the duration of sunshine is around 34–78% (BAPPEDA Pontianak City). The month with the greatest daily hours of sunshine in Pontianak is August, with an average of 9.18 hours. Throughout August, there are a total of 284.72 hours of sunshine. With an average of 7.7 hours of sunshine each day, January is the month with the least amount of sunshine in Pontianak. In January, there are 230.87 hours of sunshine. Around 3061.53 hours of sunshine are counted in Pontianak during the year. Each month, there are an average of 100.64 hours of sunshine.

2.2.3.4 Rainfall

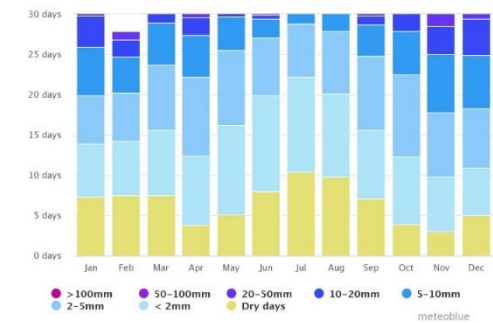


Figure 36. Chart of rainfall data in Pontianak throughout the year
Source: meteoblue

Bulan	Curah Hujan (mm)					
	2019	2018	2017	2016	2015	2014
Januari	201.8	402.0	144.2	433.3	290.8	73.8
Februari	302.2	105.0	278.7	343.1	214.4	40.2
Maret	83.7	231.0	340.4	231.6	220.9	249.6
April	299.9	346.0	110.9	359.9	226.2	198.6
Mei	276.8	552.8	327.8	403.1	436.5	270.2
Juni	506.3	400.0	226.3	290.8	284.5	254.1
Juli	227.6	51.0	315.2	264.2	257.0	104.6
Agustus	73.0	73.0	514.5	35.3	113.7	460.8
September	58.1	257.0	200.7	211.2	19.5	202.8
Oktober	579.4	517.4	143.1	217.5	286.2	269.1
November	371.5	429.8	234.3	301.2	298.0	518.2
Desember	635.8	449.0	243.5	298.0	205.4	213.2

Table 12. Table of rainfall data in Pontianak for the period 2014-2019
Source: BPS Pontianak City

From the chart and table data above, it can be seen that the rainy months occur in the city of Pontianak in September to June with the highest rainfall occurring in November reaching 518 mm while the lowest rainfall occurs in May, which is 50 mm. In July to August are 51 mm and 35 mm.

2.2.3.5 Wind Rose and Wind Velocity

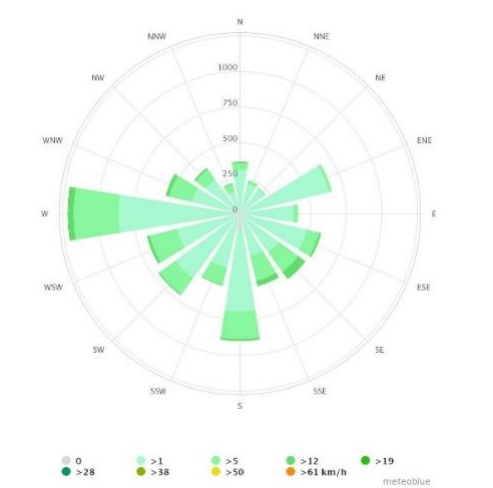


Figure 37. Image of wind rose chart in Pontianak throughout the year
Source: meteoblue

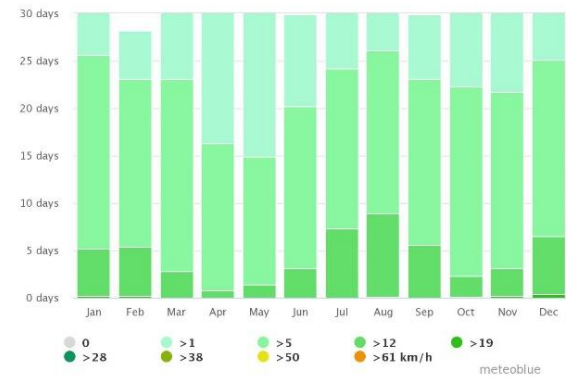
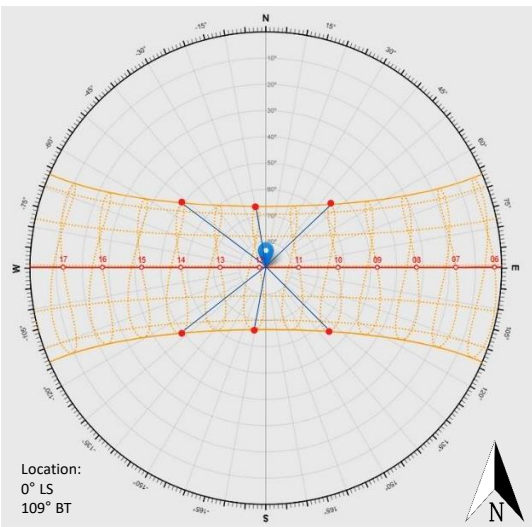


Figure 38. Image of wind speed chart in Pontianak throughout the year
Source: meteoblue

In the wind rose chart above, it can be seen that the wind speed is dominated by winds from the west and the south with wind speeds >12 km/hour. Then on the wind speed chart data, the highest max wind value occurs in December, which is >12 km/hour while the lowest max wind speed occurs in May, which is >1 km/hour.

2.2.3.6 Sun Chart



Date	10:00		12:00		14:00	
	Azimuth	Altitude	Azimuth	Altitude	Azimuth	Altitude
21 June	45.80°	55.23°	-8.25°	66.69°	-51.88°	49.90°
22 December	135.07°	55.83°	-170.08°	65.81°	-127.51°	49.24°

Table 13. Pontianak City sun chart.
Source: PD: Sun-Path Map

Plants require sunlight to grow and photosynthesize, while humans and buildings require it for natural illumination. In Indonesia, particularly in Pontianak, which is in the tropics, there is often a long time of sunshine that is consistent throughout the year.

This Sun Chart helps Porang plants obtain enough sunlight according to their demands by determining the angle of the sun falling throughout the day at specific hours (6-10 hours per day with an intensity of around 40-60 percent). It also has an impact on the use of shading devices and building envelopes in an effort to increase natural illumination in buildings optimally. On the Pontianak sun chart above (Pontianak is located at 0o 05' 37" south latitude and 109o 23' 01" east longitude), it can be seen that the sun's rays occur equally for the north and south equinoxes. So that both directions can be utilized as much as possible as a source of sunlight for a full year.

2.2.4 Map of Facilities and Infrastructure

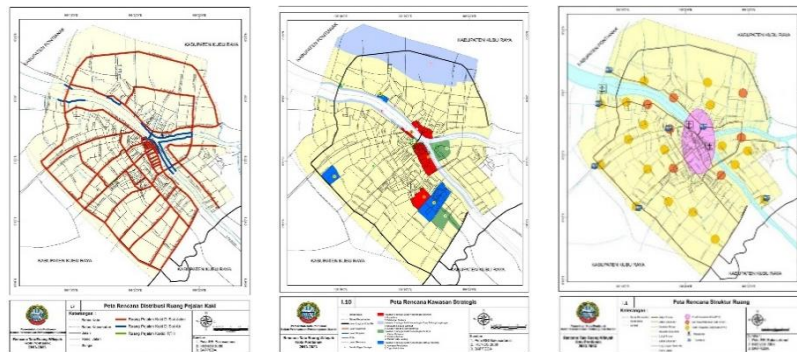


Figure 39. Map of Pontianak City pedestrian space distribution plan; strategic area plan map, spatial structure plan map (left to right).
Source: Pontianak City Government BPPD 2013-2033.

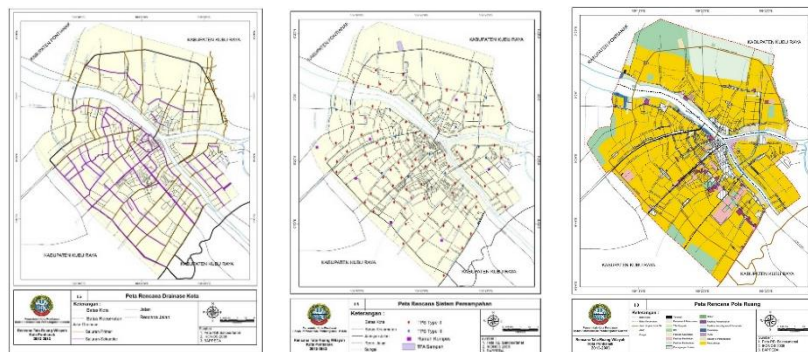


Figure 40. City drainage plan map; waste system plan map, spatial pattern plan map (left to right).
Source: Pontianak City Government BPPD 2013-2033

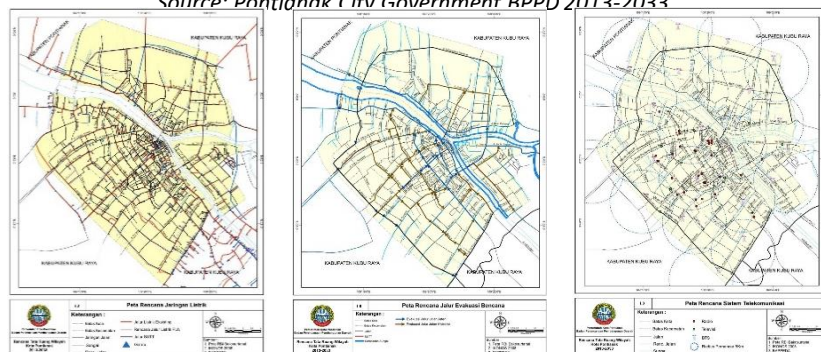


Figure 41. Electrical city plan map; disaster evacuation route plan map; telecommunication system plan map (left to right).
Source: Pontianak City Government BPPD 2013-2033.

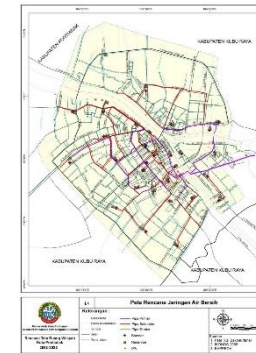


Figure 42. Clean water network plan map.
Source: Pontianak City Government BPPD 2013-2033.

2.2.5 Land Use and Regulations

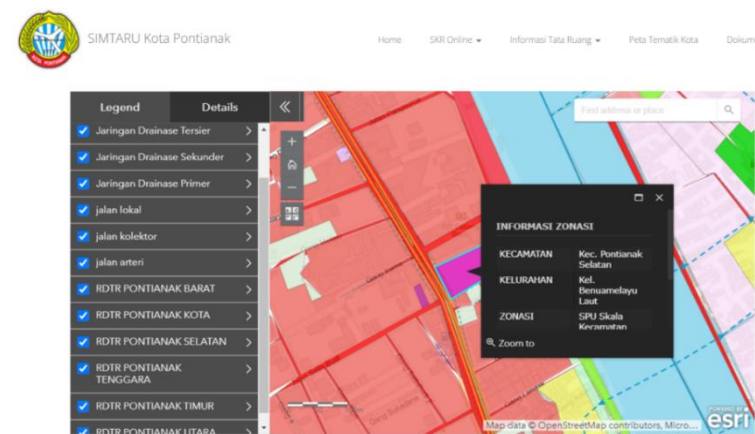
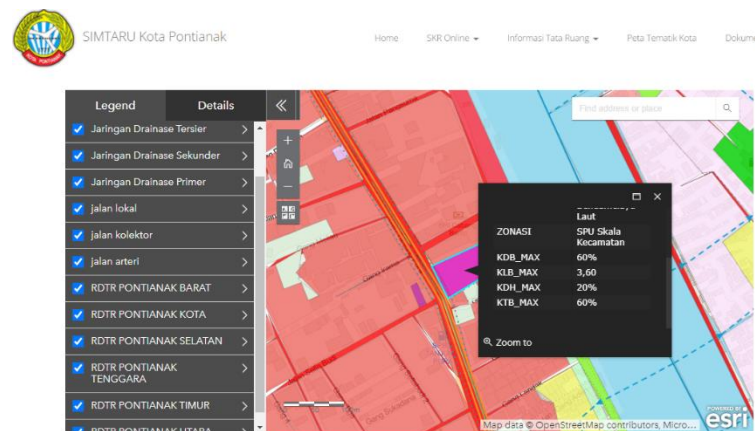


Figure 43. Pontianak City RDTR spatial pattern map.
Source: <https://simtaru.pupr.pontianakkota.go.id/index2.php?page=peta2>

The site is located in the purple zone, which is a zone that has a function as a District-scale SPU zone. The site has regulation of KDB max 60%, KLB max 3.60, KDH max 20%, and KTB max 60%.

REGULATIONS	
KDB max	60%
KLB max	3.6
KDH max	20%
KTB max	60%
Building border line (GSJ)	½ the width of the space reserved for the SPU zone.

ZONE CATEGORY:

Site location = South Pontianak (block A-4) = SPU sub-district scale = SPU zone 2.

Table 14. Regulations data of the site location.
Source: Pontianak Mayor Regulation Number 30 of 2021 concerning Detailed Spatial Plans for Pontianak City of 2021 - 2041, West Kalimantan Province.

2.3 Early Studies of Typology and Similar Precedent

2.3.1 Home Farm (by Sparks)



Figure 35. Situation of home farm
Source: sparksarchitects

Homefarm is a conceptual proposal for the next generation of urban retirement housing. It presents a residential and commercial farming typology for Singapore that combines apartments and facilities focused on but not exclusively senior living and vertical urban farming. The proposal incorporates vertical aquaponic farming and rooftop soil gardening into the domain of high-density, adaptable living that is tailored to seniors' requirements and preferences.

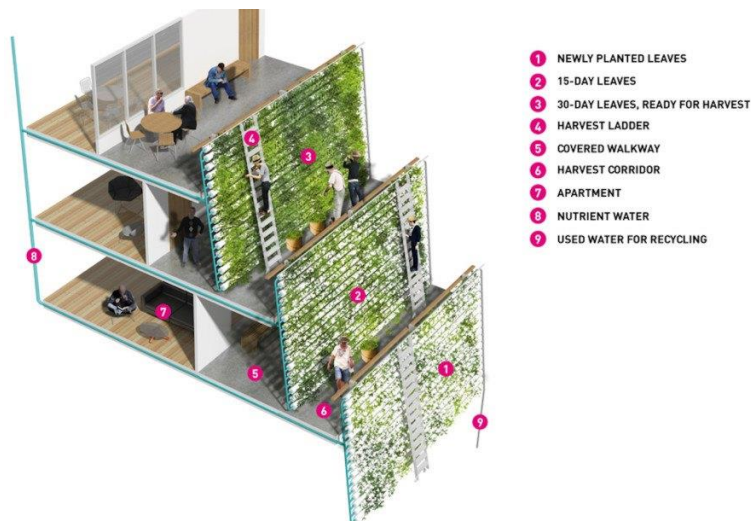


Figure 36. The arrangement of the space is designed like a ladder so that the lighting of the plants is evenly distributed.
Source: sparksarchitects

The residents live in a high-density garden environment created by the vegetable farm, where they may find employment. Working part-time at the farm under the supervision of a competent vertical farming implementation team can help residents deal with the financial stress that comes with retirement. Housing is built above in a curved tiered arrangement reminiscent of land contours, while facilities catering to the needs of an older population are given in the lower floors of the complex (and are also open to the public). SPARK's aim is to generate discussion about the potential that can emerge from the mixing of two typically separate realms. The research-based design addresses two pressing challenges faced by Singapore: how the city-state might support a rapidly ageing society, and how it might enhance its food security 90% of which is currently imported.

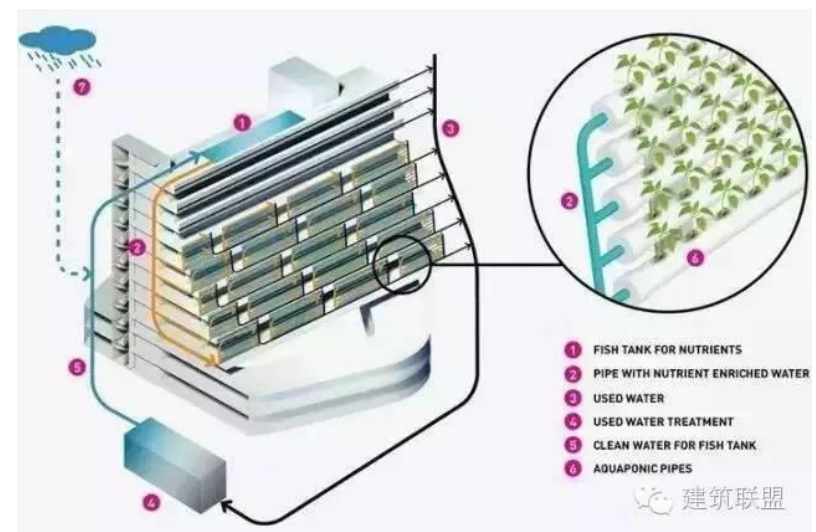


Figure 37. the plant irrigation system uses a hydroponic system through vertically arranged pipes.

Source: sparksarchitects

Gardening would provide several benefits in addition to personal money creation, such as community connectivity and health enhancement. Simultaneously, food production in the heart of the city could provide a platform for community education, help lower Singapore's high carbon footprint by closing the gap between producers and consumers, and contribute to the perpetuation of Singapore's 'City in a Garden' vision in a productive capacity, in addition to boosting the resiliency of the city's food supply.

2.3.2 Farmsphere (urban farming center) in Thailand



Figure 38. Farm sphere top perspective view.
Source: issue

Farmsphere is an urban farming center in Thailand. This project is motivated by the agricultural system in Thailand which is still very traditional and outdated. The architect explained that in developed countries, especially European countries, there are areas that are not too fertile to be planted with agricultural crops, but their more sophisticated and advanced technology makes their production of agricultural products increase continuously and have high quality.

Farmsphere has a function as a production building, processing raw food and selling it, as well as facilities for learning to farm.

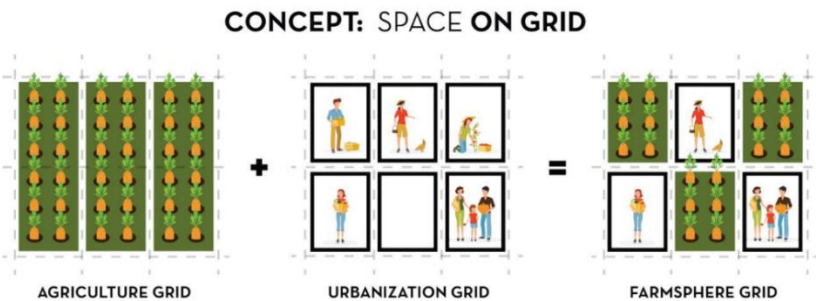


Figure 39. Concept space on grid.
Source: issue

The design concept applied to this building is “concept: space on grid”, in which the determination of building mass and spatial layout uses modules of the same size and shape. So that this can facilitate the process of designing and

calculating space requirements. As well as effective and efficient in the use of materials in making building construction.

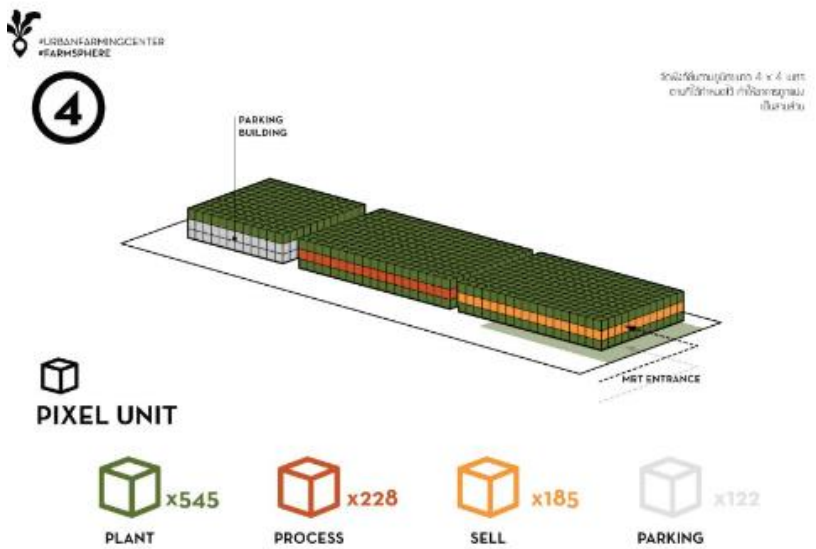


Figure 40. The zoning division.
Source: issue

The zoning division in this project is divided into four zones, namely the planting area, the processing area, the selling area, and the parking area.

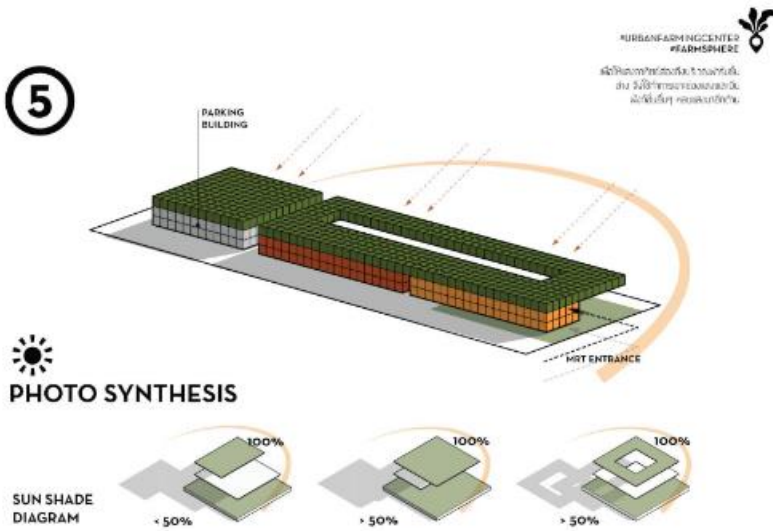


Figure 41. Sun shade diagram.
Source: issue

2.3.3 The Havana Food Port's Urban Agriculture



Figure 42. Situation of The Havana Food Port's Urban Agriculture
Source: Gonzalo Nicolau Architect

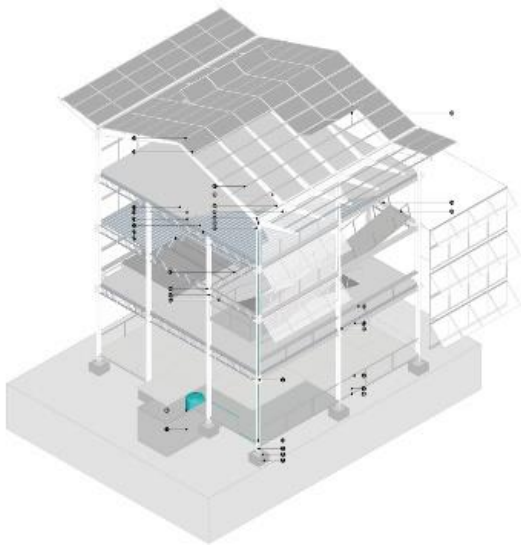


Figure 44. The Havana Food Port's Urban Agriculture building system details
Source: Gonzalo Nicolau Architect



Figure 43. Building section of The Havana Food Port's Urban Agriculture
Source: Gonzalo Nicolau Architect

The 'Havana food port' is located in the bay in Cuba, and it is here that the warehouses of products related to the sugar and coffee industries are concentrated. It is now an out-of-date download platform that manifests as a large boundary between the city and the lake, with only sheds, an industrial environment, and little orchards in green spaces.

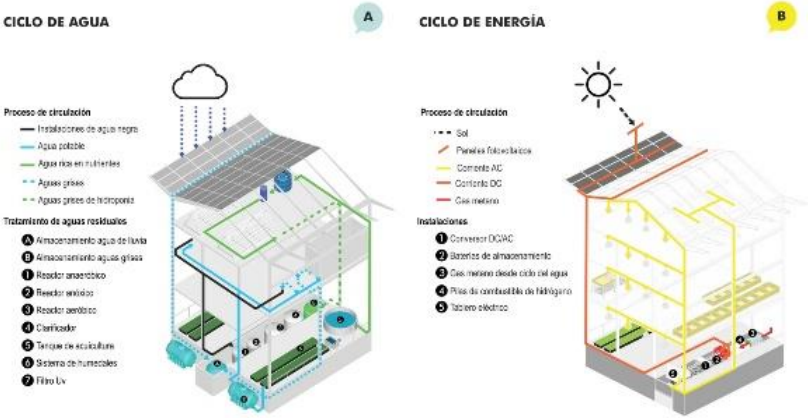


Figure 45. rainwater collection system details and solar energy The Havana Food Port's Urban Agriculture
Source: Gonzalo Nicolau Architect

Rethinking the waste spaces that because unexpected economic shifts allows us to reconsider each of the city's articulation points. The planned architecture pays homage to the bay's ancient sheds and sugar mills, creating a new typology for the city's outskirts. Local resources, such as reinforced concrete, metal profiles, wood, and disused port materials, are employed in the site's modulation and construction, as well as transportation.

03

Chapter

Design Concepts

Concept Design Guideline

	SITE PLANNING	BUILDING MASS	ROOM SPACE	BUILDING SYSTEM	BUILDING ENVELOPE	CONSTRUCTI ON
PERMACULTURE BUILDING	☑	☑	☑	☑	☑	-
BUILDING SKIN TECHNOLOGY	-	-	☑	☑	-	-
TOTAL CONCEPTS						7

Table 15. Table of Concept Design Guideline
Source: author

3.1 Permaculture Building for Site Plan Design Concept

3.1.1 Situation and Existing Condition on Site Location

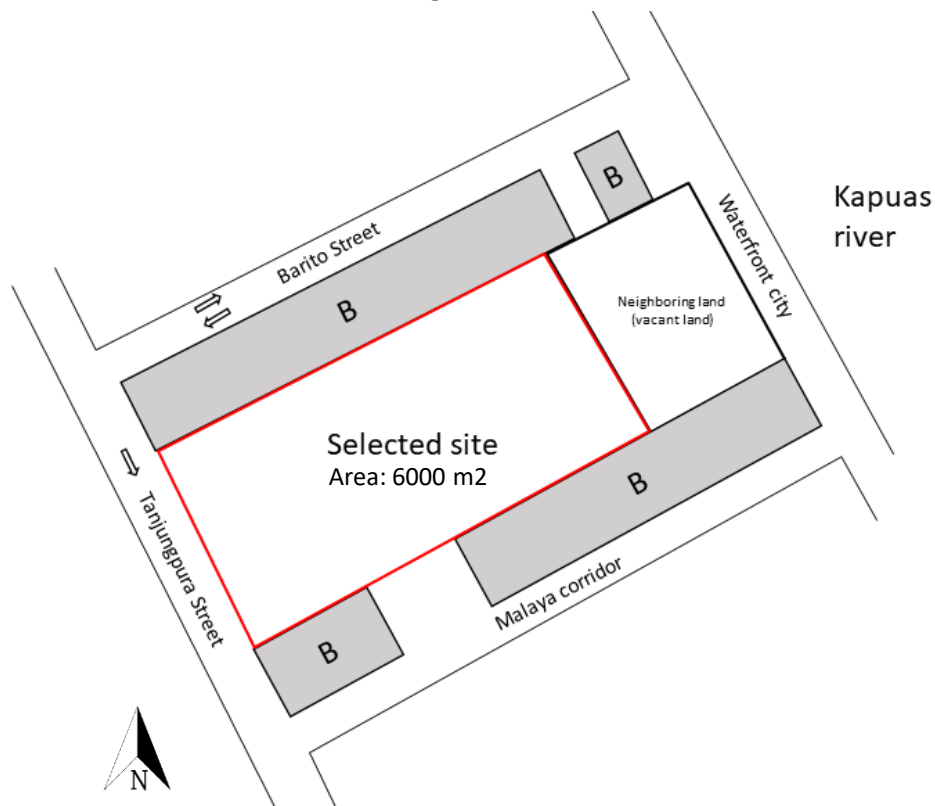


Figure 46. Existing conditions around the site.
Source: author analysis

The selected site is located at Jalan Tanjung Pura Street 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Pontianak City, West Kalimantan. The site has an area of 6000 m². The site is located in an industrial and commercial area. At the site, the condition of the land does not contain trees, or former building structures. The site is located close to the Kapuas river, which is the third water source after the use of PDAM Pontianak city water sources and harvested rainwater. The site has advantages and disadvantages, which are as follows:

- (+) industry area, near to the river
- (+) located in suburban area, easy access to sea and land transportation
- (-) the soil is not suitable for high-rise buildings
- (-) land subsidence

From this analysis, the advantages of the selected site will be utilized optimally to help the building's

performance. while the weaknesses of the selected sites will be reduced as much as possible. such as the condition of soil is not suitable for high-rise building and land subsidence, the design of the building is endeavored not to be designed as a high-rise building, as well as the selection of the right foundation for the type of subsidence soil.

Contour line conditions on the site have contour lines that tend to be flat. Contour lines have an interval of 1 meter as shown in the figure, the highest land level is 7 meters above water level, and the lowest is 4 meters.

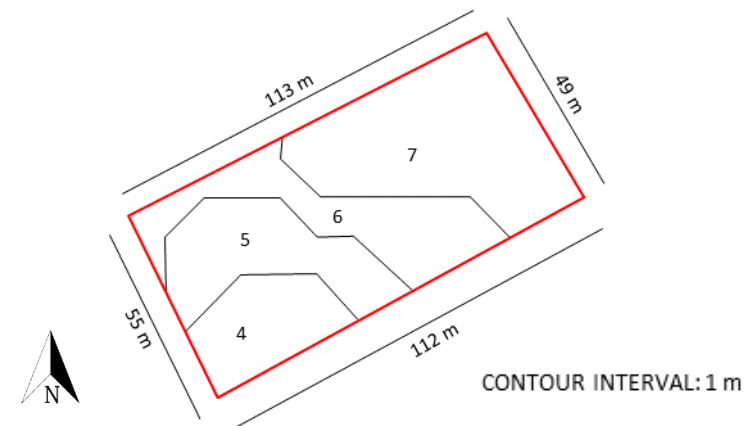


Figure 47. Condition of contour lines on sites that tend to be flat.
Source: author analysis

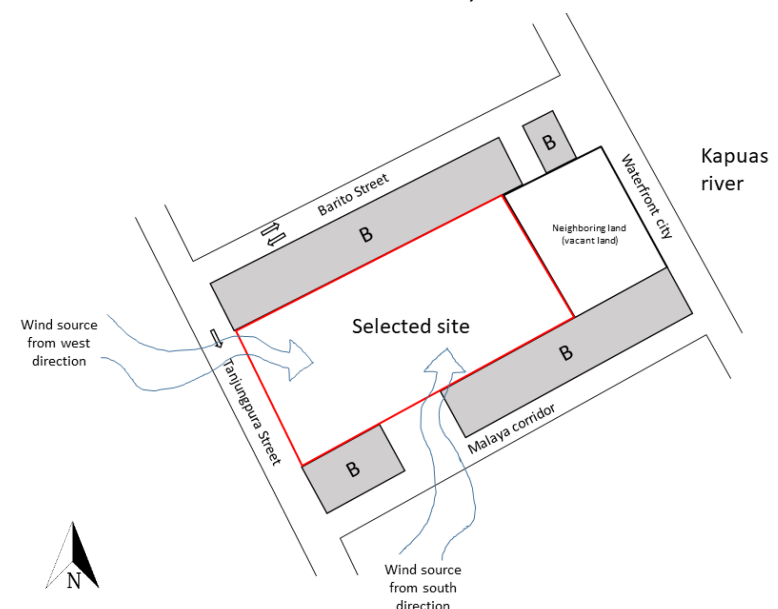


Figure 48. The direction of the wind is dominated by the west and south of the site.
Source: author analysis

Wind sources come from the west and east of the site. On the west side of the site, there is no barrier to wind coming towards the site. While in the south there are buildings and also vacant land that is not too large which is a burial ground. These buildings are dominated by buildings with a height of 2-3 floors. So it is enough to block the wind coming to

the site. So it is necessary to provide sufficient distance between buildings and neighboring buildings so that the incoming wind can reach the building and site.

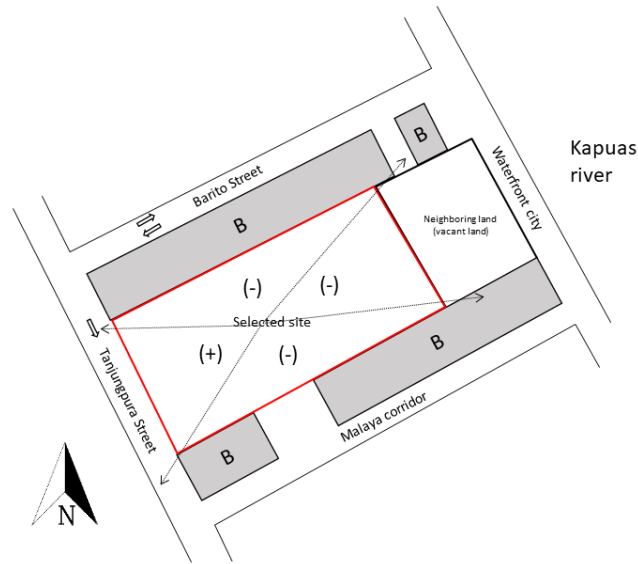


Figure 49. Site views.
Source: author analysis

View is divided into two, namely views into the site (vista) and views from of the site (views). The view site in the southwest direction is the only view site that has a positive value, where building users can see outside the building. while the northeast and southeast directions have negative values because the view is blocked by buildings flanking the site. Then to the northwest there is a neighboring vacant land, where there is a temporary building and a little view overlooking the Kapuas river. The vista site can be seen by observers from the Tanjung Pura Street.

3.1.2 Zone Division Analysis Based on Permaculture Building Activities on Site Plan Design

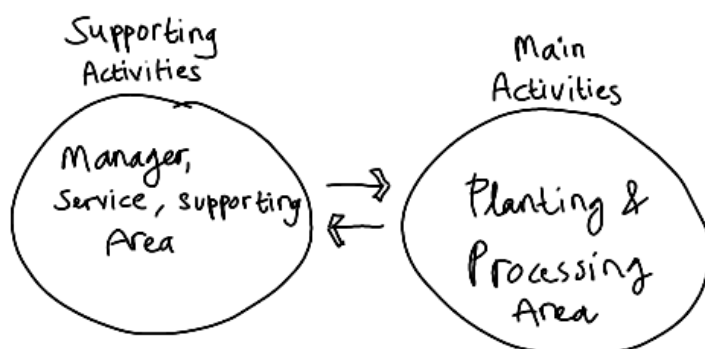


Figure 50. Permaculture Building is divided into two activities, which consist of main activities and supporting activities.
Source: author analysis

The Permaculture Building is divided into two activities, which consist of main activities and supporting activities. The division of this activity is divided based on the type of activity, activity time, and duration. The main activities consist of planting, processing, and exporting processed Porang products. While supporting activities consist of management, building maintenance, services, and other supporting activities.

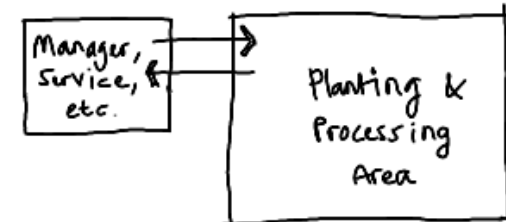


Figure 51. The scheme of space requirements for agricultural and processing activities requires more space in terms of function and the needs of space users.
Source: author analysis

The size of the space needed is based on the type of activity, function, and the needs of the space user. Planting and processing activities require more space than other activities, considering that the type of building user is not only intended for humans, but also the Porang plant, which is the main point that requires special handling in designing the space. Processing activities in permaculture building are the second most populous activity, because activities will start from transferring fresh Porang tuber products to the storage room. Then Porang is moved to a processing area which includes a Porang washing machine, Porang chopper machine, Porang drying machine, and a milling machine. Then the Porang product is continued to be extracted into Porang flour or rice. These activities certainly require a larger space in terms of the type of user activity, as well as the circulation of these activities.



Figure 52. Zoning scheme and space plotting in the site plan.
Source: author analysis

Alternative A

- (+) each zone has its own focus and is not disturbed at all.
- (+) because each zone is not merged, the planting and processing zone is much more optimal in accordance with the main function of the building, namely planting and processing.
- (-) because each zone is not mixed, the access distance between zones is a bit far.

Alternative B and C

- (+) because the zones are mixed with each other, the access distance between zones is getting closer.
- (-) because the zones are mixed with each other, the focus of each function is not effective and efficient.

Based on this analysis, it can be decided that alternative A is the best space zoning, considering that each function has a different focus and it would be better if the functions were not combined. for access, actually access that is a bit far between zone functions doesn't really have much effect, because each activity will revolve around the same zone for a long duration.

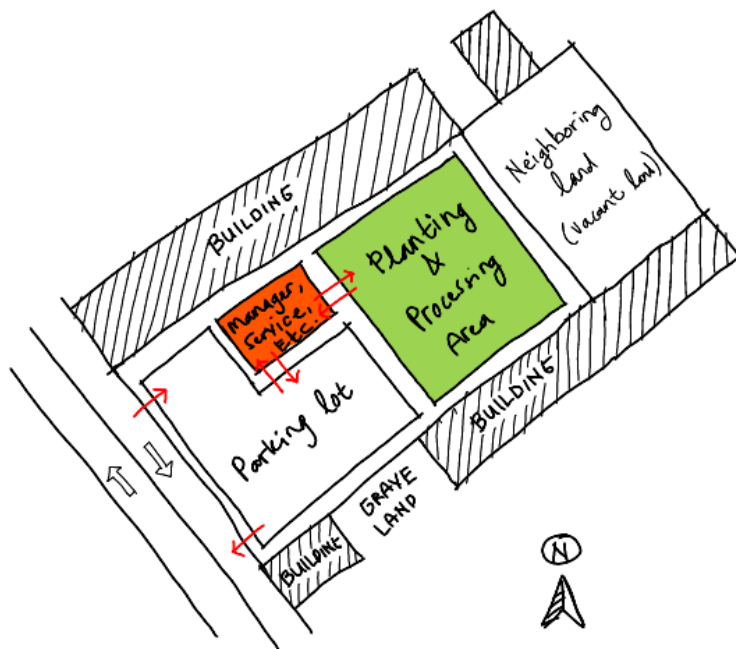


Figure 53.. Zoning applied to the site plan.
Source: author analysis

After the chosen alternative is applied to the site plan design, in designing the site plan for Permaculture Building, the zone is divided into three zones, namely the parking zone, the zone for supporting activities (manage, service, and etc) and the main activity zone (planting and processing). The zone is divided according to the activity density level of each zone function. The parking zone is placed

in front of or adjacent to the road so that building users do not enter the building using vehicles. So that it can reduce the carbon footprint of the site environment. The supporting activities zone is placed between the parking zone and the main activities zone. This zone is useful as a liaison between the two zones. Then the zone located at the rear of the site is the main activities zone, which zone has the highest activity density.

3.1.3 Zone and Access Plotting Design Analysis on Site Plan for Permaculture Building



Figure 54. Specific zone plotting and access in site plan design.
Source: author analysis

Plotting zones on the site plan are divided into more specific areas than the previous zones, in which the plotting of parking zones is divided into two, namely the zone for motorcycle parking and the zone for car parking. The two parking zones are placed close together and next to each other, but for exit access the two types of vehicles are designed differently for the convenience and safety of site users.

Pedestrian access is also designed separately between vehicle access. Pedestrian access will be designed like

a sidewalk, provided with shading devices so that the area is shaded, and connected directly from the parking area to the building so that building users can walk to the building comfortably and safely.

Service access is also designed separately from other accesses. This service access will deliver trucks directly to the loading and unloading area, which is located near the main activities zone (planting and processing area). Service access is made around the Permaculture site and building, this is not only useful for service (truck) access, it is also useful for fire truck access.

3.2 Permaculture Building for Building Mass Design Concept

3.2.1 Analysis of Appropriate Building Mass Orientation for Planting and Processing Area

Analysis of building mass orientation for Planting and Processing area is designed by considering the temperature issue, which All stages of Porang growth require air temperatures that are not hot (most optimal 23 - 25°C). In the previous analysis, namely the Table of Land Suitability Criteria for Porang Plants (by Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016), it was stated that the City of Pontianak for Temperature parameters was categorized in the S3 land category (marginal fit), where the temperature on land in Pontianak City is suitable for growing Porang but has low potential because Pontianak City has an average temperature of 28 - 32°C, which is hotter than the most optimal temperature for growing Porang plants, which is 23 - 25°C. so that to increase the potential for the Temperature parameter, efforts are needed in designing the Porang planting area so that the temperature level can be reduced, which is as in the table below which shows the design criteria and problem solving for the Temperature issue.

Design criteria in category S3 (marginal fit):

1. Arch issue: temperature

Design criteria	Problem solving
All stages of Porang growth require air temperatures that are not hot (most optimal 23 - 25°C).	<ul style="list-style-type: none">The orientation of the building faces south and north, so that the large facade area does not absorb too much solar heat.The shape of the building mass extends to the west and east to avoid absorption of solar radiation. or you can design a solid void building mass to create a shaded area on the facade.The use of shading devices to avoid the sun's altitude point which has a high level of sunlight intensity (the more perpendicular the sun's position, the higher the level of sunlight intensity).
Except for the break dormancy stage, seedlings in the form of tubers require a temperature of 45°C (drying/drying in the sun for 6 hours/day).	<ul style="list-style-type: none">The use of transparent materials, so that sunlight can be transmitted 100% (sunlight intensity 100%).Does not require a shading device.

Table 8. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.

Source: author analysis

At the building mass design stage, the orientation of the building mass for the Planting and Processing area will be analyzed using a sun chart. The orientation of the building mass will be made into two alternatives that will be considered as shown in the following figure.

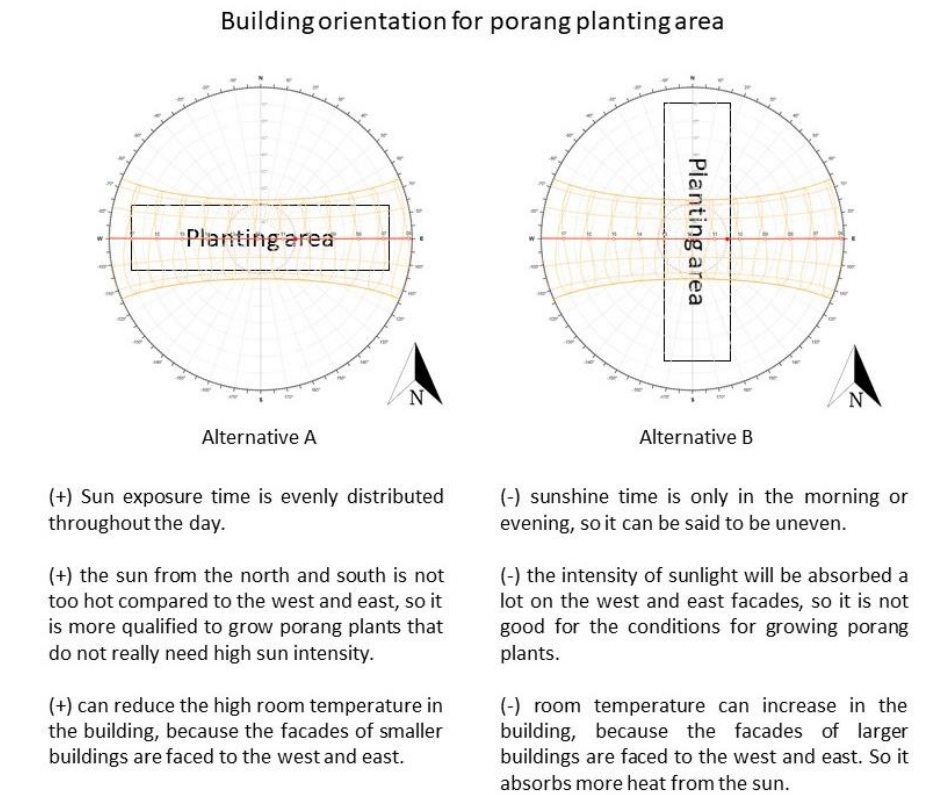


Figure 55. Analysis of the building mass orientation that meets the requirements for growing Porang plants
Source: author analysis

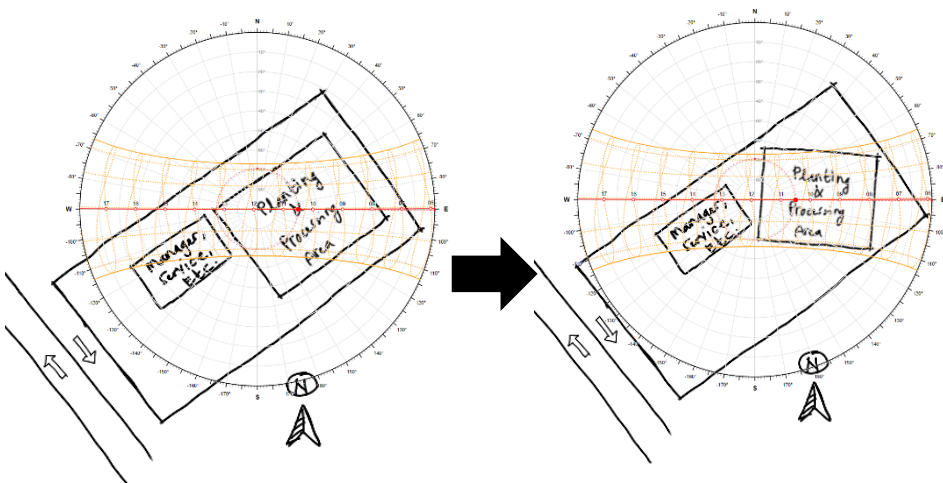


Figure 56. The orientation of the building mass for the Planting and Processing area is changed according to the movement of the sun from east to west.
Source: author analysis

Based on this analysis, it can be concluded that a good building mass orientation for porang plants is the orientation of the building mass that facing to the north and south, and extends from east to west, namely alternative A. Priority will be given to the Porang planting area. With the selection of alternative A, it is hoped that the orientation of the building mass can reduce the room temperature to be cooler for Porang planting needs, so that it can increase the potential for growing Porang plants inside the building.

Meanwhile, the management area, service and other supporting facilities will follow the shape of the site so that there is no waste of space and site area. In addition, these considerations are made because the duration of user is not carried out for a full day out (12 - 24 hours) and can make adjustments to the facade design, etc. for the convenience of building users.

3.2.2 Analysis of Appropriate Building Mass Forms for Planting and Processing Areas

In designing the form of building mass that is suitable for Planting and Processing Areas, it is necessary to consider several aspects, namely the aspect of the humidity level and the aspect of the water temperature in the building. In the previous analysis, namely the Table of Land Suitability Criteria for Porang Plants (by Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016), it was stated that the humidity in Pontianak City was categorized in S3 land (marginal fit), namely where the humidity on the land in Pontianak City is suitable for growing Porang but has little potential because Pontianak City has an average humidity of 86-92%, which is more humid than the most optimal humidity for Porang growth, which is around 24 - 80%. From this analysis, it can be said that efforts need to be made in designing the planting space so that the humidity in the building can be reduced, which can be done in several ways as listed in the following table.

2. Arch issue: humidity

Design criteria	Problem solving
The nursery stage of frogs/bulbills requires sufficient humidity/not dry (most optimal 24-80%).	<ul style="list-style-type: none">The composition of the building mass can use a single banked room so that air movement is evenly distributed.Ventilation can use the stuck effect.Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Porang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none">Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Porang.Use cross section ventilation.Make openings / ventilation in the roof to reduce excess moisture.

Table 9. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

In designing the next building mass, the two building masses, namely the building mass for supporting activities (manage, service, etc.) and the building mass for main activities (planting and processing) are combined as shown in

the following figure. This is so that every activity related to the two building masses can be carried out efficiently, effectively, and energy saved.

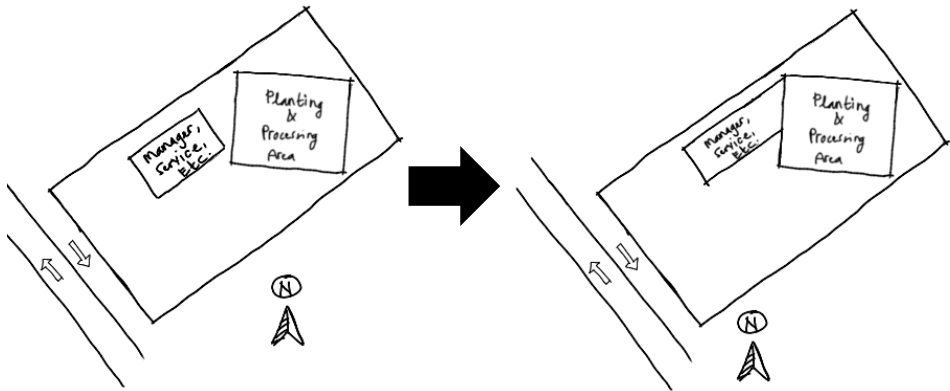


Figure 57. The process of designing the mass of the building is continued by combining the two building masses into one part.
Source: author analysis

In designing the shape of the building mass that takes into account the humidity and temperature aspects, several efforts need to be made, such as the application of a composition of the building mass can use a single banked room so that air movement is evenly distributed, ventilation can use the stuck effect, use cross section ventilation, and minimize the facade area that is exposed to the sun's heat so that heat absorption can be reduced.

As shown in the following figure, the site shows that the wind source is dominated by two directions, namely from the wind source coming from the west and also the wind source from the south. And the east facade of the building gets quite a lot of solar heat absorption.

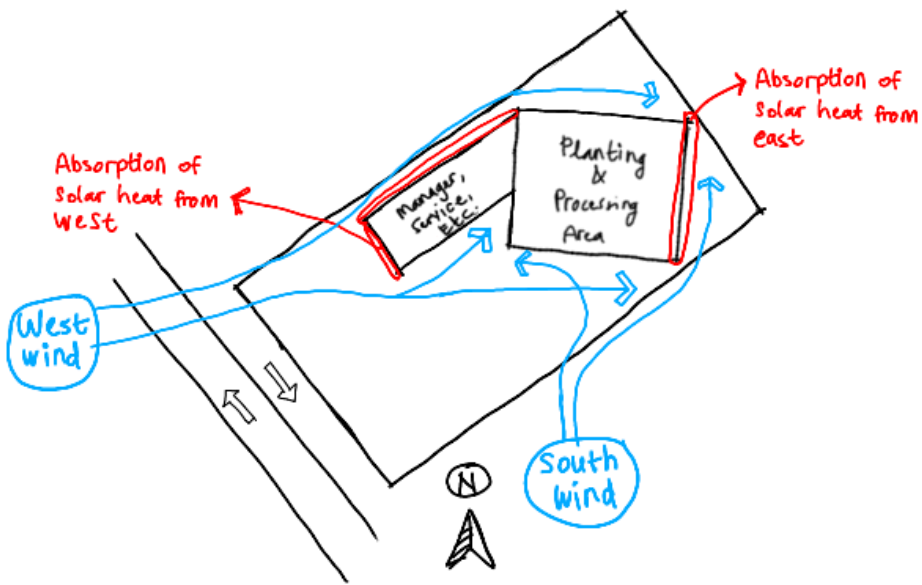


Figure 58. Wind sources come from the west and south of the site.
Source: author analysis

The shape of the building mass is then divided into two parts as shown below. So that the absorption of solar heat is reduced and the incoming wind can enter the gap between the two buildings.

The analysis of the movement of wind circulation in the building mass can be seen in the following figure. The wind source is dominated by the west and south, so to regulate the humidity level in the porang planting area, the wind circulation is designed to pass through the building to the building mass by means of a thin and elongated building from east to west where the shape of the building is like a single banked room. This is intended so that the wind can easily penetrate the spaces inside the building from the south wind. and can pass through gaps between buildings, especially for the porang planting area consisting of two building masses that have a certain distance, but not too far apart. This is so that the wind from the west can pass through the gap between the building masses.

More air circulation will enter the building mass and reduce the temperature and humidity in the Porang planting area. In addition, this is also good for the convenience of building users in the processing area because this area has a high level of activity density. So it takes the comfort of the building in terms of thermal comfort and saving energy use.

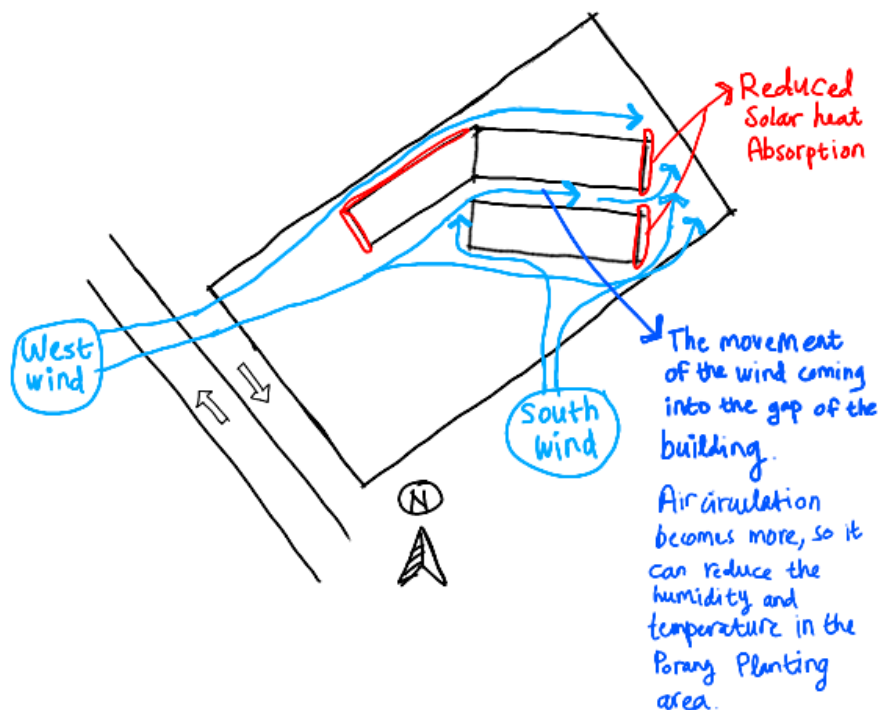


Figure 59. The shape of the mass of the building is divided into two and applies a single banked room, so that the wind will come through the gaps between the buildings.
Source: author analysis

After the form of building mass on the site is designed taking into account the needs of Porang planting in terms of temperature and humidity as well as the user's thermal comfort, the following is the initial design of the form of building mass on the site plan with access and circulation on the site plan.

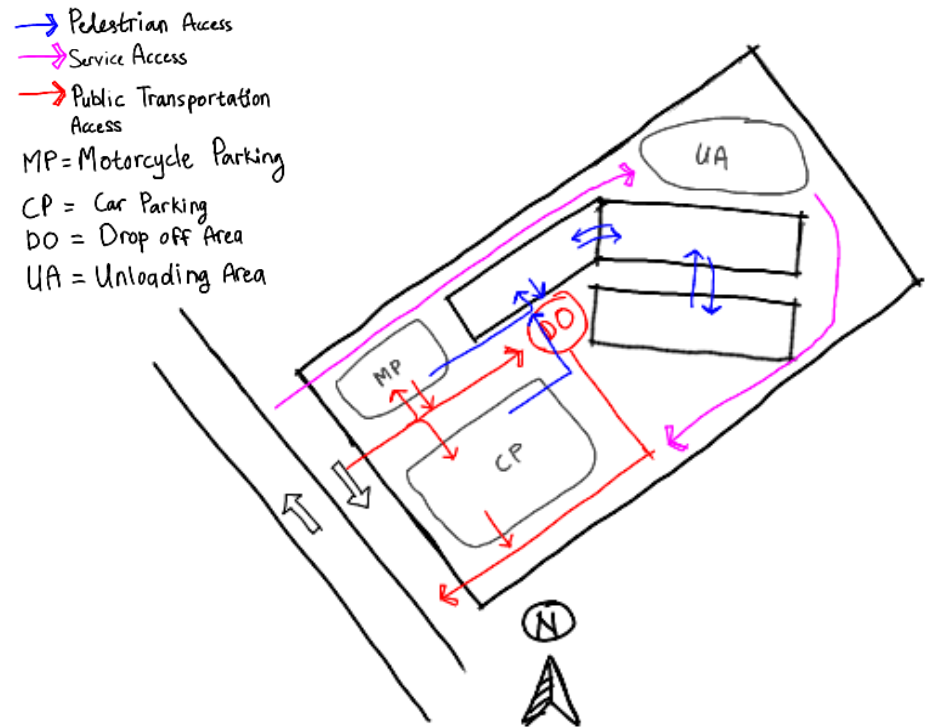


Figure 60. Placement the design of building mass forms, parking zones, drop off zones, loading and unloading zones, and access in the site plan.
Source: author analysis

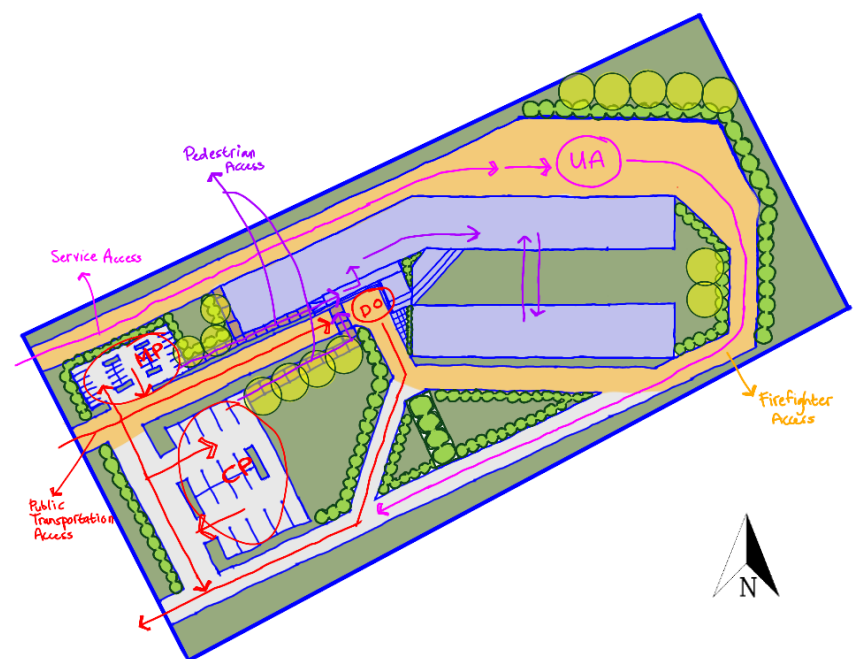


Figure 61. Placement of initial form of building mass and access in the site plan design.
Source: author analysis

At the development stage in designing the shape of the mass of the building, the next step is to determine the right roof shape for the Porang planting area. The city of Pontianak has very high rainfall, so a good roof typology is one that has a steep roof slope so that water can fall quickly and does not pool on the roof surface for too long. The shape of the roof is also recommended to have a special zone for wind movement inside the building so that the air flow inside the building is not hot, considering that the Porang plant requires a fairly low air temperature compared to the temperature in the city of Pontianak.

Here are some alternative roof shapes for the mass design of the Porang Permaculture building which will be analyzed.

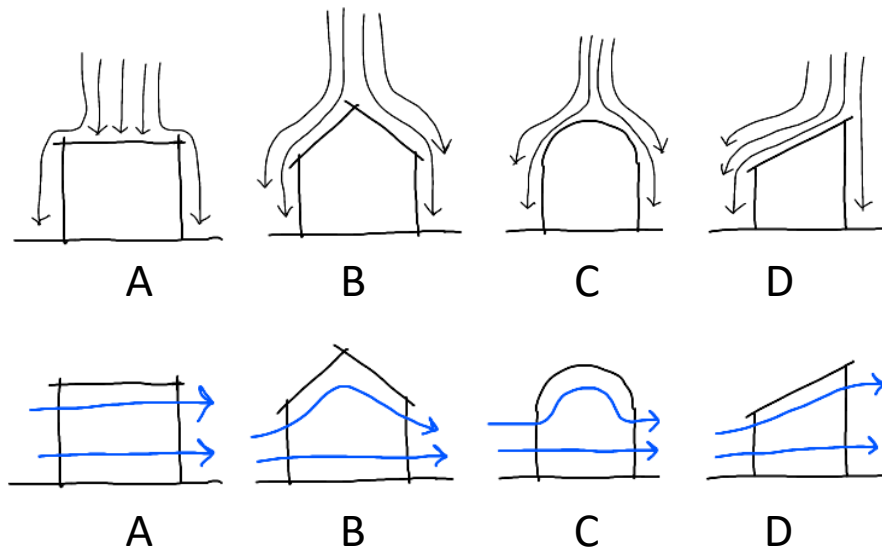


Figure 62. The various forms of roofs and the reaction to the motion of falling rainwater and air movement in the building.
Source: author analysis

a. Flat roof shape

- (+) can collect water.
- (-) but not suitable for places with high rainfall.
- (-) is not suitable for tropical climates because there is no zone large enough as a wind movement zone.

b. Gable roof shape

- (+) suitable for places that have high rainfall due to the steep slope of the roof.
- (+) the shape of the roof that protrudes upward provides space for air to move.
- (+) can catch rainwater if given gutters, etc.
- (-) the symmetrical slope causes the roof to be unable to protect Porang plants from high sunlight intensity at a certain slope.

c. Arch roof shape

- (+) has a zone for wind movement in the room.
- (+) can catch rainwater if given gutters, etc.
- (-) is quite suitable for use in places that have a fairly high level of rainfall, but not suitable for very high rainfall such as in the city of Pontianak.

d. Leaning roof shape

- (+) suitable for places that have high rainfall due to the steep slope of the roof.
- (+) has a good air movement zone.
- (+) can catch rainwater if given gutters, etc.
- (+) can protect Porang plants at 12:00 and 14:00 from the high intensity of sunlight.
- (-) rainwater falls only on one side that gets a slope, so protection is needed on the other side.

Based on the analysis of the shape of the roof, it can be concluded that the shape of the roof that suits the needs of growing Porang plants is an alternative D roof form, because the architectural issue that requires the most action is the need for sunlight intensity. Which in the alternative roof form D can protect Porang plants at certain hours (at 12:00 and 14:00) from the high intensity of sunlight. In addition, in terms of rainfall and humidity, the alternative D roof shape is suitable for use in places that have high levels of rainfall. Likewise with humidity, where the rising roof provides a zone for air movement within the building.

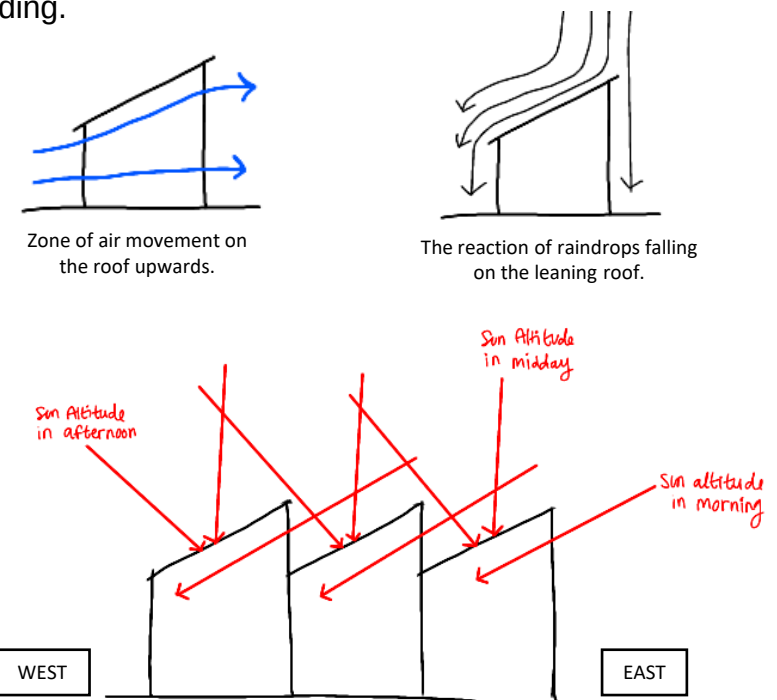


Figure 63. The shape of the leaning roof lets sunlight in morning into the building. while sunlight in midday and afternoon is avoided because it has a high level of sunlight intensity.
Source: author analysis

Design criteria in category N (not suitable):
1. Arch issue: Sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">• The roof can use a massive material or an ordinary roof.• Sufficient light comes from windows, etc.• Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">• The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.• Avoid the sun's altitude point which has a high level of solar radiation.• Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).• Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).• Must use transparent roofing material but have a louver.• Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">• Use transparent materials so that sunlight can be transmitted into the building 100%.• Avoid using shading devices, etc.• Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table 7. Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

The design of the form of building mass for the Porang Permaculture Building is then continued by planning the roofing material according to the function of each room. In designing this building, there are three types of lighting requirements needed in the Porang Permaculture Building. That is lighting with 40 - 50% sunlight intensity for the Porang planting area, 100% lighting for the Porang tuber burning/heating area, and an area with <50% lighting for the nursery/seeding area and special areas for managing, service, control. Which is for an area <50% most of the building users are humans, not adult Porang plants. So for thermal comfort in lighting the building only uses morning sunlight as shown in the following picture, while the afternoon and evening sun tends to be avoided. So for areas with <50% lighting, massive roofing materials or ordinary roofing materials are needed to protect building users (humans) from direct sunlight.

In the following picture it is explained that the roof of the building is divided into three types, namely semi-transparent roof made of Plastic UV material (light can penetrate <100% of the building), ordinary massive roofing material, and transparent roofing material that can transmit sunlight up to 100% into the building.

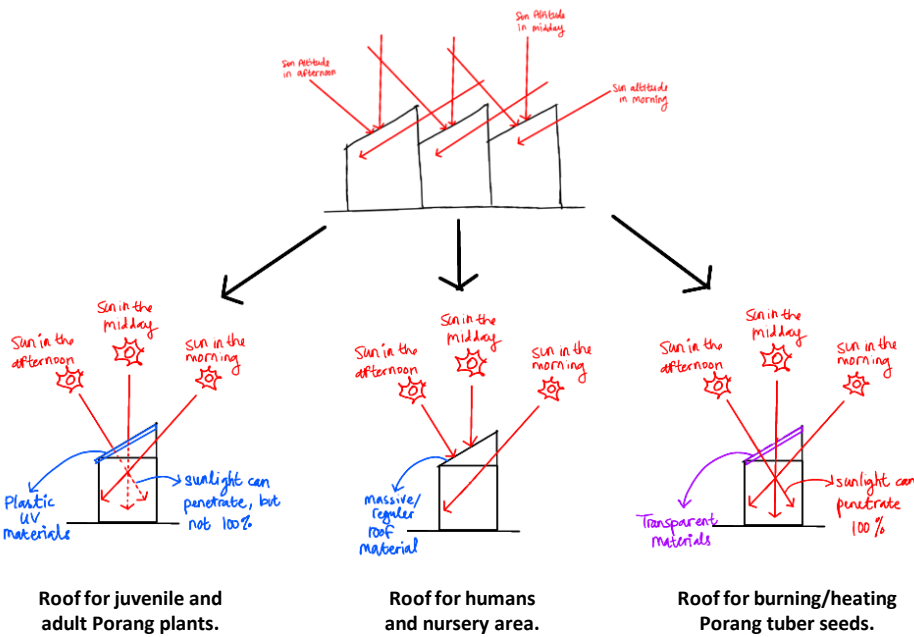


Figure 64. The function of the leaning roof form for each room function, which is divided into 3 types of roofs based on the material to be used.
Source: author analysis

After making the roof design into three types according to the needs of their respective functions, here is a design drawing of the Porang Permaculture Building mass building on the site plan.

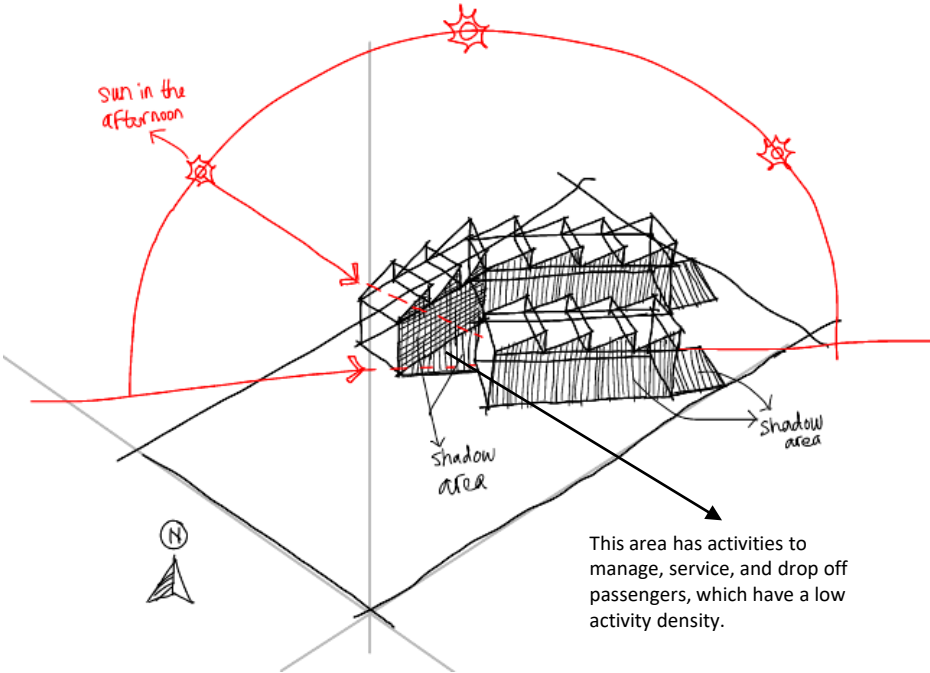


Figure 65. The location of the shadow on the surface of the building mass when the sun is in the west. The sun in the afternoon is the most critical time the sun is hottest.
Source: author analysis

The design of the Porang Permaculture Building mass building design that responds to the afternoon sun, ie when the sun is in the west (afternoon), the area that is shaded

is far more than the area that is exposed to direct sunlight. On the inside of the building, which is between the gap between the two building masses, is an area for building users to carry out activities, such as manage, service, control, etc. In that area, the activity density level is not too high. Meanwhile, the planting and processing area is an area with a high activity density level or is the main activity in a building.

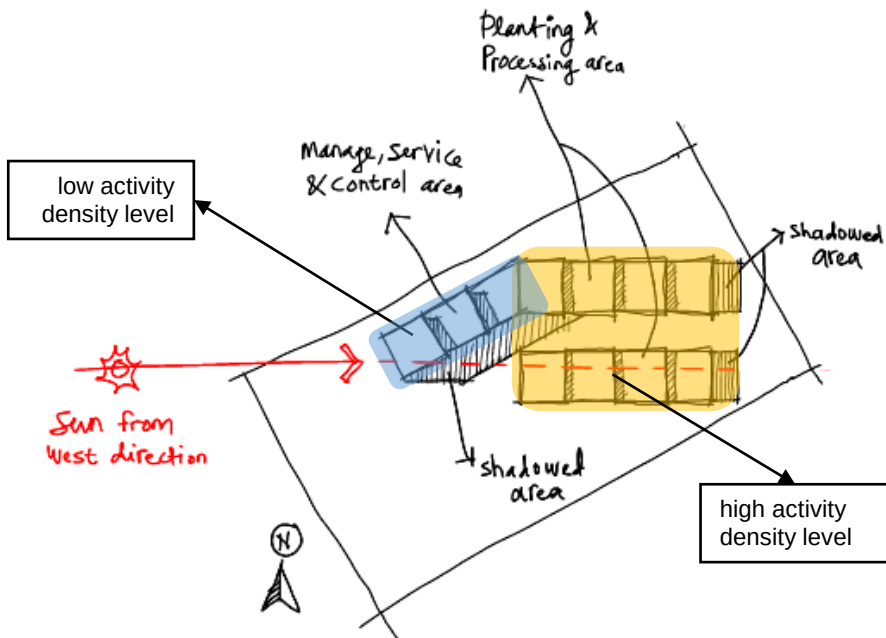


Figure 66. Top view of the building mass, planting and processing area has a little shadow due the surface of the building mass is not exposed to much sunlight from the west. This is because this area has a high activity density level, and Porang plants should not have high room temperatures.

Source: author analysis

In the following picture, the sun's position is in the east, this time is good for Porang plants because the sunlight at that time has a low level of sunlight intensity. The placement of planting and processing areas in the east is also intended to avoid thermal discomfort to building users due to the high activity density in these areas. Besides that, the shape of the building that extends from east to west, and the main facade oriented to the south and north is intended to reduce the absorption of solar heat on the surface of the facade, so that the room temperature does not become high in the Porang planting area, which basically Porang plants do not really need hot temperatures to grow.

Meanwhile, in the west location, it is placed for the management, service, and control areas, where the activity density level is not too high. So that the main priority is given to planting and processing activities.

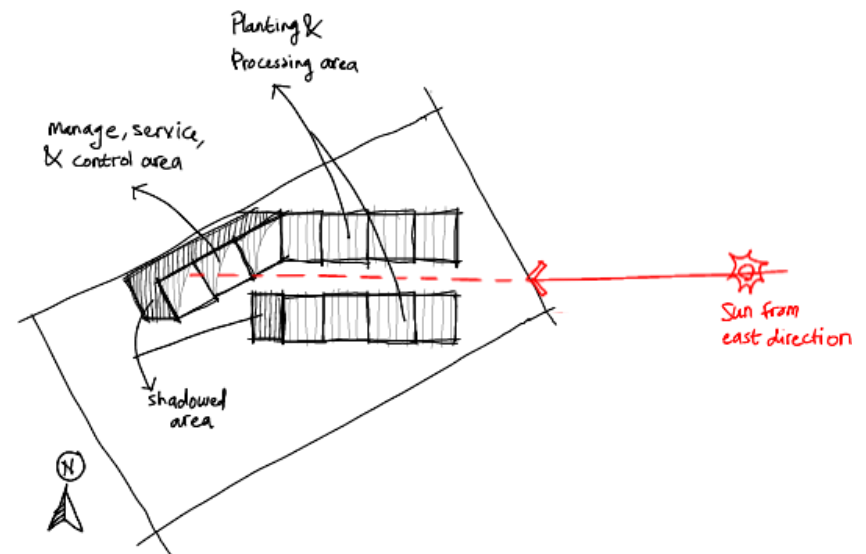


Figure 66. Top view of the building mass, the location of the shadow on the surface of the building mass when the sun is in the east.

Source: author analysis

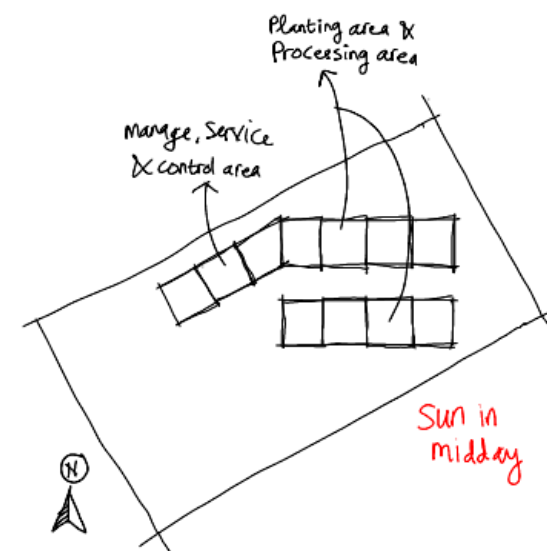


Figure 67. The top view of the building mass, almost no shadow at midday.

Source: author analysis

3.3 Permaculture Building for Building Room Space Concept

3.3.1 User Activity Analysis

3.3.1.1 Analysis of Porang Agricultural Activities

Activities that will be carried out by employees or porang farmers are starting with seeding, seeding, planting, harvesting mature plants, controlling regularly, and taking care of the storage of raw products and finished products. Then there are supporting activities such as rest, worship, and sanitation needs.

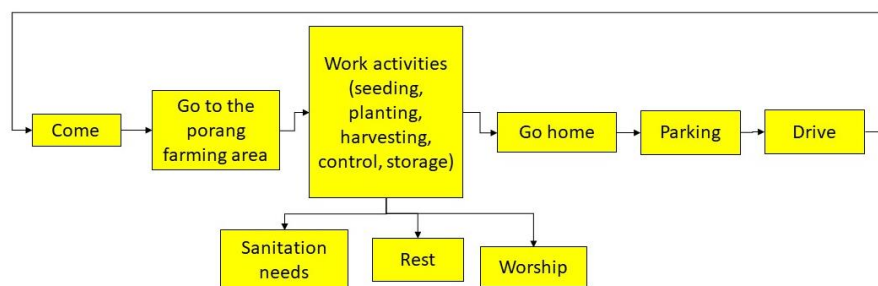


Figure 68. Porang Agricultural Activites Chart.
Source: author analysis

3.3.1.2 Analysis of Porang Manager Activities

Management activities include building maintenance, control, administrative, security, mechanical, electrical, and cleaning management activities. Then there are supporting activities such as rest, worship, and sanitation needs.

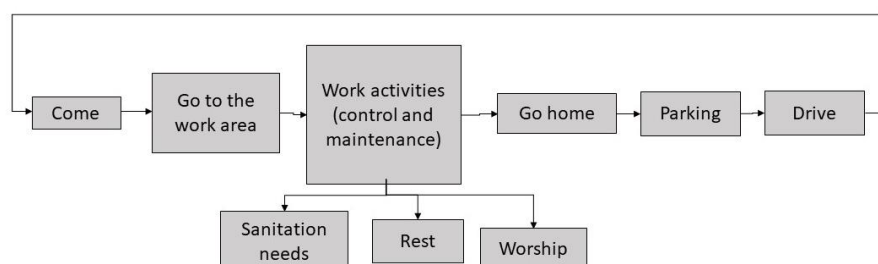


Figure 69. Porang Manager Activites Chart.
Source: author analysis

3.3.2 Space Requirements Analysis for Permaculture Building

Based on the results of the analysis of the activities of Porang Permaculture Building users and the results of the previous typology and theme studies, the space requirements for Porang Permaculture Building users in Pontianak with several criteria are shown in the table below:

Planting Area

Space need	Reference	Standard	Capacity	Area (m2)
Seeding room	Assumption	Capacity of 300 medium plastic containers (size= 25 cm x 35 cm) Medium container= 0,875 m2 Person= 1 m2	300 medium plastic containers + 30 persons	$(300 \times 0,875) + (1 \times 30) = 467,5 \text{ m}^2$
Nursery room	Assumption	Capacity of 500 polybags (diameter 20 cm) Polybag= 0,4 m2 Person= 1 m2	500 polybags + 40 person	$(500 \times 0,4) + (1 \times 40) = 240 \text{ m}^2$
Equipment storage	NAD	Person= 1m2 wardrobe= 1,44 m2	10 persons + 3 wardrobes	$(1 \times 10) + (1,44 \times 3) = 14,2$
Planting room 1 (juvenile plant)	Assumption	-	-	800 m2
Tuber seeds drying room	Assumption	-	-	800 m2
Planting room 2 (mature plant)	Assumption	-	-	500 m2
Storage 1 (raw product)	Assumption	-	-	1600 m2
Processing room	Assumption	Porang chopper machine (size= 130 x 60 x 60 cm) Porang washing machine (size= 320 x 90 x 120 cm) Person= 1m2	3 Porang chopper machine 3 Porang washing machine	400 m2
Storage 2 (finished product)	Assumption	-	-	500 m2
TOTAL				5321,7 m2
TOTAL + CIRCULATION (20% + AREA)				6386 m2



Porang washing machine
Dimensions: 320 x 90 x 120 cm
Capacity: 1000-1200 kg/hour
Source: kiosmachine



Porang chopper machine
Dimensions:
Height 130 cm
Length and width 60 cm
Capacity: 500 kg – 1000 kg/hour
Source: shopee



Porang Dryer Machine
Dimensions of machine: 3000 mm x 2200 mm x 1200 mm
Dimesions of box: 2400 mm x 2200 mm x 2200 mm
Capacity: +- 1 ton
Source: rumah mesin

Employee Room

Space need	Reference	Standard	Capacity	Area (m2)
Locker	NAD	1,6 m2/person	20	32
Changing room	NAD	7 m2/person	3	21
Rest room	NAD	7 m2/person	4	28
TOTAL				55
TOTAL + CIRCULATION (30% + AREA)				71,5

Service and MEE

Space need	Reference	Standard	Capacity	Area (m2)
Equipment Warehouse	Assumption	15% lobby	-	24
Generator room	Assumption	7 m2/person	4 generator s	32
Control panel room	Assumption	7 m2/person	0,14 m2/room	2,5
Phone panel	Assumption	7 m2/person	0,14 m2/room	2,5
Pump room and water reservoir	Assumption	4 x 8 m	-	32
Sewage Water Treatment	Assumption	5 x 6 m	-	30
Security room	Assumption	7 m2/person	4	28
TOTAL				151
TOTAL + CIRCULATION (30% + AREA)				196,3

Manager Room

Space need	Reference	Standard	Capacity	Area (m2)
Manager room	NAD	10 m2/person	2	20
Secretary room	NAD	4,48 m2/person	3	13,8
Assistant Manager room	NAD	4,48 m2/person	3	13,8
Front Office Manager room	NAD	4,48 m2/person	3	13,8
Marketing Manager room	NAD	4,48 m2/person	3	13,8
Manager staff room	NAD	4,48 m2/person	3	13,8
Meeting room	NAD	2,4 m2/person	8	19,2
TOTAL				108,2
TOTAL + CIRCULATION (30% + AREA)				140,66

Table 16. room programming requirement table.
Source: PD: Sun-Path Map

The Porang Permaculture building consists of 2 floors. the ground floor of the building is used for area management, service, and other supporting needs. The ground floor is also used for the Porang tuber processing area, the storage area for the ripe Porang tuber harvest, and the Porang product storage area that has been processed. In addition, on the ground floor, the placement of a warehouse area for finished Porang products is intended to facilitate moving warehouse goods to the loading and unloading area. while on the 1st floor it is used specifically for the Porang plant farming area, starting from the planting control room, soil preparation, seeding, planting juvenile Porang bulbs, drying and heating area for tuber seeds, up to the area for ripening Porang tubers that are already mature. This 1st floor area is specifically intended for farming because the area can reach enough sunlight.

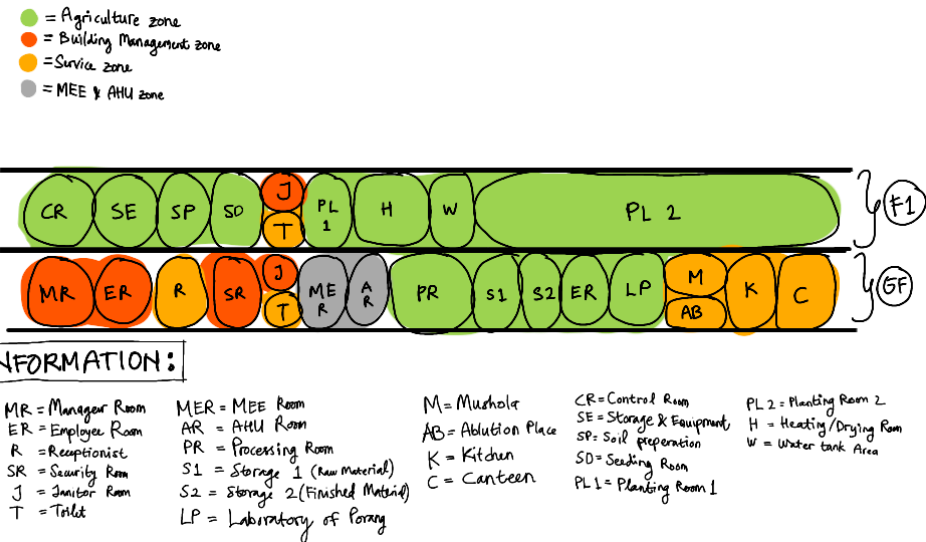


Figure 71. The division of zones on the ground floor and 1st floor of the building. the entire 1st floor will be used for planting area. While the ground floor for processing and other needs.

Source: author analysis

3.3.3 Spatial Relations and Spatial Organization

3.3.3.1 Spatial Relationships (Bubble Diagrams)

The relationship between spaces is shown in the diagram below. The relationship between spaces shows the closeness of functions between spaces that affect spatial planning.

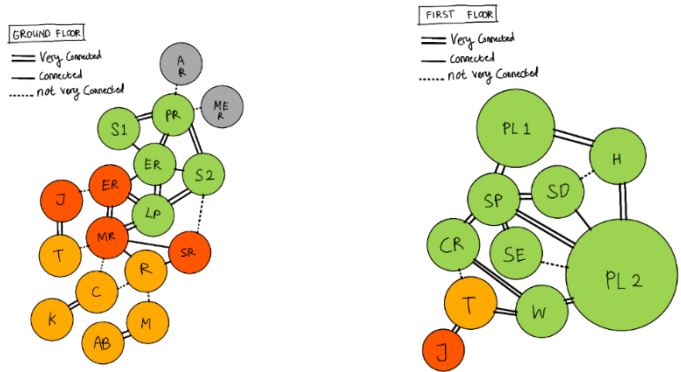


Figure 70. Spatial relations in Porang Permaculture Building.
Source: author analysis

3.3.3.2 Spatial organization in Porang Permaculture Building with permaculture zoning approach (Zoning Diagrams)

The application of the permaculture zoning approach to the Porang Permaculture Building is carried out by considering three permaculture zoning principles, which consist of spatial relationship, time, and energy use. Or for the case of the Porang Permaculture Building design, it refers to three aspects, namely the size of the area, the duration of plant growth, and the level of activity density (related to energy use). The application of the permaculture zoning approach was

applied because the Porang plant has two cropping cycles, so when at a certain age, this plant must be replanted a second time on a wider area and of course, the bulbs have been warmed to break the dormant period of the bulbs. Therefore, the permaculture zoning approach is suitable for use on Porang plants grown in buildings so that the use of space, time or duration, activities, and energy can be used efficiently and effectively in carrying out their performance, namely producing Porang tubers.

As shown in the following figure, the zones applied for Porang Permaculture Building, especially for the Porang planting area, consist of three zones, namely zone 0 (seeding), zone 1 (nursery), and zone 2 (planting). Each of these three zones must be placed in sequence so that the Porang tuber planting process becomes effective and efficient. As seen in the following image, Spatial organization applied permaculture approach in Porang planting area.

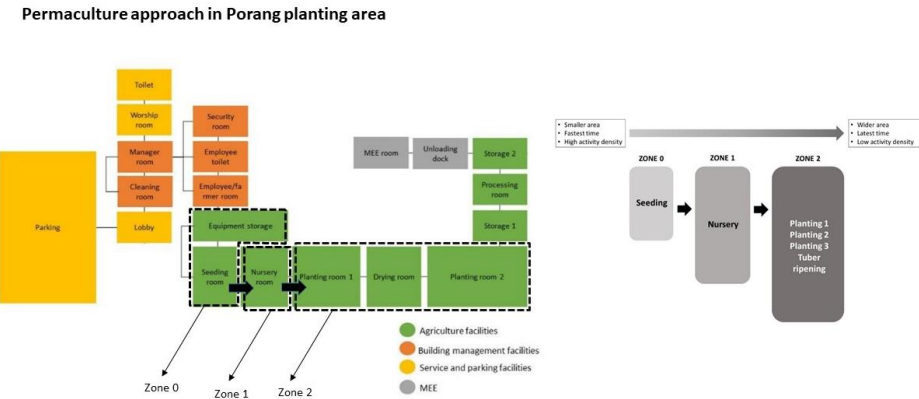


Figure 72. Spatial organization applied permaculture approach in Porang planting area.
Source: author analysis

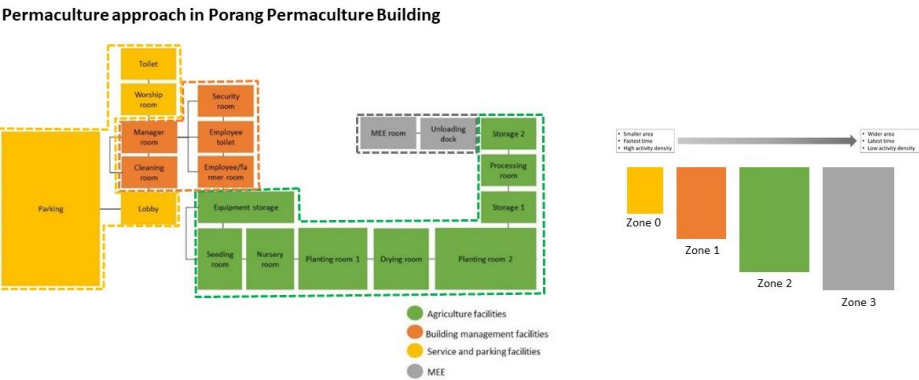


Figure 73. Spatial organization applied permaculture approach in Porang permaculture building.
Source: author analysis

3.3.4 Development on Plotting Design for Room Space in Buildings

The zoning analysis and the relationship between the spaces are then arranged according to the shape of the previous building mass, where the placement of each space can be seen in the following figure.

On the ground floor, it can be seen in the following figure that there is an increase in the mass of the building that connects the two building masses, the function of which is to increase the mass of this building as storage 2 (S2) and for the water tank area. In addition, the addition of building mass between the two main building masses is also intended so that the wind coming from the west can be diverted to two special building masses for the Porang planting area, where the planting area requires a humidity level that is not too high. So it is good for natural ventilation systems in the Porang planting area and processing area on the ground floor. The processing area on the ground floor which in fact has a high activity density level also requires natural ventilation so that thermal comfort for building users inside the building is achieved.

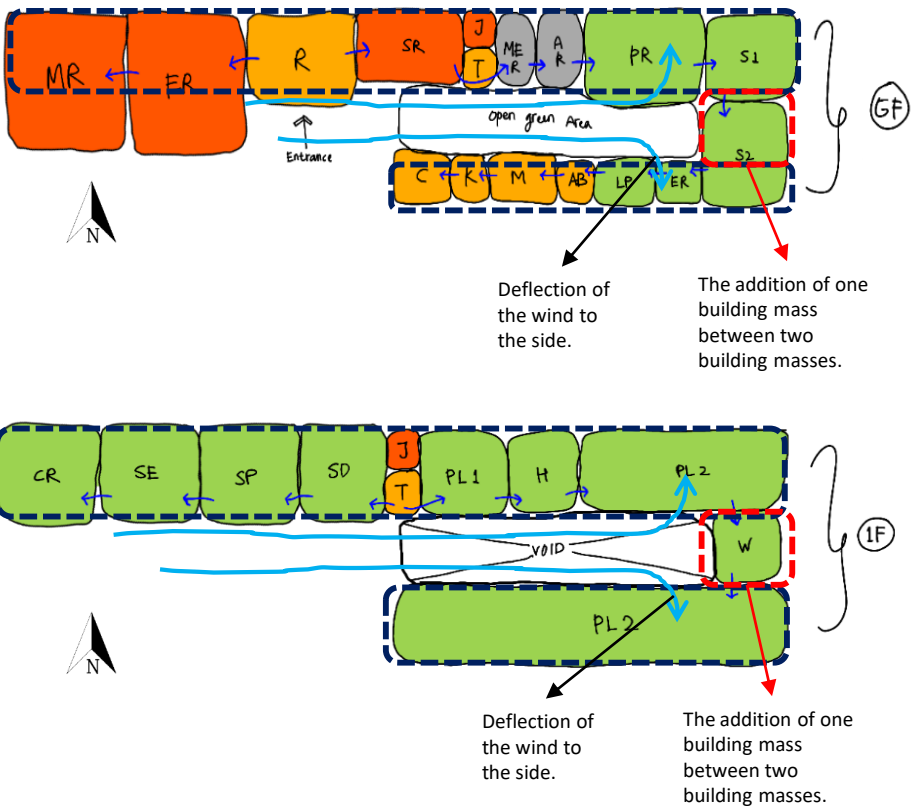


Figure 74. The addition of one building mass between two building masses.
Source: author analysis

After the placement of zoning for each room is complete, previously there was an addition of one building mass, then the zoning of the room is continued by placing it directly on the plan of the building mass that has been previously determined, as shown in the following figure. Each floor applies its own space zone plotting.

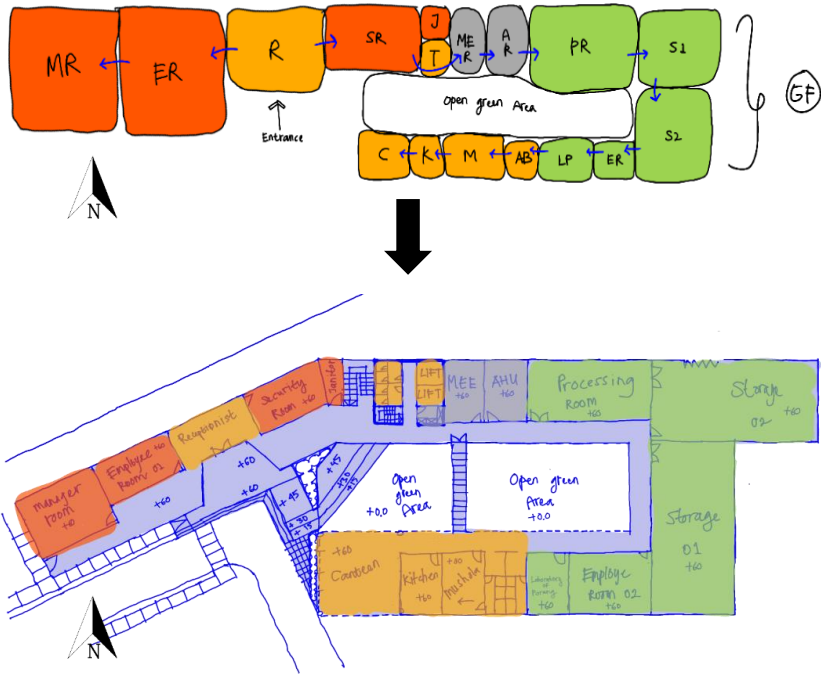


Figure 75. Plotting the placement of each space zone on the building mass for ground floor.
Source: author analysis

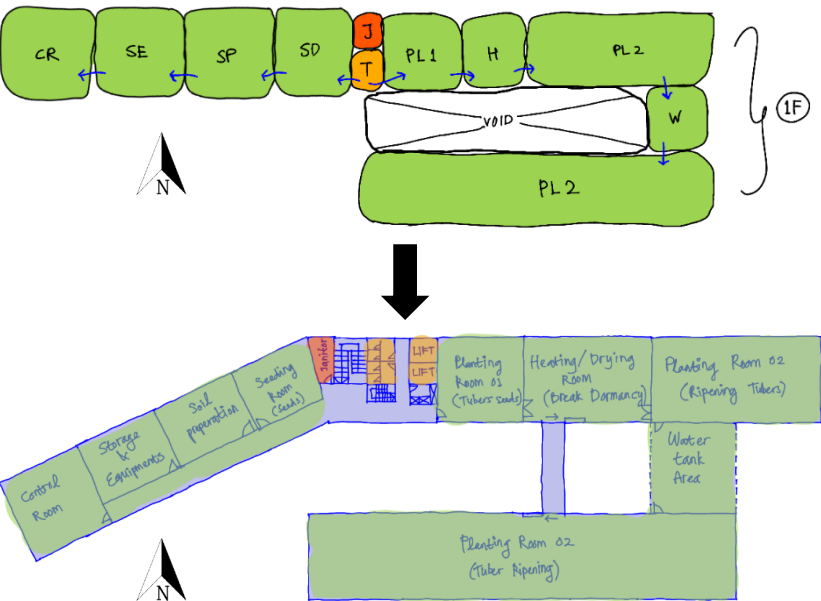


Figure 76. Plotting the placement of each space zone on the building mass for 1st floor.
Source: author analysis

3.3.5 Initial design of building mass and site plan

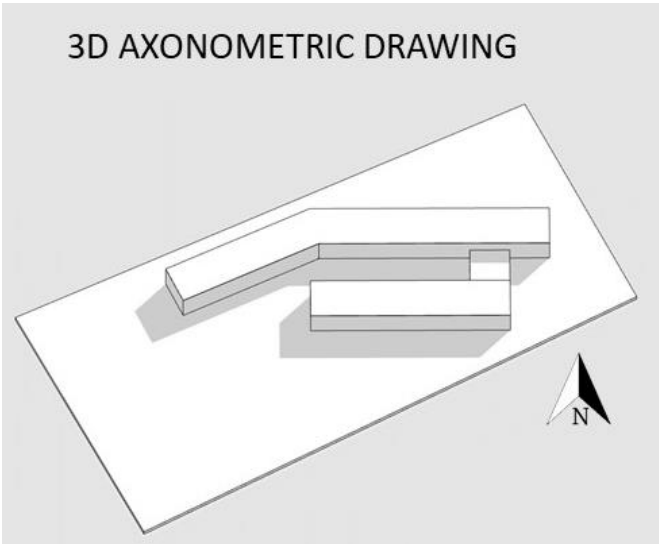


Figure 77. Initial design of the new building mass after the building plan is completed.
Source: author analysis

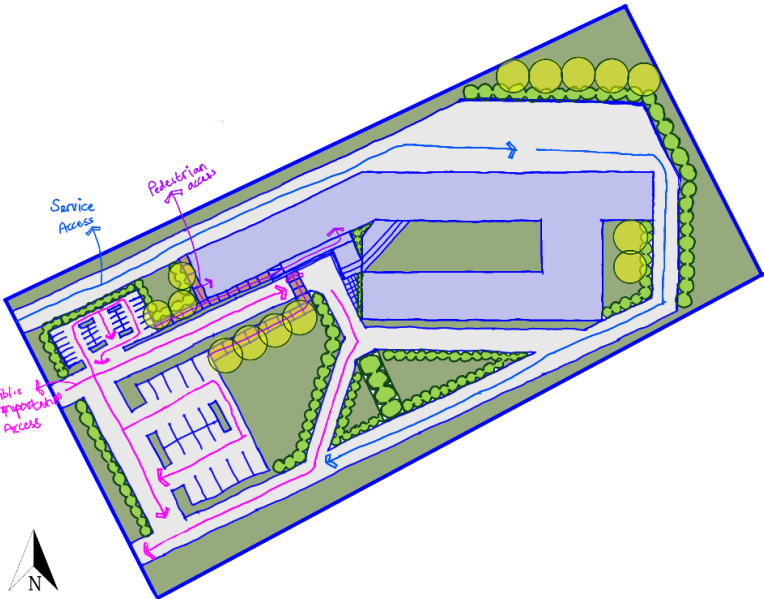


Figure 78. Initial design of the new site plan after the building plan is completed.
Source: author analysis

3.4 Permaculture Building for Building System Concept (Building Utility System Analysis)

3.4.1 Utility Systems for Porang Plant Nutrition and Water Requirements in Porang Culture Buildings

3.4.1.1 Water Needs Fulfillment System in Porang Permaculture Building

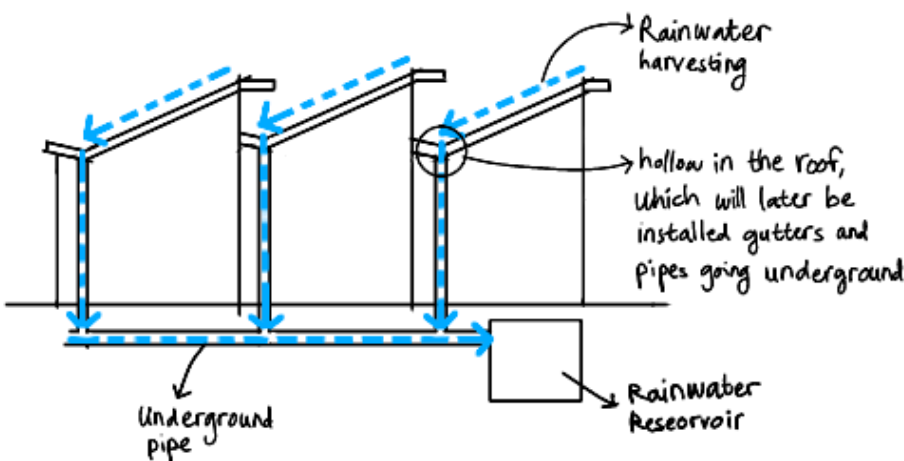


Figure 79. Roof design that is able to perform rain water harvesting for water needs in buildings.
Source: author analysis

This Porang permaculture building is a building whose water needs are dominated by the need for watering plants inside the building compared to the needs of other functions. Of course, the water needs of the building are not only obtained from PDAM Pontianak city water sources, but also obtained through the rain water harvesting system, as shown in the picture. The picture shows that the roof shape is designed to be capable of rainwater harvesting, so that the water needs in the building can be met.

In the roof design, rainwater that is on the roof will flow directly into the roof basin where gutters and pipes have been installed. Rainwater in the pipe will fall to the bottom and pass through the pipe in the ground to the rainwater reservoir, which then the rainwater can be distributed to all building functions after going through filtration.

3.4.1.2 Gray Water Treatment System in Porang Permaculture Building

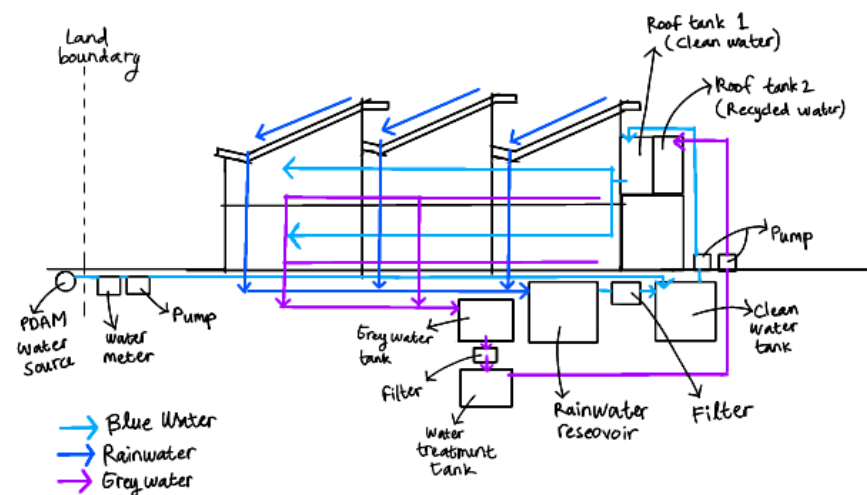


Figure 80. Gray water treatment system in the Porang Permaculture building.
Source: author analysis

In addition to utilizing rainwater, water needs can also be met through reprocessing dirty water or gray water. The gray water (dirty water) can be reused for watering and building maintenance. Gray water (dirty water) will be channeled to the filter tank and then channeled to the collection tank. From the collection tank, the water is filtered again and then used again to fulfill the needs of other building functions such as flushing toilets, other out door needs, etc.

3.4.1.3 Plant Nutrition System

In designing the nutrition system for Porang plants, Porang plants have several criteria for their growth needs at certain stages, such as at the stage of planting seeds in the form of tubers and the stage of ripening of adult Porang tubers, as shown in the design criteria table below.

2. Arch issue: humidity

Design criteria	Problem solving
The nursery stage of frogs/bulbills requires sufficient humidity/not dry (most optimal 24-80%).	<ul style="list-style-type: none">The composition of the building mass can use a single banked room so that air movement is evenly distributed.Ventilation can use the stuck effect.Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Porang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none">Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Porang.Use cross section ventilation.Make openings / ventilation in the roof to reduce excess moisture.

Table 9. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

Porang plants basically do not require high humidity in the soil. But the humidity level is sufficient, not dry and the humidity level is not high. It is also not recommended that the soil area be flooded by standing water, considering that this plant is a tuber plant, which if submerged by water will cause the tubers in the soil to rot and die (Porang Agricultural Research and Development Agency, 2015). The study on the Porang planting procedure only applies to the stage of planting seedlings in the form of Porang tubers, and the maturation stage of mature Porang tubers.

Based on this study, the proper design of the nutrition system for Porang plants at these two stages is to create a drainage system in the Porang planting media. In Porang planting media, it will be made like a long box containing soil that has been treated with a neutral acidity level and the addition of fertilizer. Also at the bottom of the ground will be installed a filter that will prevent hard substances in the soil from entering the drainage channel, and will only allow water that has settled on the ground to immediately go down to the drainage channel, thus keeping the soil from being too moist, and a bit dry. Then the water that enters the drainage channel will be forwarded to the nutrient tank and will be pumped through the pipes installed with sprinklers so that the water containing nutrients is continued for watering the Porang plants periodically according to the duration and schedule of watering the Porang plants.

By carrying out this plant nutrition system, the Porang plant will maintain its moisture level and reduce the risk of decay in Porang tubers.

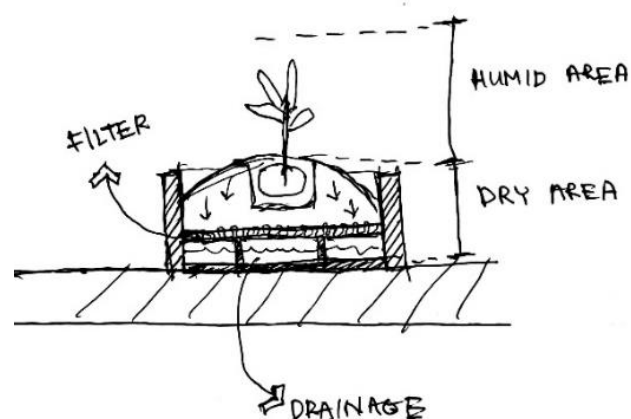


Figure 81. Section drawing: The division of dry zones and humid zones on Porang planting media.

Source: author analysis

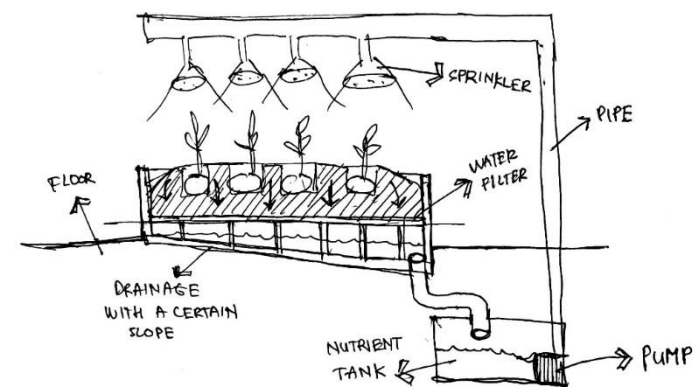


Figure 82. Section drawing: the water on the soil will go down and enter the drainage channel on the Porang planting media.

Source: author analysis

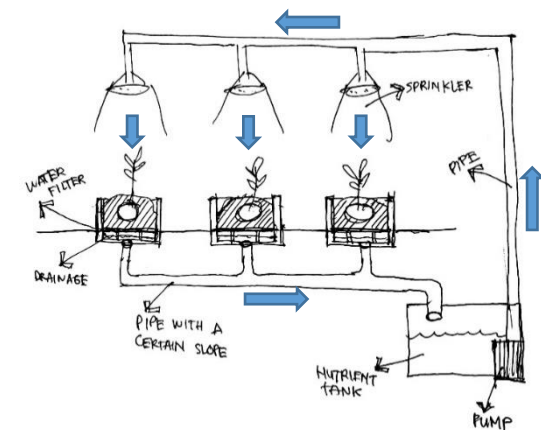
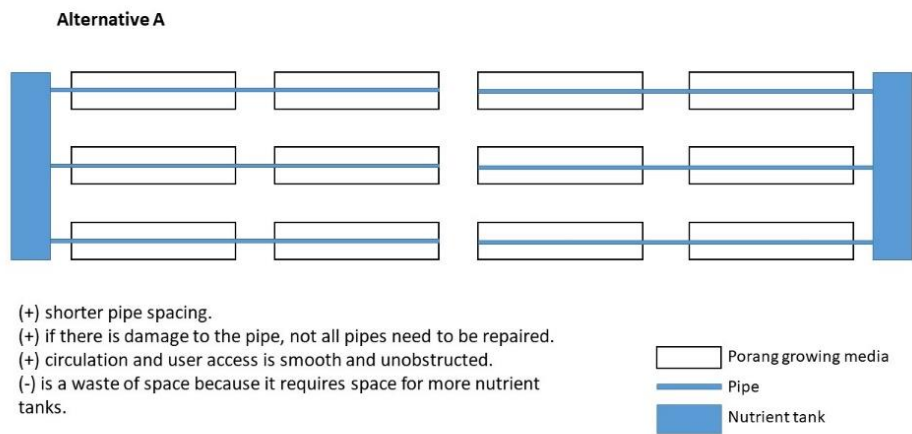
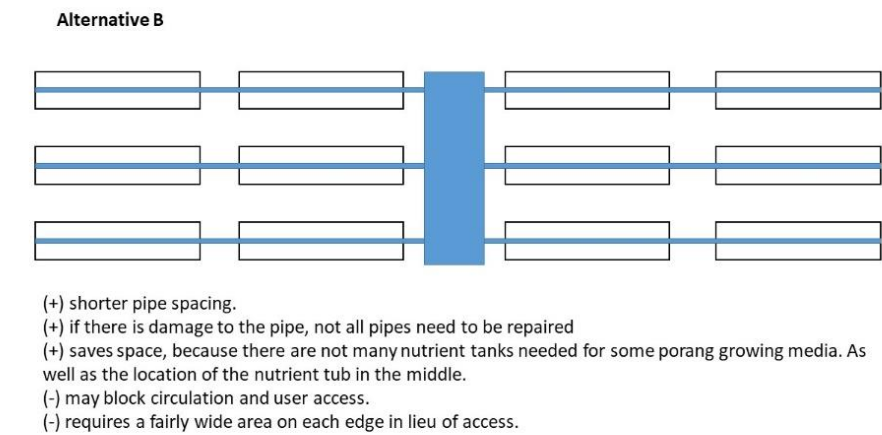
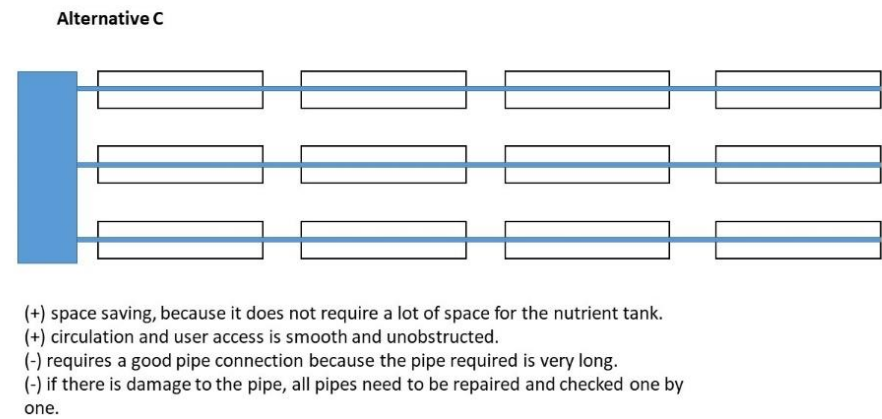


Figure 83. Section drawing: water that enters the drainage will be forwarded to the nutrient tank and then pumped so that the water can be re-watered through the sprinkler.

Source: author analysis

3.4.1.4 Spatial Planning for Porang Planting Media



Based on the analysis of the alternative design of the porang plant nutrition utility system, it can be seen that alternative B is the one that has the most (+) values of three, and with quite a few (-) values and the (-) value can still be handled and deficiencies are reduced.

Figure 84. Alternative design of spatial Planning for Porang Planting Media.
Source: author analysis

3.5 Permaculture Building for Building Envelope Design Concept

3.5.1 Design Concept for the Shape of the Roof in Accordance with the Needs of Each Function of the Building.

Design criteria in category N (not suitable):

1. Arch issue: Sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">The roof can use a massive material or an ordinary roof.Sufficient light comes from windows, etc.Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.Avoid the sun's altitude point which has a high level of solar radiation.Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).Must use transparent roofing material but have a louver.Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">Use transparent materials so that sunlight can be transmitted into the building 100%.Avoid using shading devices, etc.Use ventilation to prevent evaporation and cause tuber seeds to become damp.

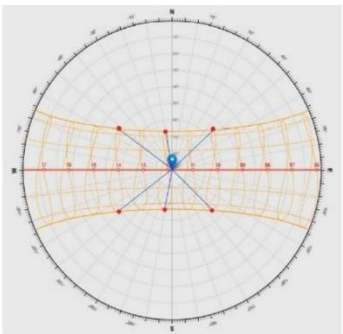
Table 7. Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

The Porang Permaculture building will focus on roof design which has an intensity of 40 – 60%, considering that the spaces in this building are dominated by special rooms for the Porang planting area at the tubers ripening stage and the seedling stage in the form of tubers. At this stage, apart from the large space requirement, another thing to consider is the length of time required for the these two stages.

To design the shape of the roof on the Porang Permaculture building, it must consider the sun's altitude which must be avoided, because at the sun's altitude and certain hours there is a very high level of solar intensity. Usually the more perpendicular an angle of fall (altitude) of the sun on a surface, the higher the level of intensity of the sun. So it has the potential to burn any surface, including plant leaves. For Porang

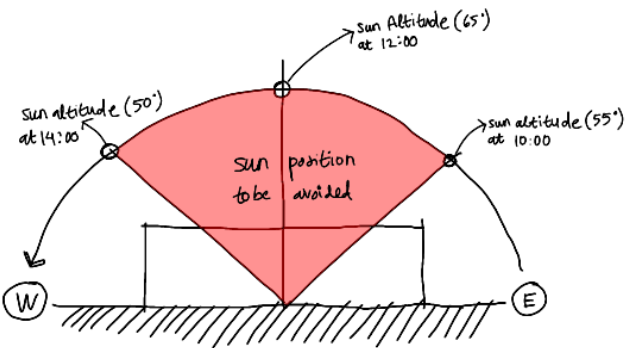
plant, at temperatures above 35 °C, the plant leaves will burn, while at low temperatures, the plant is dormant (Porang Agricultural Research and Development Agency, 2015).

For locations in Pontianak City, there are three specific times that have a high level of sunlight intensity, starting from 10:00 – 12:00 – 14:00.



Date	10:00		12:00		14:00	
	Azimuth	Altitude	Azimuth	Altitude	Azimuth	Altitude
21 June	45.80°	55.23°	-8.25°	66.69°	-51.88°	49.90°
22 December	135.07°	55.83°	-170.08°	65.81°	-127.51°	49.24°

Table 13. Pontianak City sun chart.
Source: PD: Sun-Path Map



The time and position of the sun's altitude to avoid.
Source: author analysis

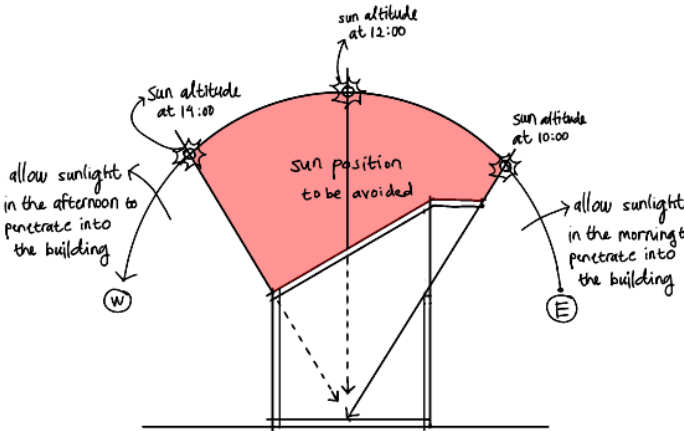


Figure 85. The design of the roof shape to avoid the sun's altitude at 10:00 – 14:00 and only allow the sun's altitude in the morning and afternoon.
Source: author analysis

It can be seen in the design of the roof shape as shown above, it shows that the roof design is able to avoid the position of the sun's altitude at 10:00 - 14:00, at which time the intensity of the sun is very high and not good for Porang plants. Then when the sun in the morning and evening has a level of sun intensity that is not too high and not hot, so it is allowed to penetrate into the building.

After determining the shape of the roof that is able to avoid the time and position of the sun's altitude, the construction of the mass form of the Porang Permaculture Building is then continued by determining the design for each function room in the building. In this Porang Permaculture building, the lighting level of the building is divided into three types. The first type is the lighting level for the juvenile and adult Porang tuber maturation planting area (sunlight intensity 40 – 60%), the second is the lighting level for human thermal comfort and the nursery area (sunlight intensity <50%), and the third is the lighting level for the nursery area. burning/heating of Porang tubers to break the dormant period of tubers (sunlight intensity 100%). This method of burning porang tubers by drying in the sun at a temperature of 45°C for 6 hours a day is a traditional technique that is widely used by Porang farmers to break the dormant period of the tubers to make it faster. That is, the dormant period of the tubers will last from 2 months to 1 month.

The following figure shows the roof design of the building into three types based on the materials used, namely roofs for juvenile and adult Porang plants, roofs for humans and nursery areas, and roofs for burning/heating Porang tuber seeds.

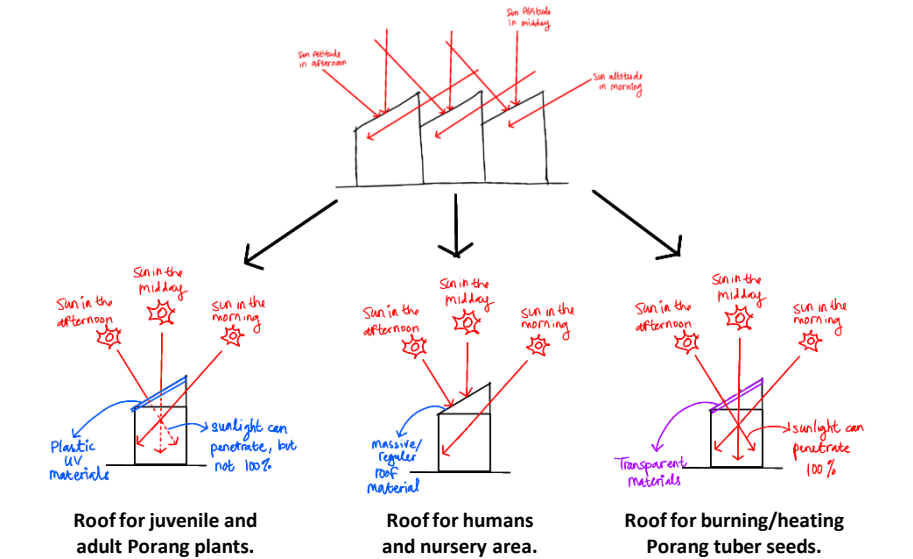


Figure 64. The function of the leaning roof form for each room function, which is divided into 3 types of roofs based on the material to be used.
Source: author analysis

Based on the placement of each room in the room space design concept, the division of the zone is divided into several parts by taking into consideration regarding on the sequence of activities and stages of planting porang, they are arranged as shown in the diagram of the need for sunlight on the building envelope. Which area starts from the nursery area and ends with the porang tuber maturation area. After the areas are arranged in order, the building envelope design is designed according to the needs of the intensity of sunlight. namely in the nursery area, lighting is needed <50%, planting tubers seeds is 50%, the area for drying/heating seeds is 100%, and the maturation (tuber ripening) area for porang tubers is 50%.

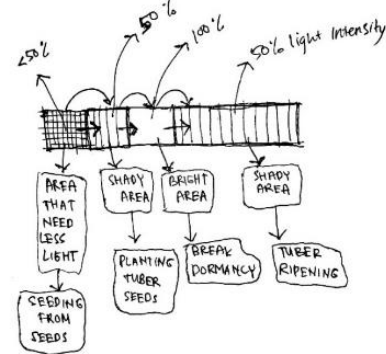


Figure 86. Diagram of arrangement and sunlight requirements based on the sequence of Porang planting procedures.
Source: author analysis

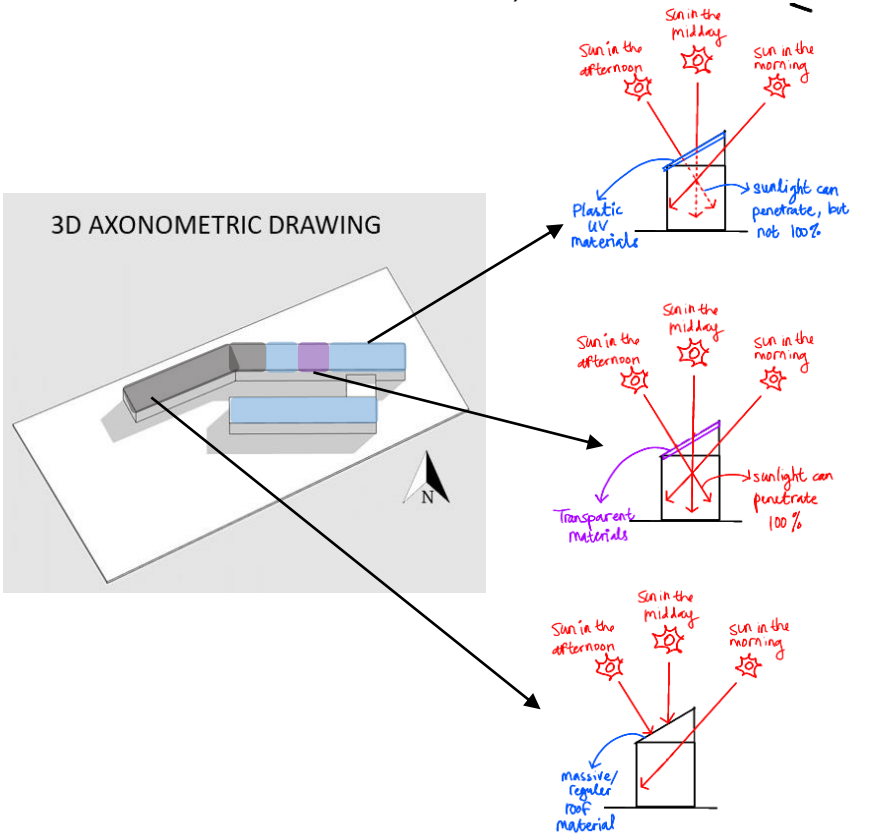


Figure 87. Placement of three types of roofs according to the order of Porang planting procedures.
Source: author analysis

3.6 Building Skin Technology for Room Space Design Concept

3.6.1 The division of each building facade design for each room function.

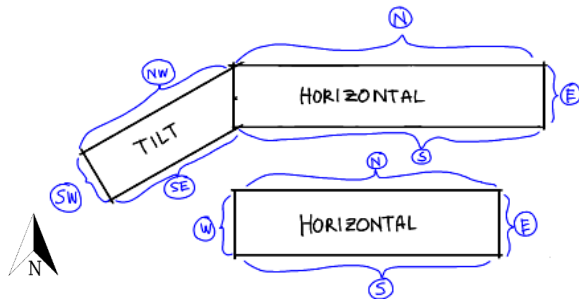
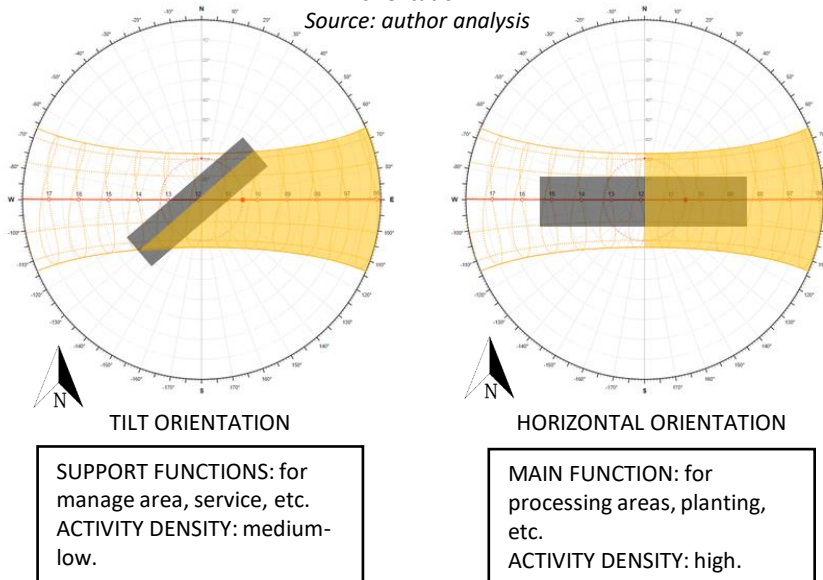


Figure 88. Two building masses have a horizontal orientation and one building mass tilt orientation.

Source: author analysis



- The sun in the east in June will shine and hit the facade of the building until 10:00.
- The sun in the east in December will illuminate the facade of the building until 14:00. This is intended so that in December, the need for light and thermal comfort is met because in that month the rainy season comes, so the need for solar heat is needed much longer than in June.
- Sunlight will illuminate the planting area evenly throughout the day, both in the morning at 07:00 – 11:00, and in the afternoon at 13:00 – 17:00.
- The duration of sunlight will also be evenly distributed throughout the year. So it is good to maintain the consistency and duration of irradiation of Porang plants.

In the development stage of the Porang Permaculture Building, the next step is to determine which rooms have a facade and what type of facade is suitable for each function of the room in the Porang Permaculture Building.

The following figure shows that each room on the 1st floor plan has its own type of sunlight intensity according to the function needs of the space.

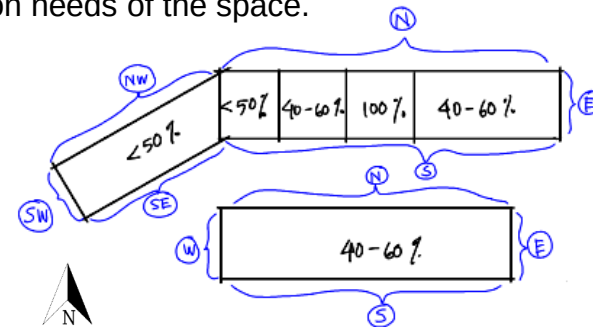


Figure 89. Each room on the first floor plan has its own level of sunlight intensity based on the function of the room.

Source: author analysis

- A = 40-60% → for plant, Human
- B = 100% → for tuber seeds
- C = ≤ 40% → for human, Nursery area

- Facade Design 1
- Facade Design 2
- Facade Design 3
- Transparent Material

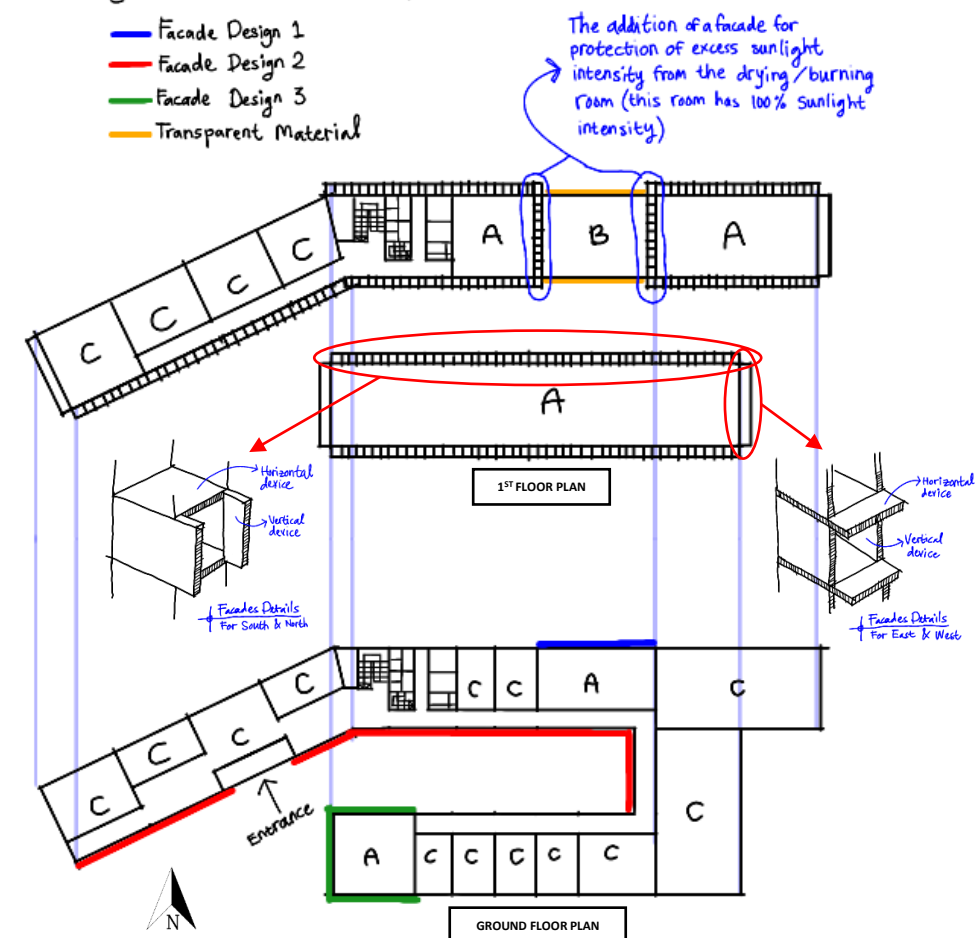


Figure 90. All rooms on the schematic ground and first floor plan show the application of the building's facade, except for the drying/burning room which has 100% sunlight intensity.

Source: author analysis

3.6.2 Façade design for Porang Planting Area.

3.6.2.1 Facade design for North and South directions for Porang Planting Area.

To design the north and south facades of the Porang Permaculture Building, it can be determined by determining the altitude (angle of elevation) of the sun and the azimuth (angle of orientation) of the sun at the times you want to avoid. It is necessary to round off the numbers as well as the equivalence of numbers for the azimuth and altitude of the sun to make it easier to perform calculations, as shown in the following table.

Date	10:00		12:00		14:00	
	Azimuth	Altitude	Azimuth	Altitude	Azimuth	Altitude
21 June	45.80° = 45°	55.23° = 55°	-8.25° = 10°	66.69° = 65°	-51.88° = 50°	49.90° = 50°
22 December	135.07° = 45°	55.83° = 55°	-170.08° = 10°	65.81° = 65°	-127.51° = 50°	49.24° = 50°

Table 17. Pontianak City sun chart.
Source: PD: Sun-Path Map

The critical times to avoid are 10:00, 12:00, and 14:00. at this stage of designing the shape of the north and south facades, in order to produce designs that match the needs of the right design criteria, it can be done by designing horizontal devices and vertical devices on the facade. As can be seen in the following picture, the vertical device design is much more highlighted than the horizontal device design. This is done because the sun's altitude angle is greater than the sun's azimuth angle. In designing horizontal and vertical devices on the facade, the greater the angle of altitude, the shorter the horizontal device dimensions (inversely proportional to). Meanwhile, the greater the sun's azimuth angle, the longer the vertical device dimension (directly proportional). so as to avoid the sun's angle, both azimuth and altitude, the design of the facade is as shown in the following picture.

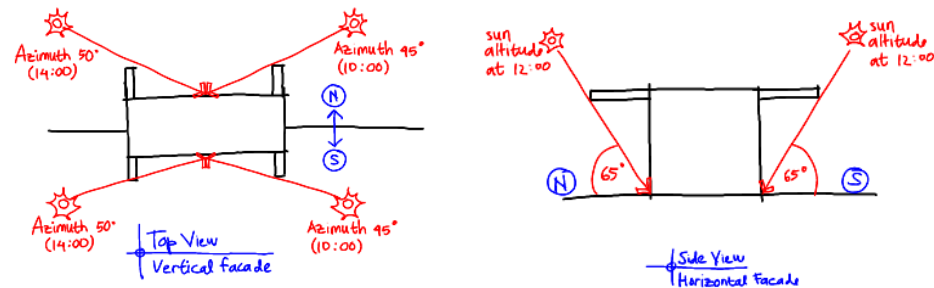


Figure 91. The position of the altitude and azimuth of the sun on the north and south facades to determine the design of the north and south facades.
Source: author analysis

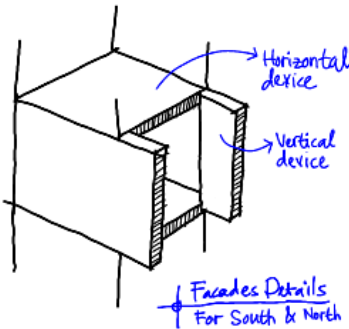


Figure 92. The shape of the vertical device is more dominant than the horizontal device in the north and south facade designs.
Source: author analysis

A. South Facade Design in December with sun tools software for Porang Planting Area

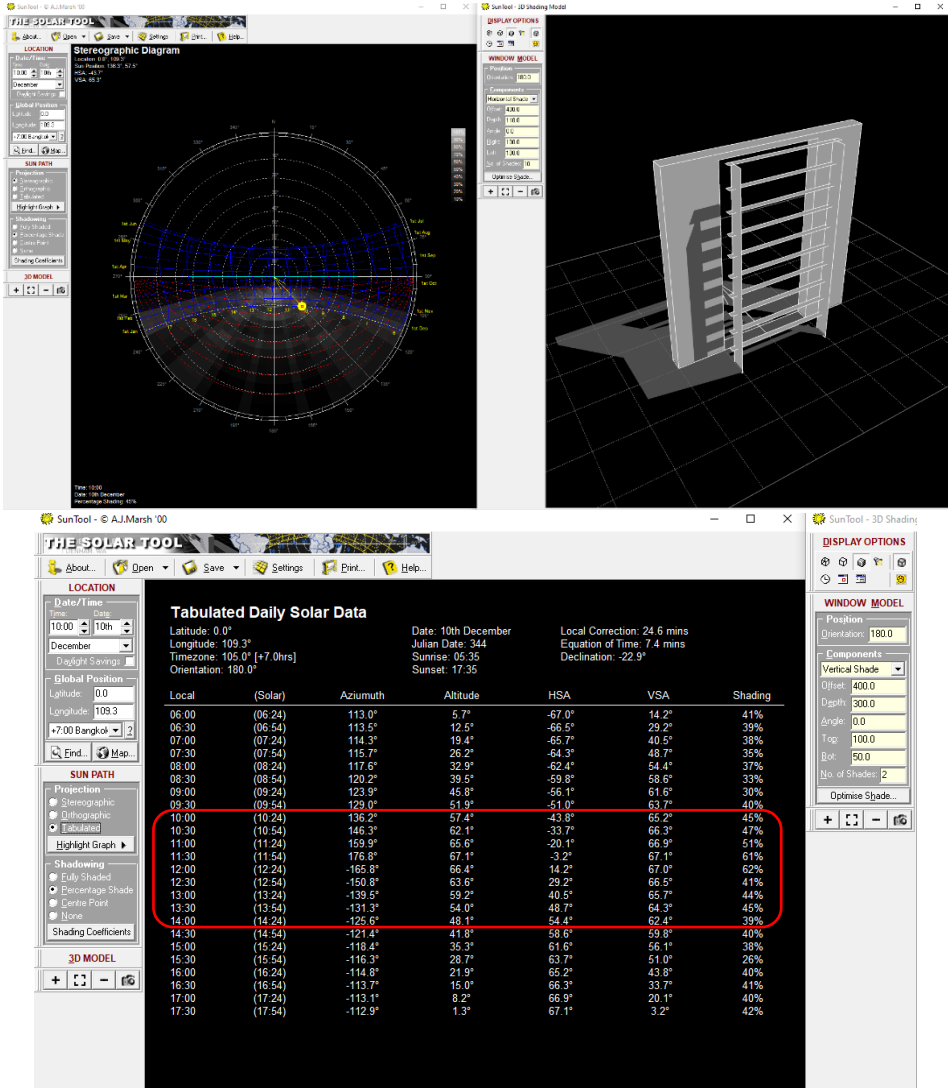


Figure 93. Determination of the dimensions of the south facade in accordance with the needs of sunlight intensity 40-60% with sun tools software.
Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	45%	55%	☑
11:00	51%	49%	☑
12:00	62%	38%	-
13:00	44%	56%	☑
14:00	39%	61%	☑*

Information:
 (-) = not included, because the position of the sun is right in the middle of the day.
 ☑ = fulfilled (sunlight intensity 40 – 60%)
 * = 1% tolerance

Table 18. Table of analysis on the fulfillment of sunlight intensity needs in the south facade design.
 Source: author analysis

B. North Facade Design in June with sun tools software for Porang Planting Area

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	50%	50%	☑
11:00	40%	60%	☑
12:00	61%	39%	-
13:00	59%	41%	☑
14:00	41%	59%	☑

Information:
 (-) = not included, because the position of the sun is right in the middle of the day.
 ☑ = fulfilled (sunlight intensity 40 – 60%)

Table 19. Table of analysis on the fulfillment of sunlight intensity needs in the north facade design.
 Source: author analysis

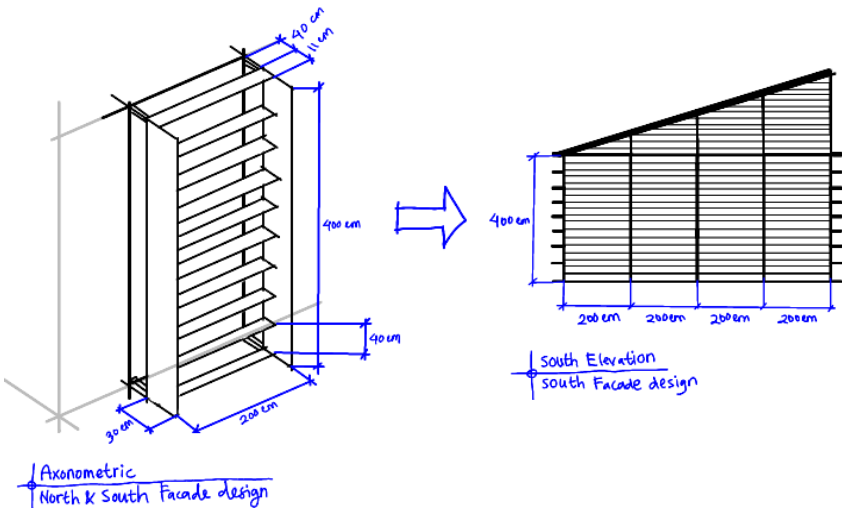


Figure 95. Dimensions of the north and south facade designs for the Porang planting room applied to the building.
 Source: author analysis

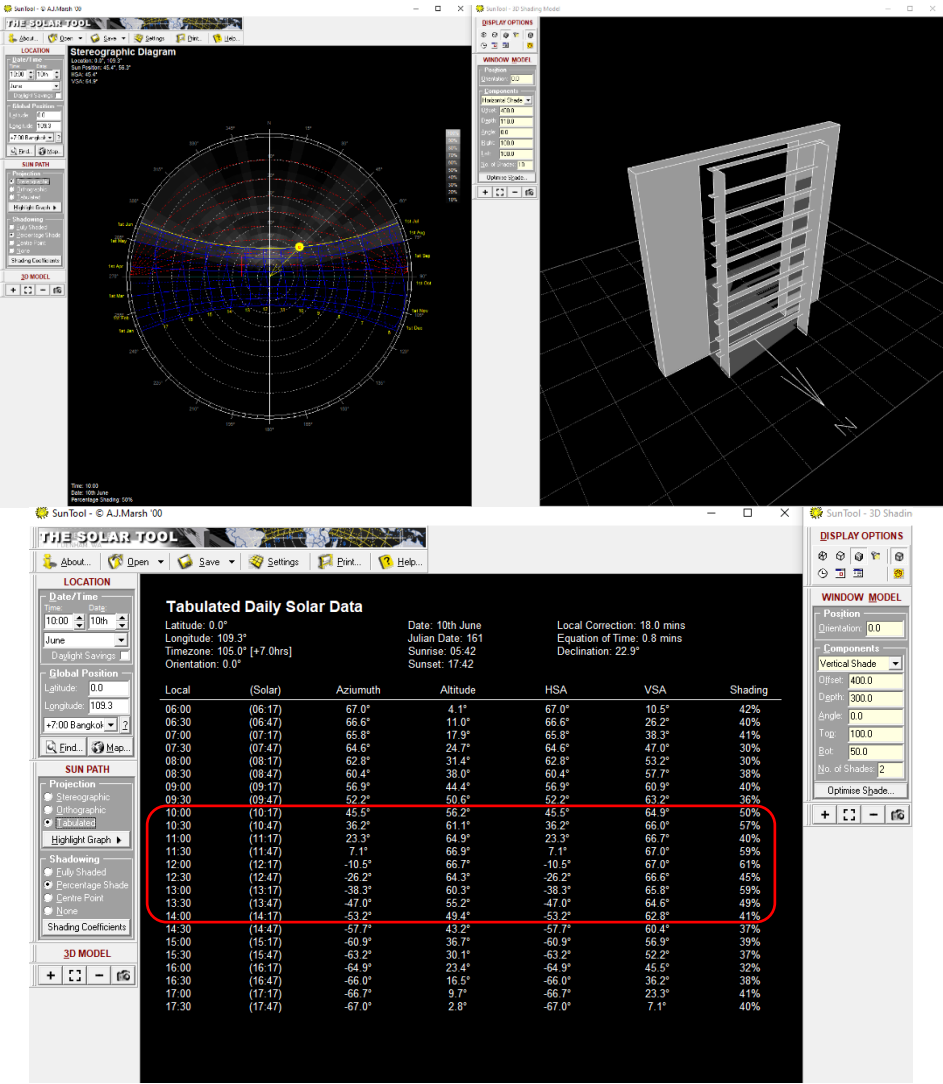
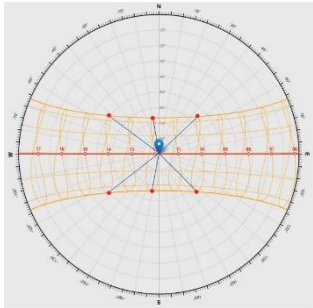


Figure 94. Determination of the dimensions of the north facade in accordance with the needs of sunlight intensity 40-60% with sun tools software.
 Source: author analysis

3.6.2.2 Facade design for East and West directions for Porang Planting Area.

At the design stage of the west and east facades for the Porang planting area, the design of the west and east facades can be determined by determining the altitude (angle of elevation) of the sun and the azimuth (angle of orientation) of the sun at the times you want to avoid. It is necessary to round off the numbers as well as the equivalence of numbers for the azimuth and altitude of the sun to make it easier to perform calculations, as shown in the following table.



Date	10:00		12:00		14:00	
	Azimuth	Altitude	Azimuth	Altitude	Azimuth	Altitude
21 June	45.80° = 45°	55.23° = 55°	-8.25° = 10°	66.69° = 65°	-51.88° = 50°	49.90° = 50°
22 December	135.07° = 45°	55.83° = 55°	-170.08° = 10°	65.81° = 65°	-127.51° = 50°	49.24° = 50°

Table 13. Pontianak City sun chart.
Source: PD: Sun-Path Map

As shown in the following table, critical times to avoid are 10:00, 12:00, and 14:00. at this stage of designing the shape of the western and eastern facades, in order to produce designs that match the needs of the right design criteria, it can be done by designing horizontal devices and vertical devices on the facade. As seen in the following picture, the horizontal device design is much more highlighted than the vertical device design. This is done because the sun's altitude angle is greater than the sun's azimuth angle.

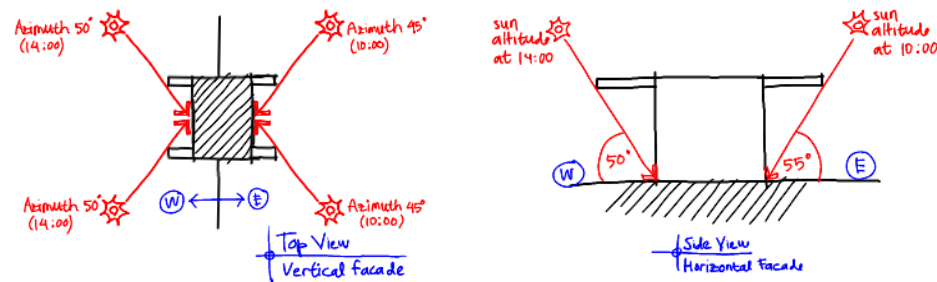


Figure 96. The position of the altitude and azimuth of the sun on the west and east facades to determine the design of the north and south facades.
Source: author analysis

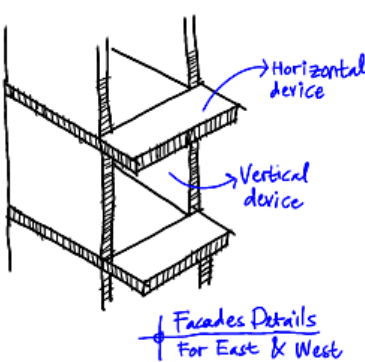


Figure 97. The shape of the horizontal device is more dominant than the vertical device in the west and east facade designs.
Source: author analysis

A. East Facade Design in June on 10:00 with sun tools software for Porang Planting Area

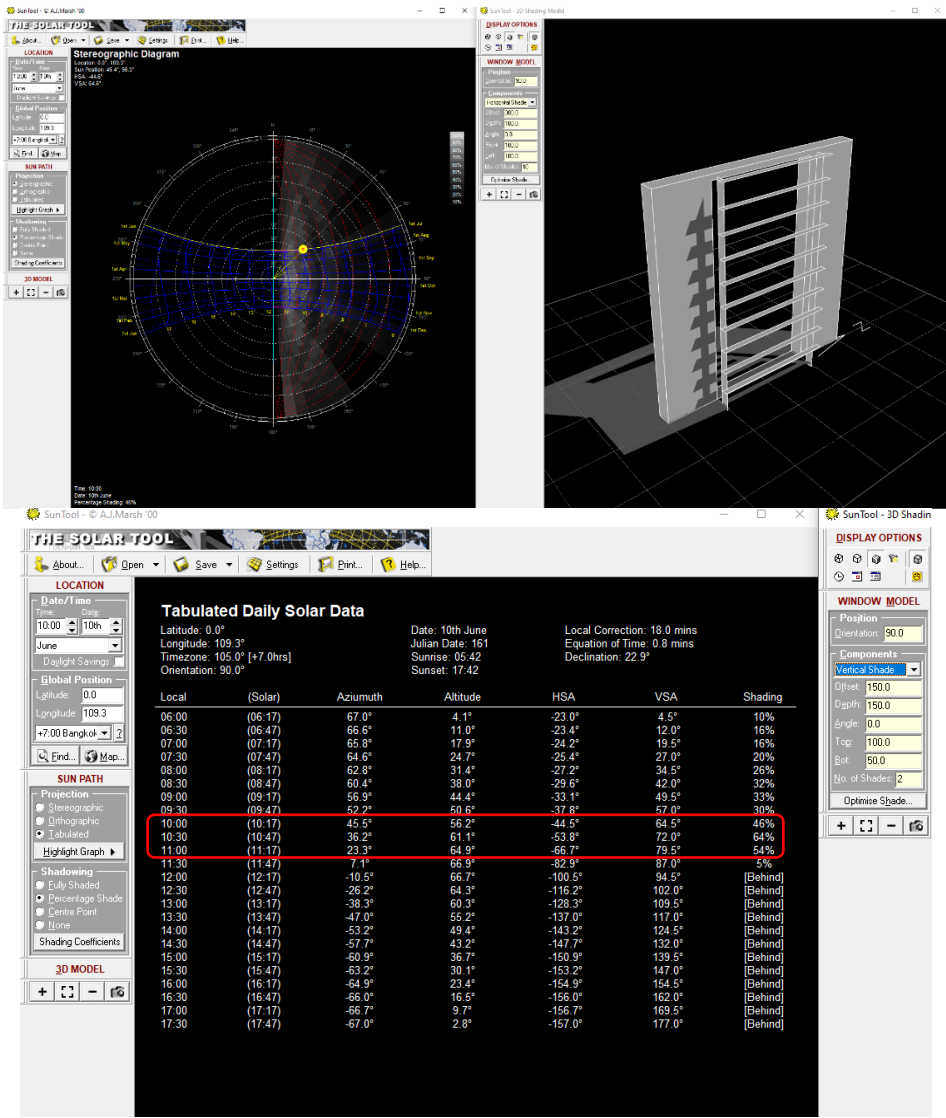


Figure 98. Determination of the dimensions of the east façade in June on 10:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software.
Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	46%	54%	☑
11:00	54%	46%	☑
12:00	-	-	-

Information:
 (-) = not included, because the position of the sun is right in the middle of the day.
 ☑ = fulfilled (sunlight intensity 40 – 60%)

Table 20. Table of analysis on the fulfillment of sunlight intensity needs in the east facade design in June.
 Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	48%	52%	☑
11:00	53%	47%	☑
12:00	-	-	-

Information:
 (-) = not included, because the position of the sun is right in the middle of the day.
 ☑ = fulfilled (sunlight intensity 40 – 60%)

Table 21. Table of analysis on the fulfillment of sunlight intensity needs in the east facade design in December.
 Source: author analysis

B. East Facade Design in December on 10:00 with sun tools software for Porang Planting Area

C. West Facade Design in June on 14:00 with sun tools software for Porang Planting Area

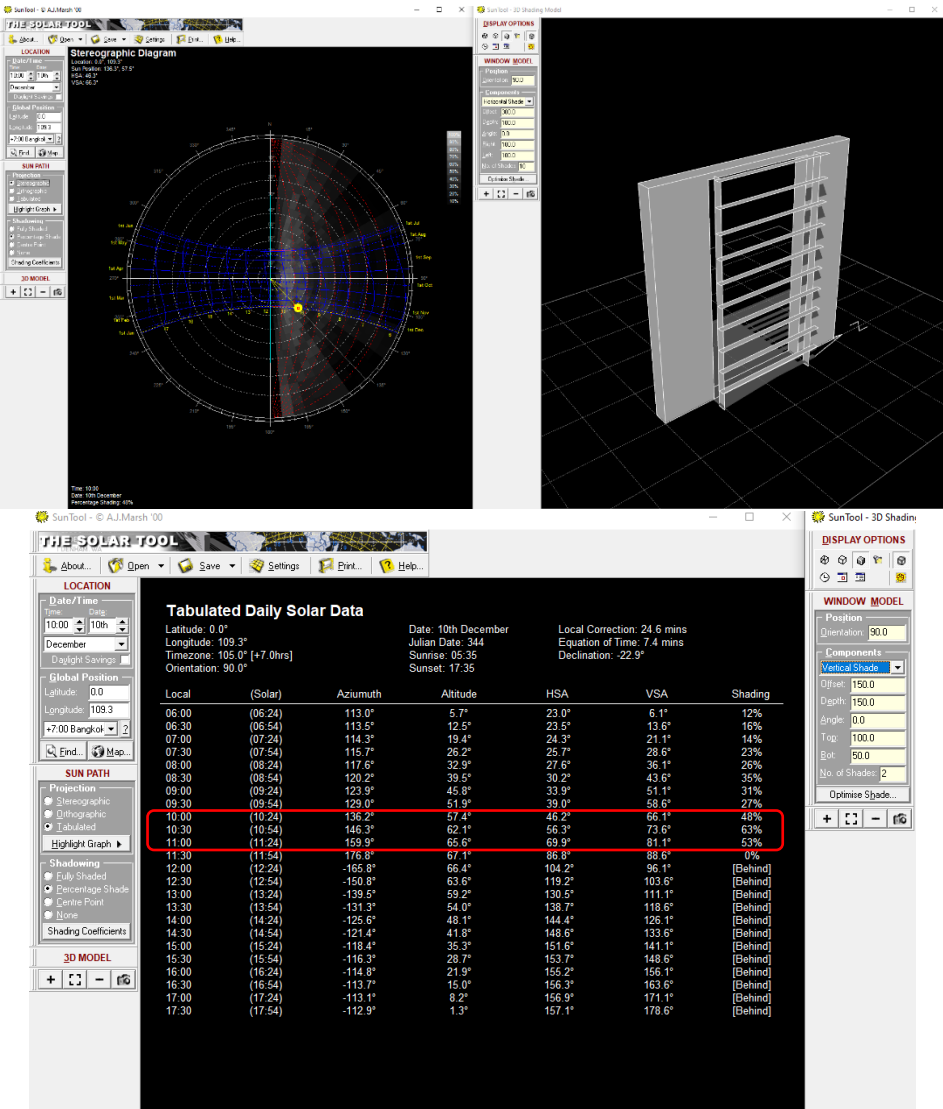


Figure 99. Determination of the dimensions of the east façade in December on 10:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software.
 Source: author analysis

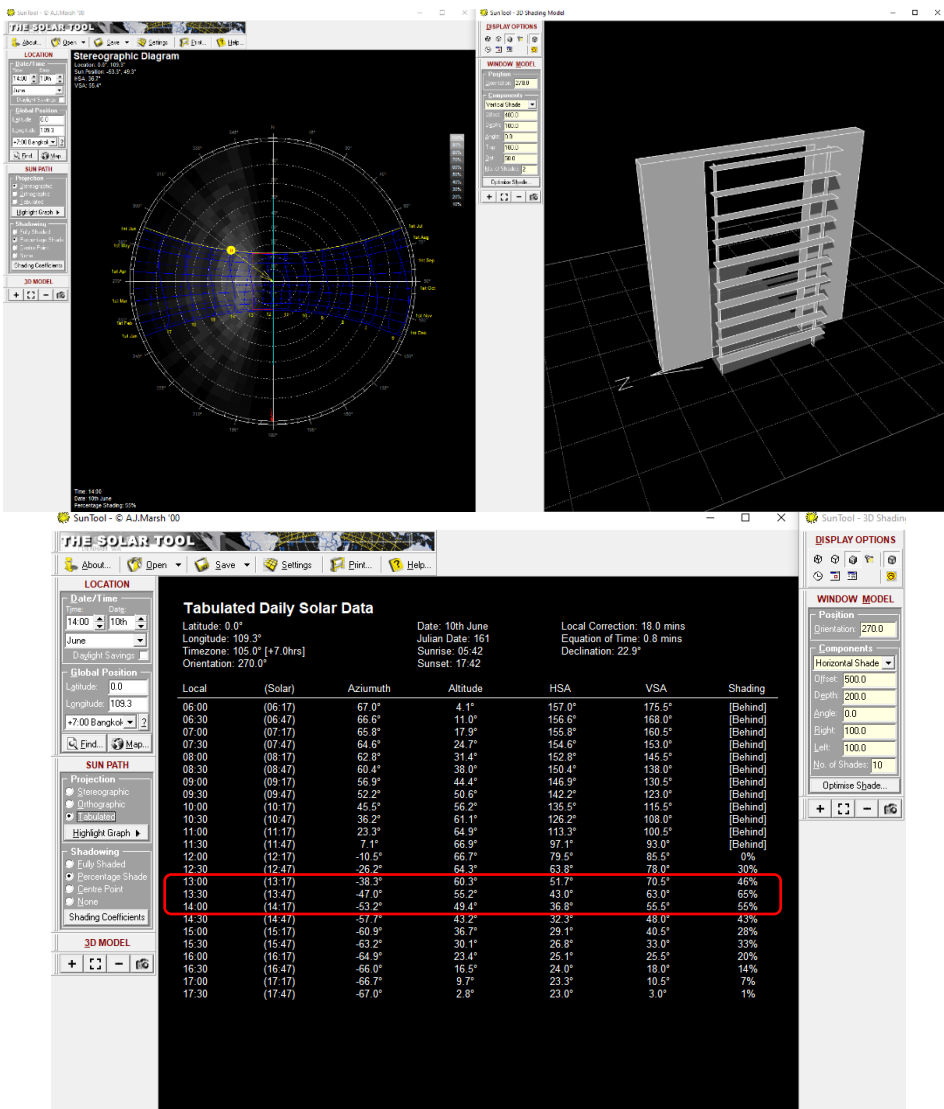


Figure 100. Determination of the dimensions of the West façade in June on 14:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software.
 Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
12:00	-	-	-
13:00	46%	54%	☑
14:00	55%	45%	☑

Information:
 (-) = not included, because the position of the sun is right in the middle of the day.
 ☑ = fulfilled (sunlight intensity 40 – 60%)

Table 22. Table of analysis on the fulfillment of sunlight intensity needs in the west facade design in June.
 Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
12:00	-	-	-
13:00	60%	40%	☑
14:00	57%	43%	☑

Information:
 (-) = not included, because the position of the sun is right in the middle of the day.
 ☑ = fulfilled (sunlight intensity 40 – 60%)

Table 23. Table of analysis on the fulfillment of sunlight intensity needs in the west facade design in December.
 Source: author analysis

D. West Facade Design in December on 14:00 with sun tools software for Porang Planting Area

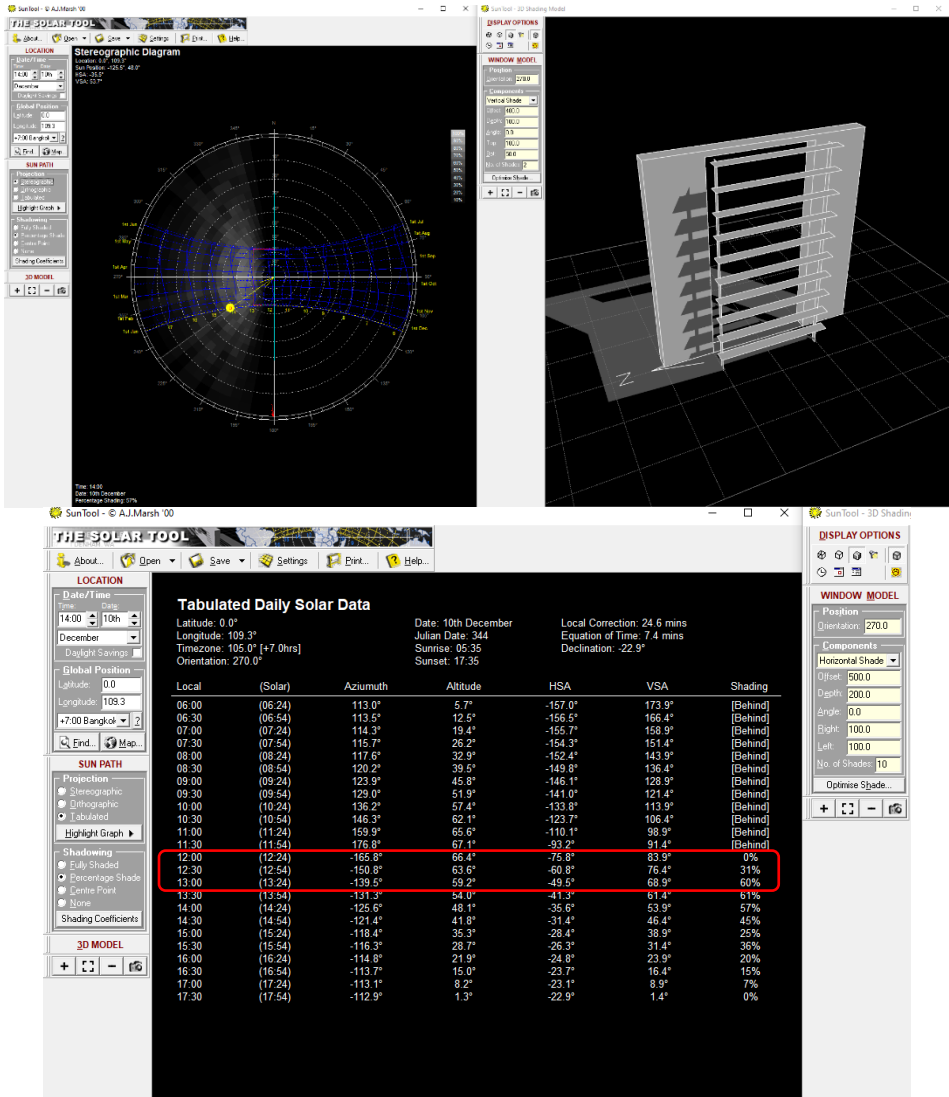


Figure 101. Determination of the dimensions of the West façade in December on 14:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software.
 Source: author analysis

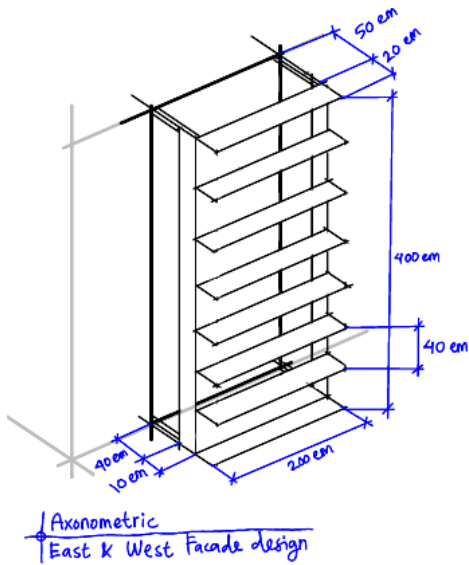
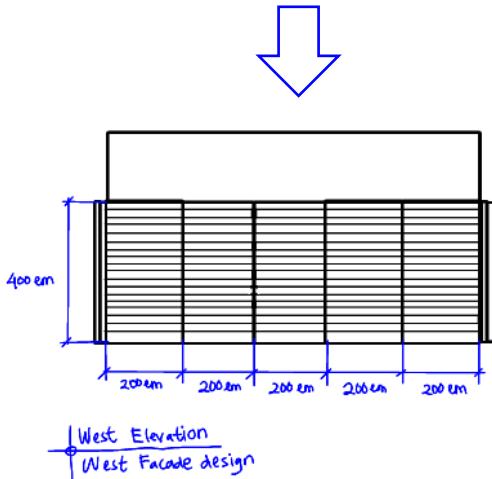


Figure 102. Dimensions of the east and west facade designs for the Porang planting room applied to the building.
 Source: author analysis

3.7 Building Skin Technology for Building System Concept

3.7.1 Building Skin Technology for Building System Concept in each rooms.

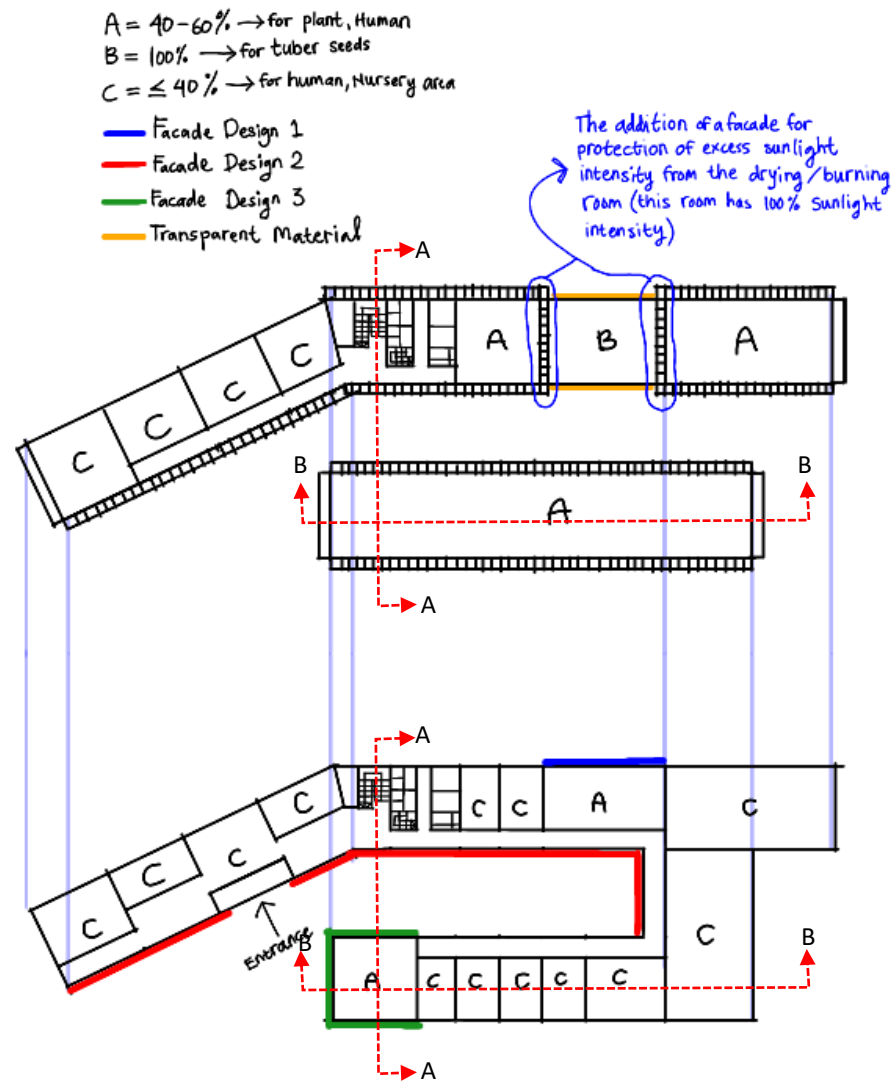


Figure 103. Image of section A and B lines on schematic drawing of ground floor plan and 1st floor plan.

Source: author analysis

At the next stage of the Porang Permaculture Building development, it is to determine the concept of the system in the building, where the system in this building skin technology will focus on the natural lighting system and air ventilation system in accordance with each function of the room in the building. as seen in the section lines drawings on the ground floor plan and the 1st floor plan, where the sectional drawing of the building will show the building skin technology system to achieve a good natural lighting system according to the needs of the space function, as well as an air ventilation system that can provide natural ventilation inside building.

3.7.1.1 Building System Concept for natural lighting systems and air ventilation in building.

The concept of a natural lighting system and ventilation system in the Porang Permaculture Building, which is shown in the image of building section A, shows how the building's facade can respond to the arrival of sunlight and wind sources.

In the planting area, it can be seen that the room applies a double skin façade system. In the first layer of skin, the room uses a layer of UV plastic material, which plastic can filter the intensity of sunlight from 6 to 18%, so it needs a second facade layer (the outermost facade) to filter the intensity of the sun at a certain sun altitude position so that the intensity of sunlight decreases and becomes 40 – 60%. As has been done in the previous design trials using Sun Tools software, the facade design of the building consisting of horizontal and vertical devices with a predetermined size is able to reduce the intensity of sunlight by about 40-60%. So that the double skin facade design is in accordance with the design criteria for the Porang planting area. In addition, on the UV plastic facade layer and the roof of the building a ventilation system is installed in which the air in the room will move upwards to reduce excess humidity in the planting area.

The canteen area uses a horizontal device on the south facade of the building. This is intended as a response to the arrival of sun altitude (65°) at 12:00 in December, so that incoming sunlight will indirectly penetrate the building. This can reduce the hot air temperature due to the position of the sun at 12:00, but still get natural light indoors. Facade design 3, namely the facade design applied to the canteen area has a removable and hollow design, so it is good for responding to the wind coming from the south.

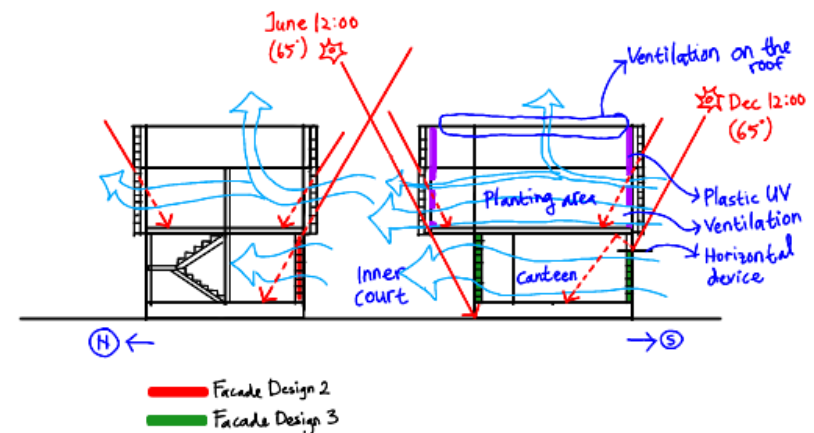


Figure 104. Building section A shows the lighting and ventilation system according to the function of each room in the building.

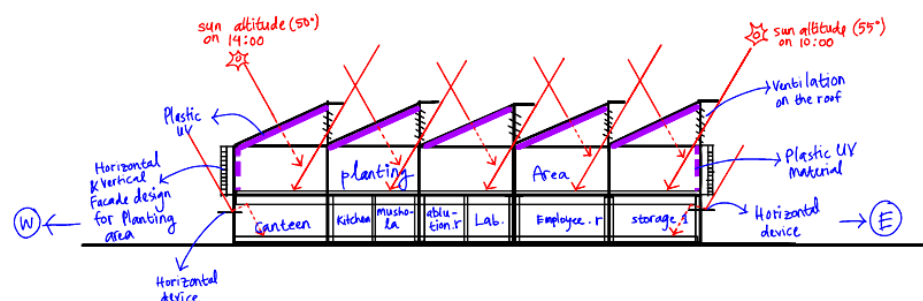
Source: author analysis

While the mass of the building on the left, it can be seen that the use of facade design 2 which has a louver facade design, this will have the effect of reducing excess sunlight on the building corridor and can let air into the building coming from the inner courtyard.

The concept of the building lighting system in the image of building section B shows that the shape of the roof of the building responds to the arrival of sunlight (sun altitude 55°) from the east by allowing sunlight into the planting area until the limit at 10:00. Meanwhile, after 10:00 to 14:00, the sunlight intensity will be reduced by installing UV plastic material and using the roof structure as a shading device for the Porang planting area, so that the sunlight that penetrates into the planting area is the reduced sunlight intensity. .

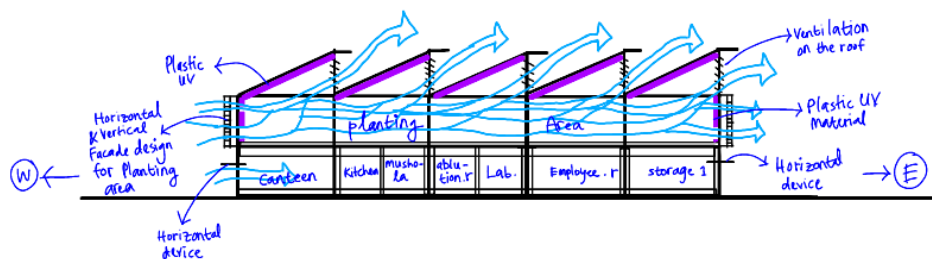
In addition, the facades on the east and west sides have also been added with a double skin faade whose design has been tested with Sun Tools Software so that it can let the incoming sunlight have a sun intensity of 40-60% from 10:00 to 14:00.

Air ventilation systems are also installed on each building facade and roof so that air can continue to move and reduce high humidity in the Porang planting area, as shown in the image of building section B on the ventilation system.



105. Building section B shows the lighting system according to the function of each room in the building.

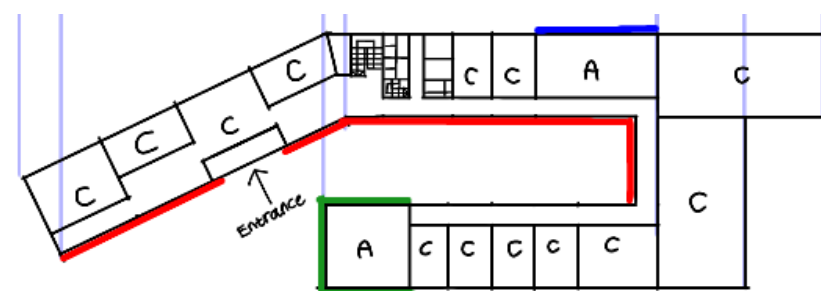
Source: author analysis



106. Building section B shows the ventilation system according to the function of each room in the building.

Source: author analysis

3.7.1.2 Concept of the building system in the facade design 1, 2, and 3.



A = 40-60% → for plant, Human
B = 100% → for tuber seeds
C = $\leq 40\%$ → for human, Nursery area

— Facade Design 1
— Facade Design 2
— Facade Design 3

107. The application of facade designs 1, 2, and 3 on the 1st floor plan based on the needs of the room function.

Source: author analysis

The concept of the building system in the next Porang Permaculture Building is a natural lighting and ventilation system in facade designs 1, 2, and 3. This facade design is divided into 3 types according to the function of the space, so it is necessary to make design criteria for each facade design.

For facade design 1, the facade applied is the facade for the Processing Room, the design criteria are as follows:

- This room has a type of activity in the room is very dense, namely processing the Porang crops with machines, so a room with good sunlight is needed and a bit bright but not excessive.
- The air ventilation system in this room must have good and fast air movement, considering that there are many machines that will work.
- It is recommended to use a removable type of facade (such as a door) so that dirty air can continue to circulate freely outside the room.
- The use of horizontal devices to reflect sunlight to enter the room indirectly.

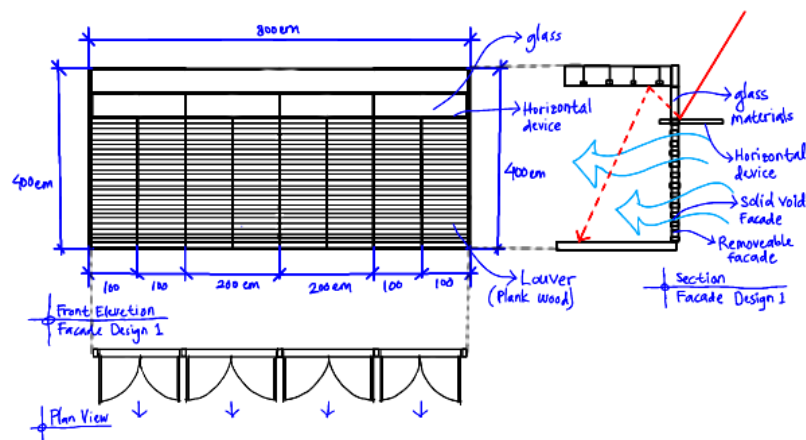


Figure 108. Natural lighting system and air ventilation in accordance with the function of the room (processing room) in the facade design 1.

Source: author analysis

For the facade design 2, the facade applied is the facade for the building corridor area, the design criteria are as follows:

- The room is semi-private.
- It needs a fairly high level of security, because the building is not open to the public. So it is recommended that the type of facade is fixed facade.
- The facade design is must able to let sunlight and air flow into the building.

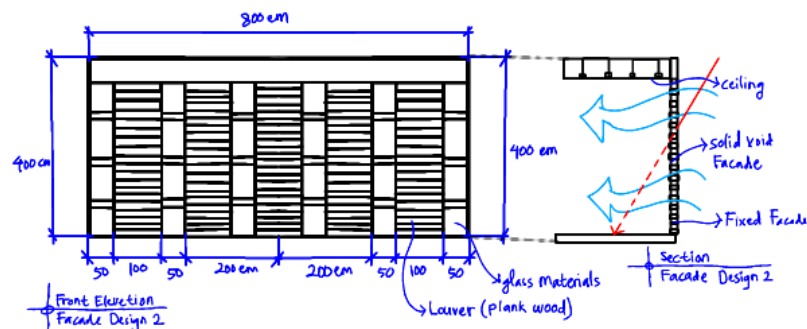


Figure 109. Natural lighting system and air ventilation in accordance with the function of the room (building corridor) in the facade design 2.

Source: author analysis

For facade design 3, the facade applied is the facade for the canteen area, the design criteria are as follows:

- Space is public.
- This space has a type of activity in that space has a medium-low activity density level, such as eating, drinking, resting, and gathering, so a room with good sunlight is needed and a bit bright but not excessive.
- It is recommended to use a removable facade type to provide broad views when building users see and enjoy the landscape design on the site when they take a rest in the canteen area.

- The facade design is able to let light and air flow into the building.
- A horizontal device is recommended to let sunlight do not enter the room directly.

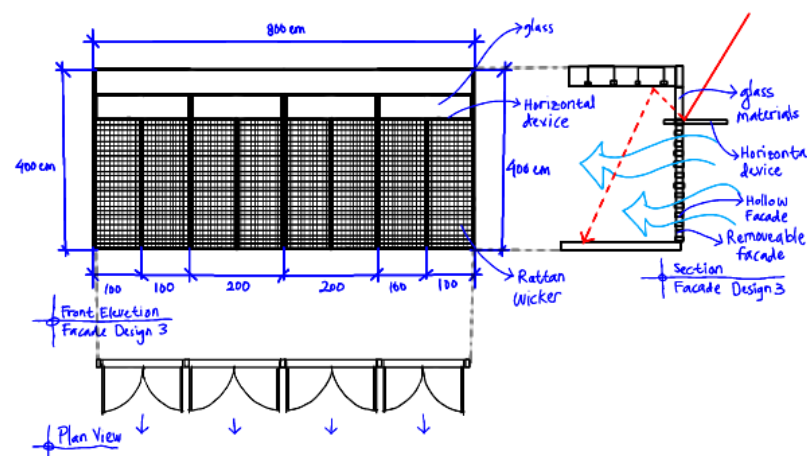


Figure 110. Natural lighting system and air ventilation in accordance with the function of the room (canteen) in the facade design 3.

Source: author analysis

Chapter

04

Design Development

4.1 Site Plan Design for Permaculture Building

4.1.1 Site Plan Design Response on Situation and Existing Condition on Site Location

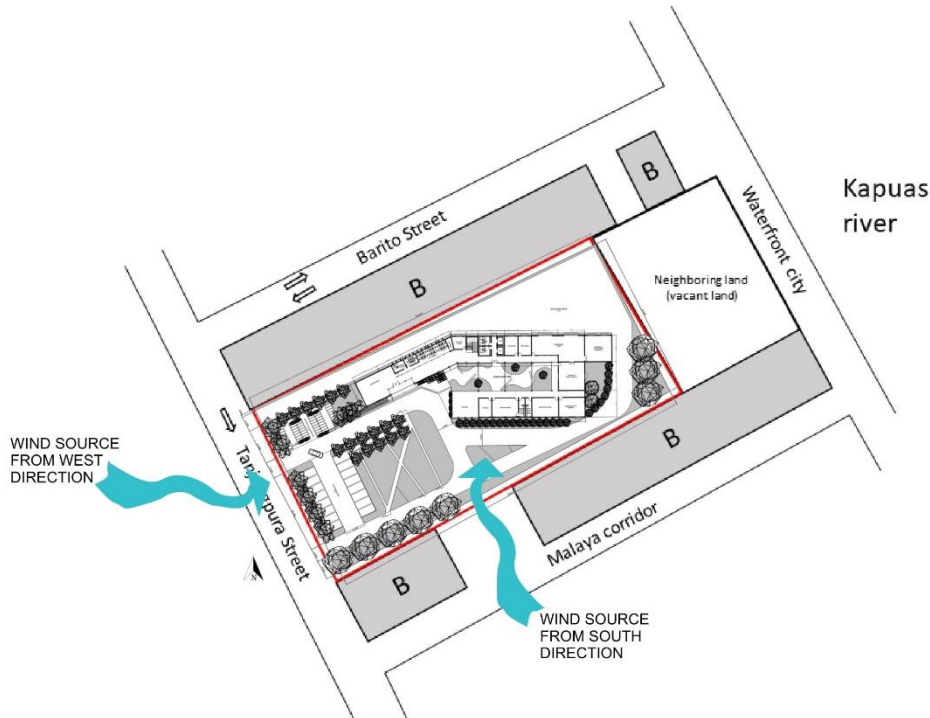


Figure 111. Site plan design that considers the source of wind direction and sunpath because the main function of the building.
Source: author analysis

The site is located in an industrial and commercial area. At the location, the condition of the land is that there are no trees, or former buildings. The location is close to the Kapuas river which is the third water source after the use of PDAM Pontianak City water and harvested rainwater.

The selected site plan is located at Jalan Tanjung Pura Jalan 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Pontianak City, West Kalimantan. This 6000 m² site plan emphasizes the consideration of the direction of the wind and the position of the sun, which is related to the main function of the Porang Permaculture Building, namely producing Porang plants. Porang plants themselves need sufficient and not excessive moisture, and these plants are shade tolerant. So it does not really need a lot of excess sunlight intensity.

The site is surrounded by wind sources to the west and east. There is nothing to stop wind from blowing in from the site's western side. While in the south, there are structures as well as some somewhat vast undeveloped space that is used as a cemetery. The majority of the building in this

area are two to three stories tall. Therefore, it is adequate to prevent the wind from reaching the place. In order for the incoming wind to reach the building and site, it is required to maintain a proper distance between buildings and their neighbors' buildings.

The contour line conditions on the site have contour lines that tend to be flat. The highest and lowest land levels are 7 meters above sea level and 4 meters, respectively, on contour lines, which have a 1 meter spacing between them. Because the condition of the land contour tends to be flat, it is not necessary to make changes to the existing contour.

4.1.2 Zoning division on Site Plan Design

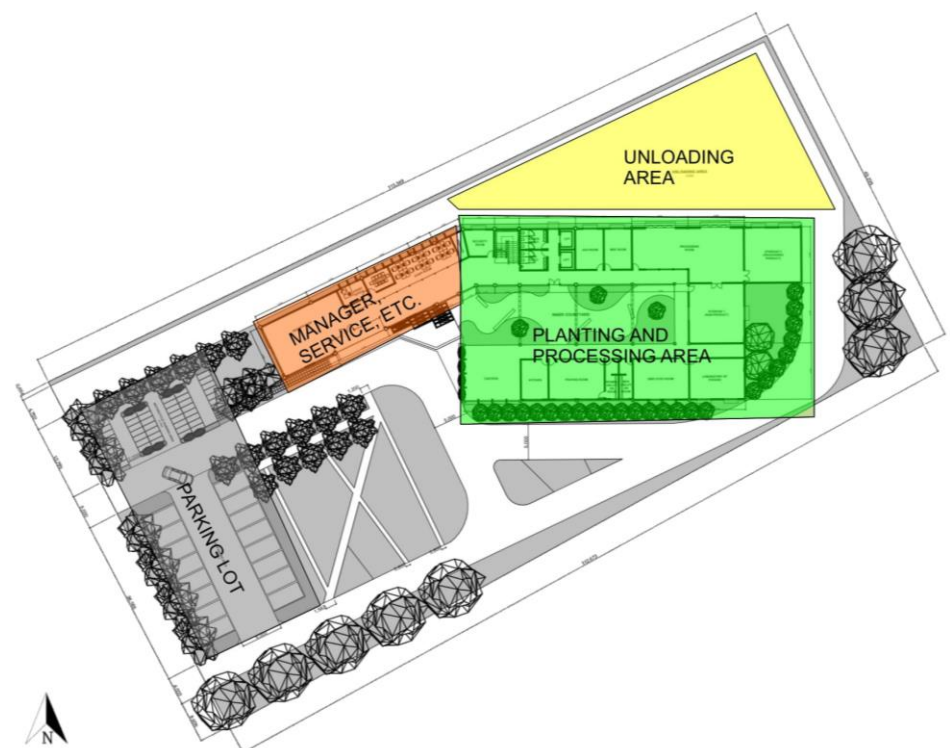


Figure 112. Zoning division based on each activities and function on the site plan design.
Source: author analysis

Two activities, each of which has a core activity and a supporting activity, make up the Permaculture Building. Based on the type of activity, the duration, and the activity time, this activity is divided. The primary pursuits are the planting, processing, and export of processed Porang goods. While supporting activities include management, building maintenance, services, and other supporting activities.

Based on the kind of activity, purpose, and requirements of the space user, the required space size is determined. Since the Porang plant is the primary factor that necessitates particular consideration in the design of the space, planting and processing activities require more room than other activities. This is because the kind of building user is meant for both people and the Porang plant. Due to the fact that activities begin by transferring fresh Porang tuber products to the storage room, processing activities make up the second-most popular activity in a permaculture facility. Then, Porang is transferred to a processing area that has a mill, a washing machine, a drying machine, and a chopping equipment for Porang. After that, Porang flour or rice are extracted from the Porang product. These activities certainly require a larger space in terms of the type of user activity, as well as the circulation of these activities.

The zone is separated into three zones on the site plan for the Permaculture Building: the parking zone, the zone for supporting activities (management, service, etc.), and the primary activity zone (planting and processing). According to the level of activity density for each zone function, the zone is split. In order to prevent building users from entering the structure with vehicles, the parking area is situated in front of or close to the road. so that it can lessen the environment's carbon impact at the site. Between the parking area and the main activities zone is the supporting activities zone. As a bridge between the two zones, this zone is beneficial. Then the zone located at the rear of the site is the main activities zone, which zone has the highest activity density.

4.1.3 Distribution of Access and Placement of Building Mass in Site Plan Design

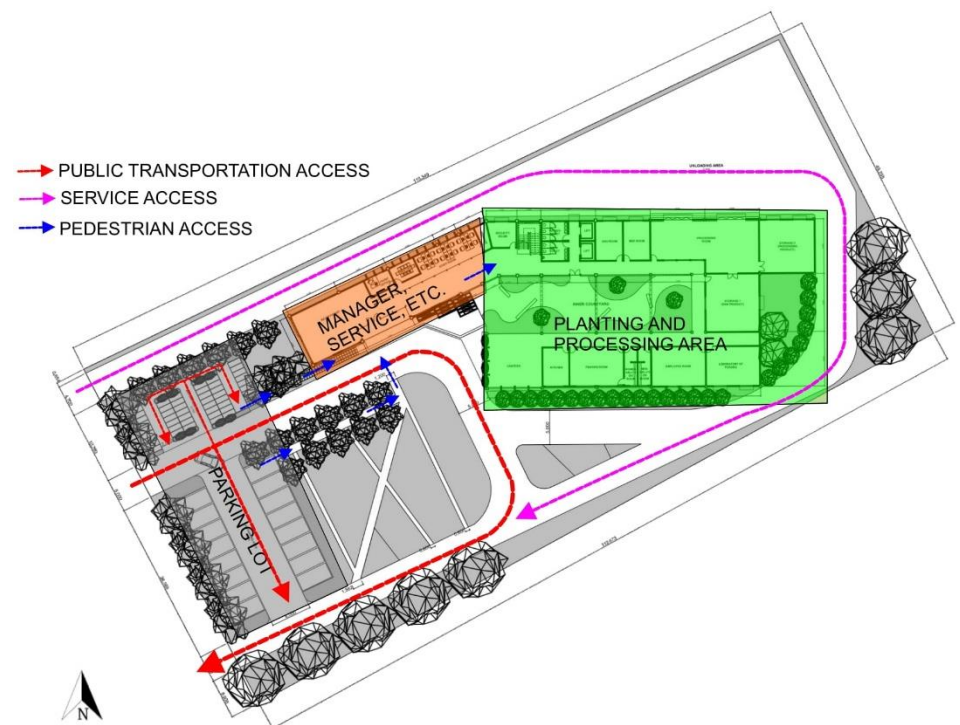


Figure 113. Distribution of access and circulation in the site plan design.
Source: author analysis

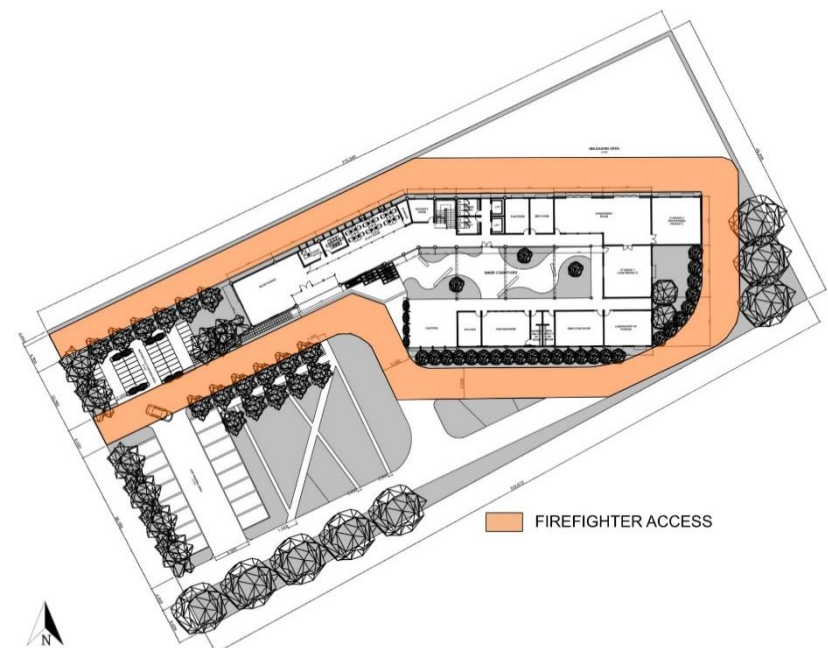


Figure 114. Firefighter access and circulation in the site plan design.
Source: author analysis

The mapping of parking zones for the Permaculture Building site plan is separated into two zones: one for motorbike parking and the other for car parking. Although the two parking areas are positioned close to one another and next to one another, the two types of cars are structured differently for exit access for the comfort and safety of site visitors.

Access for pedestrians is also planned independently from that for vehicles. Users of the building will be able to travel there in comfort and safety thanks to the pedestrian access, which will be designed like a walkway, furnished with shading devices to keep the area shaded, and connected directly from the parking area to the building.

Also distinct from other accesses, service access is designed. The loading and unloading area is close to the main activity zone, and this service access will bring trucks there immediately (planting and processing area). The perimeter of the Permaculture site and building has been designed to allow for service access, which is useful for both service (truck) access and fire truck access. The minimum standard for the circulation of fire engines is 4 meters wide without any obstructions. In the site plan design, the width of the road provided for fire engines is 5 meters.

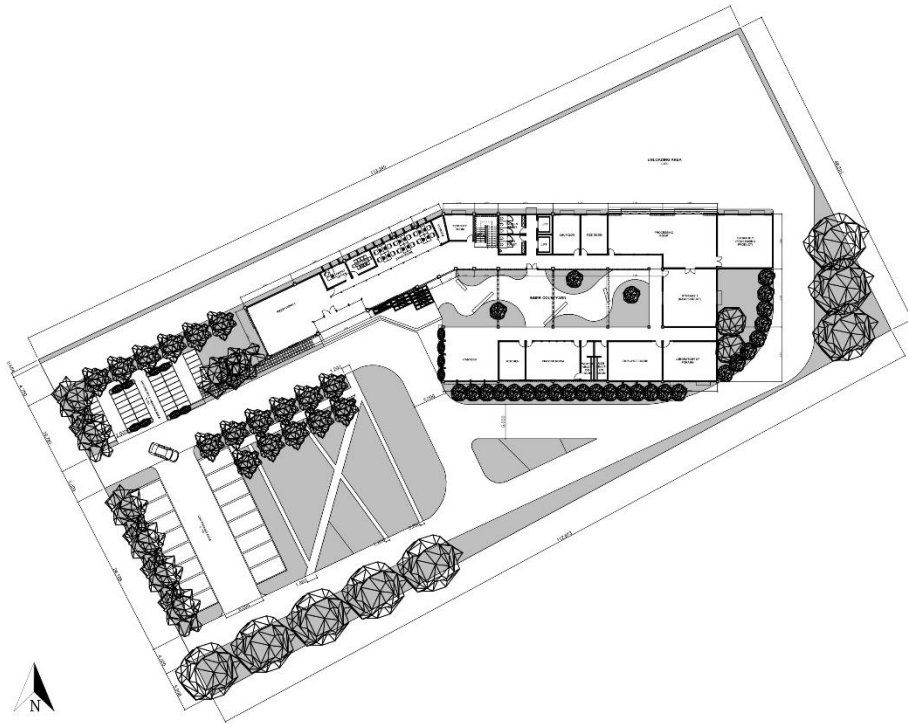


Figure 115. The final drawing of site plan design.
Source: author analysis

4.2 Building Mass Design for Permaculture Building

4.2.1 Proper Building Mass Orientation Design for Planting and Processing Areas.

All phases of Porang growth require air temperatures that are not hot (most ideal 23 – 25°C), so this is taken into account while analyzing the building mass orientation for the plantation and processing area. The City of Pontianak was classified in the S3 land category (marginal fit) for temperature parameters in the previous analysis, which was the Table of Land Suitability Criteria for Porang Plants (by Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016). Although the temperature on land in Pontianak City is suitable for growing Porang but has low potential because Pontianak City has an average temperature of 28 to 32°C, which is hotter than the most optimal temperature for growing Porang plants, which is 23 - 25°C. so that to increase the potential for the Temperature parameter, efforts are needed in designing the Porang planting area so that the temperature level can be reduced, which is as in the table below which shows the design criteria and problem solving for the Temperature issue.

Design criteria in category S3 (marginal fit):

1. Arch issue: temperature

Design criteria	Problem solving
All stages of Porang growth require air temperatures that are not hot (most optimal 23 - 25°C).	<ul style="list-style-type: none">• The orientation of the building faces south and north, so that the large facade area does not absorb too much solar heat.• The shape of the building mass extends to the west and east to avoid absorption of solar radiation. or you can design a solid void building mass to create a shaded area on the facade.• The use of shading devices to avoid the sun's altitude point which has a high level of sunlight intensity (the more perpendicular the sun's position, the higher the level of sunlight intensity).
Except for the break dormancy stage, seedlings in the form of tubers require a temperature of 45°C (drying/drying in the sun for 6 hours/day).	<ul style="list-style-type: none">• The use of transparent materials, so that sunlight can be transmitted 100% (sunlight intensity 100%).• Does not require a shading device.

Table 8. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.

Source: author analysis

A sun chart will be used to examine the orientation of the building mass for the Planting and Processing area at the building mass design stage. The following figure illustrates the two choices that will be taken into consideration for the building mass's orientation.

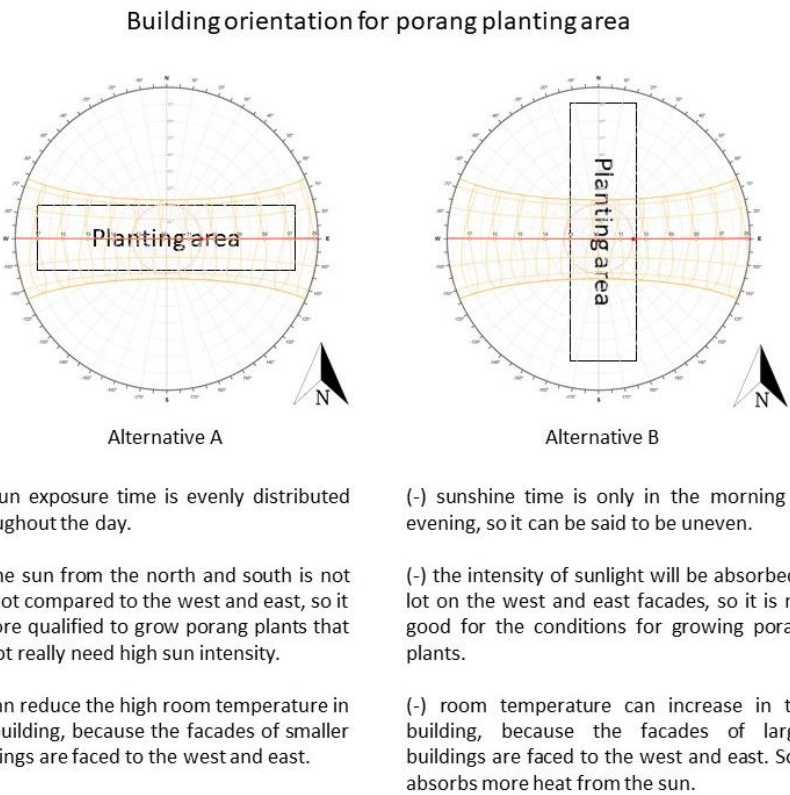


Figure 55. Analysis of the building mass orientation that meets the requirements for growing Porang plants
Source: author analysis

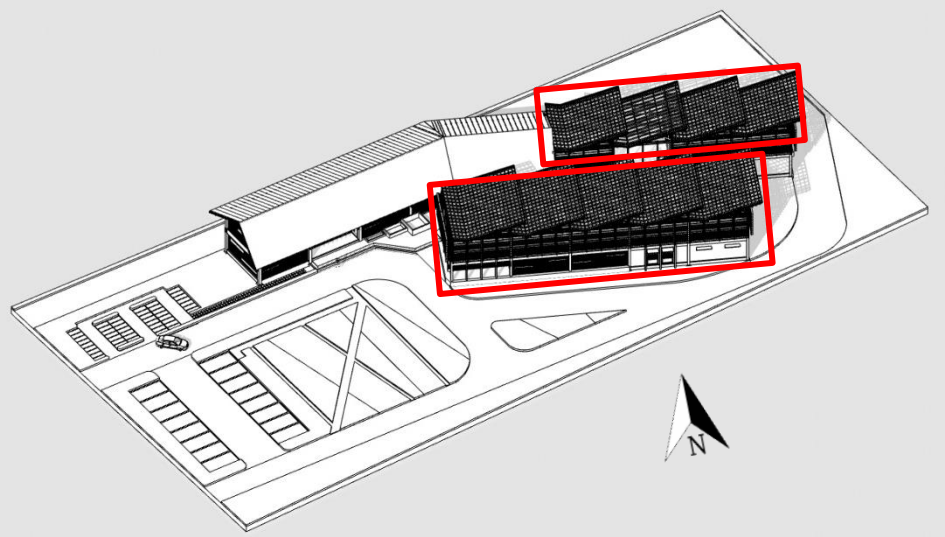


Figure 116. the orientation of the building mass for the porang planting and processing areas faces north and south to avoid excessive solar heat.
Source: author analysis

According to the analysis, the building mass for the porang planting and processing area is oriented to face north and south in order to reduce excessive solar heat. The planting area at Porang will receive priority. By choosing option A, it is intended that the direction of the building mass will allow for a cooler room temperature, which will boost the possibility of growing Porang plants inside the building.

In the interim, the management area, services, and other supporting facilities will conform to the contour of the site to prevent space and site area waste. These factors are also taken into account because users do not often use a building for a full day (12–24 hours), which allows for modifications to the facade design, etc., for the benefit of building occupants.

4.2.2 Proper Building Mass Forms Design for Planting and Processing Areas.

The amount of humidity and the temperature of the building's water are two factors that must be taken into account when developing the type of building mass that is appropriate for plantation and processing areas. The land in Pontianak City was classified as S3 land (marginal fit) in the previous analysis, which was the Table of Land Suitability Criteria for Porang Plants (by Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016). This means that while the land in Pontianak City is suitable for growing Porang, it has limited potential because its average humidity of 86 to 92 percent is higher than the most ideal, which is around 24 - 80%. From this analysis, it can be said that efforts need to be made in designing the planting space so that the humidity in the building can be reduced, which can be done in several ways as listed in the following table.

2. Arch issue: humidity

Design criteria	Problem solving
The nursery stage of frogs/bulbills requires sufficient humidity/not dry (most optimal 24-80%).	<ul style="list-style-type: none">• The composition of the building mass can use a single banked room so that air movement is evenly distributed.• Ventilation can use the stuck effect.• Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Porang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none">• Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Porang.• Use cross section ventilation.• Make openings / ventilation in the roof to reduce excess moisture.

Table 9. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

There are a number of things that need to be done in order to design the shape of the building mass that considers the aspects of humidity and temperature, such as applying a composition of the building mass that uses a single

banked room so that air movement is evenly distributed, ventilation that uses the stuck effect, uses cross section ventilation, and minimizes the facade area that is exposed to the sun's heat in order to reduce heat absorption.

The following figure illustrates the analysis of wind circulation movement within a building mass. In order to control the humidity level in the porang planting area, the wind circulation is designed to pass through the building to the building mass by means of a thin and elongated building from east to west with a shape similar to a single banked room. The wind source is dominated by the west and south. The purpose of this is to allow the south wind to easily enter the building's interior spaces. in particular for the porang planting area, which consists of two building masses that are spaced apart by a specific amount but not by a great deal, and can pass through gaps between buildings.

This is done to allow for the passage of the wind from the west through the opening between the masses of the buildings. The temperature and humidity in the Porang planting area will decrease as more air is circulated inside the structure. Furthermore, because the processing area has a high level of activity density, this is also beneficial for the comfort of the building's users in that region. In order to save energy and improve thermal comfort, it takes into account the building's comfort.

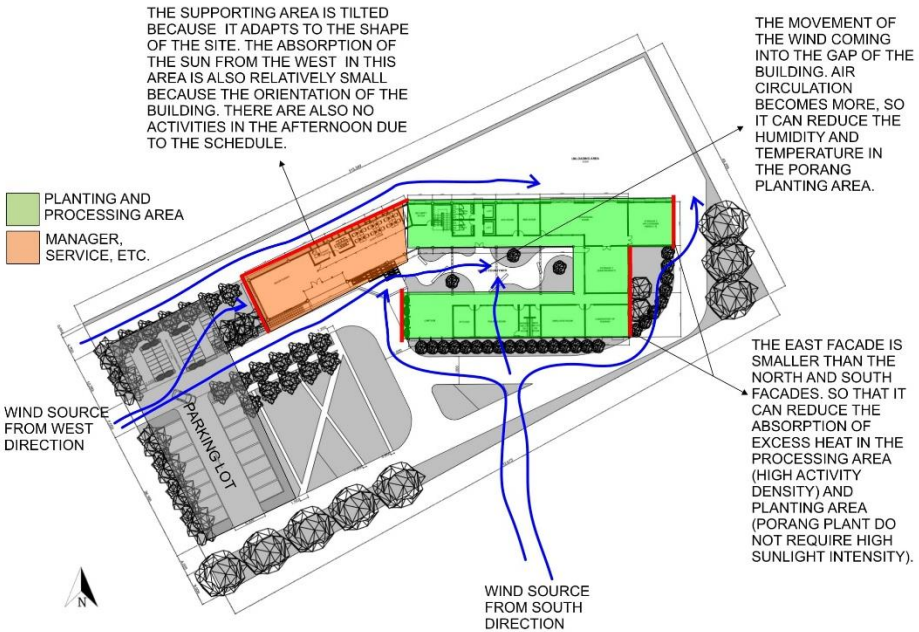


Figure 117. The shape of the mass of the building is divided into two and applies a single banked room, so that the wind will come through the gaps between the buildings.
Source: author analysis

The appropriate roof shape for the Porang planting area needs to be decided upon in the development stage of designing the shape of the building's mass. A good roof typology for Pontianak would have a steep roof slope so that water may flow swiftly and not sit in one place on the roof surface for an extended period of time. This is because Pontianak experiences high rainfall. Given that the Porang plant requires a relatively low air temperature compared to the temperature in the city of Pontianak, it is also advised that the design of the roof include a distinct zone for wind movement inside the building so that the air flow inside the building is not hot.

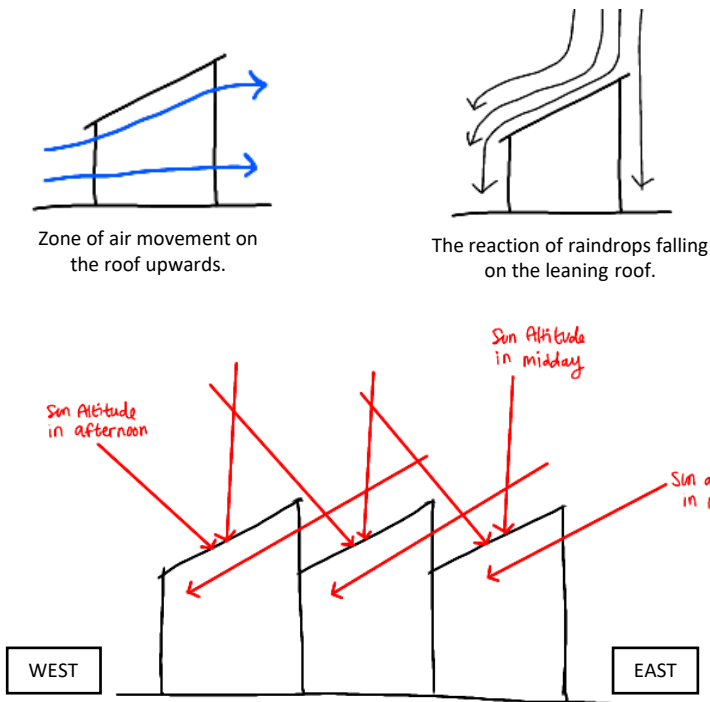


Figure 63. The shape of the leaning roof lets sunlight in morning into the building, while sunlight in midday and afternoon is avoided because it has a high level of sunlight intensity.
Source: author analysis

The analysis of the roof's shape in chapter 3 led to the conclusion that an alternative D roof form is the best shape for growing Porang plants since it addresses the need for sunshine intensity, which is the architectural problem that needs the greatest attention. Which, in the alternative roof form D, is capable of shielding Porang plants from the intense sunshine between the hours of 12:00 and 14:00. Moreover, the alternative D roof form is appropriate for use in regions with high rainfall rates in terms of humidity and rainfall. The rising roof also creates a zone for air movement inside the building, which is similar to how humidity is controlled.

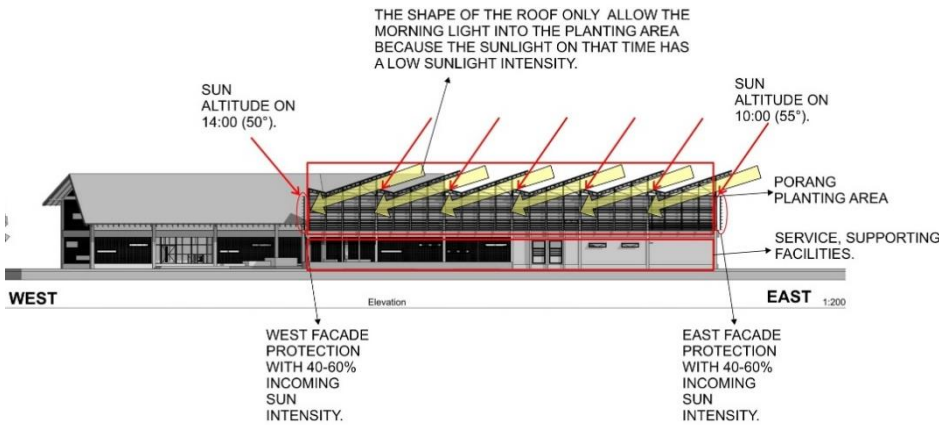


Figure 118. The shape of the leaning roof lets sunlight in morning into the building, while sunlight in midday and afternoon is avoided because it has a high level of sunlight intensity.
Source: author analysis

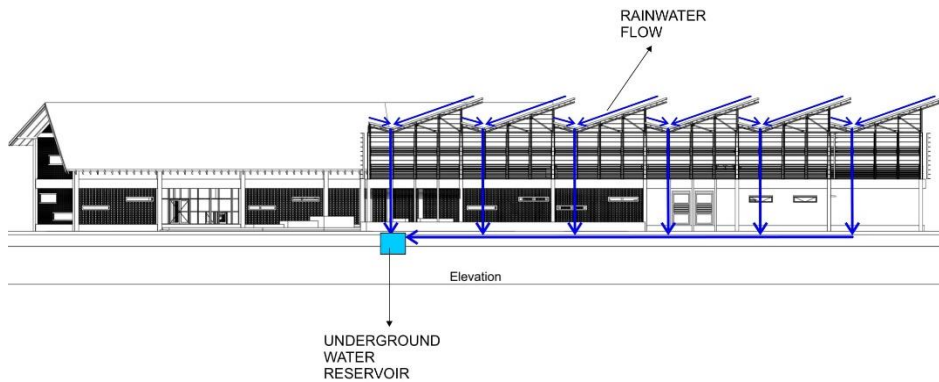


Figure 119. direction of water flow on the roof design.
Source: author analysis

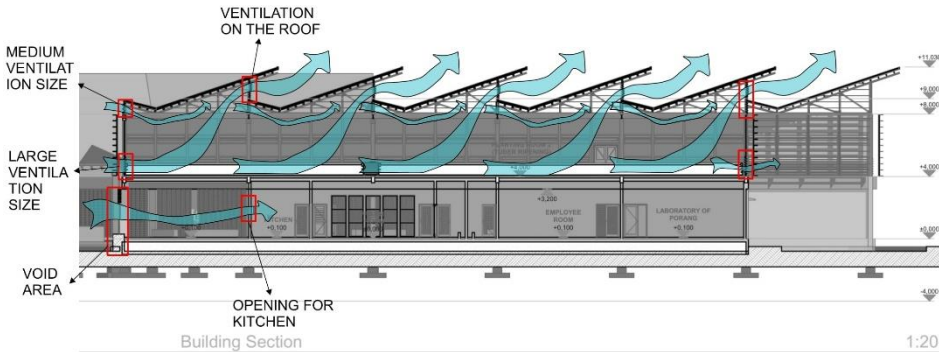


Figure 120. direction of wind flow on a ventilated roof design.
Source: author analysis

Design criteria in category N (not suitable):
1. Arch issue: Sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">• The roof can use a massive material or an ordinary roof.• Sufficient light comes from windows, etc.• Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">• The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.• Avoid the sun's altitude point which has a high level of solar radiation.• Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).• Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).• Must use transparent roofing material but have a louver.• Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">• Use transparent materials so that sunlight can be transmitted into the building 100%.• Avoid using shading devices, etc.• Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table 7. Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

There are three different sorts of lighting requirements for the Porang Permaculture Building when developing it. For the Porang planting area, this means lighting with an intensity of 40 to 50 percent sunshine, 100 percent lighting for the Porang tuber burning or heating area, and an area with about 50 percent illumination for the nursery/seeding area and special areas for managing, servicing, and controlling. For an area where adults Porang plants make up less than 50% of building users, this is true. As a result, only morning sunlight is used in the building's lighting for thermal comfort; afternoon and evening sunlight is typically avoided, as seen in the following photo. As a result, to shield building occupants (humans) from direct sunlight in places with less than 50% brightness, huge roofing materials or regular roofing materials are required.

In the following picture it is explained that the roof of the building is divided into three types, namely semi-transparent roof made of Plastic UV material (light can penetrate <100% of the building), ordinary massive roofing material, and transparent roofing material that can transmit sunlight up to 100% into the building.

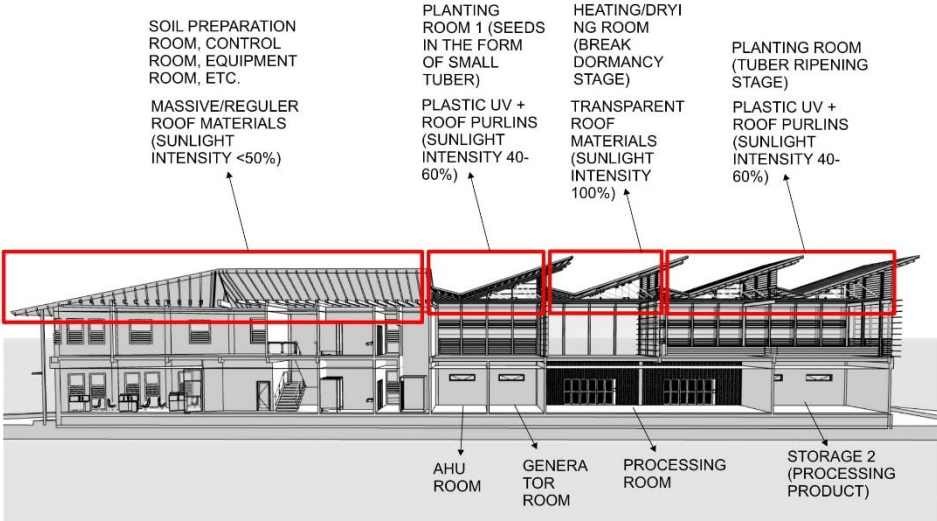


Figure 121. Division of the type of roof design based on each function space on the 1st floor.
Source: author analysis

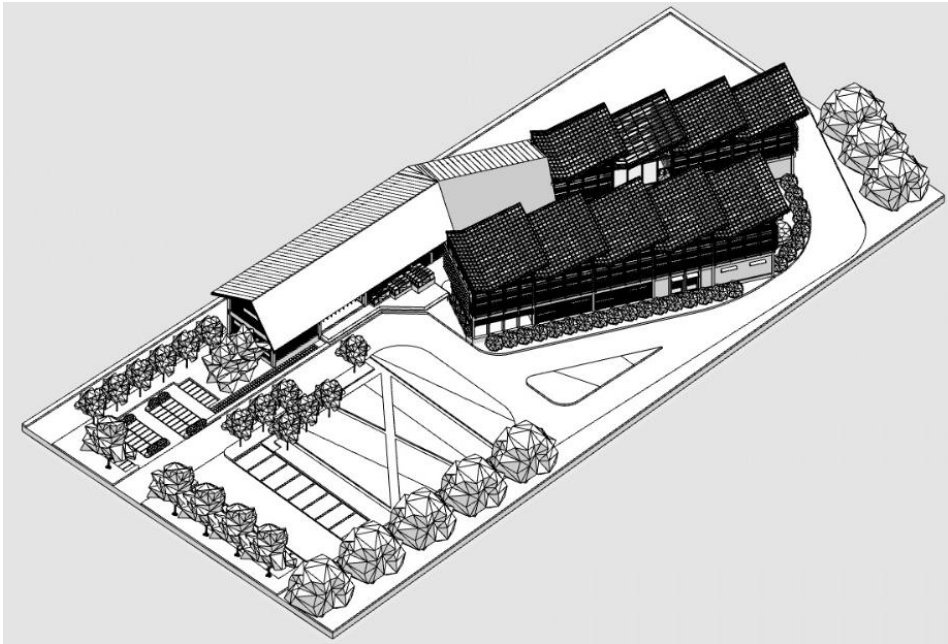


Figure 122. The final form of building mass design.
Source: author analysis

4.3 Room Space Design for Permaculture Building

4.3.1 Plotting Design for Room Space in Buildings based on Functions, Activities, and Relationships Between Spaces.

The following figure shows where each space is located after the zoning analysis and connections between the spaces are organized in accordance with the shape of the existing building mass.

There are 2 storeys in the Porang Permaculture structure. Area management, service, and other supporting requirements are served by the building's ground floor. The processing facility for Porang tubers, the storage space for the harvest of ripe Porang tubers, and the area for storing processed Porang products are all located on the ground floor. It is also planned to make it easier to move warehouse goods to the loading and unloading area by placing a warehouse for finished Porang products on the ground floor.

Following the completion of the zoning placement for each room, where there had previously been an addition of one building mass, the zoning of the room is continued by placing it immediately on the plan of the previously established building mass, as illustrated in the following figure. Space zone plotting is used differently on each floor.



Figure 123. Final the placement of each space zone on the building mass for ground floor.
Source: author analysis

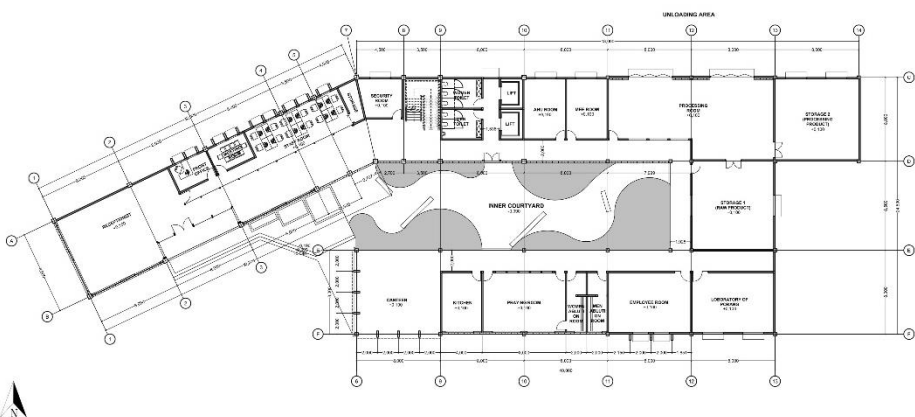


Figure 124. The final drawing of ground floor plan design.
Source: author analysis

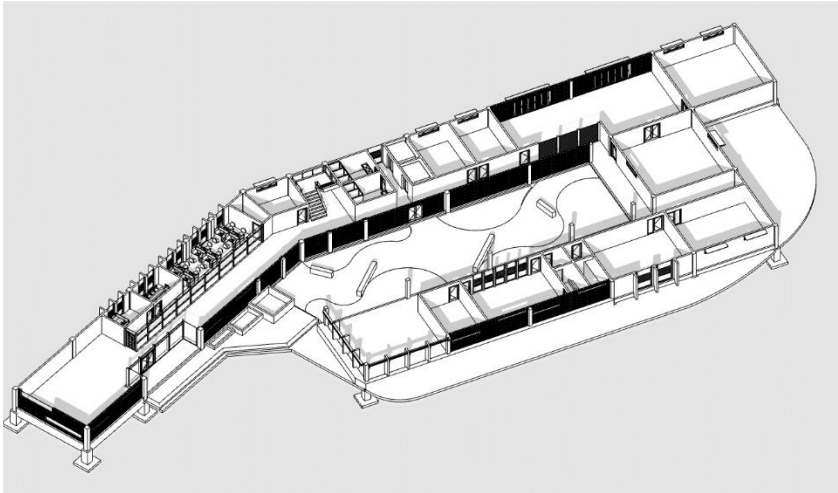


Figure 125. The final drawing of ground floor plan design in 3d axonometric.
Source: author analysis

While the first floor is dedicated to the Porang plant farming area, including the planting control room, soil preparation, seeding, planting juvenile Porang bulbs, drying and heating areas for tuber seeds, up to the area for ripening mature Porang tubers, it includes all of these activities. The area on the first floor is built primarily for farming because it receives ample sunlight.

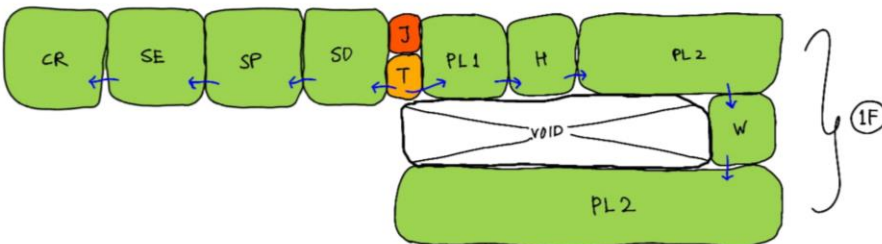




Figure 126. Final the placement of each space zone on the building mass for 1st floor.
Source: author analysis

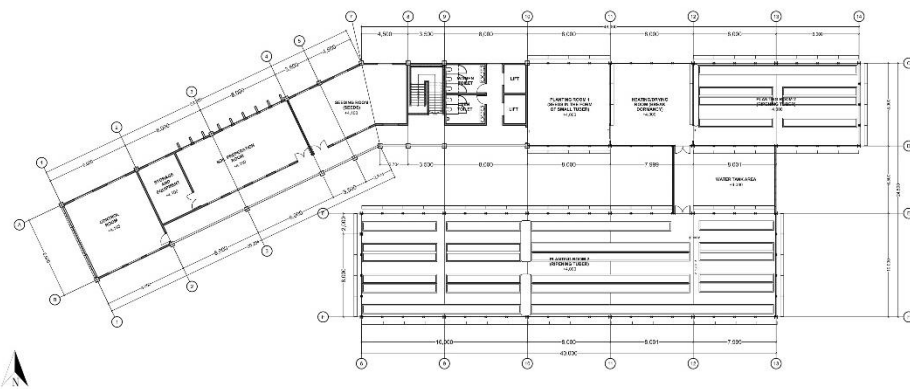


Figure 127. The final drawing of 1st floor plan design.
Source: author analysis

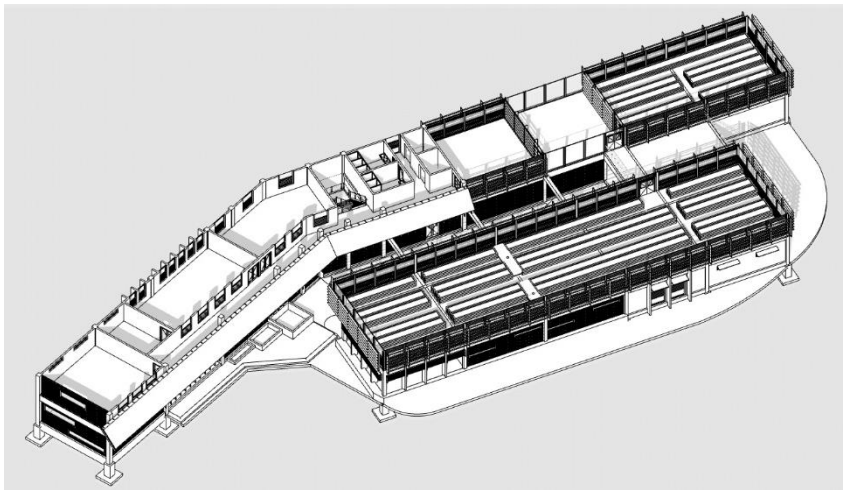
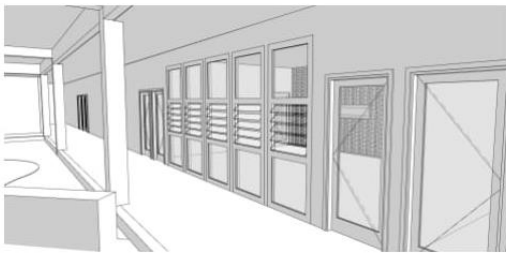
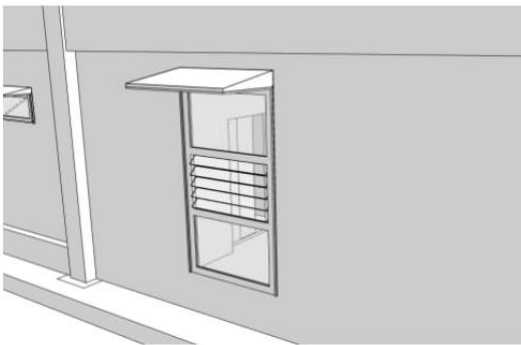


Figure 128. The final drawing of 1st floor plan design in 3d axonometric.
Source: author analysis

 FACADE DESIGN 3



 FACADE DESIGN 4

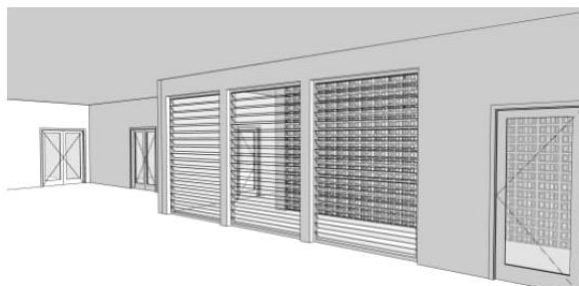
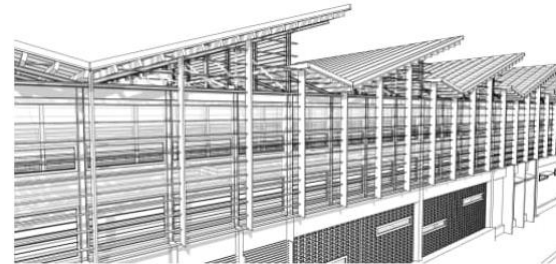
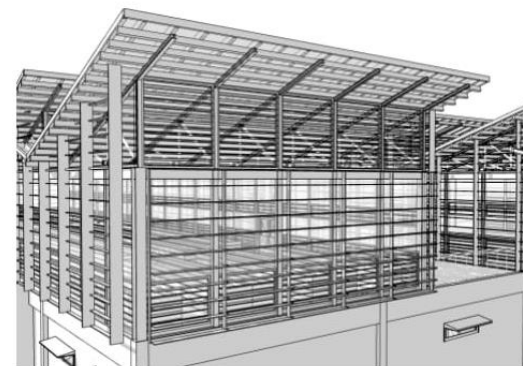


Figure 131. Image of the appearance of each facade on the building.
Source: author analysis

 FACADE DESIGN 5



 FACADE DESIGN 6



 FACADE DESIGN 7

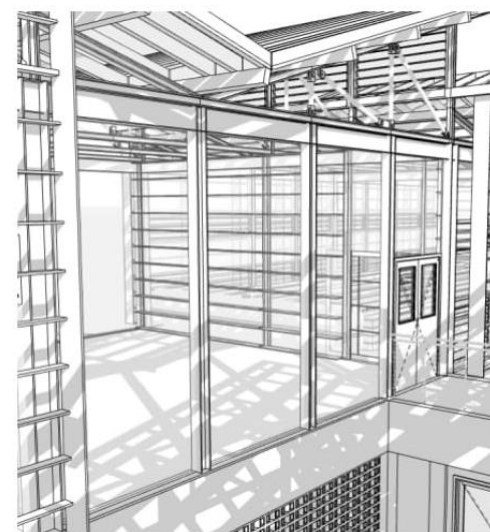


Figure 132. Image of the appearance of each facade on the building.
Source: author analysis



Figure 133. The final drawing of south and north elevations.
Source: author analysis



Figure 134. The final drawing of east and west elevations.
Source: author analysis

4.5 Building System Design for Permaculture Building

4.5.1 Water System Needs Fulfillment Design in Porang Permaculture Building

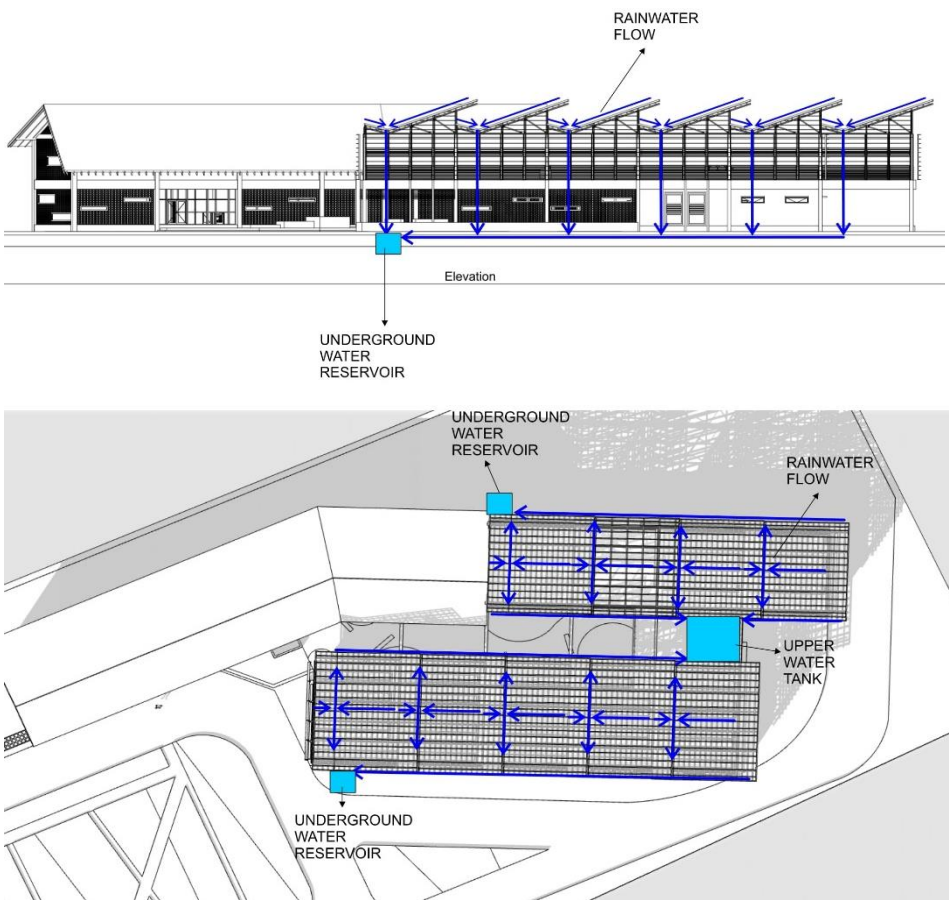


Figure 135. Roof design that is able to perform rain water harvesting for water needs in buildings.
Source: author analysis

In comparison to the needs of other operations, the necessity for watering the inside plants dominates the water needs of this Porang permaculture building. Of course, the building's water requirements are met not only by PDAM Pontianak city water sources but also by the rain water harvesting system, as seen in the picture. As you can see from the photo, the roof is shaped in such a way that it can collect rainwater in order to meet the building's water needs.

As a result of the roof's design, rainwater that falls on the roof will flow directly into the basin on the roof, which has gutters and pipelines already set up. The pipe will collect rainwater as it falls to the bottom and travels underground to a reservoir where it is filtered before being distributed to all building uses.

4.5.2 Porang Plant Nutrition System Design

As shown in the design criteria table below, Porang plants have a number of requirements for their growth at specific stages, such as when planting seeds in the form of tubers and when adult Porang tubers are ripening. These requirements are taken into consideration when designing the nutrition system for Porang plants.

2. Arch issue: humidity

Design criteria	Problem solving
The nursery stage of frogs/bulbills requires sufficient humidity/not dry (most optimal 24-80%).	<ul style="list-style-type: none">• The composition of the building mass can use a single banked room so that air movement is evenly distributed.• Ventilation can use the stuck effect.• Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Porang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none">• Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Porang.• Use cross section ventilation.• Make openings / ventilation in the roof to reduce excess moisture.

Table 9. Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

In general, high soil humidity is not needed for porang plants. But the humidity is just appropriate it's too dry and it's not too high. Considering that this plant is a tuber plant, which if immersed by water will cause the tubers in the soil to rot and die, it is also not advised that the soil area be inundated by standing water (Porang Agricultural Research and Development Agency, 2015). The study on the Porang planting process only pertains to the stages of planting seedlings in the form of Porang tubers and the maturation stage of mature Porang tubers.

According to this study, the Porang planting media should be designed with a drainage system to provide the nutrition system that Porang plants need at these two stages. The planting media used in Porang will be shaped like a long box and include soil that has been fertilized and given an acidity treatment that is neutral. Additionally, a filter will be built at the base of the ground to stop hard soil particles from entering the drainage channel and only allow water that has already collected on the ground to do so. This will prevent the soil from becoming overly wet and will maintain it just slightly dry. The water that enters the drainage channel is then directed to the nutrient tank and pumped through sprinkler-equipped pipes so

that the water containing nutrients is continued for watering the Porang plants on a regular basis in accordance with the frequency and schedule of watering the Porang plants. The Porang plant will maintain its moisture level and lower the chance of Porang tuber decay by implementing this plant nutrition strategy.

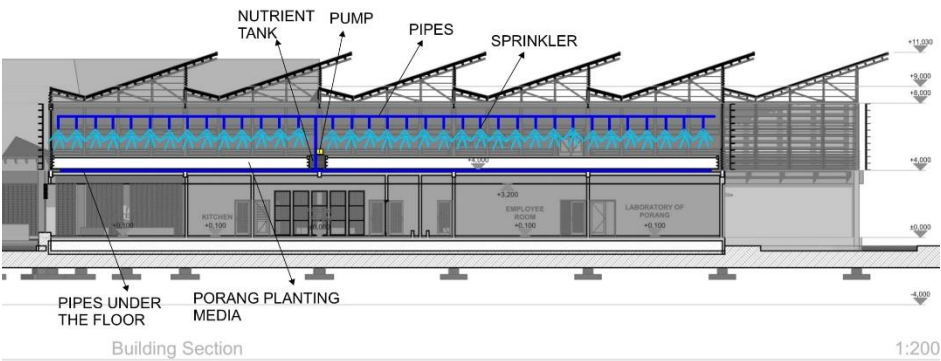


Figure 136. Section drawing: Porang irrigation system using drainage pipes under the floor.
Source: author analysis

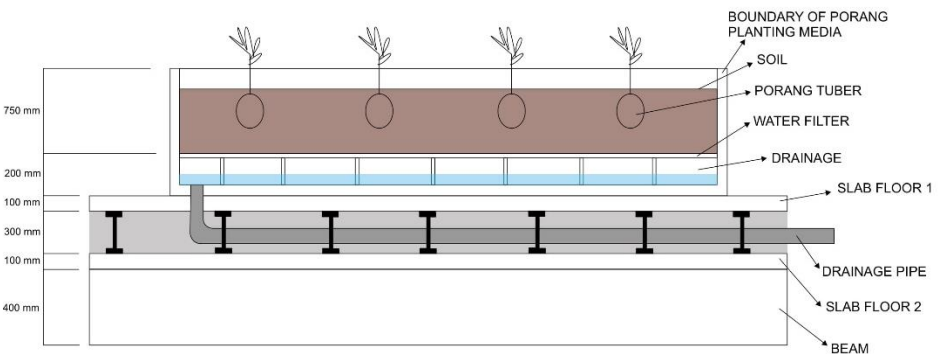


Figure 137. Section drawing: the water on the soil will go down and enter the drainage channel on the Porang planting media.
Source: author analysis



Figure 138. The final drawing of section A and B.
Source: author analysis

4.5.3 Design of Spatial Planning for Porang Planting Media

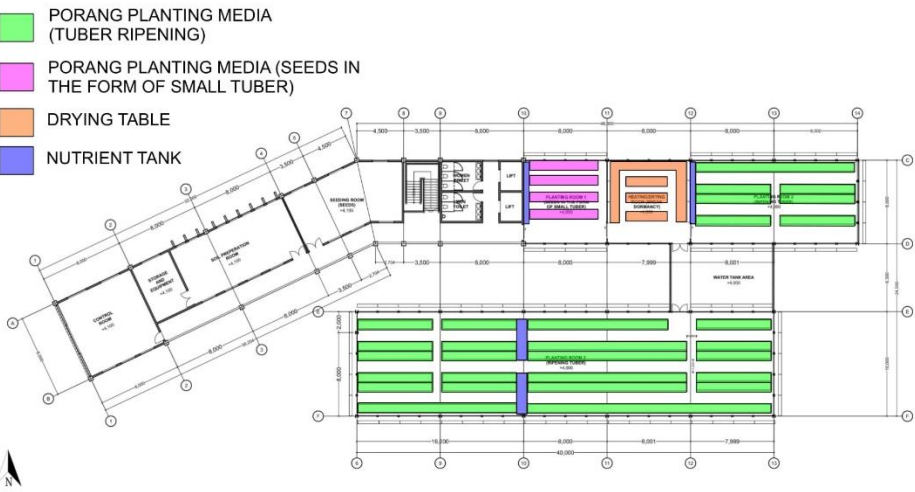


Figure 139. 1st floor plang drawing: Porang planting media arrangement at each stage.
Source: author analysis

On the first floor plan of the Porang Permaculture building, you can see the arrangement and pattern of the Porang planting media and furniture according to the function of each stage of the Porang product production process. You can see in the picture that there are special planting media for seeds in the form of small Porang tubers, drying table furniture for the Porang tuber drying stage (break dormancy stage), Porang planting media, and the last is the nutrient tank for the Porang plant watering process.

4.6 Building System Design for Building Skin Technology

4.6.1 Building Skin Technology design in each Room Space based on the function of the room.

4.6.1.1 Building Skin Technology design on the facade design 1.

FACADE DESIGN 1

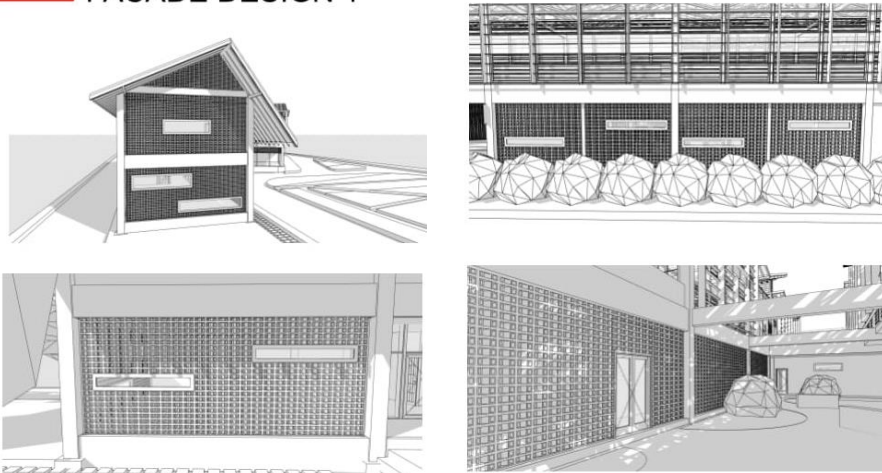


Figure 140. Image of the appearance of of façade design 1.
Source: author analysis

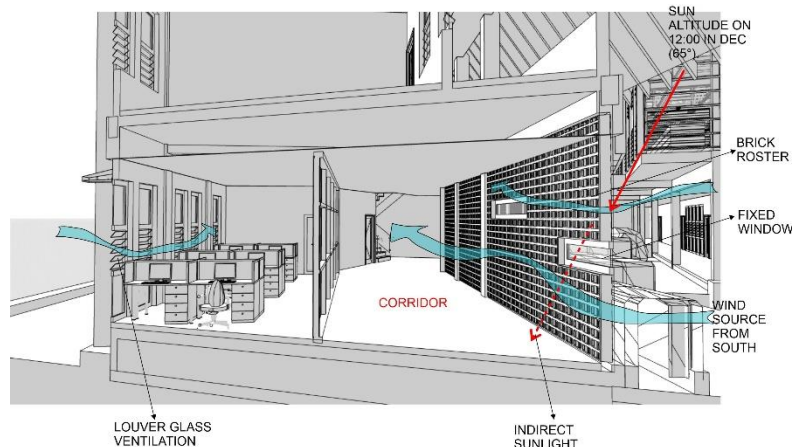


Figure 141. Image of air circulation system and solar lighting system in the section drawing corridor area.
Source: author analysis

The following design requirements apply to the facade employed in the facade design 1, which is the façade for the building corridor area, kitchen, and prying room:

- It is a semi-private space.
- Because the building is not accessible to the general public, it requires a high level of protection. As a result, the sort of facade that is advised is a fixed facade.
- The building's front must be able to permit light and air into the building.

4.6.1.2 Building Skin Technology design on the facade design 2.

FACADE DESIGN 2

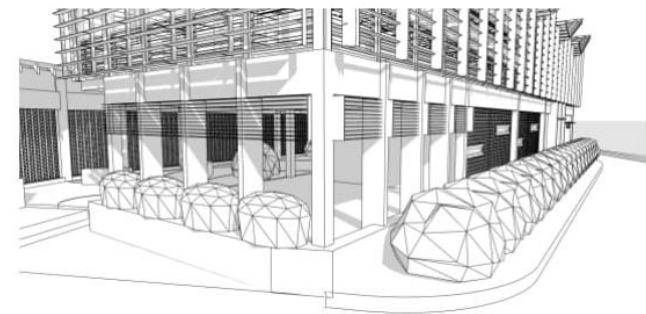


Figure 142. Image of the appearance of of façade design 2.
Source: author analysis

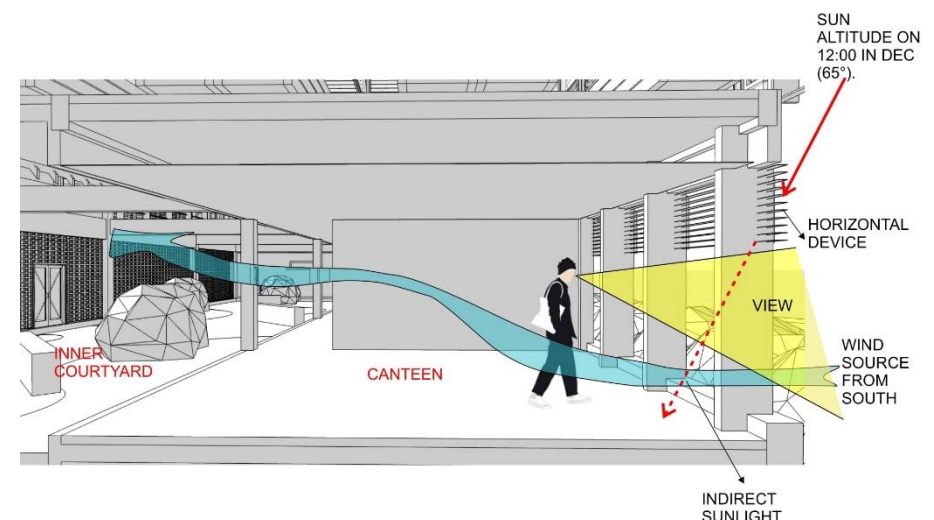


Figure 143. Image of air circulation system and solar lighting system in the section drawing canteen.
Source: author analysis

The following design criteria apply to facade design 2, which is the facade for the canteen area:

- It's a public area.
- As eating, drinking, resting, and gathering are activities that take place in this area with a medium-low activity density level, a room with good sunshine and a moderate amount of brightness is required.
- When building users rest in the canteen area, it is recommended to use a facade type that can provide a broad view so that they can observe and appreciate the landscape design on the site.
- The facade design is able to let light and air flow into the building.
- A horizontal device is recommended to let sunlight do not enter the room directly.

4.6.1.3 Building Skin Technology design on the facade design 3.

FACADE DESIGN 3

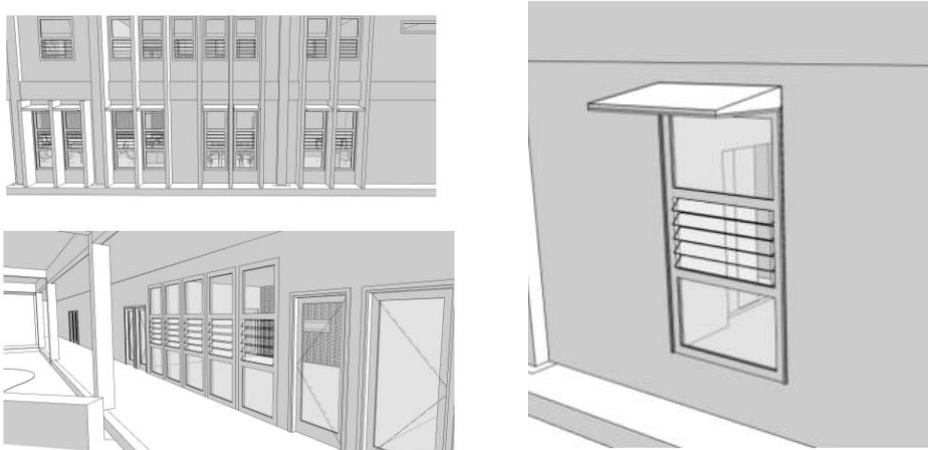


Figure 144. Image of the appearance of façade design 3.
Source: author analysis

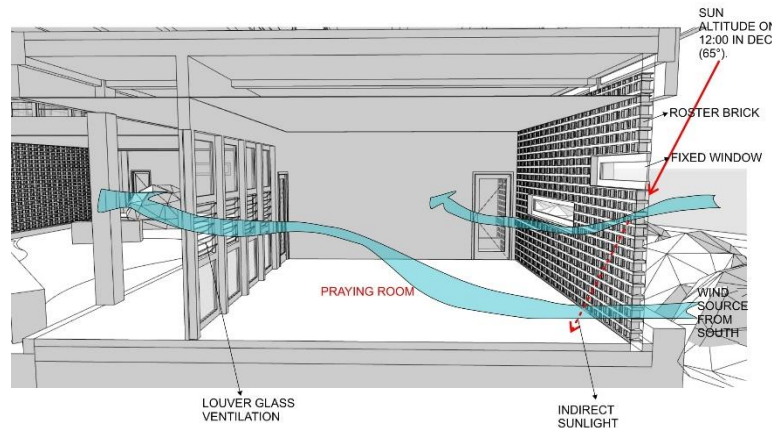


Figure 145. Image of air circulation system and solar lighting system in the section drawing of praying room.
Source: author analysis

For the design of facade 3, the facade applied is the facade for the administration room, manager, and also the prayer room, the design criteria are as follows:

- This room has moderate to dense types of indoor activity, so it needs a room with good sunlight and a little light but not too much.
- The air ventilation system in this room must have good air movement.
- It is recommended to use a fixed type of facade with louver ventilation so that air can continue to circulate freely in the room.
- Use of vertical and horizontal devices to block excess sunlight from entering the room.

4.6.1.4 Building Skin Technology design on the facade design 4.

FACADE DESIGN 4

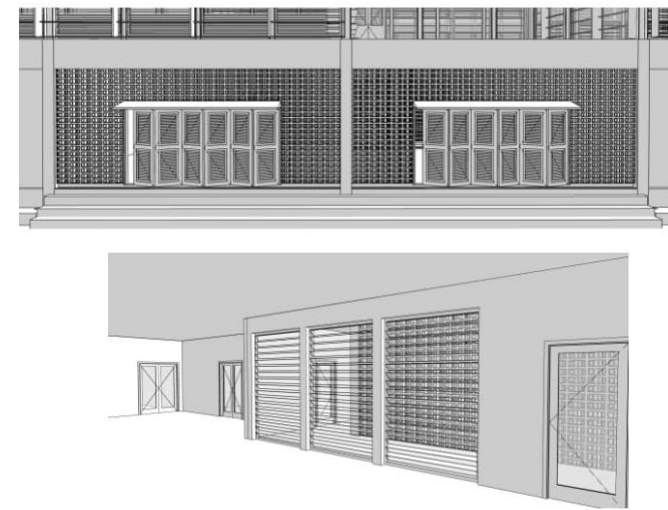


Figure 146. Image of the appearance of façade design 4.
Source: author analysis

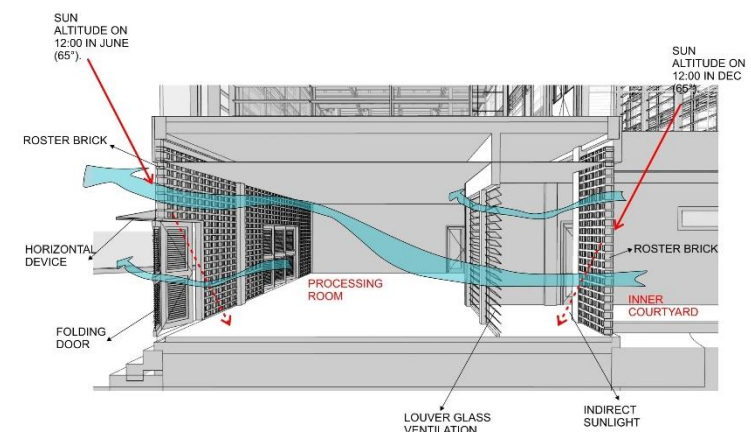


Figure 147. Image of air circulation system and solar lighting system in the section drawing of processing room.
Source: author analysis

For facade design 4, the facade applied is the facade for the Processing Room, the design criteria are as follows:

- This room has a type of activity in the room is very dense, namely processing the Porang crops with machines, so a room with good sunlight is needed and a bit bright but not excessive.
- The air ventilation system in this room must have good and fast air movement, considering that there are many machines that will work.
- It is recommended to use a removable type of facade (such as a door) so that dirty air can continue to circulate freely outside the room.
- The use of horizontal devices to reflect sunlight to enter the room indirectly.

4.7 Building Envelope for Permaculture Building

4.7.1 Design the appropriate roof shape for the Porang planting area.

Design criteria in category N (not suitable):
1. Arch issue: Sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">The roof can use a massive material or an ordinary roof.Sufficient light comes from windows, etc.Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.Avoid the sun's altitude point which has a high level of solar radiation.Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).Must use transparent roofing material but have a louver.Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">Use transparent materials so that sunlight can be transmitted into the building 100%.Avoid using shading devices, etc.Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table 7. Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

Given that the spaces in this building are mostly covered by special rooms for the Porang planting area at the tuber-ripening stage and the seedling stage in the form of tubers, the Porang Permaculture building will concentrate on roof design with an intensity of 40 to 60 percent. The time needed for these two processes is something else to think about at this point, in addition to the considerable space demand.

The sun's altitude, which must be avoided since there is a very high level of solar intensity at that altitude and during specific hours, must be taken into consideration while designing the shape of the roof of the Porang Permaculture building. The intensity of the sun is often inversely proportional to the angle at which it falls (altitude) on a surface. In other words, it has the capacity to burn any surface, even plant leaves. For the Porang plant, temperatures exceeding 35 °C will

cause the plant's leaves to burn, while low temperatures will cause the plant to go dormant (Porang Agricultural Research and Development Agency, 2015). There are three specific times in Pontianak City that have a high amount of solar intensity, commencing at 10:00, 12:00, and 14:00.

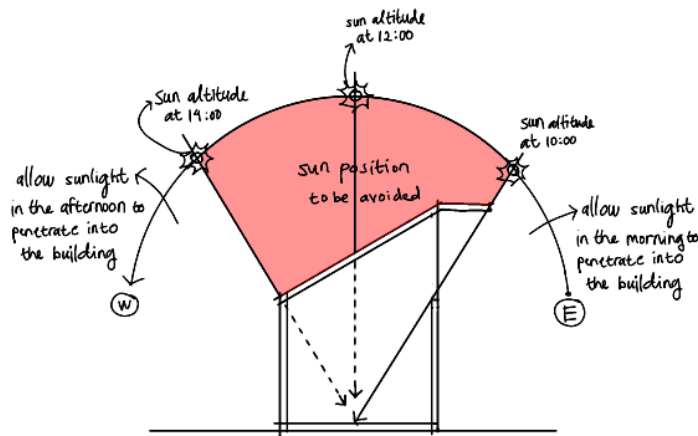


Figure 85. The design of the roof shape to avoid the sun's altitude at 10:00 – 14:00 and only allow the sun's altitude in the morning and afternoon.
Source: author analysis

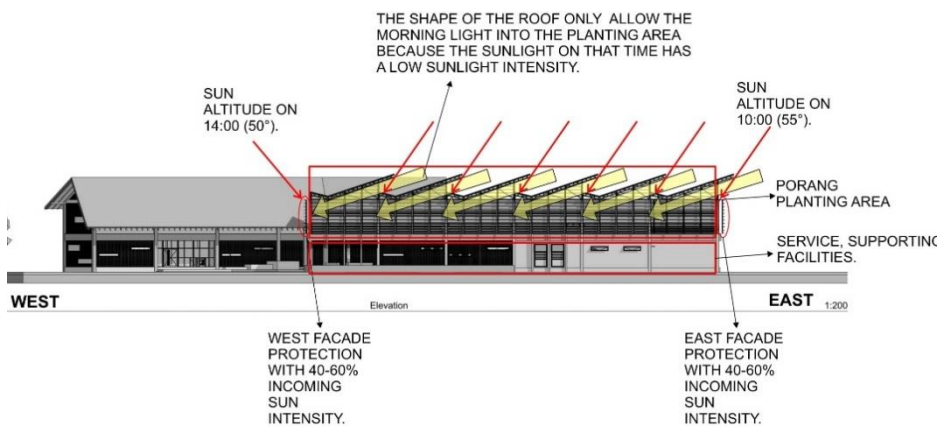


Figure 118. The shape of the leaning roof lets sunlight in morning into the building, while sunlight in midday and afternoon is avoided because it has a high level of sunlight intensity.
Source: author analysis

The roof's ability to avoid the sun's position between 10:00 and 14:00, when its intensity is quite high and bad for Porang plants, can be seen in the design of the roof's shape as shown above. The sun is then permitted to enter the building when it is not too hot outside and has a moderate level of intensity in the morning and evening.

The construction of the Porang Permaculture Building's mass form continues by deciding on the design for each of the building's function rooms after choosing a roof shape that can avoid the sun's height at certain times and in certain locations. Three different types of illumination are used in this Porang Permaculture building. The first type is the lighting level for the area where young and mature Porang tubers are planted (sunlight intensity ranges from 40 to 60 percent), the second type is the lighting level for people's comfort and the nursery (sunlight intensity is less than 50 percent), and the third type is the lighting level for the nursery. Porang tubers are heated or burned to end their dormant state (sunlight intensity 100 percent). It is a common practice among Porang farmers to burn porang tubers by exposing them to the sun for six hours each day at a temperature of 45 °C in order to shorten the tubers' dormant period. In other words, the tubers' inactive period will span between two and one month.

According to the materials utilized, the roof design of the structure is divided into three categories in the following figure: roofs for young and mature Porang plants, roofs for people and nurseries, and roofs for smoldering or heating Porang tuber seeds.

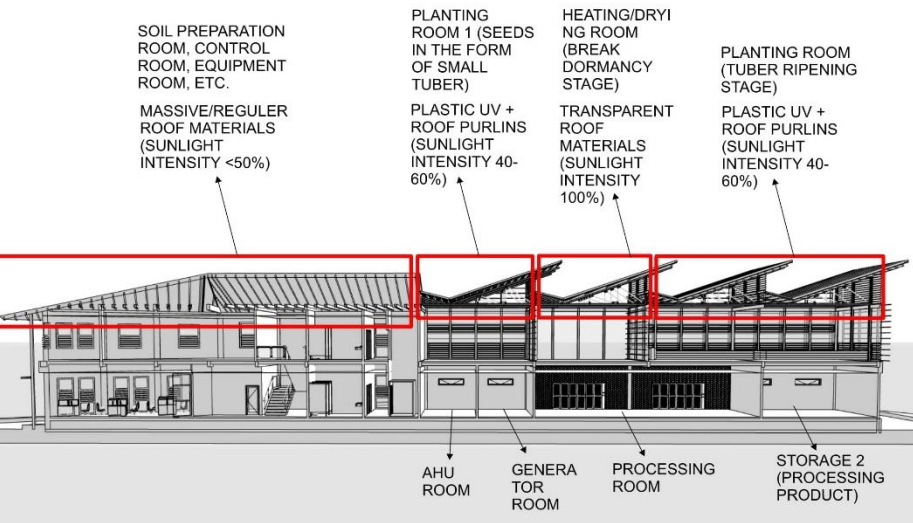


Figure 121 . Division of the type of roof design based on each function space on the 1st floor.
Source: author analysis

Based on the positioning of each room in the room space design concept, the zone is separated into numerous portions by taking into account the progression of activities and stages of planting porang, and they are placed as shown in the figure of the need for sunshine on the building envelope. The area begins with the nursery area and finishes with the maturity area for porang tubers. After the spaces have been organized, the building envelope is constructed to meet the demands of the

amount of sunshine. Lighting is needed in the nursery area 50% of the time, tuber seeds need to be planted 50% of the time, seeds need to be dried/heated 100% of the time, and porang tubers need to mature (ripen) 50% of the time.

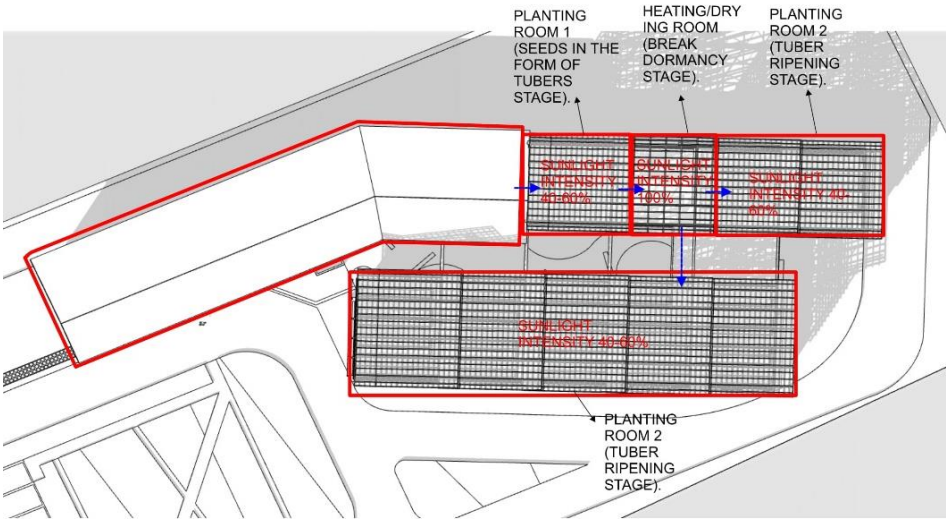


Figure 148. Placement of three types of roofs according to the order of Porang planting procedures.
Source: author analysis

4.7.2 Building Skin Technology design on the facade design for the Porang planting room.

4.7.2.1 North and south facade designs for the Porang planting room.

The height (angle of elevation) and azimuth (angle of orientation) of the sun at the periods we want to avoid can be used to construct the north and south sides of the Porang Permaculture Building. To make computations simpler, it is important to round down the values for the azimuth and height of the sun as well as the equivalence of numbers.

The crucial hours to steer clear of are 10:00, 12:00, and 14:00. By creating horizontal and vertical devices on the facade at this stage of designing the north and south facades, it is possible to create designs that meet the requirements of the appropriate design standards. The following image demonstrates how the vertical device design is much

more prominent than the horizontal device design. Because the sun's azimuth angle is bigger than its altitude angle, this is done. The larger the angle of altitude, the smaller the horizontal device dimensions while creating the horizontal and vertical devices on the facade (inversely proportional to). Additionally, the vertical device dimension increases with the sun's azimuth angle (directly proportional). The facade is constructed in the manner depicted in the following image to avoid the sun's azimuth and height.

 FACADE DESIGN 5

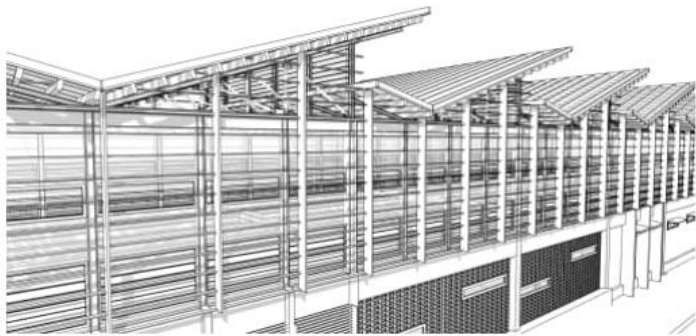


Figure 149. Image of the appearance of façade design 5 or north and south façade design for Porang planting area.
Source: author analysis

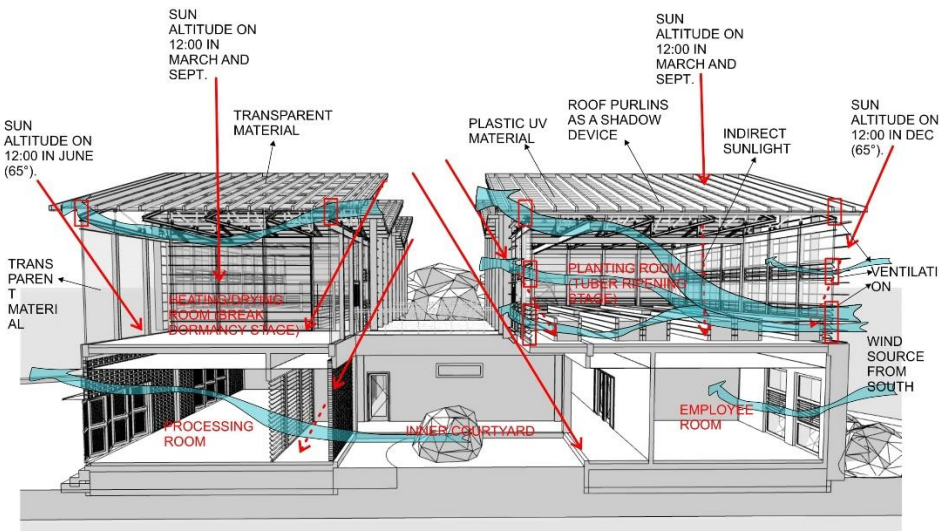


Figure 150. Image of air circulation system and solar lighting system in the section drawing of the Porang planting room and heating/drying room.
Source: author analysis

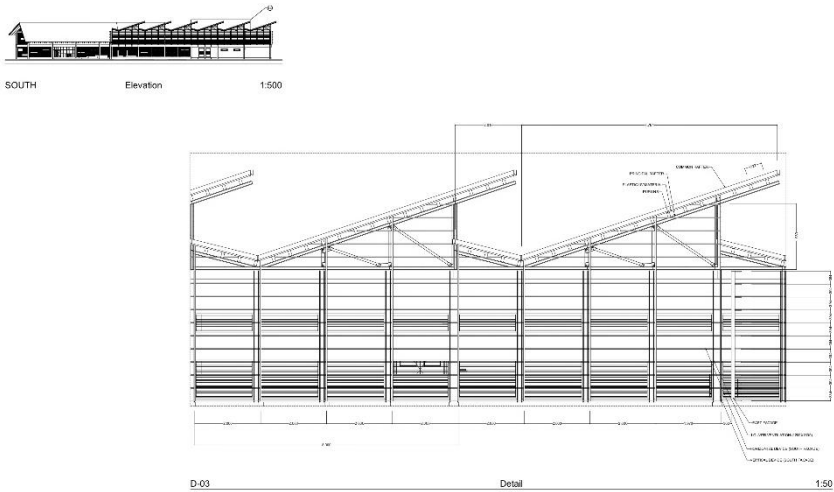


Figure 151. The final drawing of planting room south façade detail (D-03).
Source: author analysis

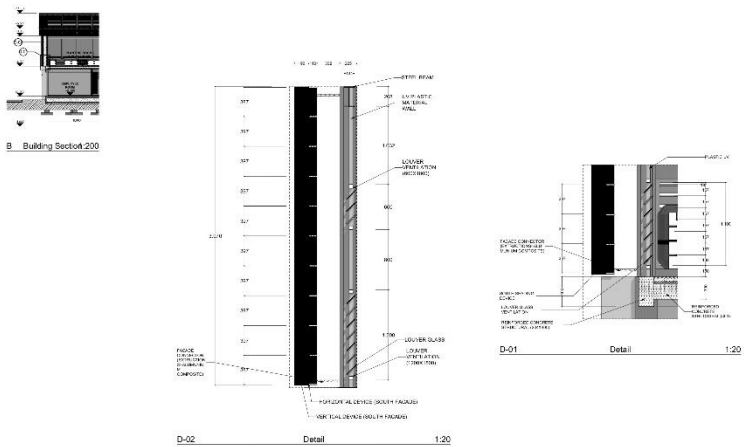


Figure 152. The final drawing of planting room south façade detail (D-01 and D-02).
Source: author analysis

4.7.2.2 East and west facade designs for the Porang planting room.

When designing the west and east facades for the Porang planting area, the height (angle of elevation) and azimuth (angle of orientation) of the sun at such times can be used to help define the design of the west and east facades. To make computations simpler, it is important to round down the values for the azimuth and height of the sun as well as the equivalence of numbers.

The following table illustrates the crucial hours to avoid: 10:00, 12:00, and 14:00. The western and eastern facades are now being designed, and in order to create designs that meet the requirements of the appropriate design standards, it is possible to do so by designing both horizontal and vertical devices on the facade. The horizontal device design is much more prominent than the vertical device design, as can be seen in the following image. The reason for this is that the sun's azimuth angle is bigger than its altitude angle.

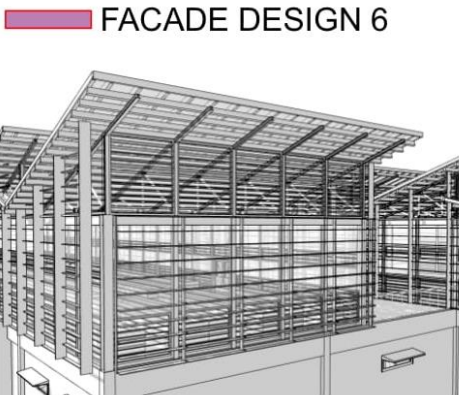


Figure 153. Image of the appearance of façade design 6 or east and west façade design for Porang planting area.
Source: author analysis

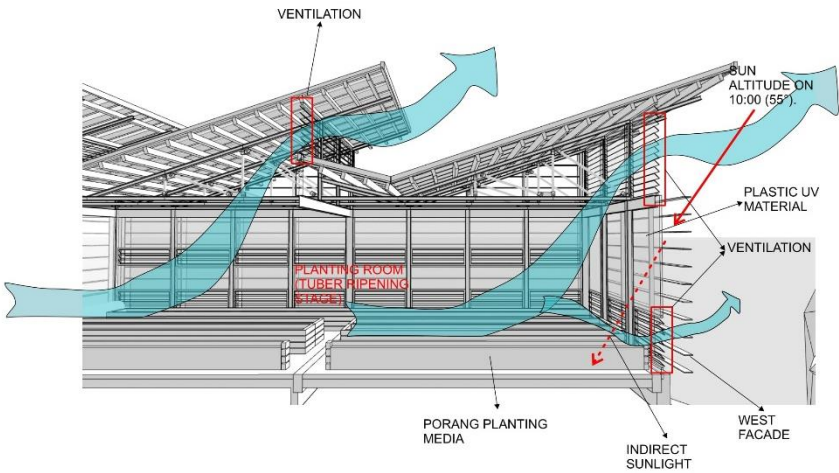


Figure 154. Image of air circulation system and solar lighting system in the section drawing of the Porang planting.
Source: author analysis

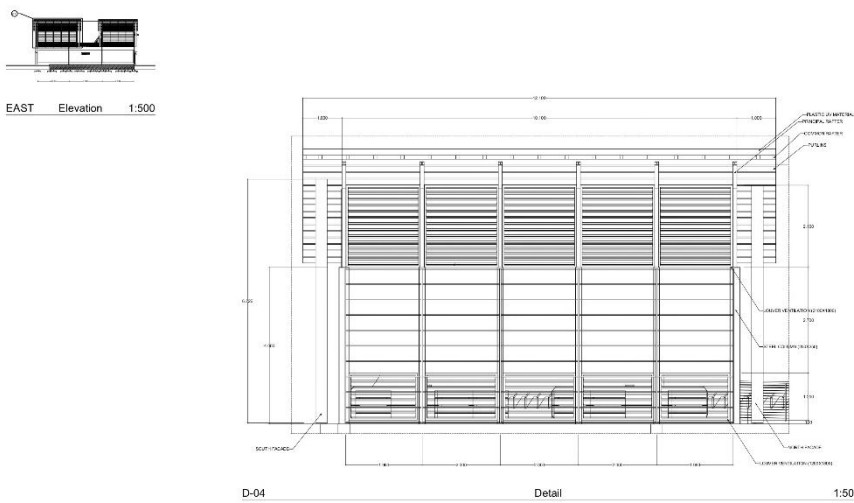


Figure 155. The final drawing of planting room east façade detail (D-04).
Source: author analysis

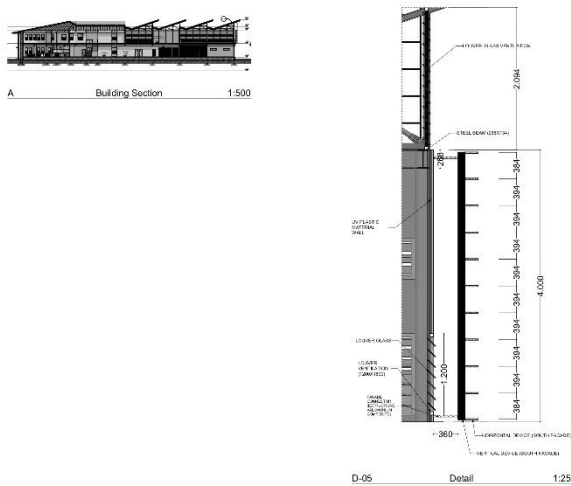


Figure 156. The final drawing of planting room east façade detail (D-05).
Source: author analysis

4.7.2.3 Facade designs for the Heating/drying room.

In designing the heating/drying room for the break dormancy stage of Porang tubers, this room is designed using transparent materials (not plastic UV) so that the incoming sunlight can enter the drying room almost 100%.

To bring an end to their dormant state, porang tubers are heated or burned (sunlight intensity 100 percent). In order to shorten the dormant phase of the porang tubers, it is a common practice among Porang farmers to burn the tubers by exposing them to the sun for six hours each day at a temperature of 45 °C. In other words, the dormant time of the

tubers will last for two to one month. The use of ventilation is also only applied to the roof so that there is no excessive evaporation in the heating/srying room. This is because if evaporation occurs, it will cause the roots and tubers of Porang to rot.



Figure 157. Image of the appearance of façade design 7 or façade design for heating/drying room (break dormancy of Porang tubers).
Source: author analysis

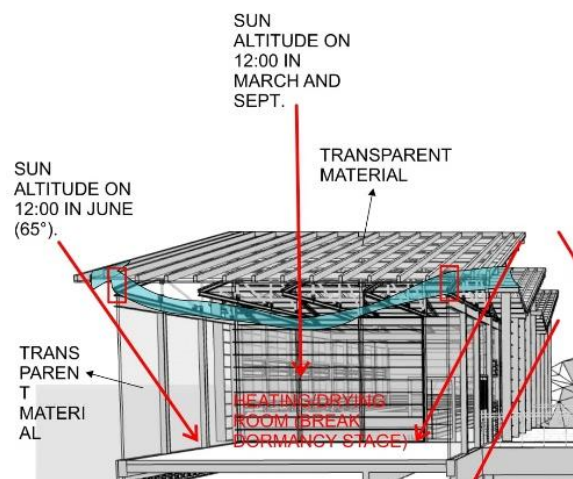


Figure 158. Image of air circulation system and solar lighting system in the section drawing of the Porang heating/drying room.
Source: author analysis

Chapter 05

Design Testing

5.1 Determining What Porang's Growth Factors Will Do To Test The Design

Porang plants have several factors that affect the growing conditions, which factors consist of soil PH, Temperature, Humidity, Sunlight Intensity, and Rainfall factors. Of the five factors, not all factors must be tested because only factors in the N category (Not Suitable) are tested. This was done after an analysis of climate data and soil types in Pontianak City was carried out using the following table for Land Suitability Criteria for Porang Plants (Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016) data.

Persyaratan penggunaan/ karakteristik lahan	Kelas kesesuaian lahan			
	S1	S2	S3	N
Temperatur (tc)				
Temperatur rerata (°C)	23 - 25	20 - 23	18 - 20	< 18
		25 - 28	28 - 32	> 32
Ketersediaan air (wa)				
Curah hujan (mm) pada masa pertumbuhan	1200 - 2000	400 - < 1200	< 400	
		> 2000 - 2800		
Kelembaban (%)	24 - 80	20 - 24	< 20	
		80 - 85	> 85	
Ketersediaan oksigen (oa)				
Drainase	baik, agak terhambat	agak cepat, sedang	terhambat	sangat terhambat, cepat
Media perakaran (rc)				
Tekstur	halus, agak halus, sedang		agak kasar	kasar
Bahan kasar (%)	< 15	15-35	35 - 55	> 55
Kedalaman tanah (cm)	> 75	50-75	20 - 50	< 20
Retensi hara (nr)				
KTK liat (cmol)	> 16	≤ 16		
Kejenuhan basa (%)	> 35	20 - 35	< 20	
pH H ₂ O	5,5 - 7,5	5,0 - 5,5	< 5,0	
		7,5 - 7,8	> 7,8	
C-organik (%)	> 1,2	0,8 - 1,2	< 0,8	
Bahaya erosi (eh)				
Lereng (%)	<8	8-16	16-30	> 30
Bahaya erosi	sangat rendah	rendah - sedang	berat	sangat berat

Information:
 S1 = very suitable
 S2 = suitable
 S3 = marginal fit
 N = not suitable

Table 4. Table of Land Suitability Criteria for Porang Plants
 Source: Djaenudin, Marwan, Subagjo, & A, 2011; Siswanto & Karamina, 2016.

In order to resolve issues within the architectural scope, it is necessary to address the specific aspects that must be addressed if a discrepancy is discovered in the circumstances for growing Porang in the Pontianak area. Such as conducting design testing to prove whether problem solving is on target and in accordance with predetermined design criteria.

Parameters	Porang plant	Pontianak condition	Results
PH of soil	6-7 (PH neutral)	PH <4.0 (acidic)	X (N)
Temperature	23 - 25°C (most optimal)	28 - 32°C	V (S3)
Humidity	24 - 80% (optimally) (Porang plants require moist conditions only for leaf growth, while dry conditions are required for porang tuber development.)	86 – 92% (air temperature)	V (S3)
Sunlight intensity	40 - 60% (most optimal)	34 - 78%	X (N)
Rainfall	1200 – 2000 mm/year (most optimal)	3000 – 4000 mm/year	V (S2)

Information:
 S1 = very suitable
 S2 = suitable
 S3 = marginal fit
 N = not suitable

Information:
 V= suitable (suitable, or even though the potential is small).
 X= not suitable

Table 6. Table of Pontianak Soil and Climatic Condition Data for Porang
 Source: author analysis

It can be seen from the Conclusion Table of Pontianak Soil and Climate Conditions for Porang above that the soil pH of Pontianak City and the intensity of sunlight are in the N category (not suitable) or do not meet the requirements for Porang plant cultivation. As a result, the design of the Porang permaculture building must be arranged, especially in the building envelope system in the Porang planting area. For the temperature, humidity, and rainfall in Pontianak are classified as S3 (marginal fit) and S2 (appropriate), respectively. This implies that although the temperature and humidity factors have a small potential impact, these factors are suitable and meet the standards for growing porang plants even though the effect is small (S3). So it only needs to increase its potential with architectural design.

So that the Porang's Growth Factors that must be proven by conducting a design test are in category N (not suitable), namely the intensity of sunlight. For the S3 category (marginal fit), which requires a little adjustment to increase the amount to make it more optimal (more suitable) for porang plant

growing conditions, which consists of Temperature and Humidity. So that no design testing is needed on Porang's Growth Factors with category S (S1, S2, S3).

Meanwhile, soil pH is not included in architectural problems, although soil pH is included in the N category (Not suitable), so there is no need for design testing. However, it can be done by providing Porang planting media. For the rainfall factor, solving architectural problems is not really necessary, because the plant watering system is carried out inside the building and uses a schedule, so there is no need for design testing as well.

5.1.1 Design testing on the sunlight intensity factor with SunTool simulation

Sunlight Intensity Needs for Porang plants in the Design Criteria in the following table shows that Porang plants at the tuber maturation stage (this stage is the longest stage of Porang plant growth) requires a sunlight intensity level of 40-60%.

Design criteria in category N (not suitable):
1. Arch issue: Sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">• The roof can use a massive material or an ordinary roof.• Sufficient light comes from windows, etc.• Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">• The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.• Avoid the sun's altitude point which has a high level of solar radiation.• Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).• Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).• Must use transparent roofing material but have a louver.• Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">• Use transparent materials so that sunlight can be transmitted into the building 100%.• Avoid using shading devices, etc.• Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table 7. Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

So a shading system is needed so that Porang plants can grow ideally in buildings. To get the right level of sunlight intensity, it is necessary to test the design on the building envelope system design in the Porang planting area. To test how much sunlight intensity enters the Porang planting room, a simulation in the form of a SunTool is needed. The SunTool simulation will test what percentage of the area in the Porang planting space is affected by the shadow from the shading device. This SunTool simulation performs measurements based on the type of shading device used, the distance between the shading devices, and the dimensions of the shading device used.

In the simulation, SunTool has three kinds of shading devices, but the facade design of Porang Permaculture Building only uses two kinds of shading devices, namely horizontal devices and vertical devices. In which each facade facing north, south, east, and west uses horizontal and vertical devices but has different dimensions based on the amount of sunlight intensity needed in the planting area at certain times.

5.1.1.1 Design testing on the north and south facades of the Porang planting room

To conduct a design test or measurement of sunlight intensity on the north and south facades, the test is divided into two times. Namely a design test or measurement of sunlight intensity on the north and south facades in December, and in June. Meanwhile, the time taken (critical hour) is 10:00 – 14:00. This is because at these hours it has a high level of sunlight intensity so it requires a shading device and needs to be tested for its design.

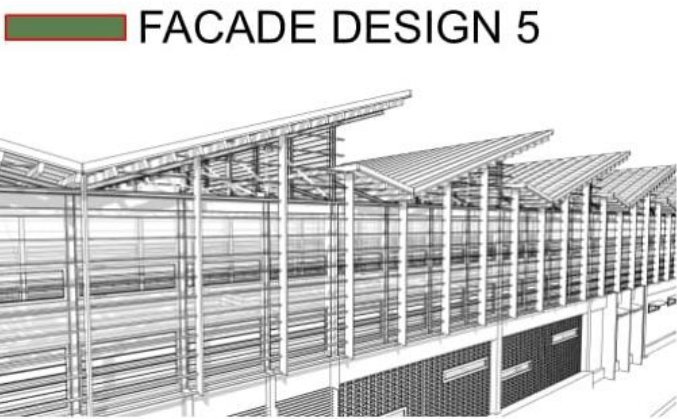


Figure 149. Image of the appearance of façade design 5 or north and south façade design for Porang planting area.
Source: author analysis

A. South Facade Design in December with sun tools software for Porang Planting Area

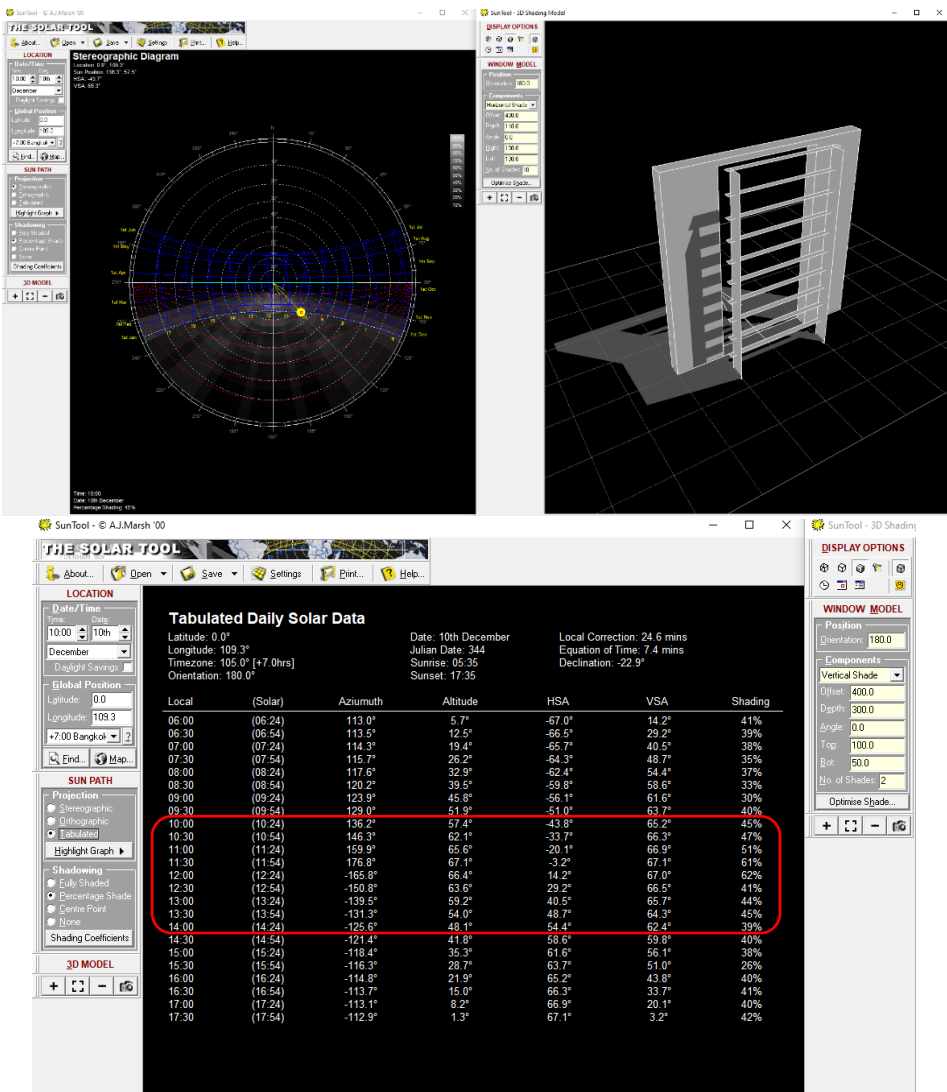


Figure 93. Determination of the dimensions of the south facade in accordance with the needs of sunlight intensity 40-60% with sun tools software.
Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	45%	55%	☑
11:00	51%	49%	☑
12:00	62%	38%	-
13:00	44%	56%	☑
14:00	39%	61%	☑*

Information:
(-) = not included, because the position of the sun is right in the middle of the day.
☑ = fulfilled (sunlight intensity 40 – 60%)
* = 1% tolerance

Table 18. Table of analysis on the fulfillment of sunlight intensity needs in the south facade design.
Source: author analysis

The SunTool Tabulated Daily Solar data above shows that the facade facing south in December at 10:00 – 14:00 shows the value of the shading area in percent. Which is then analyzed in the Table of analysis on the fulfillment of sunlight intensity needs in the south facade design. The table shows that the value of sunlight intensity is obtained from the value of 100% minus the shading value (in percent). From the remaining values, the sunlight intensity value is obtained or the area that is not exposed to shadows. The table shows that at 10:00 – 14:00, the level of sunlight intensity has been fully filled, or according to demand and has been proven to meet the requirements.

B. North Facade Design in June with sun tools software for Porang Planting Area

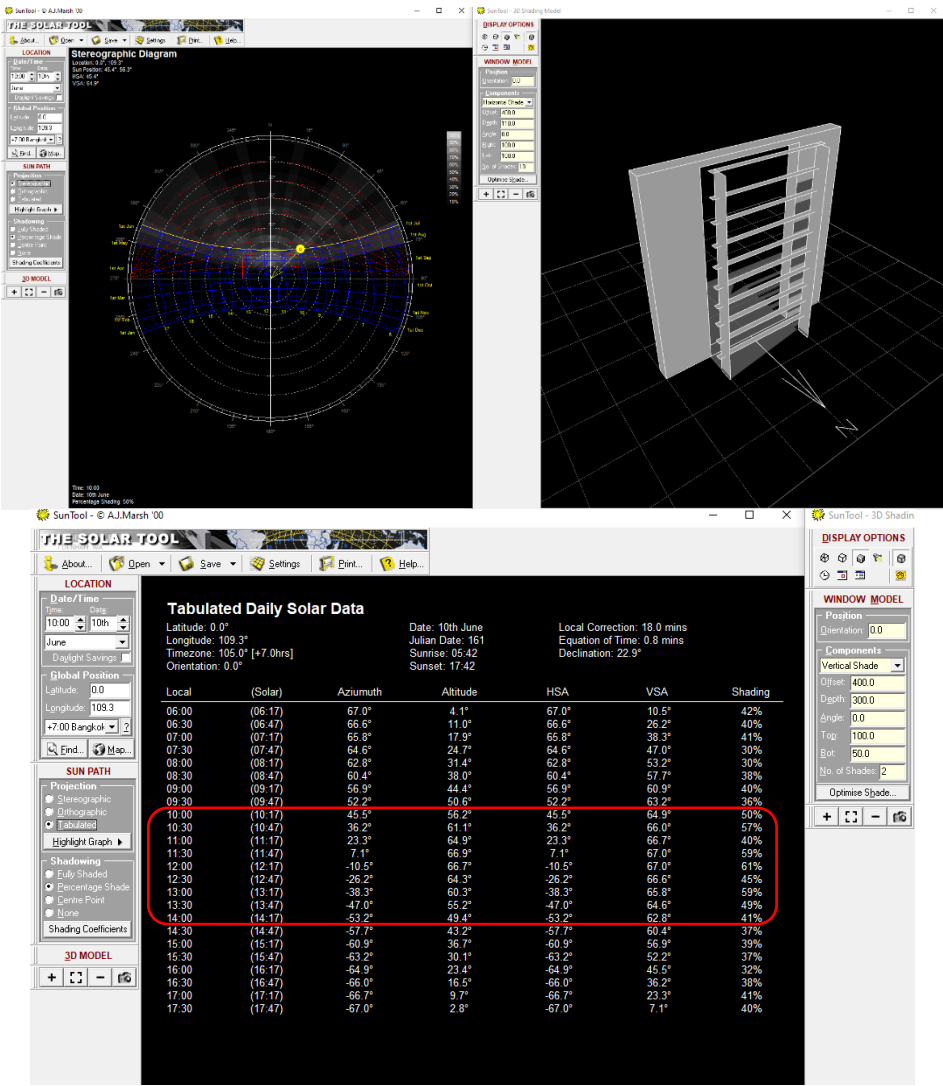


Figure 94. Determination of the dimensions of the north facade in accordance with the needs of sunlight intensity 40-60% with sun tools software.
Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	50%	50%	☑
11:00	40%	60%	☑
12:00	61%	39%	-
13:00	59%	41%	☑
14:00	41%	59%	☑

Information:
(-) = not included, because the position of the sun is right in the middle of the day.
☑ = fulfilled (sunlight intensity 40 – 60%)

Table 19. Table of analysis on the fulfillment of sunlight intensity needs in the north facade design.
Source: author analysis

According to the SunTool Tabulated Daily Solar data above, the facade facing north in June between 10:00 and 14:00 displays the percentage value of the shade area. It is then examined in the analysis table on the north facade design's fulfillment of sunlight intensity requirements. The table demonstrates that the value of sunlight intensity is calculated from the value of 100% minus the value of shade (in percent). The area that is not in the shadows or the measurement of sunlight intensity is obtained from the remaining data. According to the table, the amount of sunlight intensity has been fully utilized between 10:00 and 14:00, or in accordance with demand, and has been shown to meet the criteria.

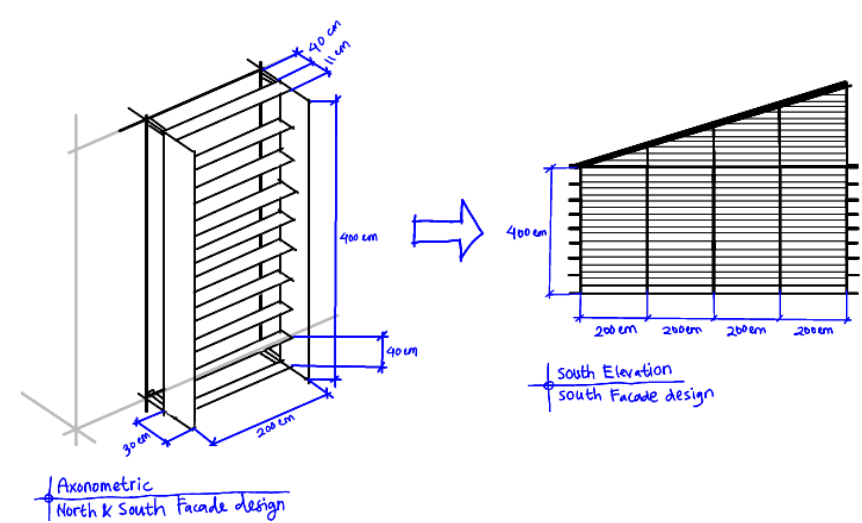


Figure 95. Dimensions of the north and south facade designs for the Porang planting room applied to the building.
Source: author analysis

5.1.1.2 Design testing on the east and west facades of the Porang planting room

To conduct a design test or measurement of sunlight intensity on the east and west facades, the test is divided into two times. Namely a design test or measurement of sunlight intensity on the east and west facades in December, and in June. Meanwhile, the time taken (critical hour) is 10:00 – 14:00. But because this measurement with SunTool has a time limit, when measuring the west and east facades will be made into two times (morning and afternoon), this is because the time limit in the morning in the SunTool simulation is only up to 11:00, while at 12:00, the sun is directly above). as well as in the afternoon, the measurement time starts at 13:00, that's because the sun will be behind the object.

To overcome the limitations of the simulation, the design testing continued with the Velux simulation.

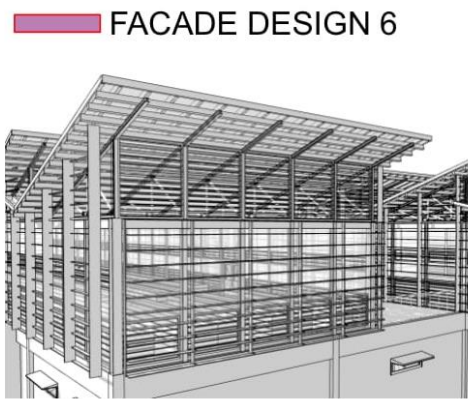


Figure 153. Image of the appearance of façade design 6 or east and west façade design for Porang planting area.
Source: author analysis

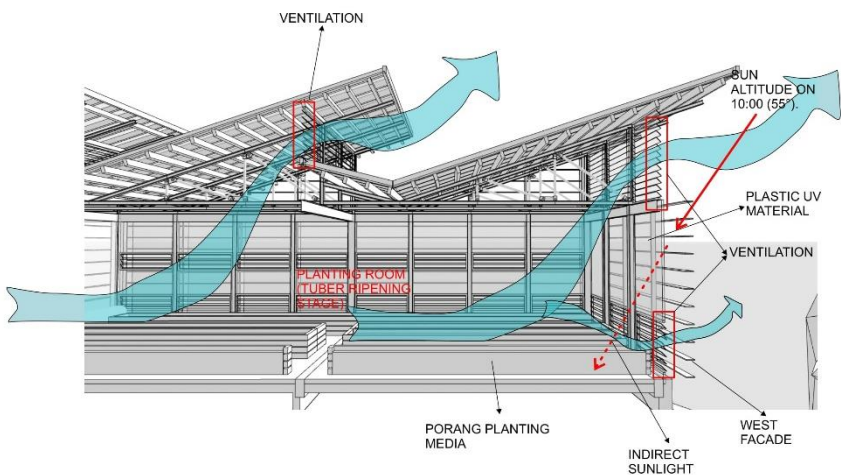


Figure 154. Image of air circulation system and solar lighting system in the section drawing of the Porang planting.
Source: author analysis

A. East Facade Design in June on 10:00 with sun tools software for Porang Planting Area

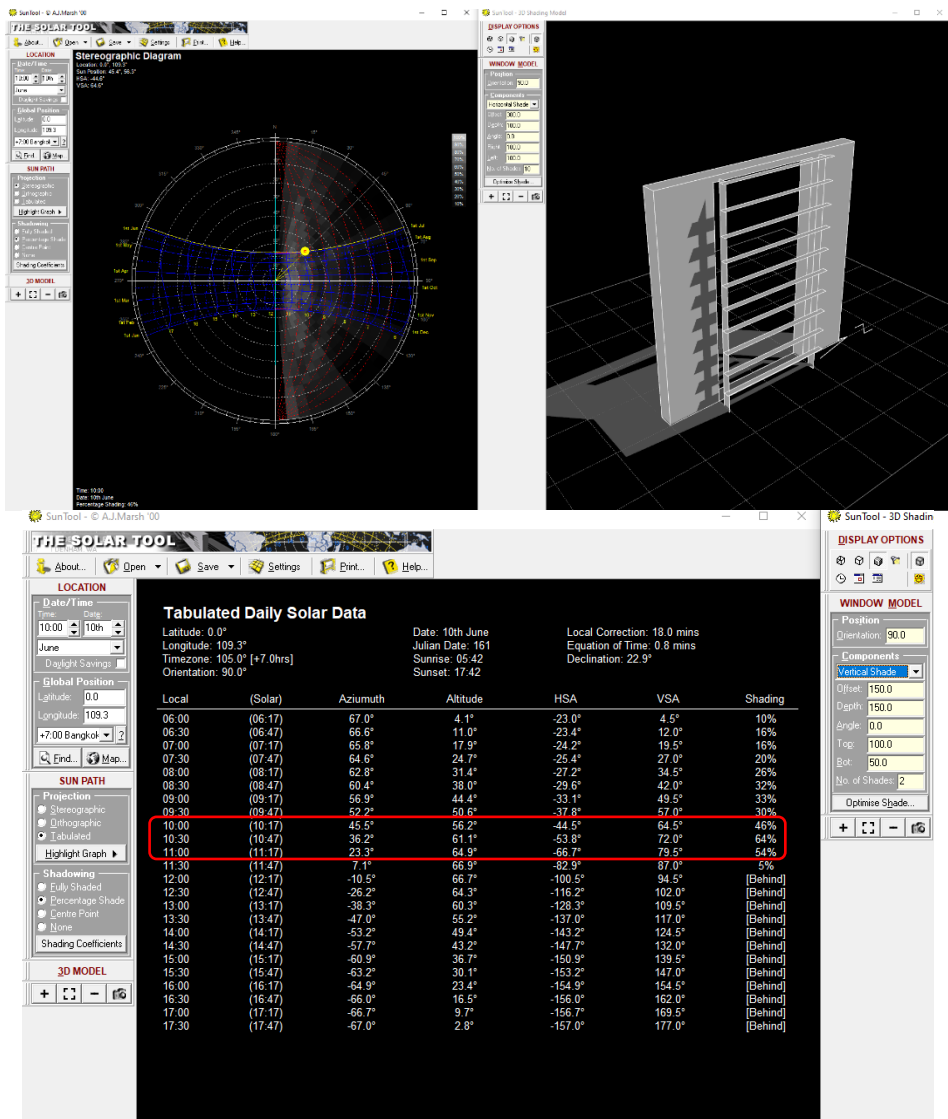


Figure 98. Determination of the dimensions of the east façade in June on 10:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software.
Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	46%	54%	☑
11:00	54%	46%	☑
12:00	-	-	-

Information:
(-) = not included, because the position of the sun is right in the middle of the day.
☑ = fulfilled (sunlight intensity 40 – 60%)

Table 20. Table of analysis on the fulfillment of sunlight intensity needs in the east facade design in June.
Source: author analysis

B. East Facade Design in December on 10:00 with sun tools software for Porang Planting Area

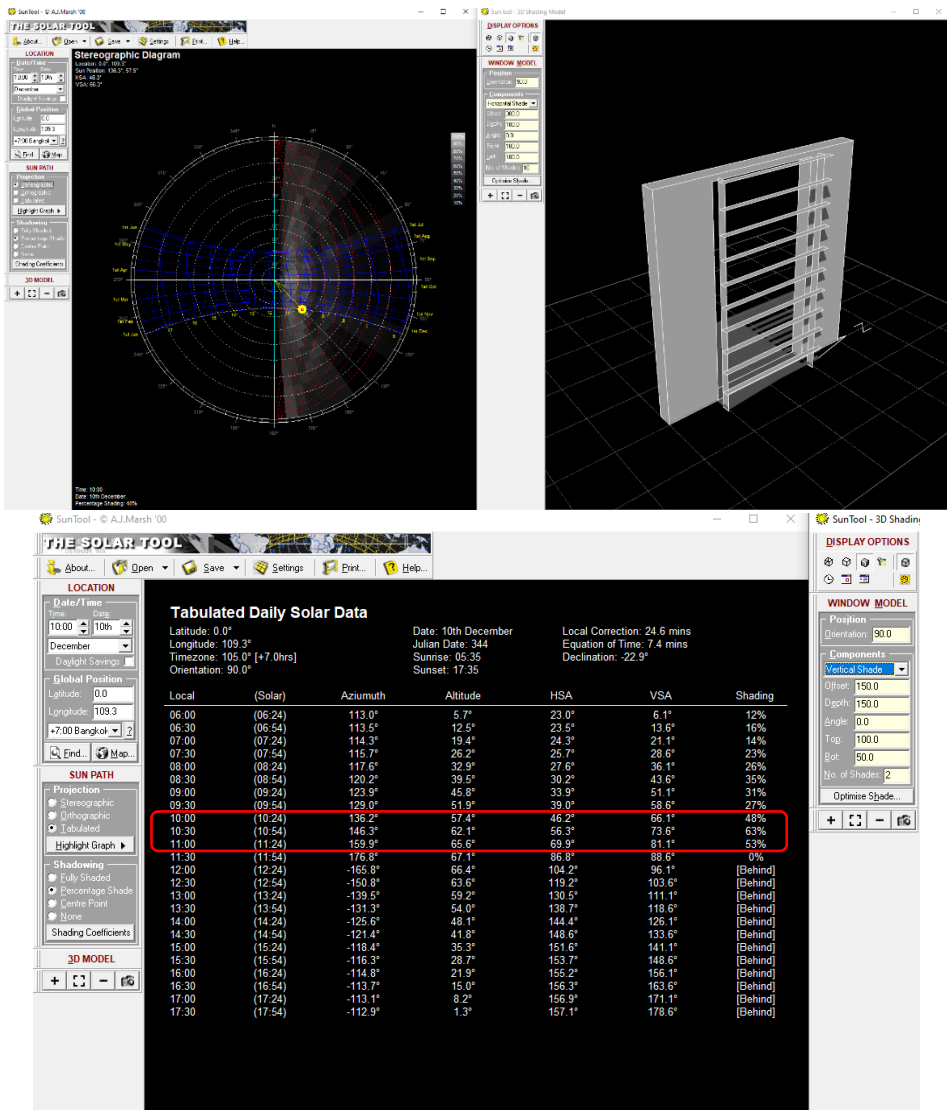


Figure 99. Determination of the dimensions of the east façade in December on 10:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software. Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
10:00	48%	52%	☑
11:00	53%	47%	☑
12:00	-	-	-

Information:
(-) = not included, because the position of the sun is right in the middle of the day.
☑ = fulfilled (sunlight intensity 40 – 60%)

Table 21. Table of analysis on the fulfillment of sunlight intensity needs in the east facade design in December. Source: author analysis

C. West Facade Design in June on 14:00 with sun tools software for Porang Planting Area

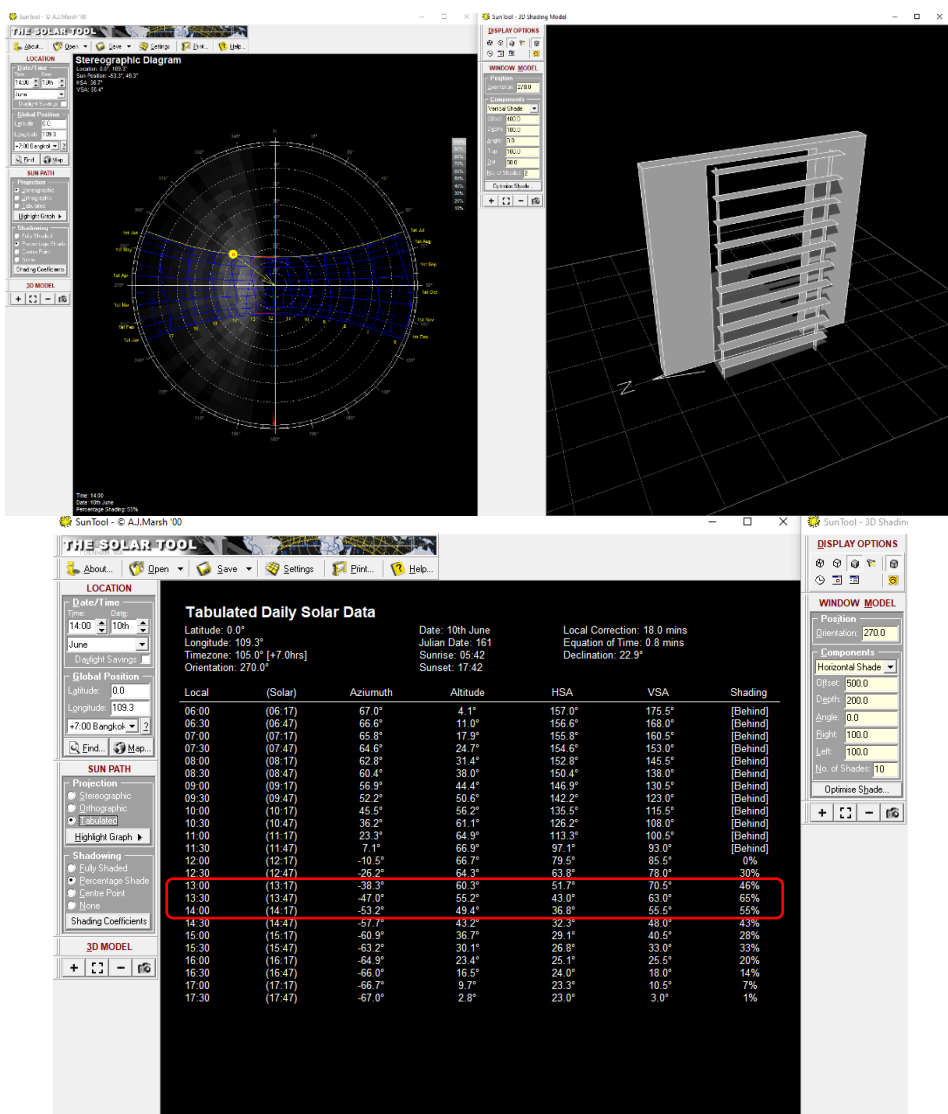


Figure 100. Determination of the dimensions of the West façade in June on 14:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software. Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
12:00	-	-	-
13:00	46%	54%	☑
14:00	55%	45%	☑

Information:
(-) = not included, because the position of the sun is right in the middle of the day.
☑ = fulfilled (sunlight intensity 40 – 60%)

Table 22. Table of analysis on the fulfillment of sunlight intensity needs in the west facade design in June. Source: author analysis

D. West Facade Design in December on 14:00 with sun tools software for Porang Planting Area

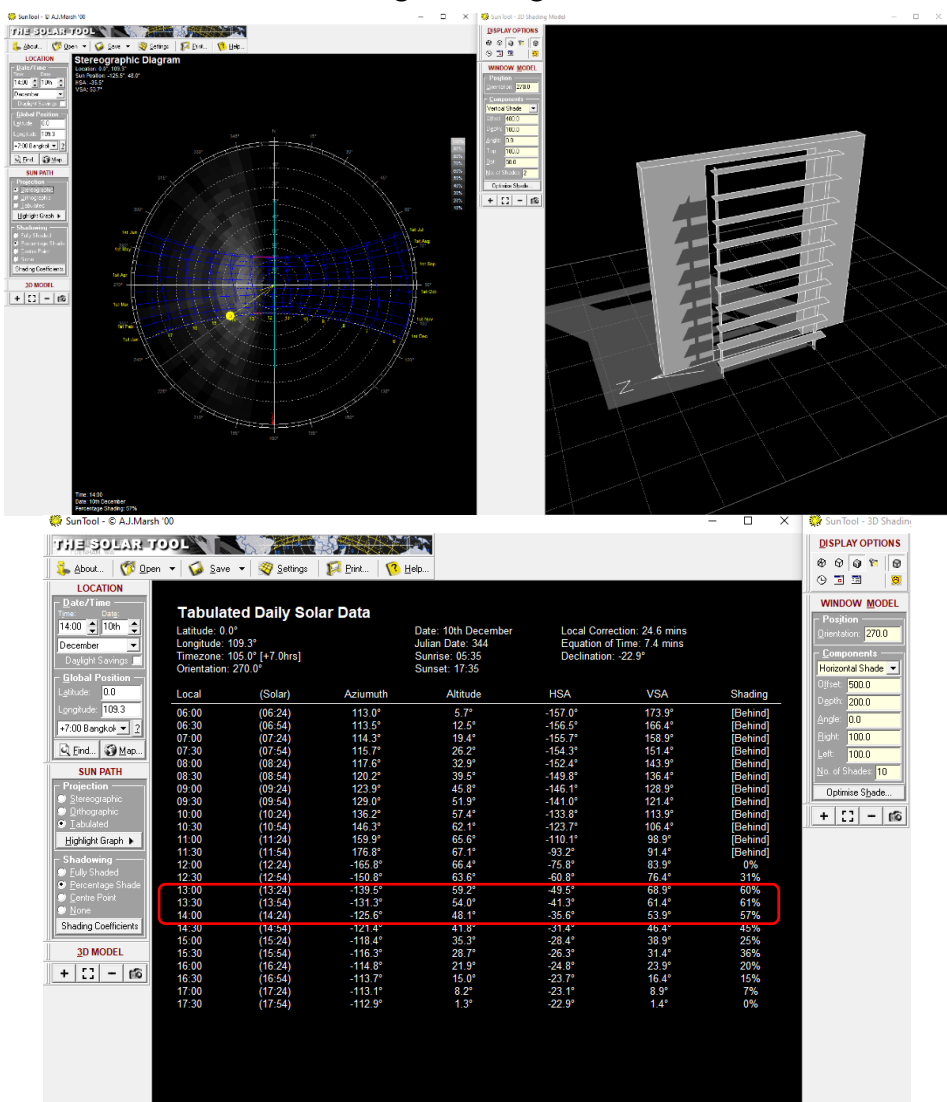


Figure 101. Determination of the dimensions of the West façade in December on 14:00 in accordance with the needs of sunlight intensity 40-60% with sun tools software. Source: author analysis

HOURS	SHADING (%)	SUNLIGHT INTENSITY (%)	FULFILLED
12:00	-	-	-
13:00	60%	40%	☑
14:00	57%	43%	☑

Information:
(-) = not included, because the position of the sun is right in the middle of the day.
☑ = fulfilled (sunlight intensity 40 – 60%)
Table 23. Table of analysis on the fulfillment of sunlight intensity needs in the west facade design in December. Source: author analysis

In the Tabulated Daily Solar, SunTools data on each of the facade design tests shows that the facades facing east and west in December and June at 10:00 – 14:00 show the data for the shading area value in percent. Which is then analyzed in the Table of analysis on the fulfillment of sunlight intensity needs in the east and west facade design. In each of these tables it shows that the value of sunlight intensity is obtained from the value of 100% minus the shading value (in percent). From the remaining values, the sunlight intensity value is obtained or the area that is not exposed to shadows. The table shows that at 10:00 – 14:00, the level of sunlight intensity has been fully filled, or according to demand and has been proven to meet the requirements.

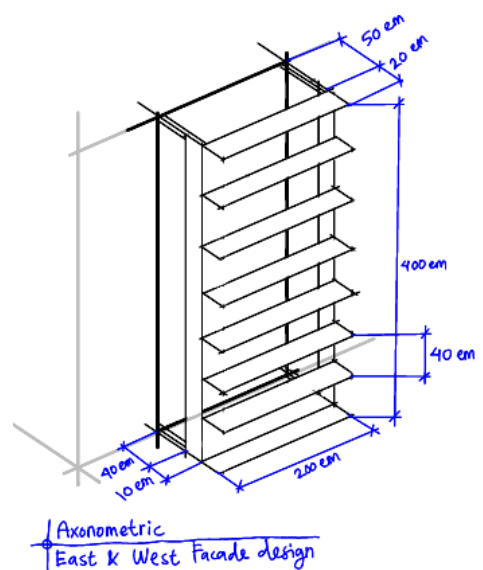
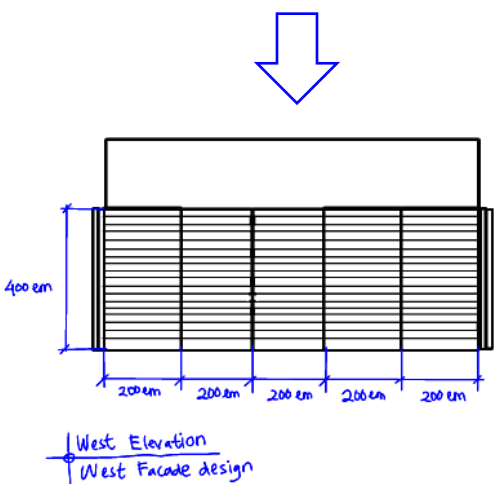


Figure 102. Dimensions of the east and west facade designs for the Porang planting room applied to the building. Source: author analysis

5.1.1 Design testing on the sunlight intensity factor with Velux simulation

For design testing in the Porang planting area at 12 noon, a Velux Daylight Visualizer simulation is needed to see what percentage of sunlight intensity enters through the roof and some facades in the planting area. However, the Velux Simulation has limited time options (custom setting time) when using the Daylight Factor (DF). So the options provided are only on March at 12:00 noon (default setting).

In measuring daylight factor using the simulation method, there are several things that must be considered. Such as determining the condition of the sky, and the type of material used in the design according to the desired material properties when reacting with light. The sky conditions in the natural lighting simulation are in cloudy sky conditions (overcast sky 1). These sky conditions are used in the Velux Visualizer 3.0 software as standard (default). This condition in the simulation is used to calculate the Daylight Factor in the worst case scenario. As for the material selection at Velux, it is divided into two materials, namely Light Diffuser material with a light transmittance level of 80% (according to the UV Plastic standard which can filter sunlight by 20% so that only 80% of sunlight can penetrate). This material is used for the Planting Room 2 area (tuber ripening) and the Planting Room 1 area (seeds in the form of small tuber). Then the second material is Glass Solid material with a light transmittance of 81% (this number is the largest number in the Velux simulation). This material is used for the heating/drying room area. Although the light transmittance level of the two materials is the same, the type of building envelope used in each room is different. So the Sunlight Intensity (Daylight Factor) produced by each room is different.

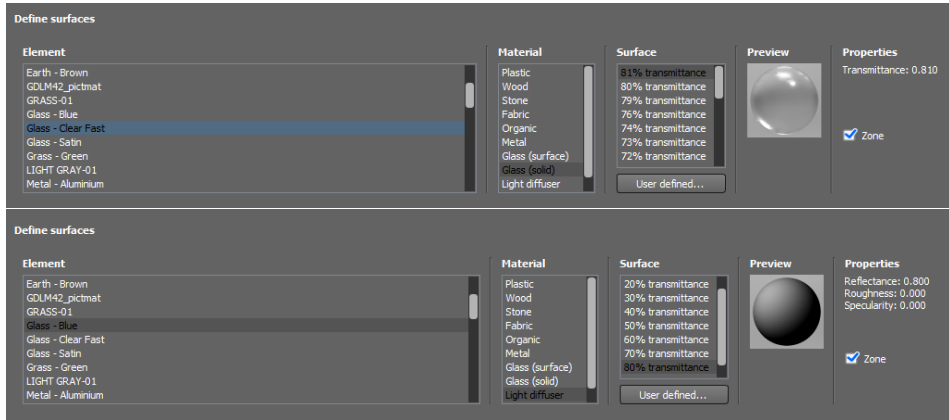


Figure 159. Determination of the type of envelope material in each room, where each material has a different surface value when reacting with daylight.
Source: author analysis

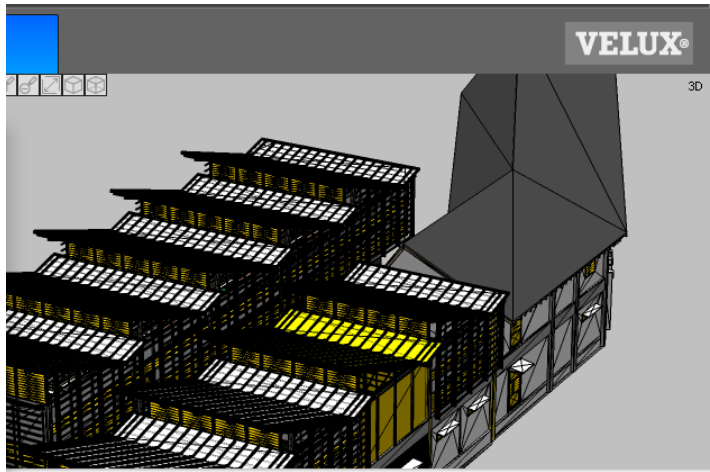


Figure 160. The white color indicates the Light diffuser material and the yellow color indicates the Glass Solid material which is translated by the Velux simulation.
Source: author analysis

The results of the Velux Daylight Visualizer 3.0 rendering show the condition of the natural lighting factor in the Porang planting room by describing the average DF which is the reference for the quality of the natural lighting factor in the room. The results of the natural lighting factor are expressed in percent (%). In this design test, the simulation results will be displayed with Iso Contour. Iso Contour is a rendering result that is displayed with light contours, that is, by displaying colored lines that state the value or light level in the simulation results. The contour line starts from red (high light level) to blue (low light level).

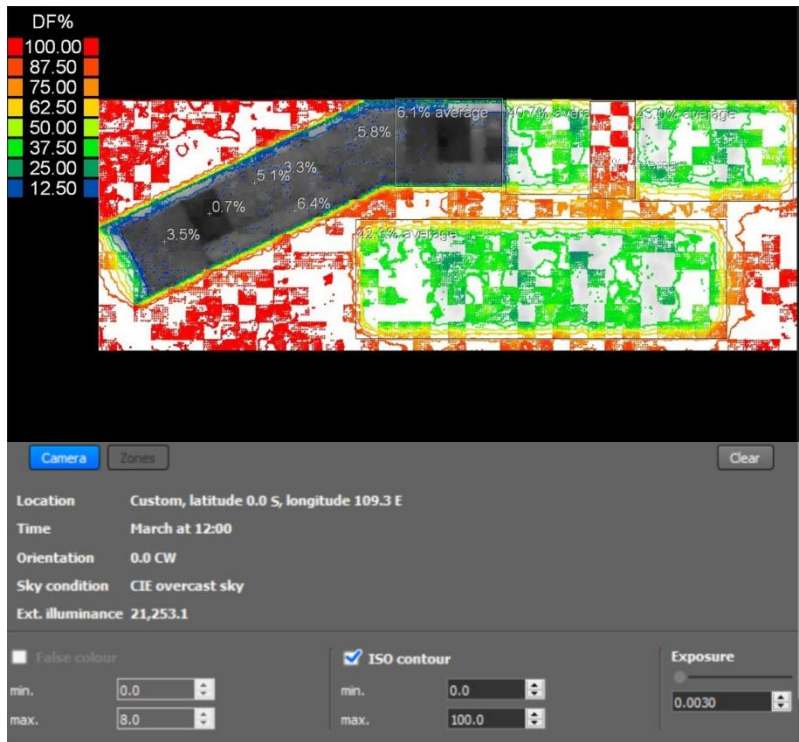


Figure 161. The green areas have an average value of around 40.7% for planting room 1, and planting room 2 are 43% and 42.3%, respectively. The red area, namely the heating/drying room, has an average value of about 80%.
Source: author analysis

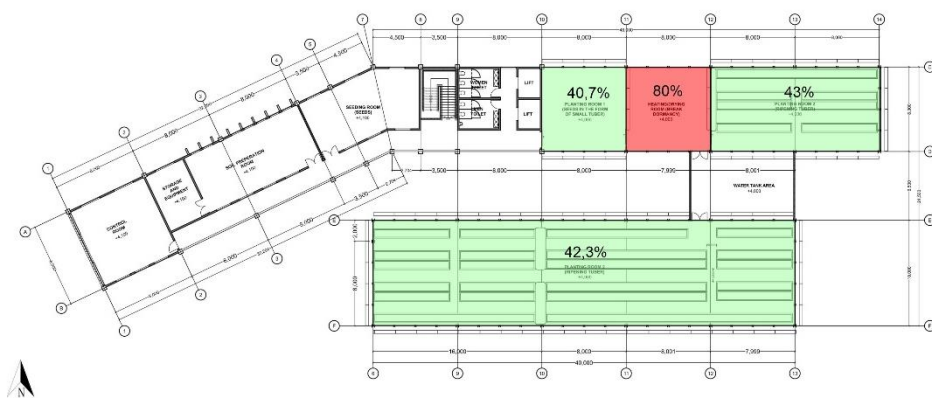


Figure 162. Image of the 1st floor plan of Porang Permaculture Building shows the planting room area 1, 2, and heating/drying room which have their respective DF (%) values.
Source: author analysis

In the rendering of the Velux simulation, as shown in the following image, it shows which areas on the 1st floor of the Porang Permaculture Building receive sunlight intensity by using the Daylight Factor (%) in the Velux Simulation. The picture shows that Planting room 1 (seeds in the form of small tuber) has an average Daylight Factor value of 40,7% of the skylight outside the building that enters the building. Planting room 2 (tuber ripening) has an average Daylight Factor value of 43% and 42,3%. As for the heating/drying room (break dormancy) it has a value of 80% of the incoming sky light.

ROOM/SPACE	DAYLIGHT FACTOR/SUNLIGHT INTENSITY (%)	STANDARD OF SUNLIGHT INTENSITY (%)	FULFILLED
Planting room 1	40,7%	40 – 60%	☑
Planting room 2	43% and 42,3%	40 – 60%	☑
Heating/drying room	80%	70 – 100%	☑*

Information:

☑ = fulfilled (sunlight intensity 40 – 60%)

* = the material in Velux has a maximum light transmittance value of 81% on Glass Solid material. There is no Glass Solid material with a transmittance of 100%. So from the limitations of the simulation, the resulting value is also not more or equal to 81%.

Table 24. Table data from testing the level of sunlight intensity in each room.
Source: author analysis

From the test results, the Daylight Factor value for each room is processed into the following test data table. As shown in the following table, Planting Room 1, Planting Room 2, and Heating/drying room have met the required sunlight intensity standards according to the functions and needs of each room.

The heating/drying room itself has a few different exceptions because the sunlight intensity value is 80% or not up to 100%. This is because in the simulation, the material in Velux

has a maximum light transmittance value of 81% on Glass Solid material. There is no Glass Solid material with a transmittance of 100%. So from the limitations of the simulation, the resulting value is also not more or equal to 81%. This is also because in the Velux simulation, if the Daylight Factor value is 100%, then that value is translated by Velux as a room without an envelope or rather outside the room, because the Daylight Factor value outside the building is 98 - 100%. However, because the resulting design test value is 80%, which is close to the value of 81%, it can be said that this value has met the requirements for the sunlight intensity heating/drying room standard in the envelope design.

From the results of the two simulations, namely SunTool and Velux, it can be concluded that all the spaces contained in the 1st floor plan of the Porang Permaculture Building, namely Planting Room 1, Planting Room 2, and Heating/drying room have met the sunlight intensity standards set in Design Criteria for solving design problems on Sunlight Intensity in buildings. The condition of the sunlight intensity will certainly affect the performance of the Porang plant growth process in the building. In addition, it will also have an impact on the use of energy, productivity, and work performance as well as the health of Porang Permaculture Building users.

Chapter

06

Evaluation of Design Results

6.1 Conclusion Evaluation from Supervisor and Examiner Lecturer

6.1.1 Supervisor

From Prof. Ar. Noor Cholis Idham, S.T., M. Arch., Ph. D., IAI

In the design, it is necessary to complete all aspects that have been requested and suggested by the judges so that the design becomes more ideal. As the evaluation that Mr. Prihatmaji explained about the ownership aspect, etc., to ensure that everything needed was in the design. Likewise the evaluation that has been explained by Mrs. Nanda on how to apply the ideal concept to the building through a proposal. So it needs to be taken into account so that the design becomes more valuable.

6.1.2 Examiner Lecturer

From Mr. Yulianto Purwono Prihatmaji, Dr., IPM., IAI

- In designing the Porang Permaculture Building, it is necessary to pay attention to the ownership aspect, this is because the ownership aspect has a strong foundation in influencing the design. Please explain more clearly and give reasons regarding ownership?
- **Response:** An explanation of further ownership and the reasons has been added on page 12. Ownership of the Porang Culture Building project is People of Pontianak City especially Porang farmer in Pontianak, and the Department of Agriculture and Food of the City of Pontianak. Determination of ownership is done because the emergence of Porang farming communities in Pontianak as a result of the trend of planting Porang which provides a lot of benefits. On the other hand, it provides the potential to export processed Porang products to neighboring, Malaysia.
- Give reasons why the site selection is in Pontianak City, why not choose another location, such as in Sidoarjo?
- **Response:** The reason for choosing the site in Pontianak City was actually because in that region, the Porang farming community already exists but the Porang farmers in Pontianak have difficulty producing this type of plant due to several obstacles, such as the condition of the soil whose PH level must be modified first to make it neutral. With this project, it is hoped that the government can provide a pilot project to the people of Pontianak and the Porang farming

community in West Kalimantan, so that they can provide education in improvising themselves on how to grow Porang indoors. On the other hand, the Porang plant itself is a plant that has a very high selling value when exported to neighboring countries such as Malaysia which is one of the third largest Porang export market shares which is directly adjacent to the West Kalimantan region, Pontianak (Trademap KBRI Tokyo, 2021). Meanwhile, why did the site selection not take place in other locations such as in Sidoarjo? For the case of land in Sidoarjo and other areas in Indonesia where the land conditions support the growth of Porang plants, such as neutral soil pH and suitable climate, agricultural buildings such as the Porang Permaculture Building are not needed. Because most of them, namely Porang farmers in that area, plant Porang directly on the land. Unless there is no land for farming in the area or there is limited agricultural land such as in urban areas, this type of building is needed. But of course by adjusting the artificial climate inside the building according to the relevant location climate data.

- Please add a dilatation structure because the type of land in Pontianak is peat soil, so even though there is no earthquake in Kalimantan, the peat soil is easy to shift and be drowned.
- **Response:** Improvements have been made to the technical drawing of the beam column structure plan, so that the dilated structure is applied.

From Mrs. Putu Ayu Pramanasari Agustiananda., Dr. Ing, S.T., M.A.

- Of all the stages of planting Porang plants, how do you apply them to the layout of the rooms (building plans)?
- **Response:** The arrangement of the space is made sequentially according to the stages of Porang's growth. This is done so that the use of energy and processes at the planting stage becomes more organized, and efficient. This can be seen from the application of the Permaculture concept with a zoning focus on the building plan on page 55. Furthermore, zoning plays a significant role in the permaculture application. This is due to the fact that permaculture zoning theory separates it into several parts to facilitate planning and layout. The permaculture zoning strategy is appropriate for application on Porang plants grown

in buildings so that the use of time, space, activities, and energy can be used efficiently and effectively in carrying out their performance, which is to produce Porang tubers.

- How do building users inside the building cultivate Porang Plants in such a large planting area when viewed from the access and circulation between Porang planting media?
- **Response:** The use of circulation and space is determined by the type of activity. Because the type of Porang plant cultivation activity is quite active and requires a lot of space, the standard space for cultivation and circulation is at least 1,2 meters (space for 2 people). This standard is also adapted to the tools needed to carry out cultivation activities, such as the use of wheelbarrows, so that wheelbarrows can access every corner of the planting area.
- Please add corridors to planting room 1, planting room 2, and heating/drying room so that when building users pass through these rooms, the humidity and temperature quality is not distracted.
- **Response:** A corridor has been added to the technical drawing of the 1st floor plan, namely the planting room1, planting room 2, and heating/drying room.

Table of Response for Jury

There are various inputs linked to the Porang Permaculture Building design based on the outcomes of the evaluation conducted with the jury.

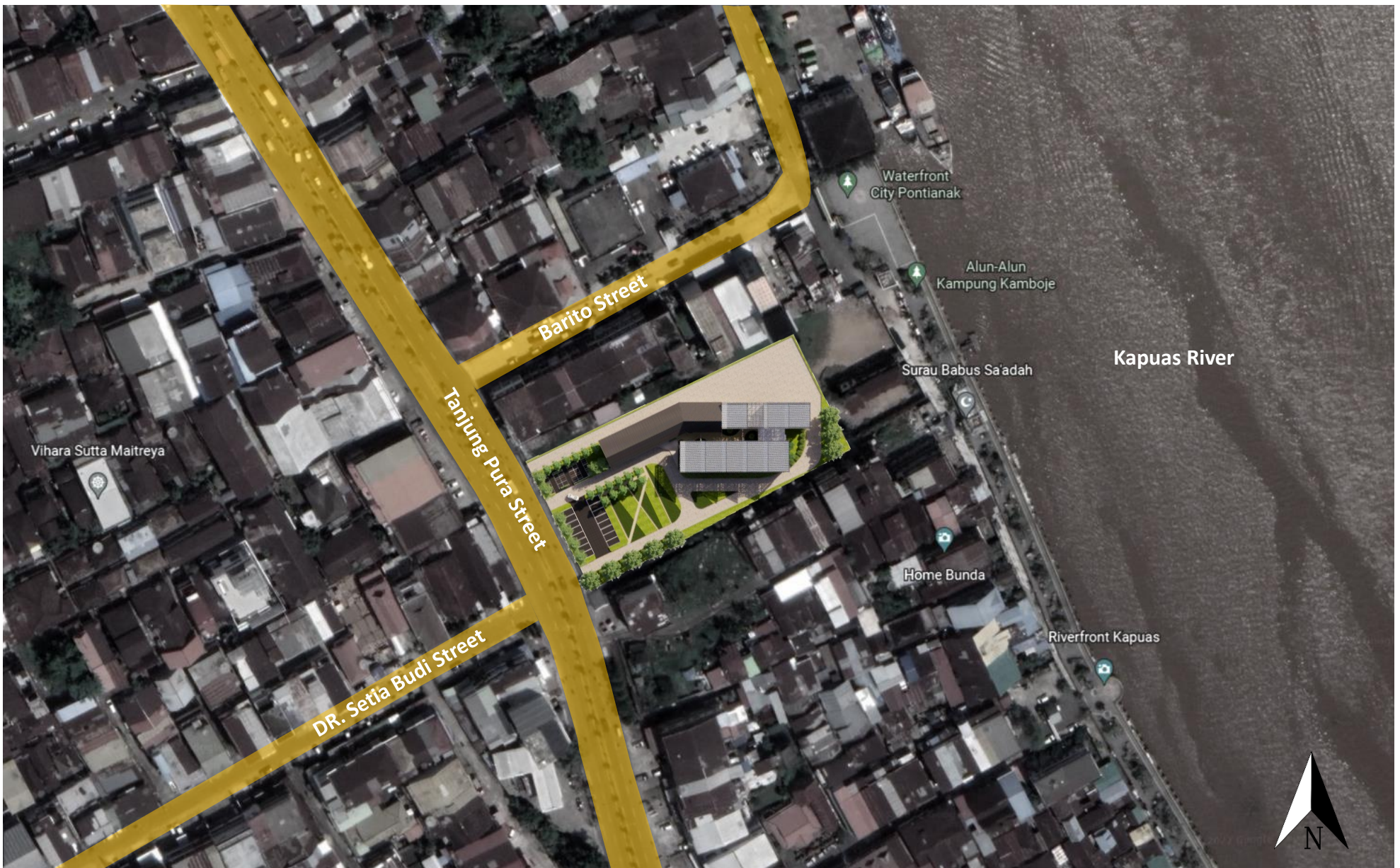
JURY	COMMENT	RESPONSE	DETAIL	PAGE
Yulianto Purwono Prihatmaji, Dr., IPM., IAI	In designing the Porang Permaculture Building, it is necessary to pay attention to the ownership aspect, this is because the ownership aspect has a strong foundation in influencing the design. Please explain more clearly and give reasons regarding ownership?	An explanation of further ownership and the reasons has been added on page 12. Ownership of the Porang Culture Building project is People of Pontianak City especially Porang farmer in Pontianak, and the Department of Agriculture and Food of the City of Pontianak. Determination of ownership is done because the emergence of Porang farming communities in Pontianak as a result of the trend of planting Porang which provides a lot of benefits. On the other hand, it provides the potential to export processed Porang products to neighboring, Malaysia.	-	12
	Give reasons why the site selection is in Pontianak City, why not choose another location, such as in Sidoarjo?	The reason for choosing the site in Pontianak City was actually because in that region, the Porang farming community already exists but the Porang farmers in Pontianak have difficulty producing this type of plant due to several obstacles, such as the condition of the soil whose PH level must be modified first to make it neutral. With this project, it is hoped that the government can provide a pilot project to the people of Pontianak and the Porang farming community in West Kalimantan, so that they can provide education in improvising themselves on how to grow Porang indoors. On the other hand, the Porang plant itself is a plant that has a very high selling value when exported to neighboring countries such as Malaysia which is one of the third largest Porang export market shares which is directly adjacent to the West Kalimantan region, Pontianak (Trademap KBRI Tokyo, 2021). Meanwhile, why did the site selection not take place in other locations such as in Sidoarjo? For the case of land in Sidoarjo and other areas in Indonesia where the land conditions support the growth of Porang plants, such as neutral soil pH and suitable climate, agricultural buildings such as the Porang Permaculture Building are not needed. Because most of them, namely Porang farmers in that area, plant Porang directly on the land. Unless there is no land for farming in the area or there is limited agricultural land such as in urban areas, this type of building is needed. But of course by adjusting the artificial climate inside the building according to the relevant location climate data.	-	11 - 13

JURY	COMMENT	RESPONSE	DETAIL	PAGE
<p>Yulianto Purwono Prihatmaji, Dr., IPM., IAI</p>	<p>Please add a dilatation structure because the type of land in Pontianak is peat soil, so even though there is no earthquake in Kalimantan, the peat soil is easy to shift and be drowned.</p>	<p>Improvements have been made to the engineering drawing of the beam column structure plan, so that the dilated structure is applied.</p>		<p>See attachment (Engineering Drawing)</p>
<p>Putu Ayu Pramanasari Agustiana nda., Dr. Ing, S.T., M.A.</p>	<p>Of all the stages of planting Porang plants, how do you apply them to the layout of the rooms (building plans)?</p>	<p>The arrangement of the space is made sequentially according to the stages of Porang's growth. This is done so that the use of energy and processes at the planting stage becomes more organized, and efficient. This can be seen from the application of the Permaculture concept with a zoning focus on the building plan on page 55. Furthermore, zoning plays a significant role in the permaculture application. This is due to the fact that permaculture zoning theory separates it into several parts to facilitate planning and layout. The permaculture zoning strategy is appropriate for application on Porang plants grown in buildings so that the use of time, space, activities, and energy can be used efficiently and effectively in carrying out their performance, which is to produce Porang tubers.</p>		<p>55 – 56 and 79 - 80</p>

JURY	COMMENT	RESPONSE	DETAIL	PAGE
Putu Ayu Pramanasari Agustiana nda., Dr. Ing, S.T., M.A.	<p>How do building users inside the building cultivate Porang Plants in such a large planting area when viewed from the access and circulation between Porang planting media?</p>	<p>The use of circulation and space is determined by the type of activity. Because the type of Porang plant cultivation activity is quite active and requires a lot of space, the standard space for cultivation and circulation is at least 1,2 meters (space for 2 people). This standard is also adapted to the tools needed to carry out cultivation activities, such as the use of wheelbarrows, so that wheelbarrows can access every corner of the planting area.</p>	<p>1st floor plan drawing</p>	<p>See attachment (Engineering Drawing)</p>
	<p>Please add corridors to planting room 1, planting room 2, and heating/drying room so that when building users pass through these rooms, the humidity and temperature quality is not distracted.</p>	<p>A corridor has been added to the technical drawing of the 1st floor plan, namely the planting room1, planting room 2, and heating/drying room.</p>		<p>See attachment (Engineering Drawing)</p>

Design Results

A. Situation



The chosen site is in Pontianak City, West Kalimantan, at Jalan Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel. The site was selected due to its strategic location close to a ship port, where the commodity export process can be carried out more quickly and efficiently. This has an influence on the environment by lowering carbon footprint. Additionally, there is quick access to public transportation on the southwest or front sides of the building. Additionally, this region is a warehouse and industrial district of Pontianak City, which is situated outside or outside of a

residential section of a city. The location of the site is also located on the banks of the Kapuas River, this is intended as good transportation access and can be used as a source of water for this agricultural building project. The site is located on Jalan Tanjung Pura, which is a 2-way road with a width of ± 10 m. The intensity of vehicles on this road tends to be moderate to high.

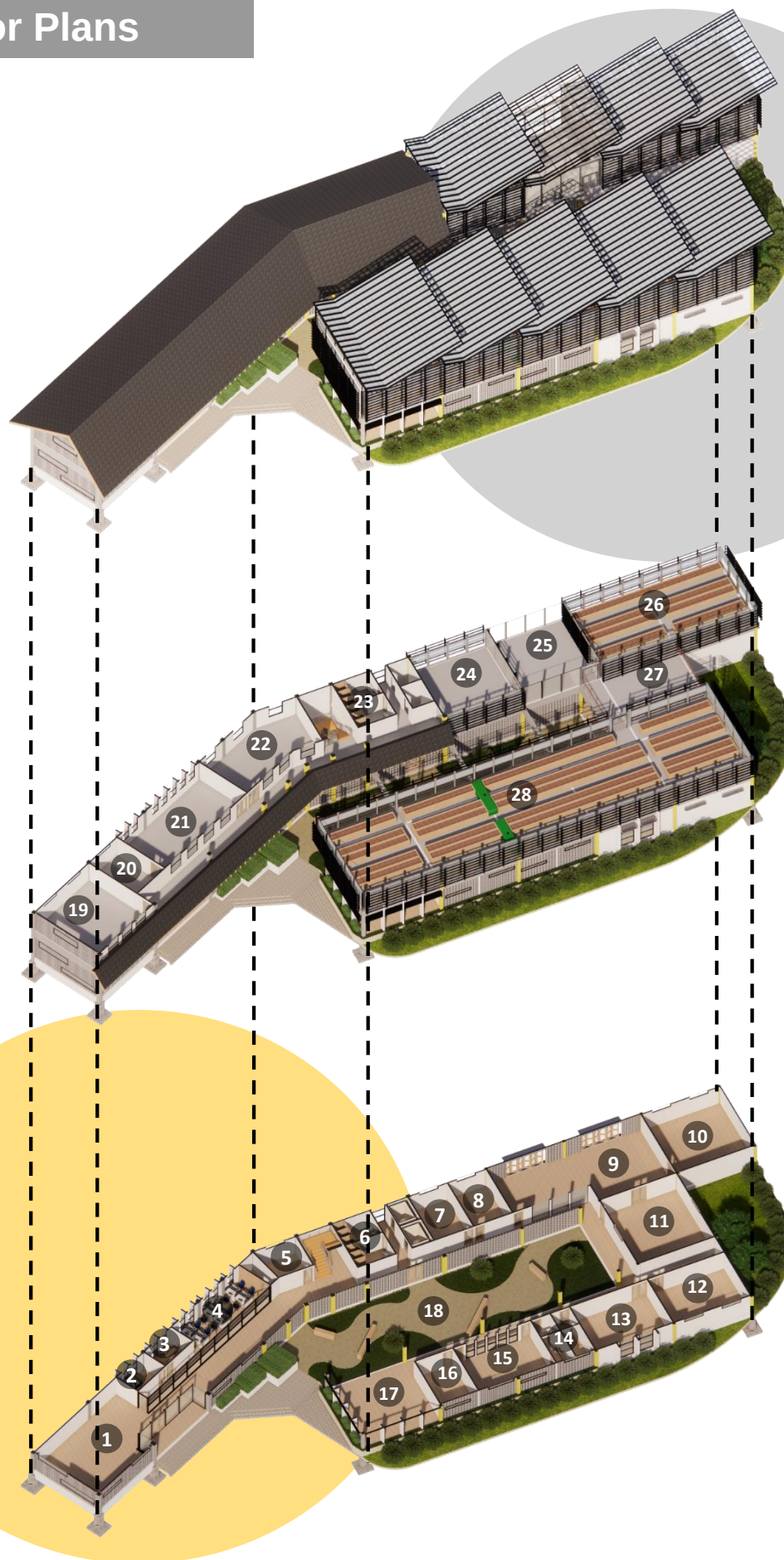
B. Site plan



Site Plan information:

1. Car parking lot
2. Motorcycle parking lot
3. Drop off area
4. Unloading area
5. Service entry area
6. public access entrance area
7. Exit

C. Floor Plans



1st Floor Plan information:

- 19. Control room
- 20. Storage and equipment
- 21. Soil preparation room
- 22. Seeding room
- 23. Restrooms
- 24. Planting room 1
- 25. Heating/drying room
- 26. Planting room 2
- 27. Water tank area
- 28. Planting room 2

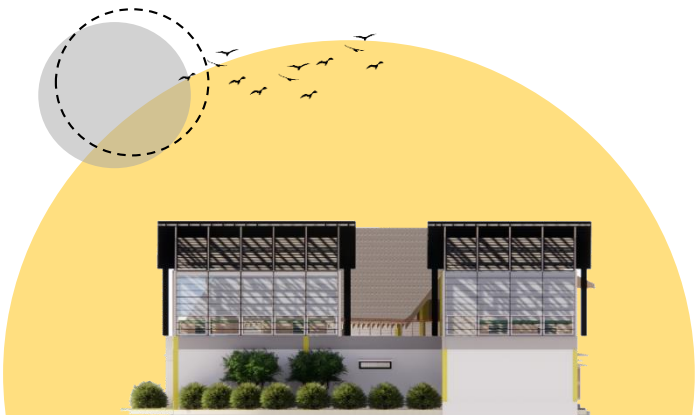
Ground Floor Plan information:

- | | |
|------------------------------------|-----------------------------|
| 1. Receptionist | 11. Storage 1 (raw product) |
| 2. Manager room | 12. Laboratory of Porang |
| 3. Meeting room | 13. Employee room |
| 4. Administration room | 14. Ablution rooms |
| 5. Security room | 15. Praying room |
| 6. Restrooms | 16. Kitchen |
| 7. AHU room | 17. Canteen |
| 8. Generator room | 18. Inner courtyard |
| 9. Processing room | |
| 10. Storage 2 (processing product) | |

D. Elevations



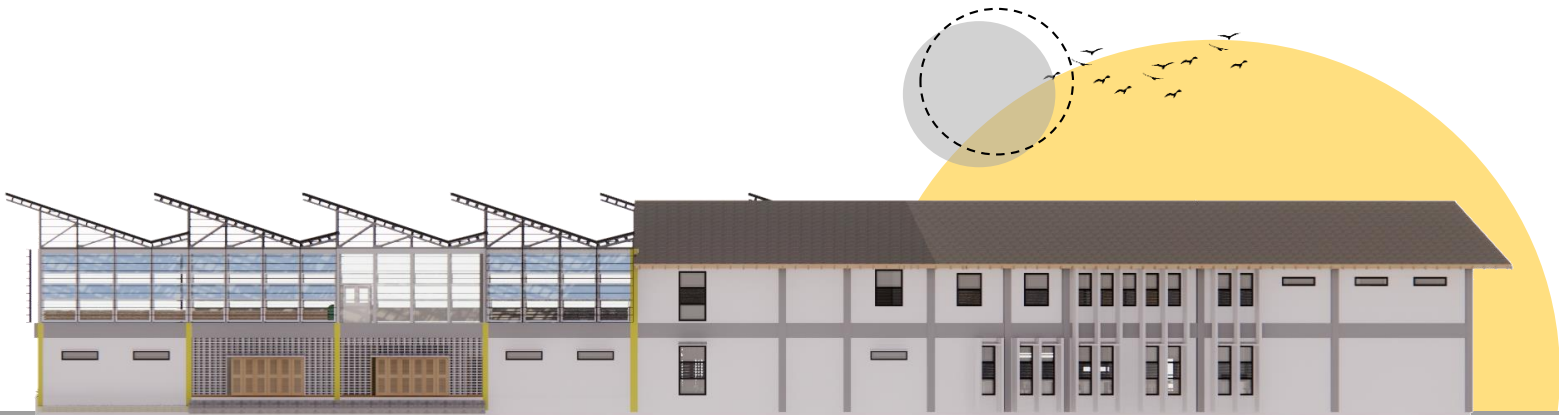
WEST ELEVATION



EAST ELEVATION



SOUTH ELEVATION



NORTH ELEVATION

E. Building Sections



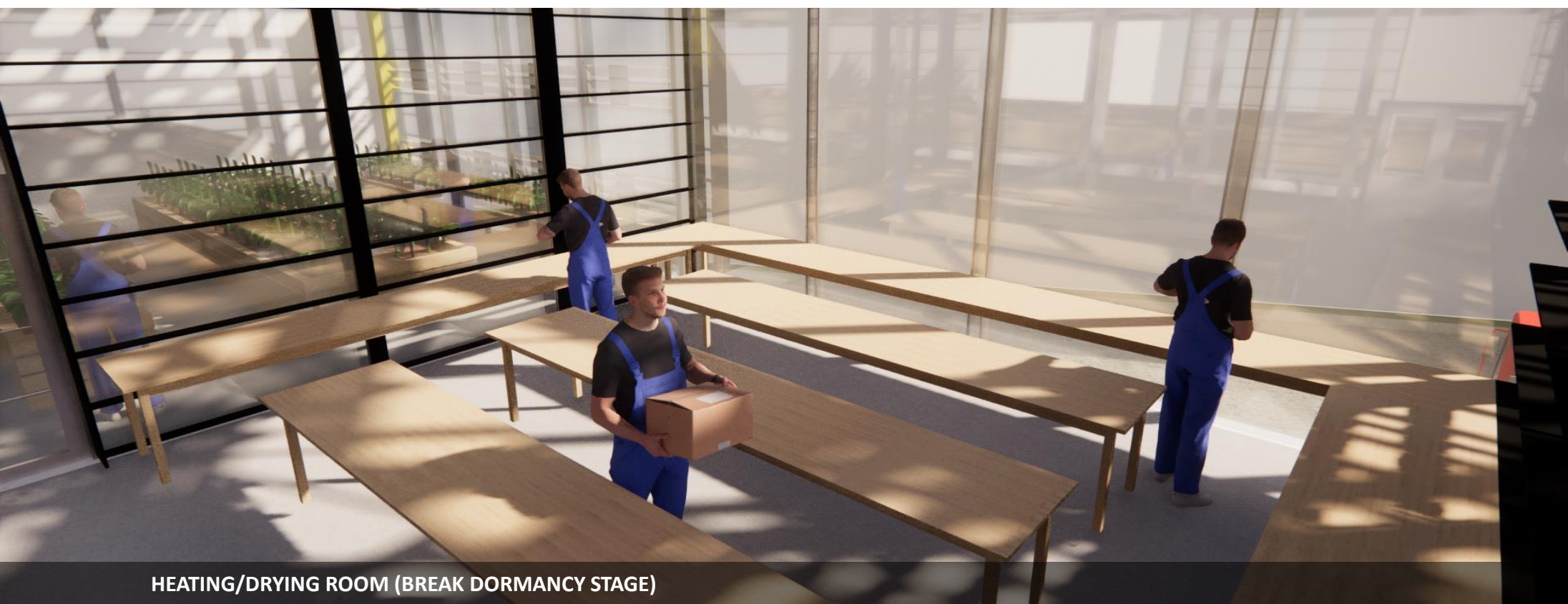
SECTION A



SECTION B

F. Interior Perspective





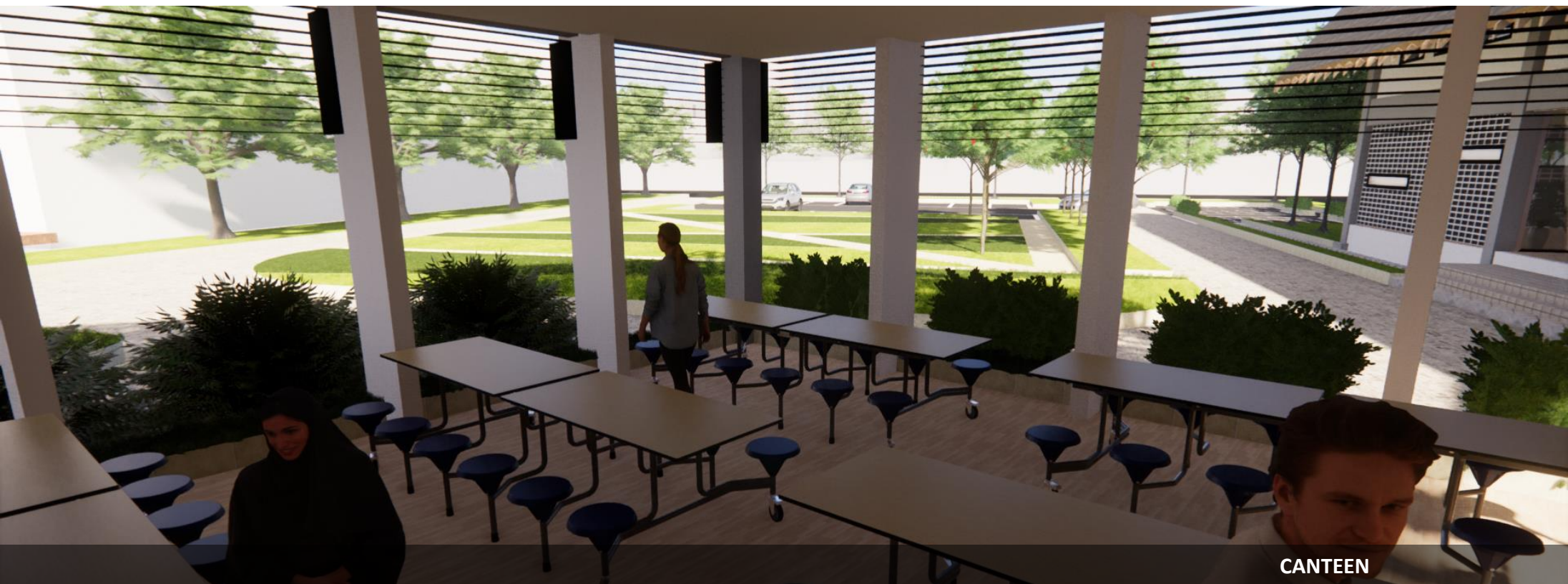
HEATING/DRYING ROOM (BREAK DORMANCY STAGE)



SOIL PREPERATION ROOM



INNER COURTYARD



CANTEEN



GROUND FLOOR CORRIDOR



MANAGER AND ADMINISTRATION ROOM

G. Exterior Axonometric



Reference:

Dinas Pangan, Pertanian, dan Perikanan Kota Pontianak. (2020). Retrieved from <https://pertanian.pontianakkota.go.id/berita/27-percontohan-budidaya-sayuran-daun-secaravertikultur-dinas-pertanian-perikanan-dan-kehutanan-kota-pontianak.html>

Dinas Pangan, Pertanian, dan Perikanan Kota Pontianak. (2020). Retrieved from <https://pertanian.pontianakkota.go.id/galeri-kategori/7-pertanian.html>

Zern Pnk. (2020, May 4). #FARMSPHERE urban farming center. Retrieved from <https://issuu.com/zern/docs/issue-com/1>

Karissa Rosenfield. (2015, February 23). OMA Designs Food Port for West Louisville. Retrieved from <https://inhabitat.com/visionary-homefarm-combines-retirement-homes-and-vertical-urbanfarms/>
<https://www.archdaily.com/601730/oma-designs-food-port-for-west-louisville>

HOMEFARM. (2022). Retrieved from <https://archello.com/project/homefarm>

Atase Perdagangan KBRI Tokyo. (2021). Laporan Analisis Intelijen Bisnis Porang HS : 071440. Kementerian Perdagangan RI. Indonesia.

Faldy Alifianto, Rodiyati Azrianingsih, Brian Rahardi. (2013). Peta Persebaran Porang (*Amorphophallus muelleri* Blume) Berdasarkan Topografi Wilayah di Malang Raya. Jurnal Biotropika, Edisi 1 No. 2.

Suharto, Suryanto, Sarana, Teguh Budi Santosa. (2018). RANCANG BANGUN MESIN PENCUCI UMBI PORANG UNTUK MENINGKATKAN KINERJA PENGOLAHAN PORANG. Jurnal Teknologi Terapan, Volume 4, Nomor 2, September 2018.

Nasir Saleh, St. A. Rahayuningsih. Budhi Santoasa, Erliana, Didik, I Made Jana. (2015). Tanaman Porang: Pengenalan, Budidaya, dan Pemanfaatannya. Bogor, Bogor: Pusat Penelitian dan Pengembangan Tanaman Pangan.

KONDISI FISIK DASAR KOTA PONTIANAK. (2020). Retrieved from <https://bappeda.pontianakkota.go.id/page/kondisi-fisik-dasar-kota-pontianak->

Dwi Nimpuna, Dayinta., Taryana, Didik., Sari Astuti, Ike. (2021). Evaluasi Kesesuaian Lahan Untuk Pengembangan Budidaya Tanaman Porang. Jurnal Pendidikan Geografi, Vol. 8 No. 2 2021, Halaman 38-51.

SUMARWOTO. (2005). Iles-iles (*Amorphophallus muelleri* Blume); Deskripsi dan Sifat-sifat Lainnya. BIODIVERSITAS, Volume 6, Nomor 3, Juli 2005, Halaman: 185-190.

Supriati, Yati. (2016). KEANEKARAGAMAN ILES-ILES (*Amorphophallus* spp.) DAN POTENSINYA UNTUK INDUSTRI PANGAN FUNGSIONAL, KOSMETIK, DAN BIOETANOL. Jurnal Litbang Pertanian Vol. 35 No. 2 Juni 2016, Halaman 69-80.

Siswanto, Bambang., and Karamina, Hidayati. (2016). PERSYARATAN LAHAN TANAMAN PORANG. Buana Sains Vol 16 No 1: 57-70, 2016.

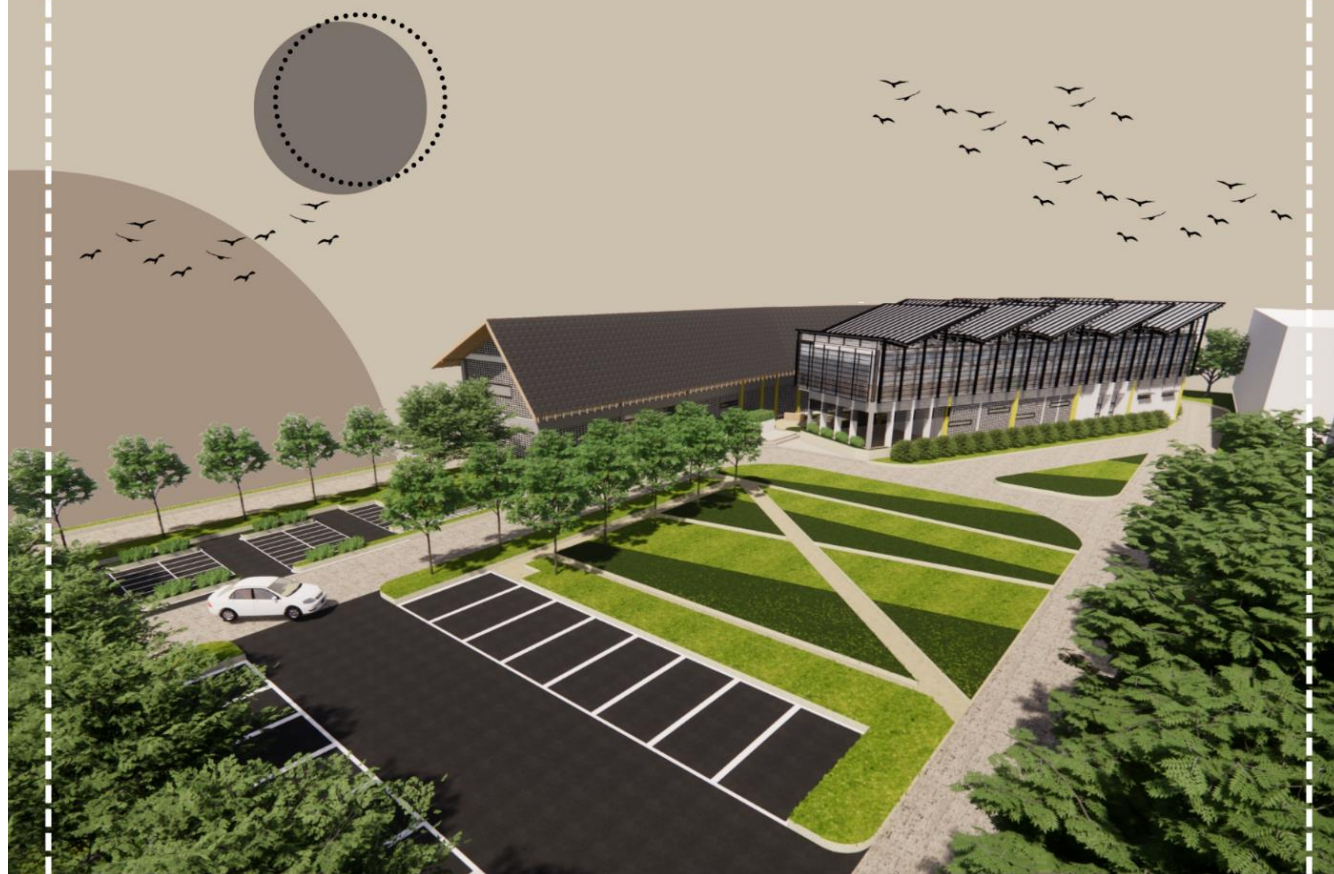
Sari, Ramdana., dan Suhartati. (2015). TUMBUHAN PORANG: PROSPEK BUDIDAYA SEBAGAI SALAH SATU SISTEM AGROFORESTRY. Info Teknis EBONI Vol. 12 No. 2, Desember 2015 Halaman: 97 – 110.

Atthaillah., Iqbal, Muhammad., Saputra Situmeang, Iman. (2017). SIMULASI PENCAHAYAAN ALAMI PADA GEDUNG PROGRAM STUDI ARSITEKTUR UNIVERSITAS MALIKUSSALEH. NALARs Jurnal Arsitektur Volume 16 Nomor 2 Juli 2017, Halaman: 113-124.

RIZQA BENNARADICTA, ZHAFIRA. (2015). BACIRO AGRI – MARKET Pasar Pertanian di Area Perkotaan dengan Penerapan Vertical Farming dan Sustainable Material pada Bangunan. Retrieved from <https://dspace.uui.ac.id/handle/123456789/32542>

Porang Permaculture Building

In Pontianak City, the production of Porang is still very low and rare, due to the fact that the type of soil in Pontianak is dominated by peat soil which has a high acid level. This land is not suitable for growing agricultural crops including Porang. Considering that the criteria for planting Porang plants have not been sufficiently met for the Pontianak area, especially because the type of land and the climate requires a little adjustment to the conditions for growing Porang plants, special treatment is needed so that Porang plants can continue to grow. In the city of Pontianak itself, the Porang farming community already exists but is still small due to several obstacles, such as the condition of the soil whose PH level must be modified first to make it neutral. With this project, it is hoped that the government can provide a pilot project to the people of Pontianak and the Porang farming community in West Kalimantan, so that they can provide education in improvising themselves on how to grow Porang indoors. On the other hand, the Porang plant itself is a plant that has a very high selling value when exported to neighboring countries such as Malaysia which is one of the third largest Porang export market shares which is directly adjacent to the West Kalimantan region, Pontianak. Pontianak as an area that is not possible to plant Porang plants has potential and challenges to the design of agricultural building development plans. To overcome this, the architectural design and design method obtained a concept with a permaculture approach by emphasizing the building envelope system, so it's able to regenerate itself within the environmental scope contained in the permaculture farming system. Permaculture building for Porang plants requires special handling in creating an artificial climate inside of the building that adapts to the growing conditions for Porang plants, so that the performance and modification of the building envelope design as the most important element of the building is highly emphasized. Architectural issues that will be resolved in this design case include the need for the appropriate intensity of sunlight, humidity, temperature, and water distribution systems in the building. By considering these aspects, it is expected to be able to increase the productivity of Porang plants.



**Final Architecture Design
Studio**
Salsabella | 18512144

Supervisor:
Prof. Ar. Noor Cholis Idham, S.T., M.Arch.,
Ph.D., I.A.I

Jury:
Yulianto Purwono Prihatmaji, Dr., IPM., IAI
and
Putu Ayu Pramanasari Agustiananda., Dr. Ing. S.T., M.A.

 **DEPARTMENT OF
ARCHITECTURE UII**

1



Government Porang Export Target

The Ministry of Agriculture through a 300% export increase program, to increase the country's foreign exchange during the COVID-19 pandemic, was issued Minister of Agriculture Decree No. 104/KPTS/HK.140/M/2/2020, Porang plant is one of the targeted commodities from the Directorate General of Food Crops from the type of nuts and tubers



Porang Plant

Porang plant has various benefits and its derivative materials can be used to produce various industry products. So that Porang plant are widely exported to foreign markets in several countries

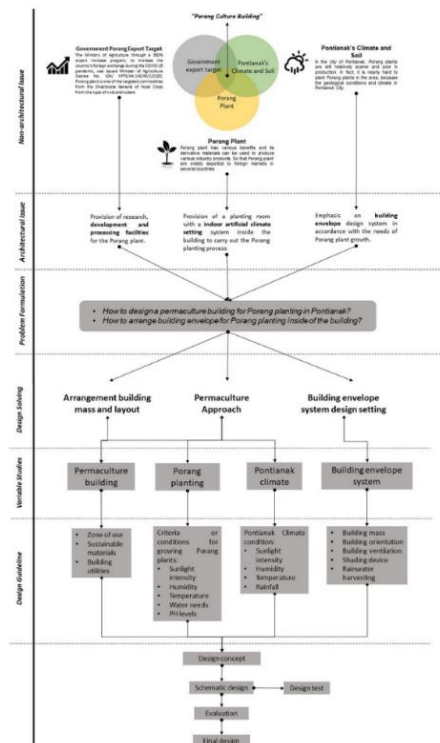


Pontianak's Climate and Soil

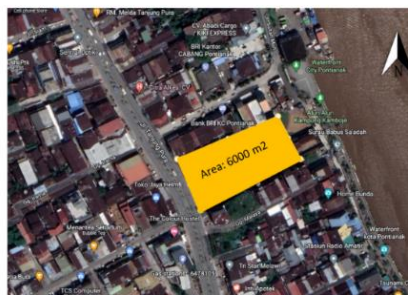
In the city of Pontianak, Porang plants are still relatively scarce and poor in production. In fact, it is nearly hard to plant Porang plants in the area, because the geological conditions and climate in Pontianak City.

Back ground

Though process



Site Location



Address: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243

Coordinated point: 0°01'49.9"S 109°20'42.7"E (-0.030526, 109.345162)

Site area: 6000 m2

SWOT Analysis:

- Strength: industry area, near to the river
- Weakness: the soil is not suitable for high-rise buildings
- Opportunity: located in suburban area, easy access to sea and land transportation
- Threats: land subsidence

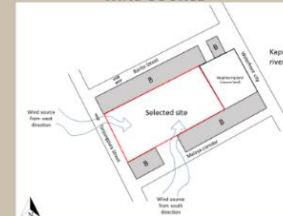
The location of the selected site is located at Jalan Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Pontianak City, West Kalimantan. The reason for choosing the site is due to its strategic location not far from the ship port where the commodity export process can be carried out more efficiently and effectively, so that this also affects the environmental impact of reducing carbon footprint on the environment. In addition, easy access to public vehicles is located right on the front or southwest side of the site. This area is also an industrial and warehousing area of Pontianak City, which is located on the outskirts or outside of a residential area of a city.

Site Analysis

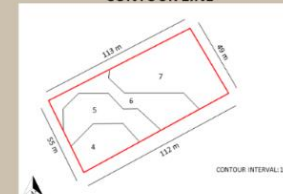
SITE SURROUNDING



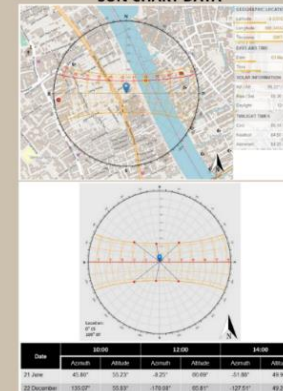
WIND SOURCE



CONTOUR LINE



SUN CHART DATA



Pontianak Soil and Climatic Condition Data

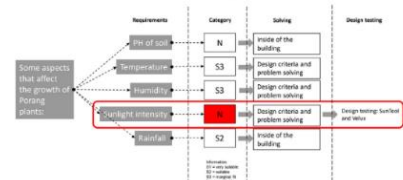
Table of Land Suitability Criteria for Porang Plants

Criteria	Value	Weight	Score
Soil texture	Clay	1	1
Soil pH	5.0 - 6.5	1	1
Soil fertility	High	1	1
Soil moisture	High	1	1
Soil temperature	25 - 30°C	1	1
Soil salinity	Low	1	1
Soil erosion	Low	1	1
Soil compaction	Low	1	1
Soil drainage	Good	1	1
Soil depth	Deep	1	1
Soil color	Dark	1	1
Soil structure	Good	1	1
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Soil structure	Good	1	1

Conclusion Table of Pontianak Soil and Climatic Condition Data for Porang

Criteria	Value	Weight	Score
Soil texture	Clay	1	1
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Soil fertility	High	1	1
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Soil depth	Deep	1	1
Soil color	Dark	1	1
Soil structure	Good	1	1

"Issue: fulfillment of the needs of Porang plants in the building."



Final Architecture Design Studio

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DEPARTMENT OF ARCHITECTURE UII

2

Design Criteria

Design Criteria in Category N (not suitable):

Arch Issue: sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of tuber/bulb and seeds)	<ul style="list-style-type: none"> The roof can use a massive material or an ordinary roof. Sufficient light comes from window, etc. Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none"> The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature. Avoid the sun's altitude point which has a high level of solar radiation. Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 - 14:00). Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Forang plants (06:00 - 10:00). Must use transparent roofing material but have a lower. Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none"> Use transparent materials so that sunlight can be transmitted into the building 100%. Avoid using shading devices, etc. Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving

Source: author analysis

Design Criteria in Category S3 (marginal fit):

Arch Issue: temperature

Design criteria	Problem solving
All stages of Forang growth require all temperatures that are not hot (most optimal 23-25°C).	<ul style="list-style-type: none"> The orientation of the building faces south and north, so that the large facade area does not absorb too much solar heat. The shape of the building mass extends to the west and east to avoid absorption of solar radiation, or you can design a solid void building mass to create a shaded area on the facade. The use of shading devices to avoid the sun's altitude point which has a high level of sunlight intensity (the more perpendicular the sun's position, the higher the level of sunlight intensity).
Except for the break dormancy stage, seedlings in the form of tubers require a temperature of 45°C (drying/drying in the sun for 6 hours/day).	<ul style="list-style-type: none"> The use of transparent materials, so that sunlight can be transmitted 100% (sunlight intensity 100%). Does not require a shading device.

Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving

Source: author analysis

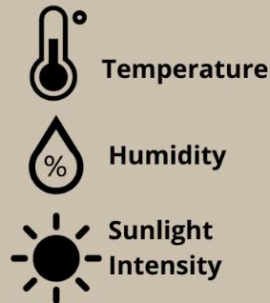
Design Criteria in Category S3 (marginal fit):

Arch Issue: humidity

Design criteria	Problem solving
The nursery stage of Forang/bulbs requires sufficient humidity/not dry (most optimal 26-80%).	<ul style="list-style-type: none"> The composition of the building mass can use a single banked room so that air movement is evenly distributed. Ventilation can use the stack effect. Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Forang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none"> Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Forang. Use cross section ventilation. Make opening / ventilation in the roof to reduce excess moisture.

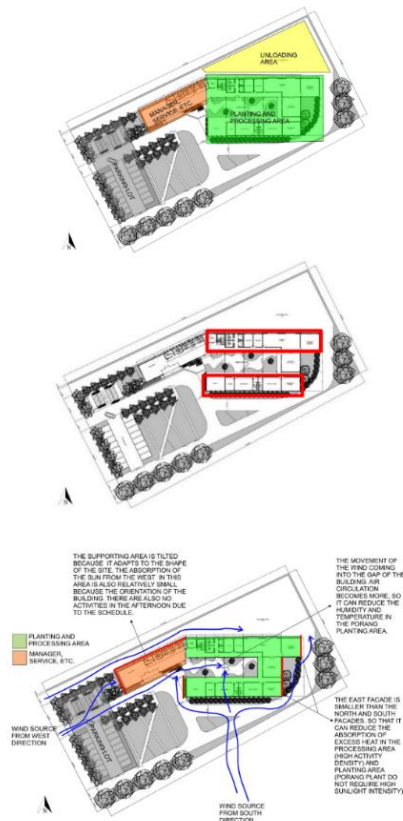
Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving

Source: author analysis



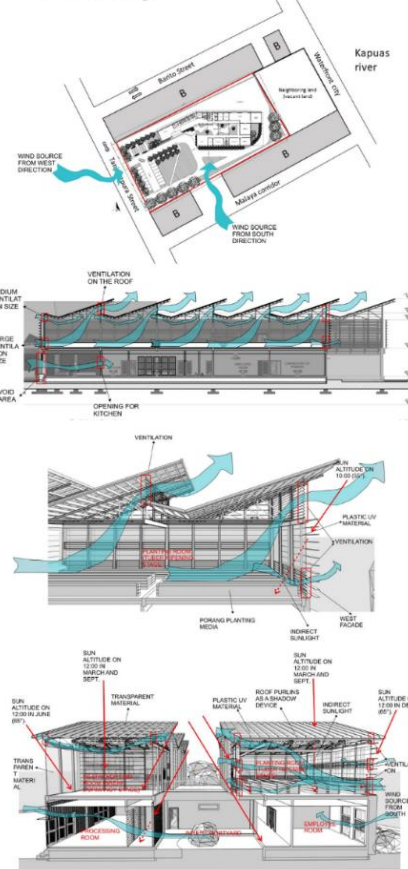
Problem Solving

Problem Solving in Temperature



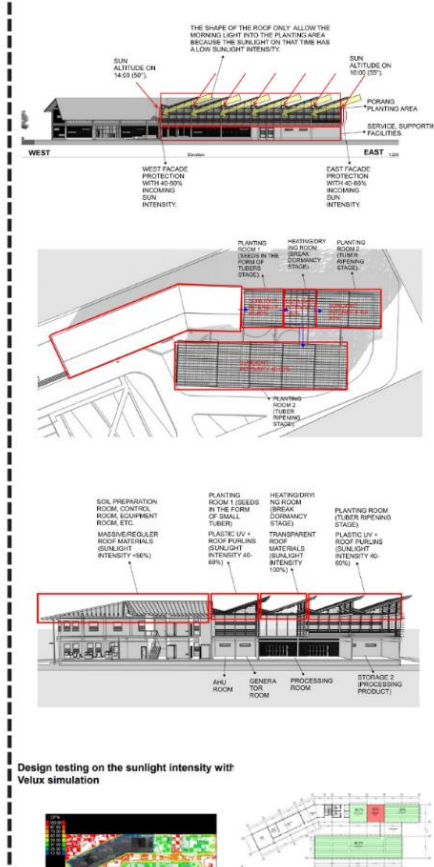
The orientation of the building mass facing north and south, as well as a shape that extends from east to west which avoids the absorption of solar heat in the building. Building orientation like this, apart from being good for planting areas, is also beneficial for the processing area considering that the area has a dense activity. So that building users do not feel too hot inside the building.

Problem Solving in Humidity

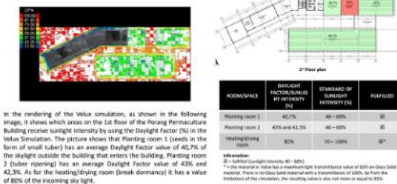


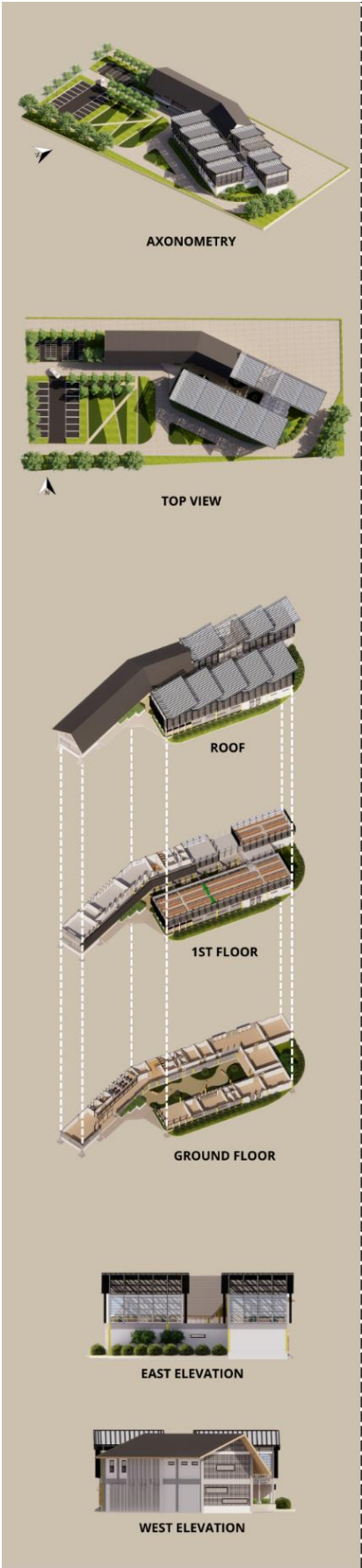
Wind sources that come to the site are from the south and west of the site. So that in the arrangement of the site plan design, the placement of trees is done as much as possible not to block the direction of the wind and can direct the movement of the wind towards the building. The shape of the building plan is also designed to have a space such as a single banked room so that the wind can penetrate inside easily and the movement of the wind keeps changing so that humidity can be reduced.

Problem Solving in Sunlight Intensity



Design testing on the sunlight intensity with Velux simulation





INTERIOR PERSPECTIVE





Direktorat Perpustakaan Universitas Islam Indonesia
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SURAT KETERANGAN HASIL CEK PLAGIASI

Nomor: 1867153590/Perpus./10/Dir.Perpus/IV/2022

Bismillaahirrahmaanirrahiim

Assalamualaikum Wr. Wb.

Dengan ini, menerangkan Bahwa:

Nama : Designed by Salsabella
Nomor Mahasiswa : 18512144
Pembimbing : Prof. Noor Cholis Idham, Ph.D., I.A.I
Fakultas / Prodi : Teknik Sipil dan Perencanaan/ Arsitektur
Judul Karya Ilmiah : Design of Porang Culture Building Permaculture Building for Porang
Plant in Pontianak by Emphasizing on Envelope System Design

Karya ilmiah yang bersangkutan di atas telah melalui proses cek plagiasi menggunakan **Turnitin** dengan hasil kemiripan (*similarity*) sebesar **1 (Satu) %**.

Demikian Surat Keterangan ini dibuat untuk dapat dipergunakan sebagaimana mestinya.

Wassalamualaikum Wr. Wb.

Yogyakarta, 7/6/2022

Direktur



Joko S. Prianto, SIP., M.Hum



DEPARTMENT *of*
ARCHITECTURE



Berdasarkan SK BAN-PT
No. 102/20/2011/PT/BAN-PT/001/2011
No. 112/20/2011/PT/BAN-PT/001/2011



한국건축학교육인증원
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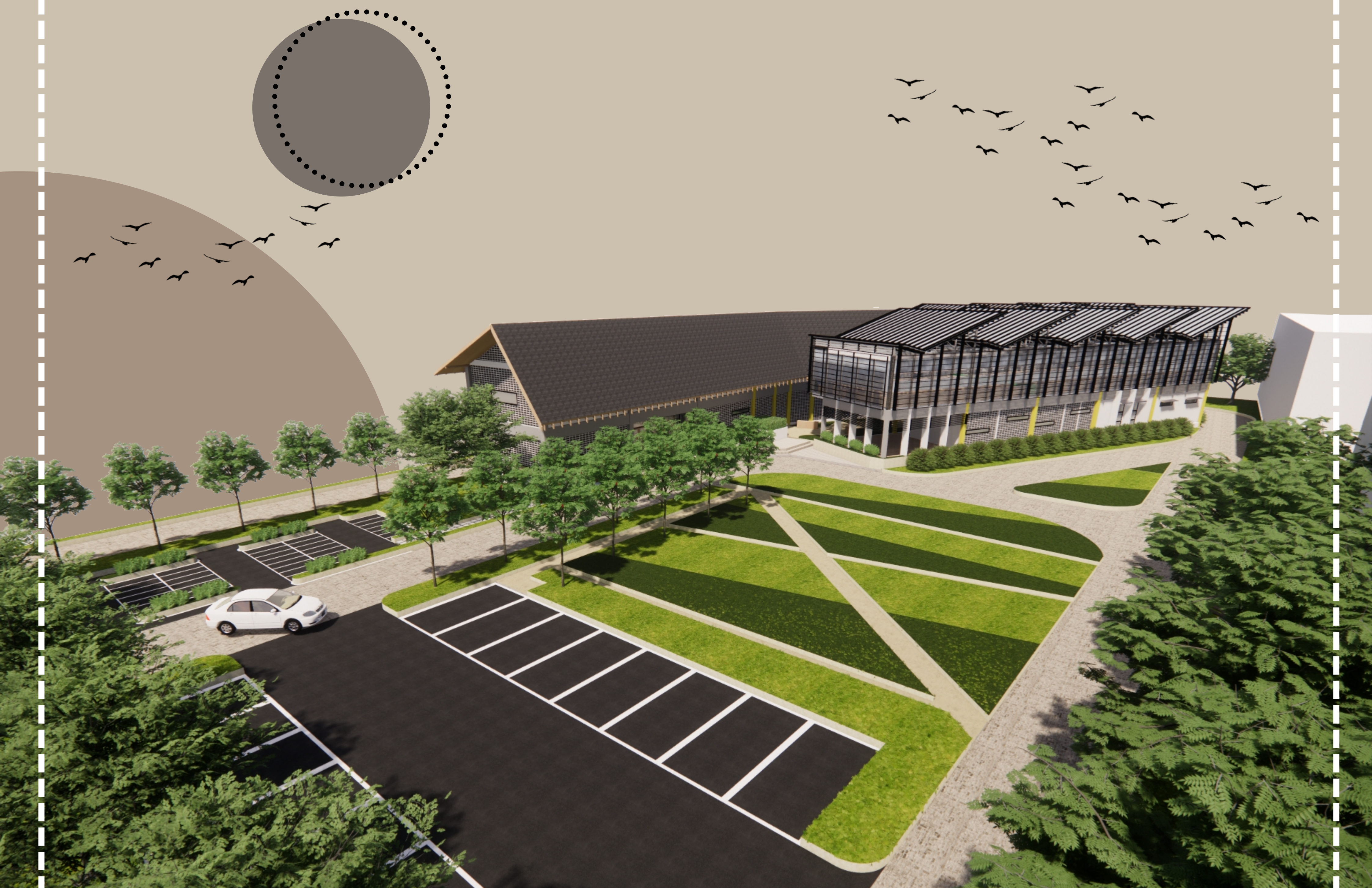
CANBERRA
ACCORD



BUILDING
PERFORMANCE &
TECHNOLOGY
LABORATORY

Porang Permaculture Building

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The Ministry of Agriculture through a 300% export increase program, to increase the country's foreign exchange during the COVID-19 pandemic, was issued Minister of Agriculture Decree No. 104/KPTS/HK.140/M/2/2020, Porang plant is one of the targeted commodities from the Directorate General of Food Crops from the type of nuts and tubers



Porang Plant

Porang plant has various benefits and its derivative materials can be used to produce various industry products. So that Porang plant are widely exported to foreign markets in several countries

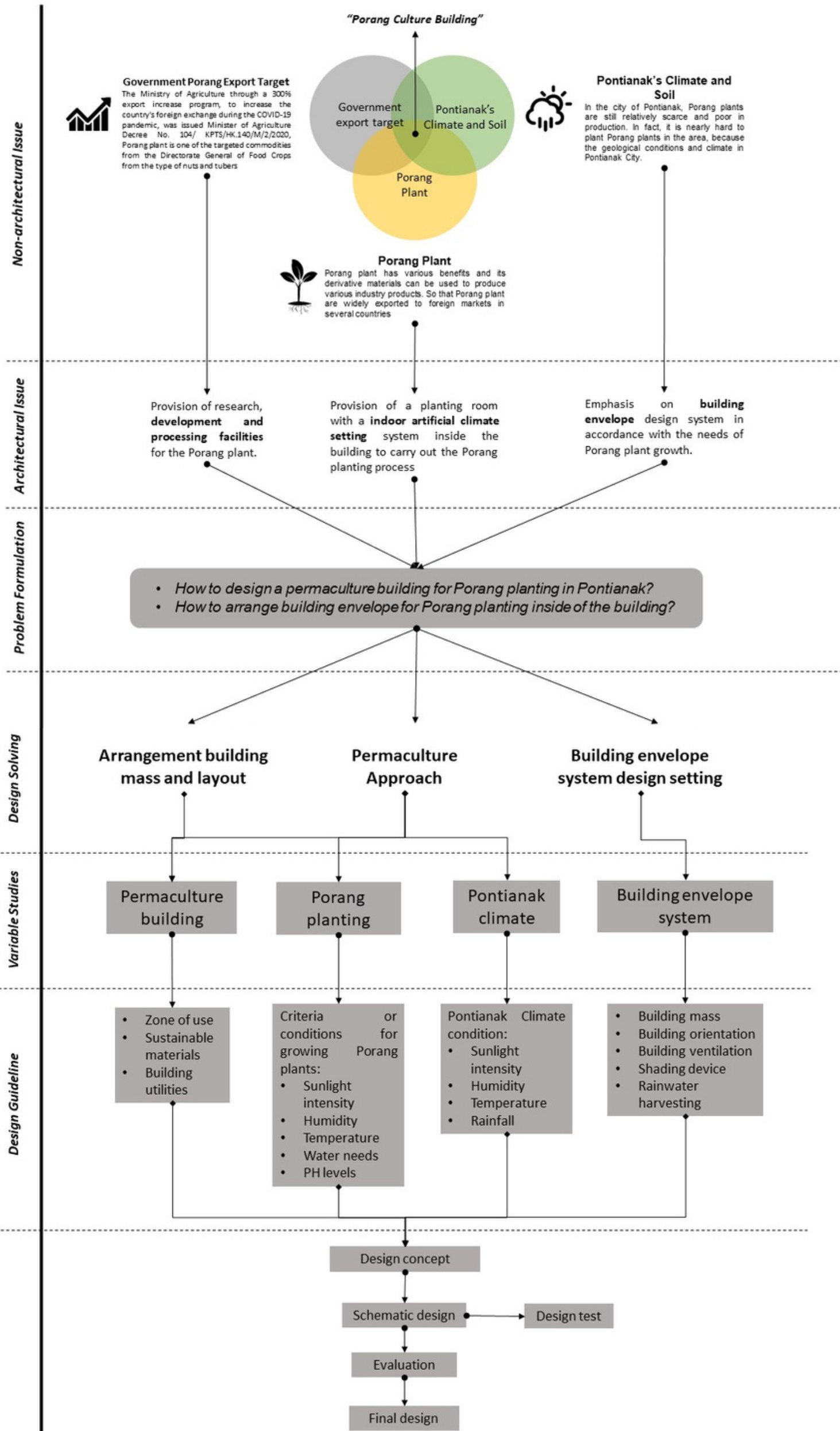


Pontianak's Climate and Soil

In the city of Pontianak, Porang plants are still relatively scarce and poor in production. In fact, it is nearly hard to plant Porang plants in the area, because the geological conditions and climate in Pontianak City.

Back ground

Though process



Site Location



Address: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243

Coordinated point: 0°01'49.9"S 109°20'42.7"E (-0.030526, 109.345182)

Site area: 6000 m2

SWOT Analysis:

- Strength: industry area, near to the river
- Weakness: the soil is not suitable for high-rise buildings
- Opportunity: located in suburban area, easy access to sea and land transportation
- Threats: land subsidence

Pontianak Soil and Climatic Condition Data

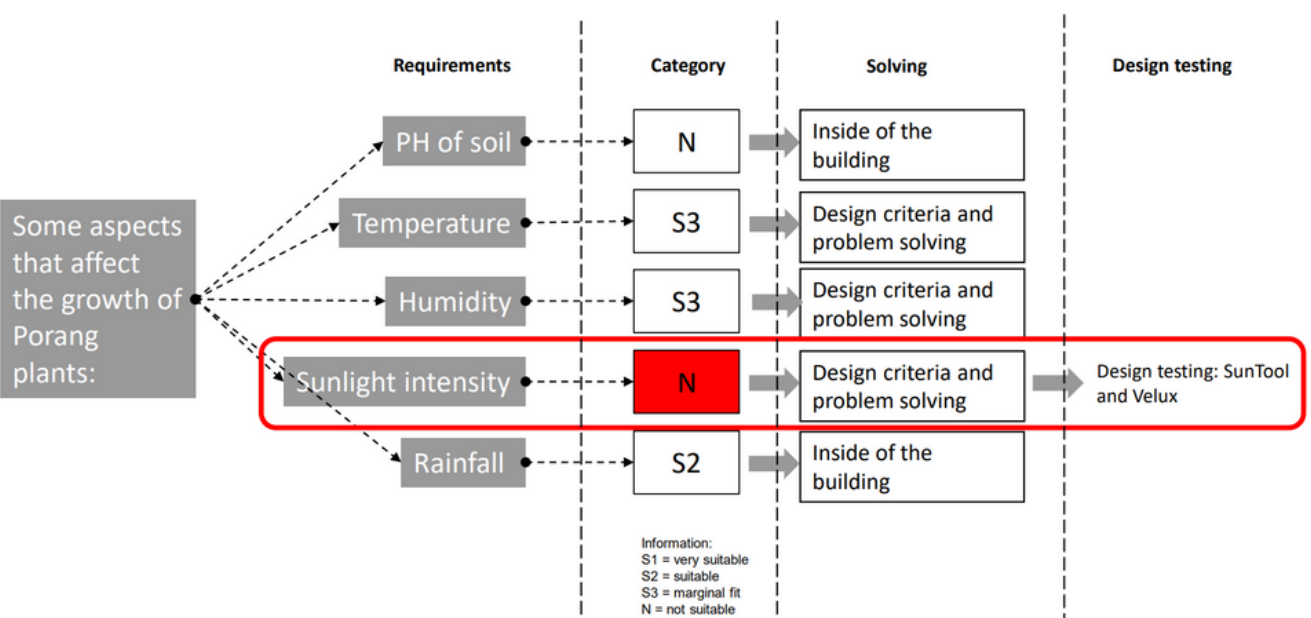
Table of Land Suitability Criteria for Porang Plants

Porang plant	Soil	Climate	Soil	Climate
Temperature (°C)	23 - 25	23 - 25	23 - 25	23 - 25
Humidity (%)	80 - 90	80 - 90	80 - 90	80 - 90
Rainfall (mm)	1500 - 2000	1500 - 2000	1500 - 2000	1500 - 2000
Soil pH	5.5 - 6.5	5.5 - 6.5	5.5 - 6.5	5.5 - 6.5
Soil texture	Clayey	Clayey	Clayey	Clayey
Soil fertility	High	High	High	High
Soil moisture	High	High	High	High
Soil depth	10 - 15	10 - 15	10 - 15	10 - 15
Soil color	Dark brown	Dark brown	Dark brown	Dark brown
Soil structure	Loose	Loose	Loose	Loose
Soil pH	5.5 - 6.5	5.5 - 6.5	5.5 - 6.5	5.5 - 6.5
Soil texture	Clayey	Clayey	Clayey	Clayey
Soil fertility	High	High	High	High
Soil moisture	High	High	High	High
Soil depth	10 - 15	10 - 15	10 - 15	10 - 15
Soil color	Dark brown	Dark brown	Dark brown	Dark brown
Soil structure	Loose	Loose	Loose	Loose

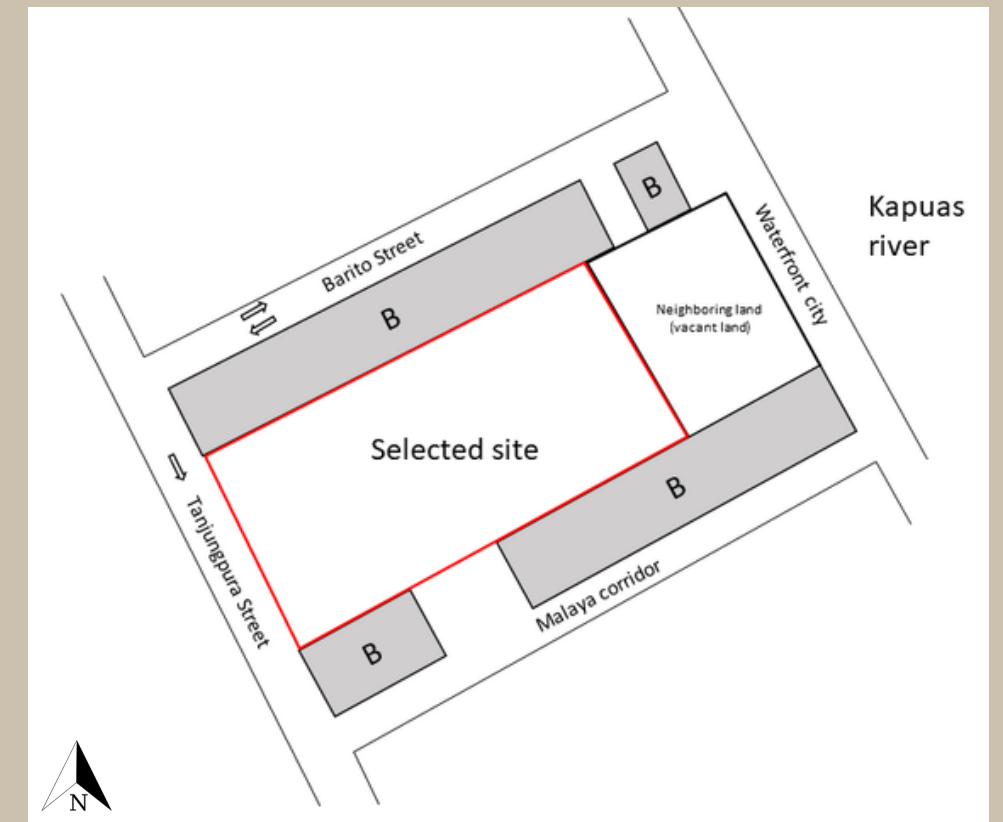
Conclusion Table of Pontianak Soil and Climatic Condition Data for Porang

Parameters	Porang plant	Pontianak condition	Results
PH of soil	6-7 (PH neutral)	PH < 4.0 (acidic)	X (N)
Temperature	23 - 25°C (most optimal)	28 - 32°C	V (S3)
Humidity	80 - 90% (optimal) (Porang plants require most conditions only for leaf growth, while dry conditions are required for porang tuber development.)	88 - 92% (air temperature)	V (S3)
Sunlight intensity	40 - 60% (most optimal)	34 - 78%	X (N)
Rainfall	1200 - 2000 mm/year (most optimal)	3000 - 4000 mm/year	V (S2)

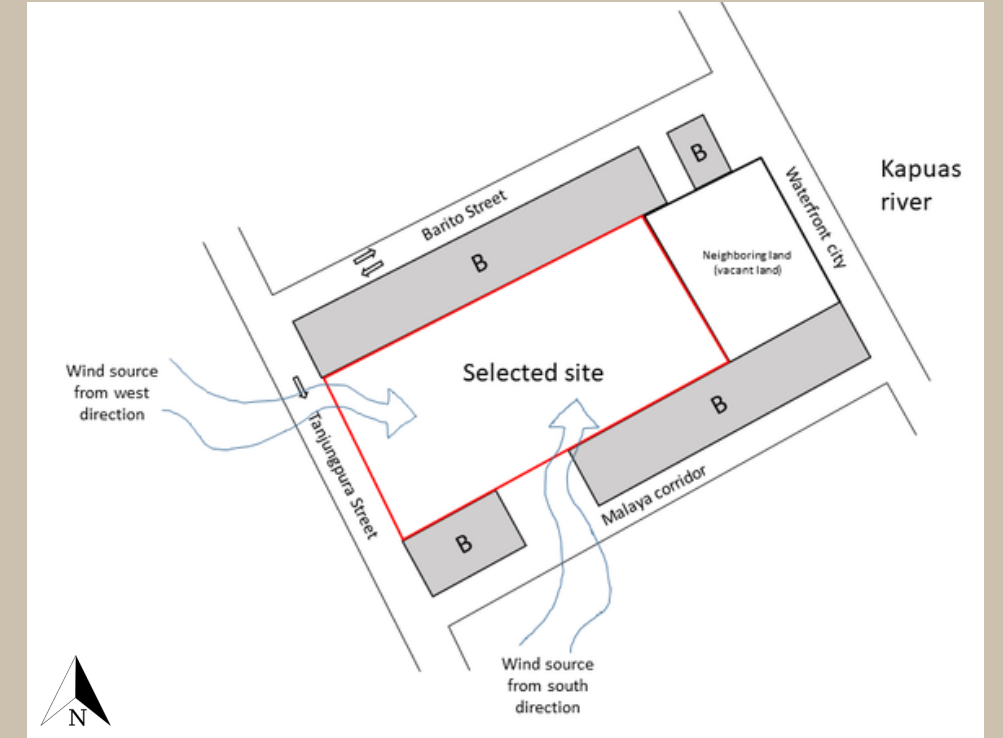
"Issue: fulfillment of the needs of Porang plants in the building."



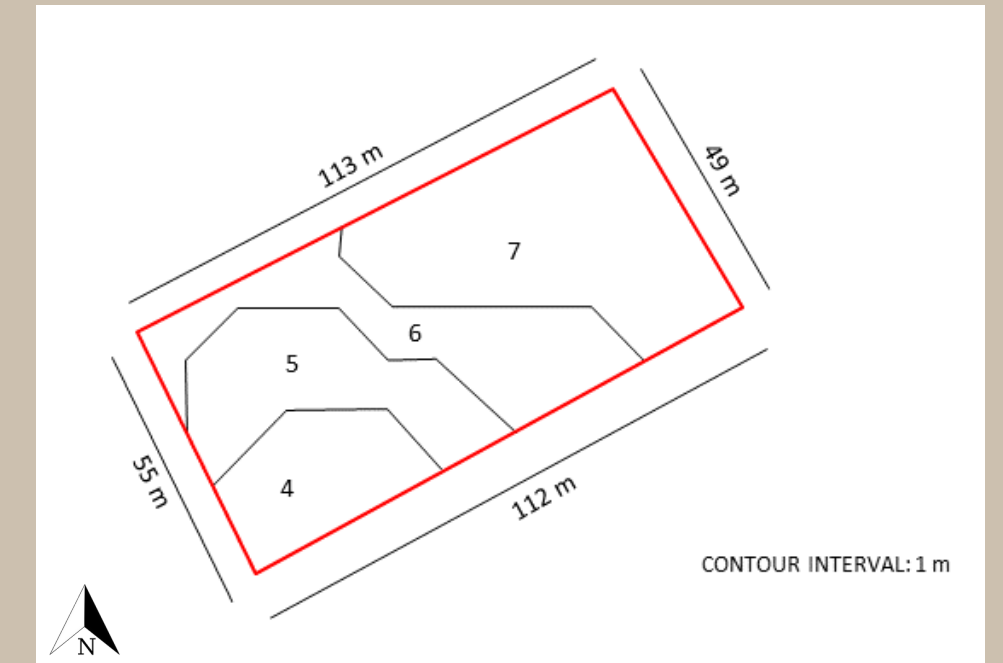
SITE SURROUNDING



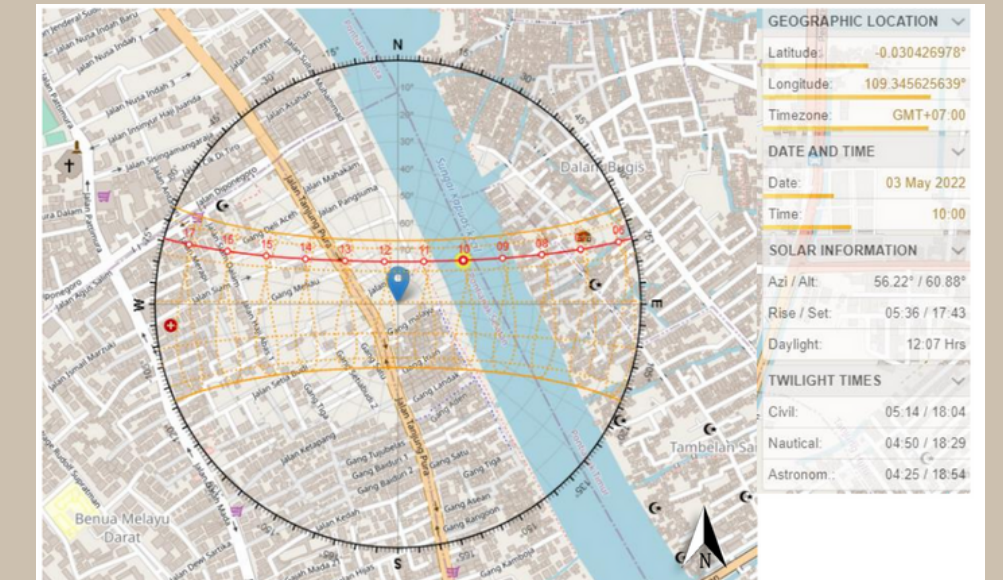
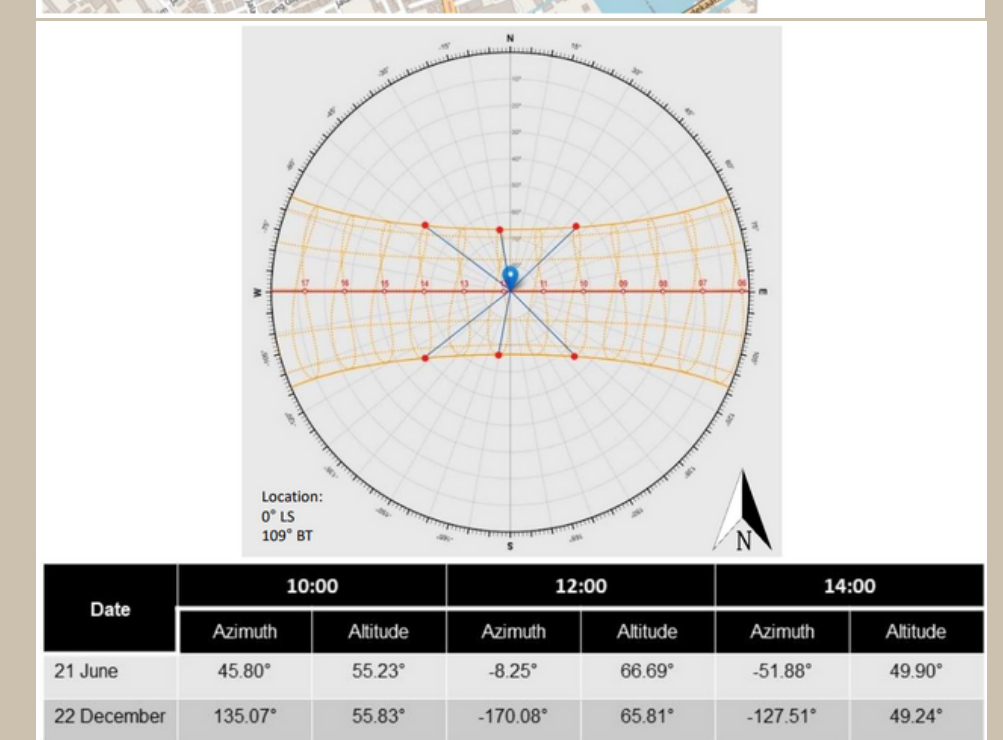
WIND SOURCE



CONTOUR LINE



SUN CHART DATA



Site Analysis

Design Criteria

Design Criteria in Category N (not suitable):

Arch Issue: sunlight intensity

Design criteria	Problem solving
Light intensity <50% (nursery stage of katak/bulbil and seeds)	<ul style="list-style-type: none">The roof can use a massive material or an ordinary roof.Sufficient light comes from windows, etc.Does not require a transparent roof, because during the growth of shoots tend to require conditions that tend to be dark.
Light intensity 40-60% (tuber ripening stage and tuber seedling stage)	<ul style="list-style-type: none">The shape of the building mass should extend to the west and east, so that sunlight is evenly distributed throughout the day. It is also intended to lower the air temperature.Avoid the sun's altitude point which has a high level of solar radiation.Avoid the afternoon sun which tends to be hot and has a high intensity of sunlight (12:00 – 14:00).Morning sunlight is quite suitable, because it is not too hot and has a low intensity of sunlight for Porang plants (06:00 – 10:00).Must use transparent roofing material but have a louver.Shading devices should be designed so that the sun can penetrate into the building up to 40-60% (take 50% for easy calculations).
Light intensity 100% (break dormancy stage)	<ul style="list-style-type: none">Use transparent materials so that sunlight can be transmitted into the building 100%.Avoid using shading devices, etc.Use ventilation to prevent evaporation and cause tuber seeds to become damp.

Table of Sunlight Intensity Design criteria in category N (not suitable) and the problem solving.
Source: author analysis

Design Criteria in Category S3 (marginal fit):

Arch Issue: temperature

Design criteria	Problem solving
All stages of Porang growth require air temperatures that are not hot (most optimal 23 - 25°C).	<ul style="list-style-type: none">The orientation of the building faces south and north, so that the large facade area does not absorb too much solar heat.The shape of the building mass extends to the west and east to avoid absorption of solar radiation, or you can design a solid void building mass to create a shaded area on the facade.The use of shading devices to avoid the sun's altitude point which has a high level of sunlight intensity (the more perpendicular the sun's position, the higher the level of sunlight intensity).
Except for the break dormancy stage, seedlings in the form of tubers require a temperature of 45°C (drying/drying in the sun for 6 hours/day).	<ul style="list-style-type: none">The use of transparent materials, so that sunlight can be transmitted 100% (sunlight intensity 100%).Does not require a shading device.

Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

Design Criteria in Category S3 (marginal fit):

Arch Issue: humidity

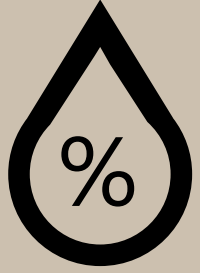
Design criteria	Problem solving
The nursery stage of frogs/bulbills requires sufficient humidity/not dry (most optimal 24-80%).	<ul style="list-style-type: none">The composition of the building mass can use a single banked room so that air movement is evenly distributed.Ventilation can use the stuck effect.Use cross section ventilation.
The seedling stage in the form of tuber seeds requires moisture only on the stems and leaves of Porang. While the soil does not really need high humidity and tends to be dry.	<ul style="list-style-type: none">Large vents are placed in the ground area for the soil part. While the small ventilation in the area of the stems and leaves of Porang.Use cross section ventilation.Make openings / ventilation in the roof to reduce excess moisture.

Table of Temperature Design criteria in category S3 (marginal fit) and the problem solving.
Source: author analysis

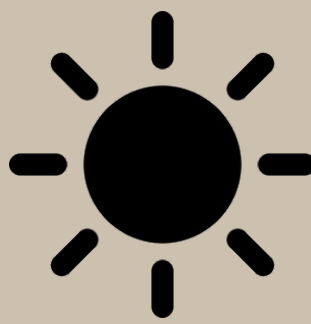
Architectural Issue



Temperature



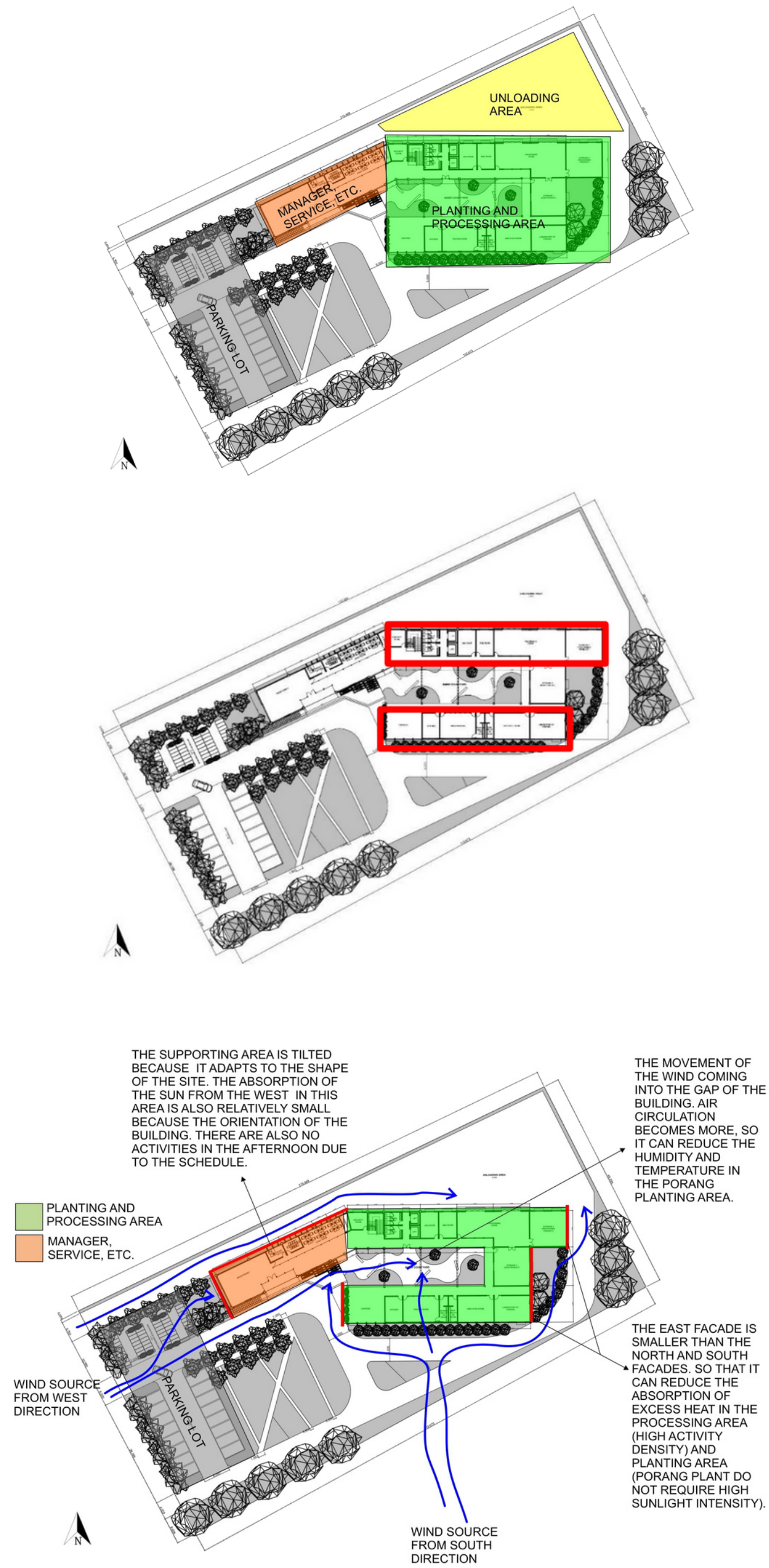
Humidity



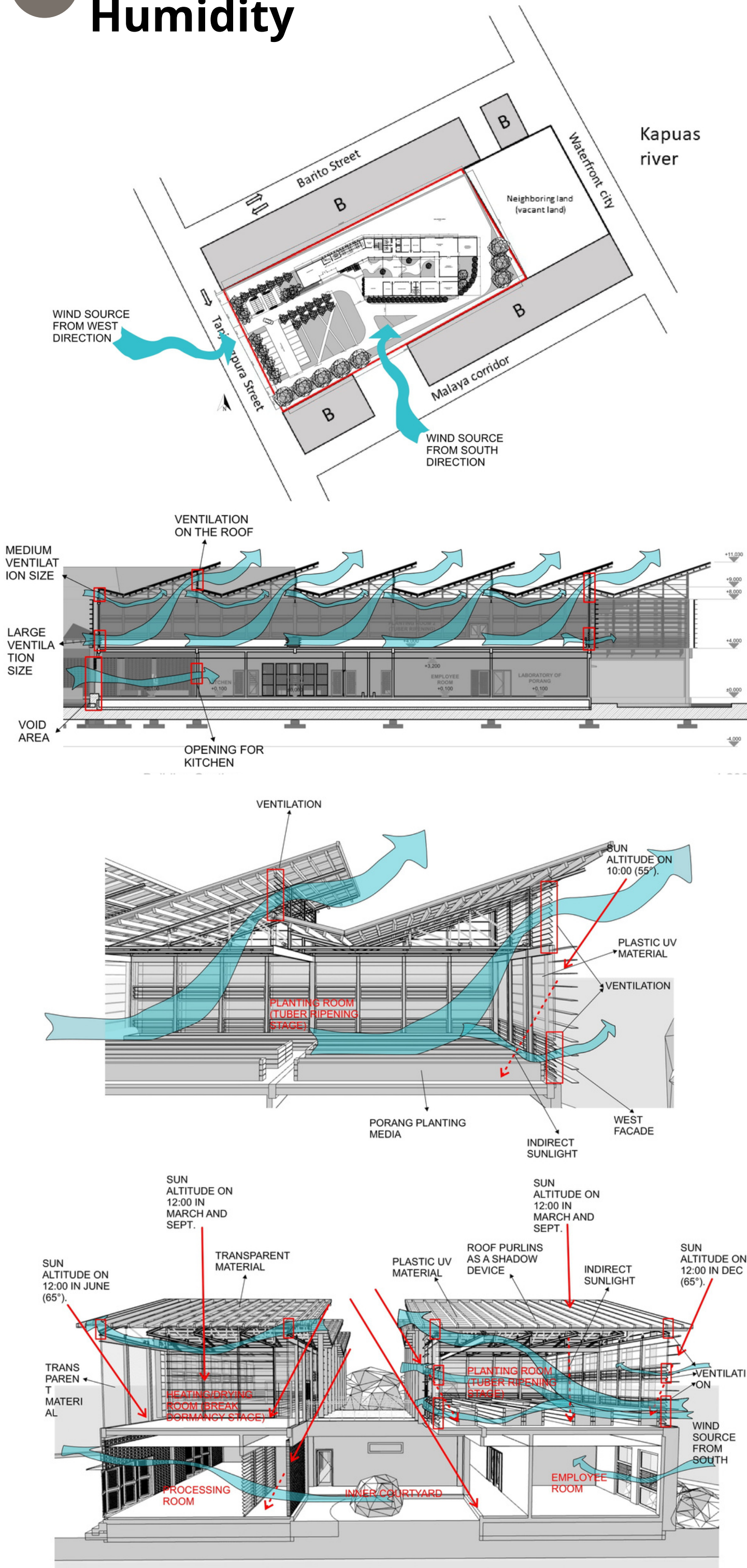
Sunlight Intensity

Problem Solving

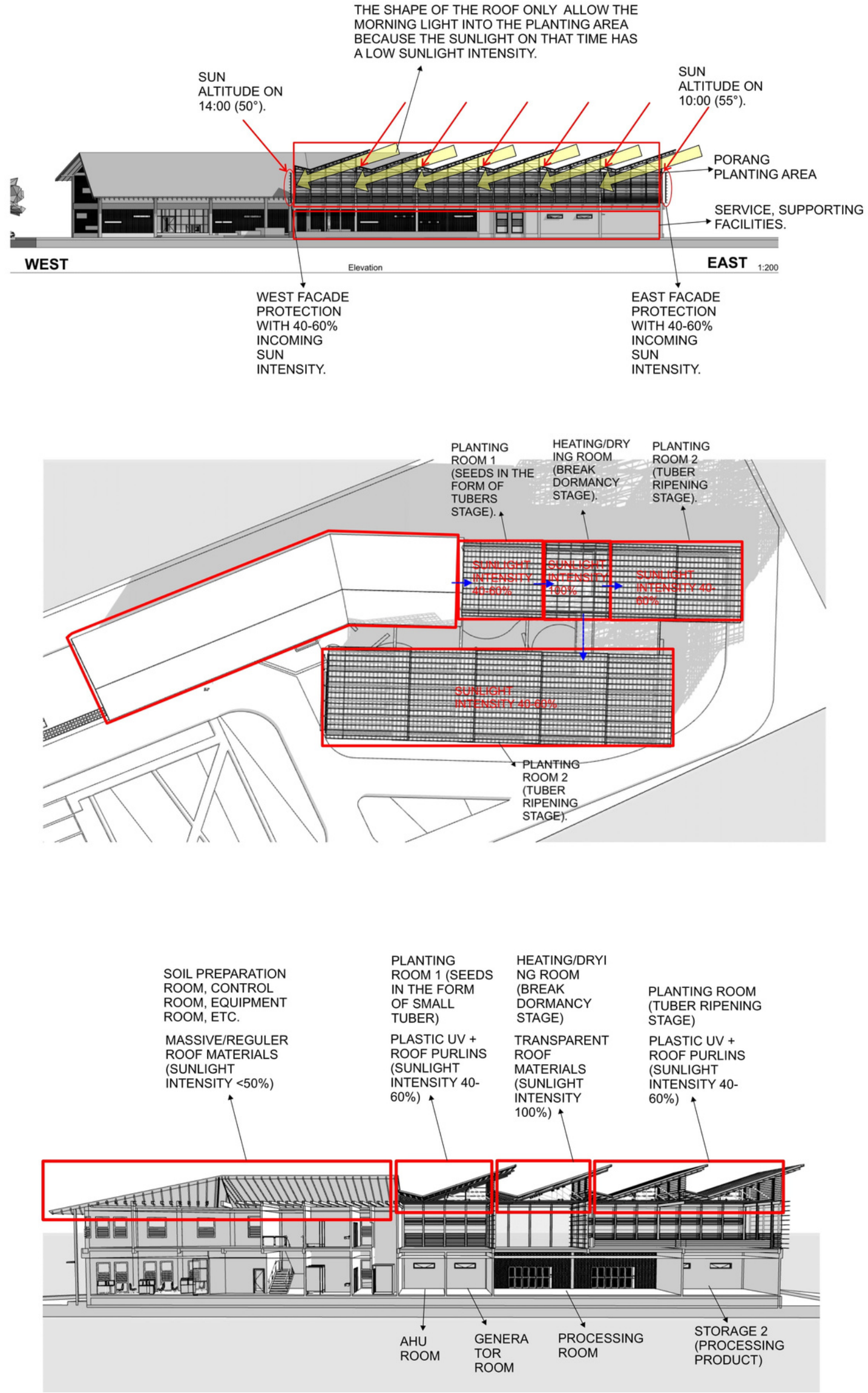
Problem Solving in Temperature



Problem Solving in Humidity



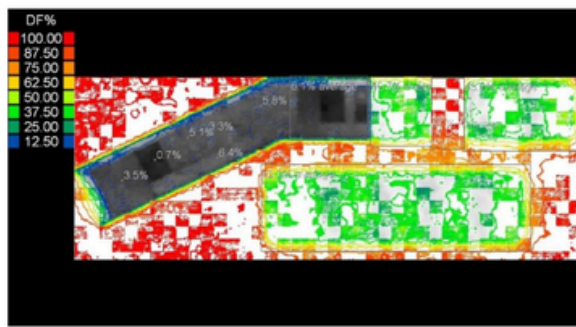
Problem Solving in Sunlight Intensity



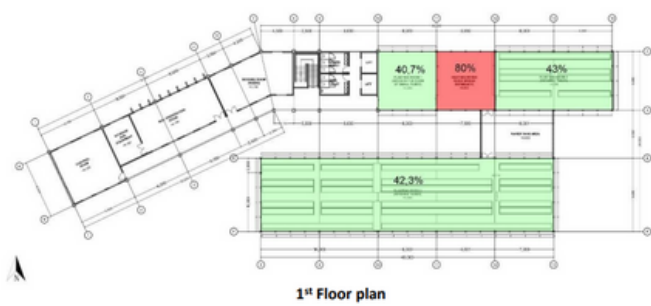
The orientation of the building mass facing north and south, as well as a shape that extends from east to west which avoids the absorption of solar heat in the building. Building orientation like this, apart from being good for planting areas, is also beneficial for the processing area considering that the area has a dense activity. So that building users do not feel too hot inside the building.

Wind sources that come to the site are from the south and west of the site. So that in the arrangement of the site plan design, the placement of trees is done as much as possible not to block the direction of the wind and can direct the movement of the wind towards the building. The shape of the building plan is also designed to have a space such as a single banked room so that the wind can penetrate inside easily and the movement of the wind keeps changing so that humidity can be reduced.

Design testing on the sunlight intensity with Velux simulation

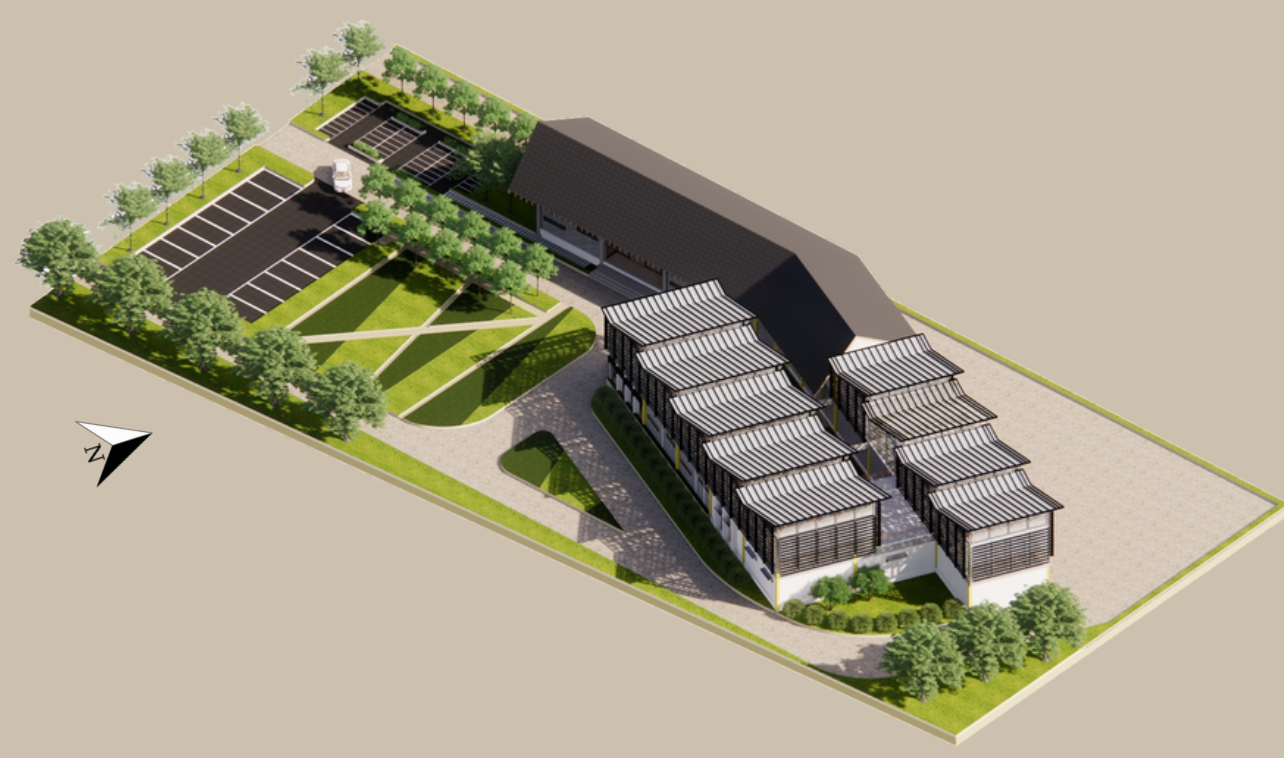


In the rendering of the Velux simulation, as shown in the following image, it shows which areas on the 1st floor of the Porang Permaculture Building receive sunlight intensity by using the Daylight Factor (%) in the Velux Simulation. The picture shows that Planting room 1 (seeds in the form of small tuber) has an average Daylight Factor value of 40,7% of the skylight outside the building that enters the building. Planting room 2 (tuber ripening) has an average Daylight Factor value of 43% and 42,3%. As for the heating/drying room (break dormancy) it has a value of 80% of the incoming sky light.

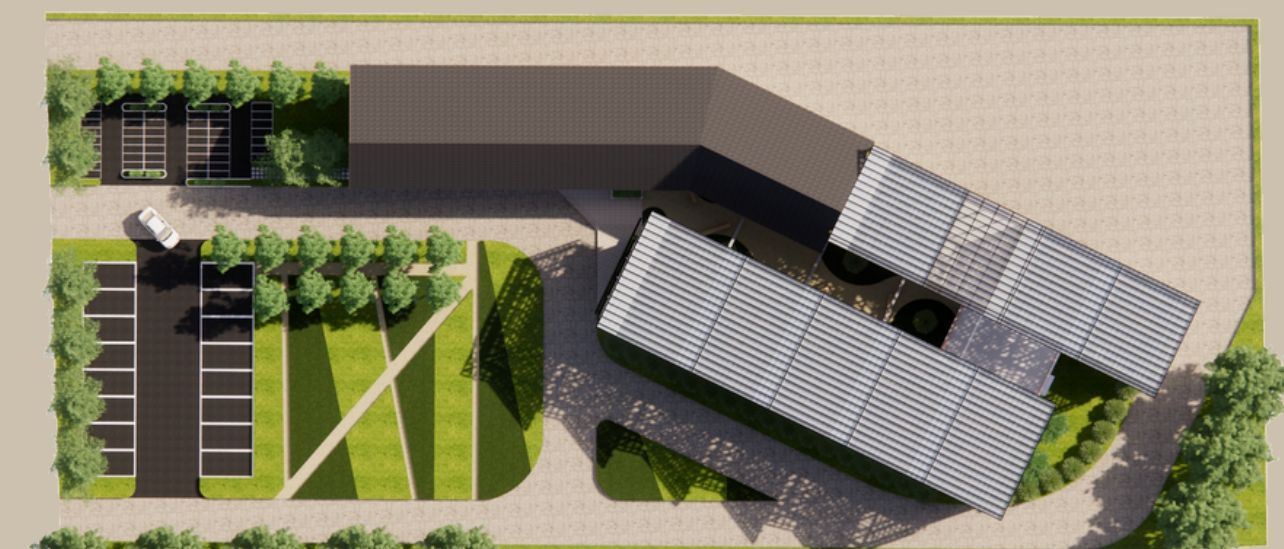


ROOM/SPACE	DAYLIGHT FACTOR/SUNLIGHT INTENSITY (%)	STANDARD OF SUNLIGHT INTENSITY (%)	FULFILLED
Planting room 1	40,7%	40 – 60%	Q2
Planting room 2	43% and 42,3%	40 – 60%	Q2
Heating/drying room	80%	70 – 100%	Q2*

Information:
Q2 = fulfilled (sunlight intensity 40 – 60%)
* = the material in Velux has a maximum light transmittance value of 81% on Glass Solid material. There is no Glass Solid material with a transmittance of 100%. So from the limitations of the simulation, the resulting value is also not more or equal to 81%.



AXONOMETRY



TOP VIEW



LANDSCAPE DESIGN

INTERIOR PERSPECTIVE



INNER COURTYARD



PLANTING ROOM 1 (SEEDS IN THE FORM OF SMALL PORANG TUBER)



HEATING/DRYING ROOM



GROUND FLOOR CORRIDOR



MANAGER AND ADMINISTRATION ROOM



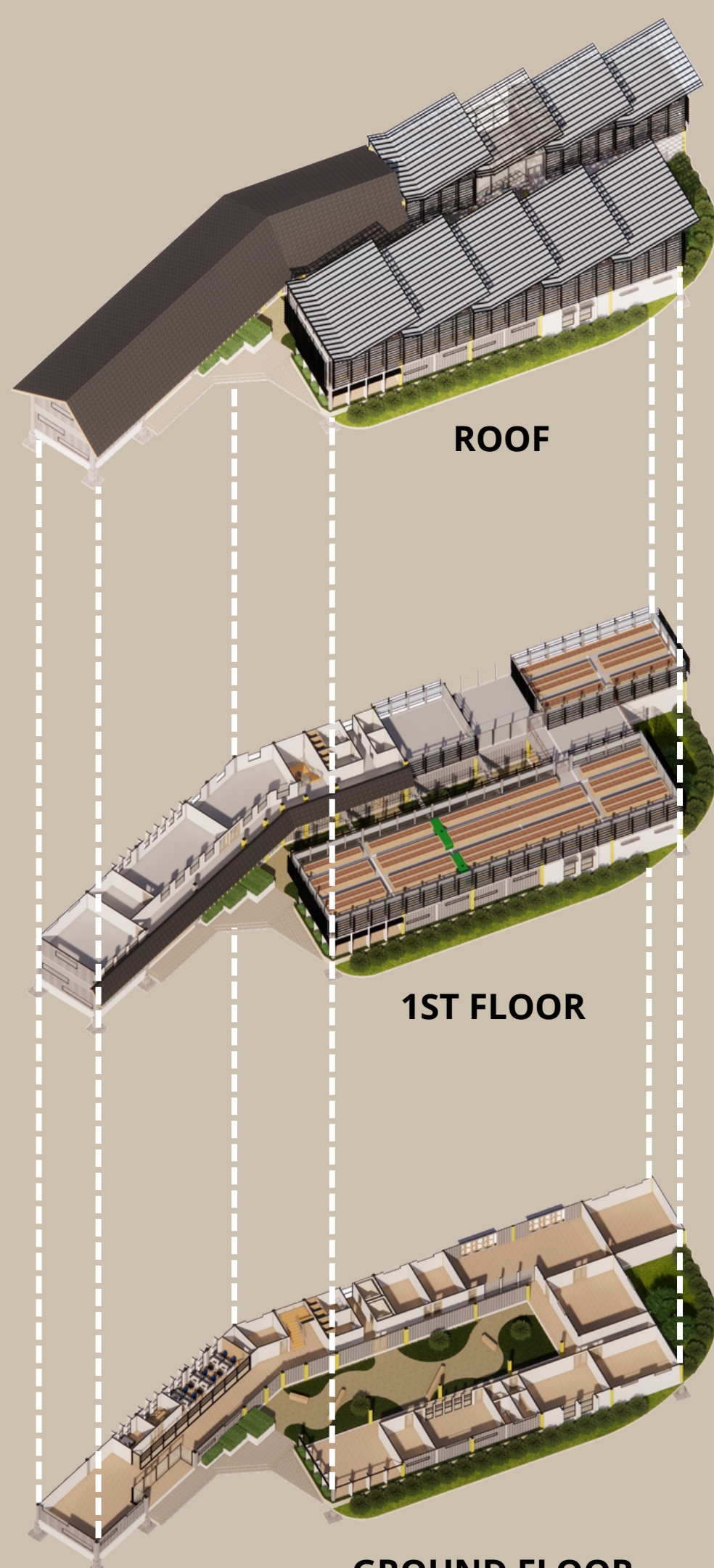
PLANTING ROOM 2 (TUBER RIPENING STAGE)



SOIL PREPERATION ROOM



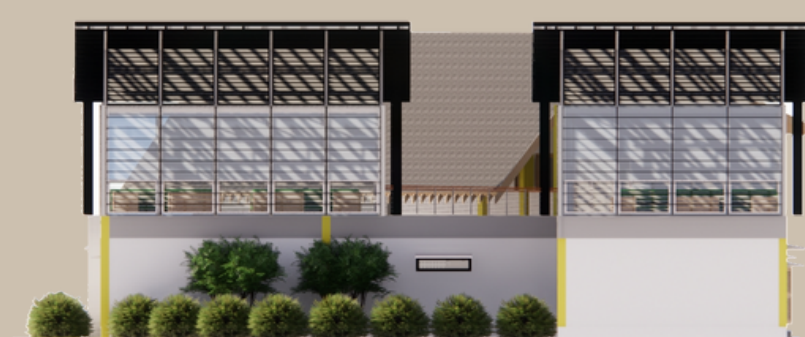
CANTEEN



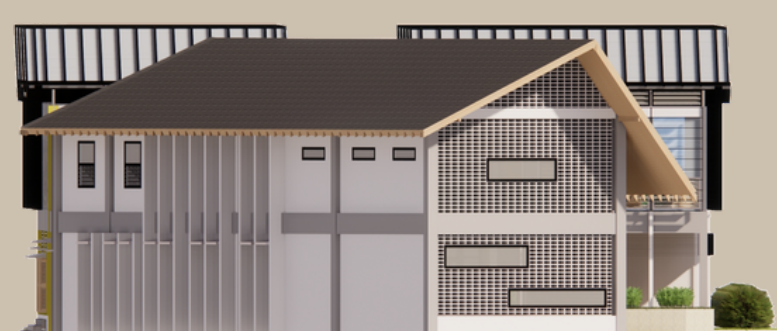
ROOF

1ST FLOOR

GROUND FLOOR



EAST ELEVATION



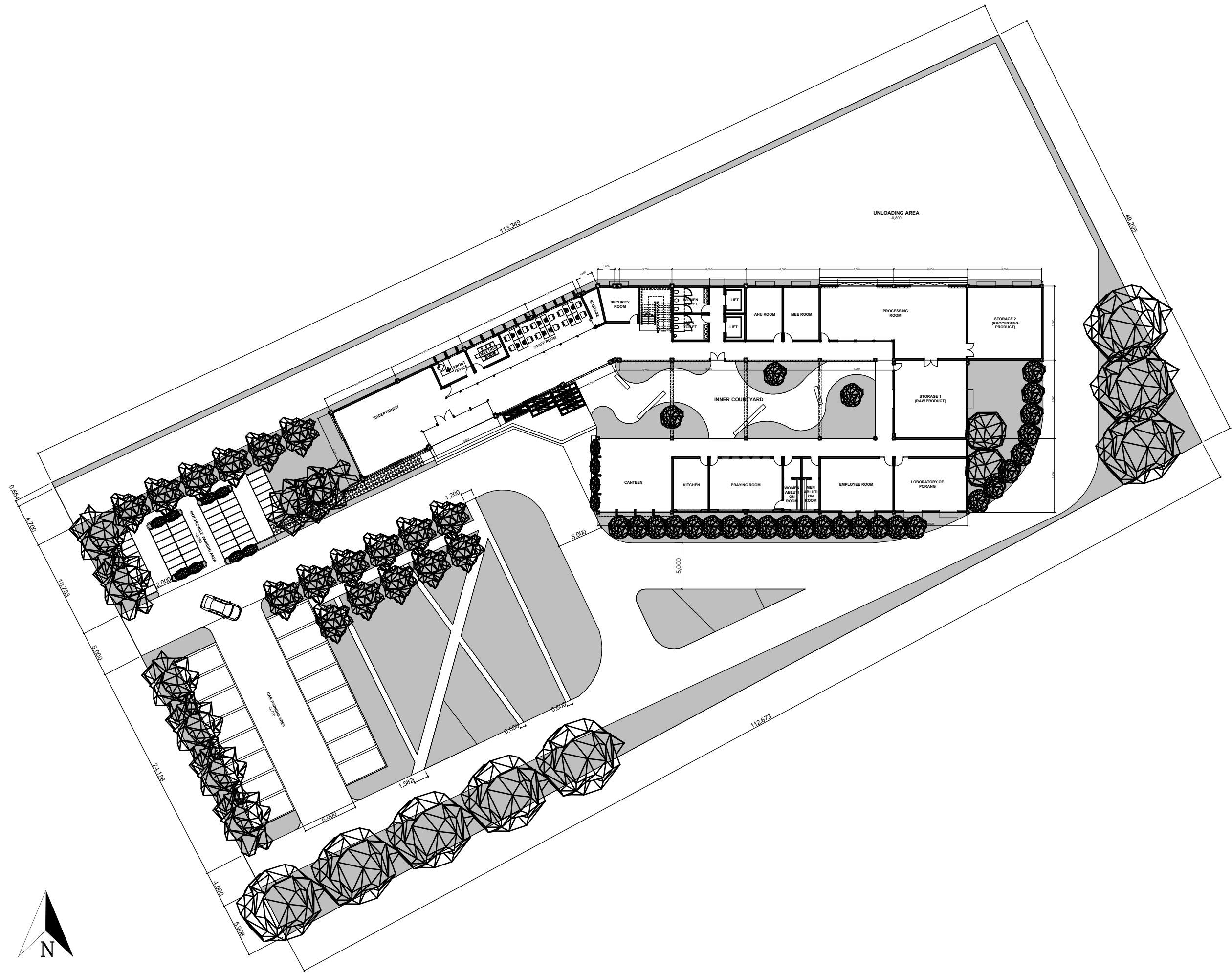
WEST ELEVATION



SOUTH ELEVATION



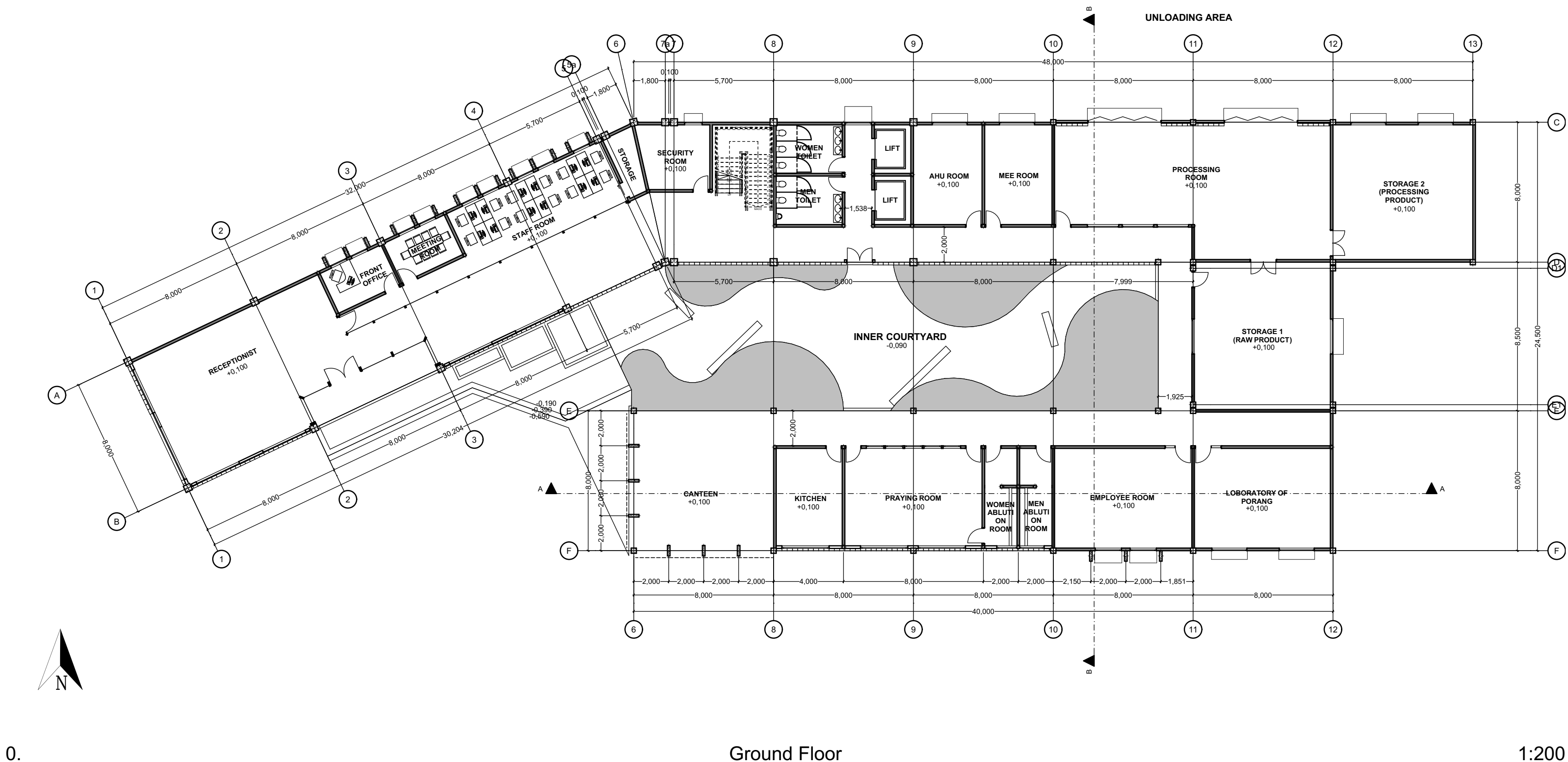
NORTH ELEVATION

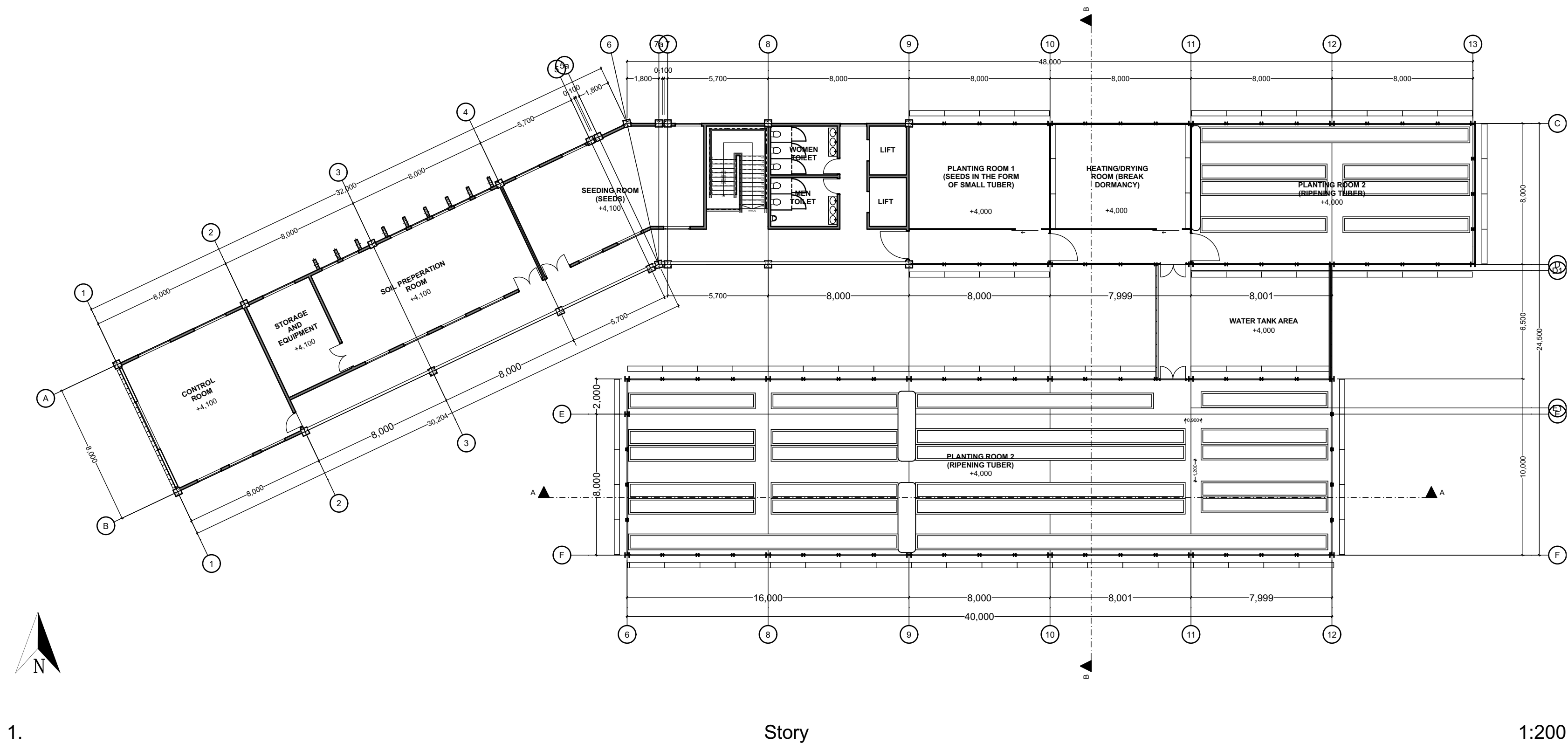


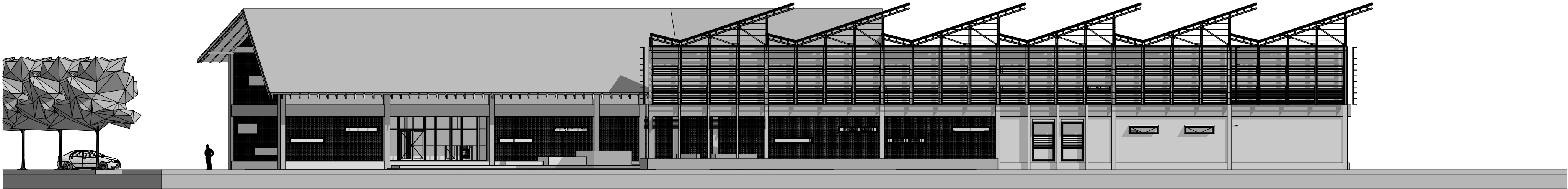
0.

Ground Floor

1:400







SOUTH

Elevation

1:200



NORTH

Elevation

1:200

<div><p>FINAL ARCHITECTURAL DESIGN STUDIO</p></div>	<div>NAME: SALSABELLA</div> <div>NIM: 18512144</div>	<div>BUILDING NAME:</div> <div>PORANG PERMACULTURE BUILDING</div>	<div>LOCATION:</div> <div>Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243</div>	<div>LECTURER:</div> <div>Prof. Noor Cholis Idham, Ph.D., I.A.I</div>	<div>TITLE: NORTH AND SOUTH ELEVATIONS</div> <div>SCALE: 1:200</div>
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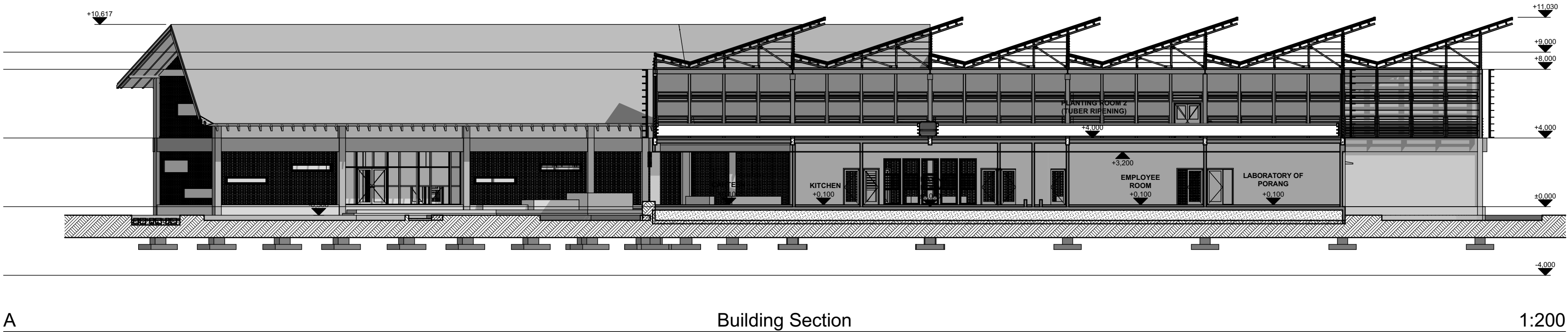


EAST Elevation 1:200

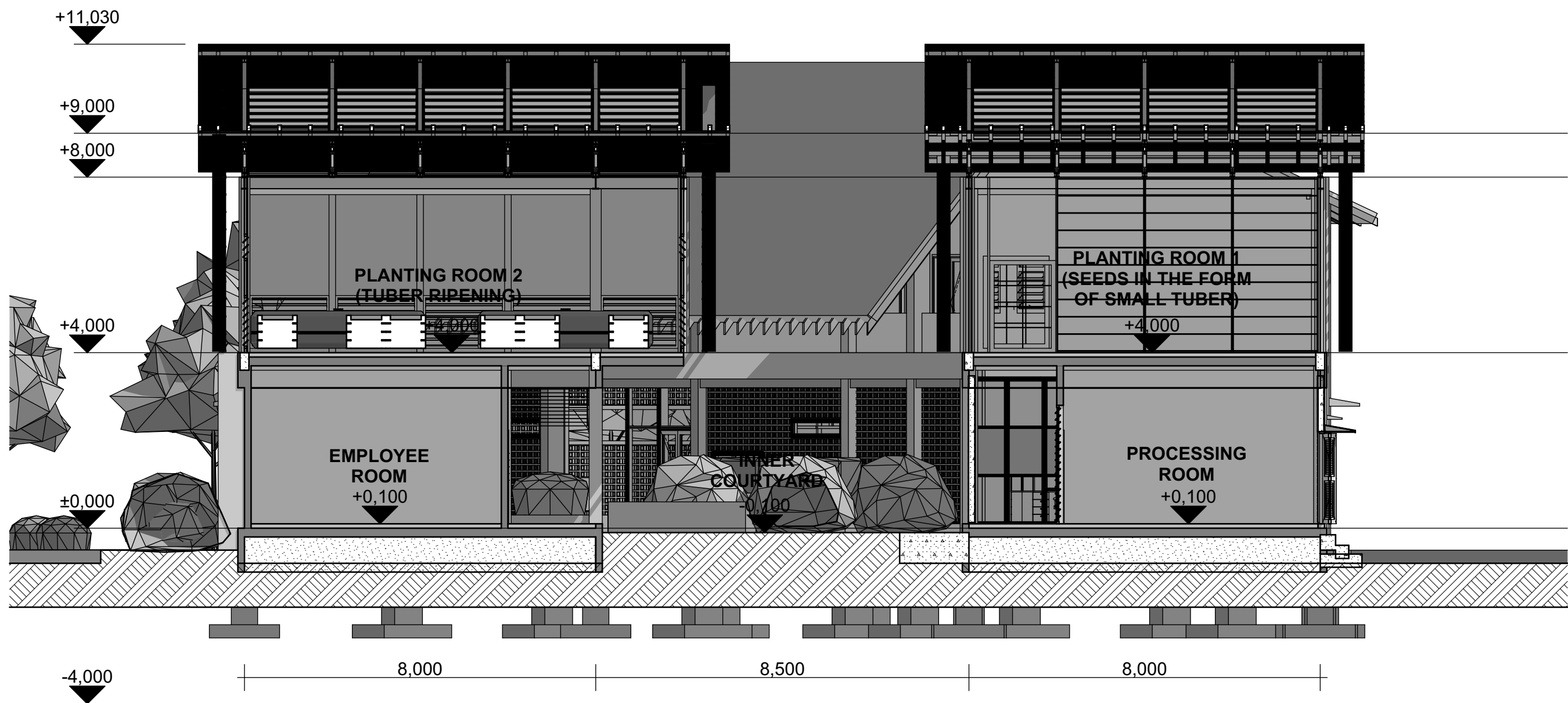


WEST Elevation 1:200

 <p>FINAL ARCHITECTURAL DESIGN STUDIO</p>	<p>NAME: SALSABELLA</p> <p>NIM: 18512144</p>	<p>BUILDING NAME: PORANG PERMACULTURE BUILDING</p>	<p>LOCATION: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243</p>	<p>LECTURER: Prof. Noor Cholis Idham, Ph.D., I.A.I</p>	<p>TITLE: WEST AND EAST ELEVATIONS</p> <p>SCALE: 1:200</p>
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 <p>FINAL ARCHITECTURAL DESIGN STUDIO</p>	<p>NAME: SALSABELLA</p> <p>NIM: 18512144</p>	<p>BUILDING NAME: PORANG PERMACULTURE BUILDING</p>	<p>LOCATION: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243</p>	<p>LECTURER: Prof. Noor Cholis Idham, Ph.D., I.A.I</p>	<p>TITLE: SECTION A-A</p> <p>SCALE: 1:200</p>
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B

Building Section

1:100



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

NIM:
18512144

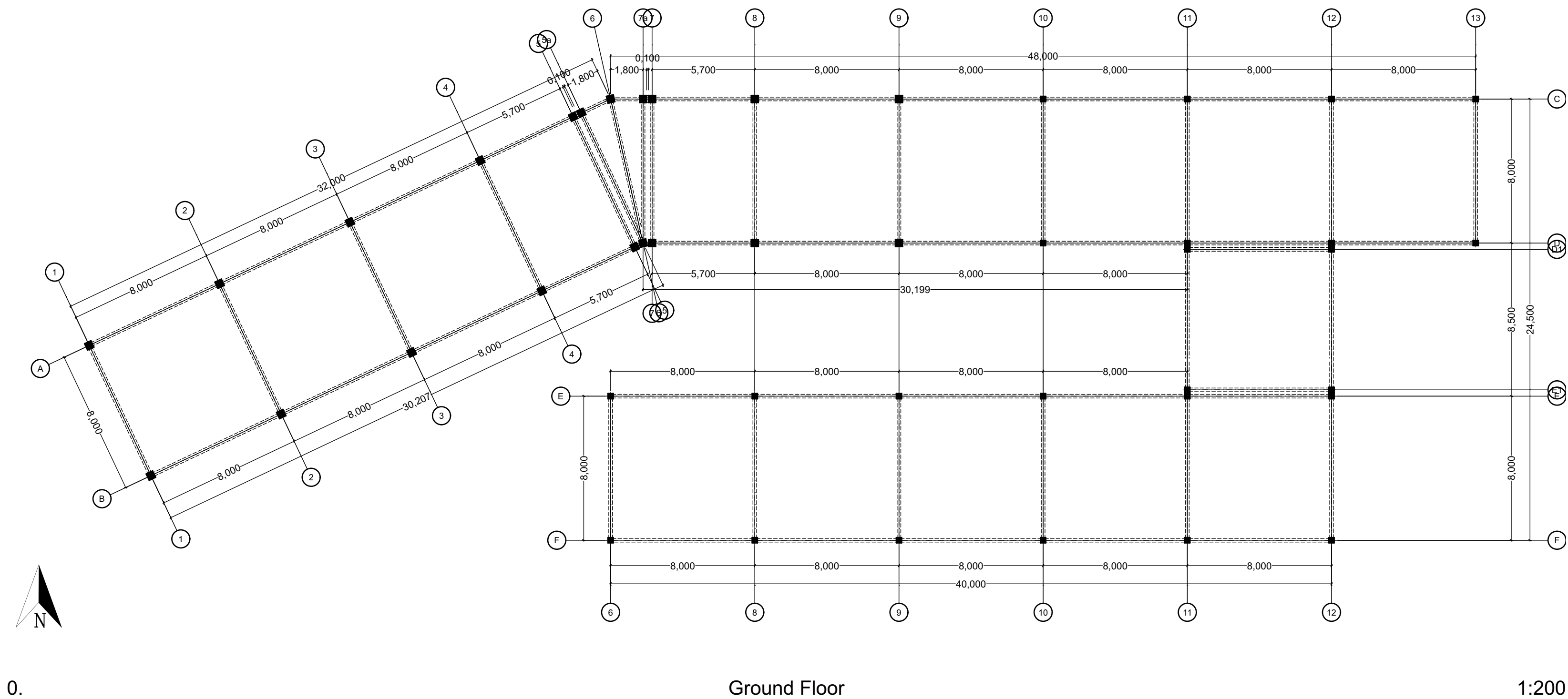
BUILDING NAME:
PORANG PERMACULTURE
BUILDING

LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

LECTURER:
Prof. Noor Cholis Idham, Ph.D.,
I.A.I

TITLE:
SECTION B-B

SCALE:
1:100



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

NIM:
18512144

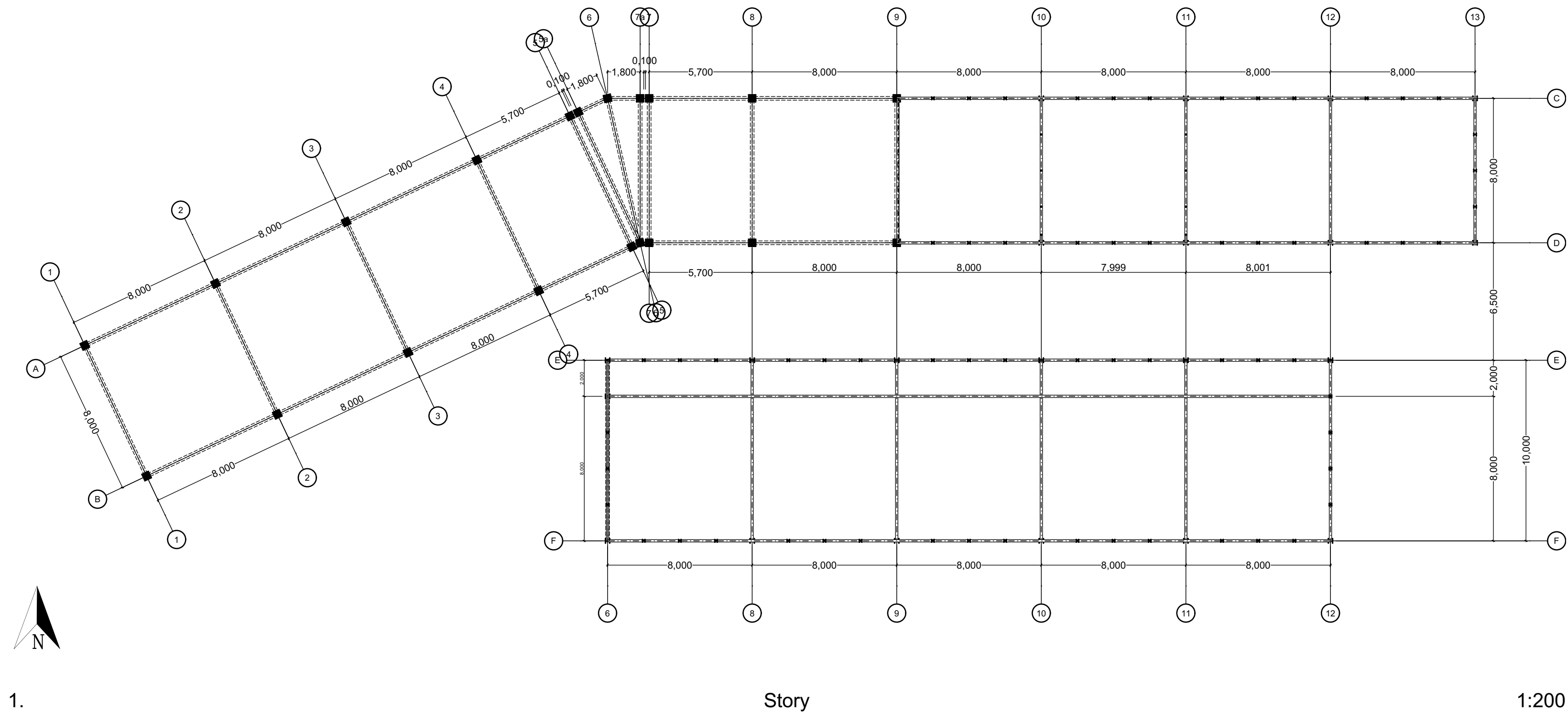
BUILDING NAME:
PORANG PERMACULTURE
BUILDING

LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

LECTURER:
Prof. Noor Cholis Idham, Ph.D.,
I.A.I

TITLE:
GROUND FLOOR COLUMN
AND BEAM PLAN

SCALE:
1:200



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

NIM:
18512144

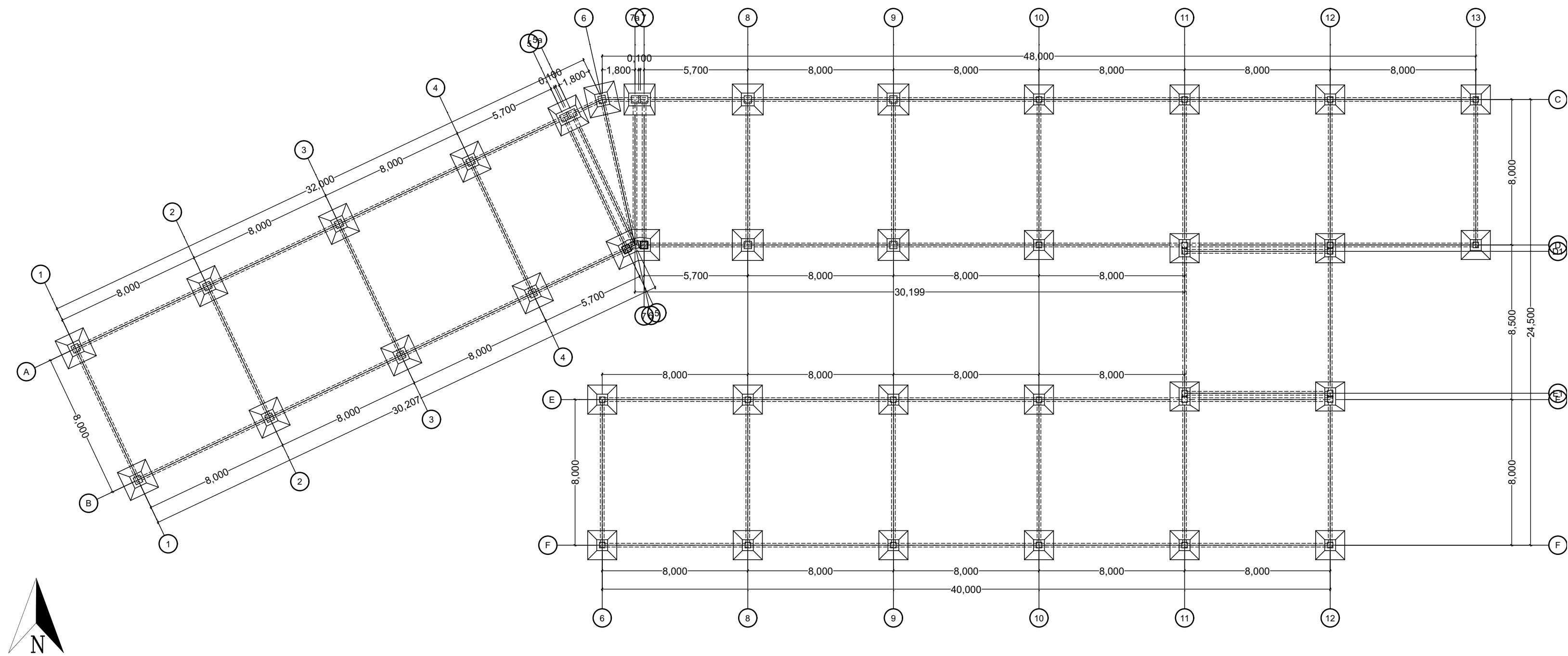
BUILDING NAME:
PORANG PERMACULTURE
BUILDING

LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

LECTURER:
Prof. Noor Cholis Idham, Ph.D.,
I.A.I

TITLE:
1st FLOOR COLUMN AND
BEAM PLAN

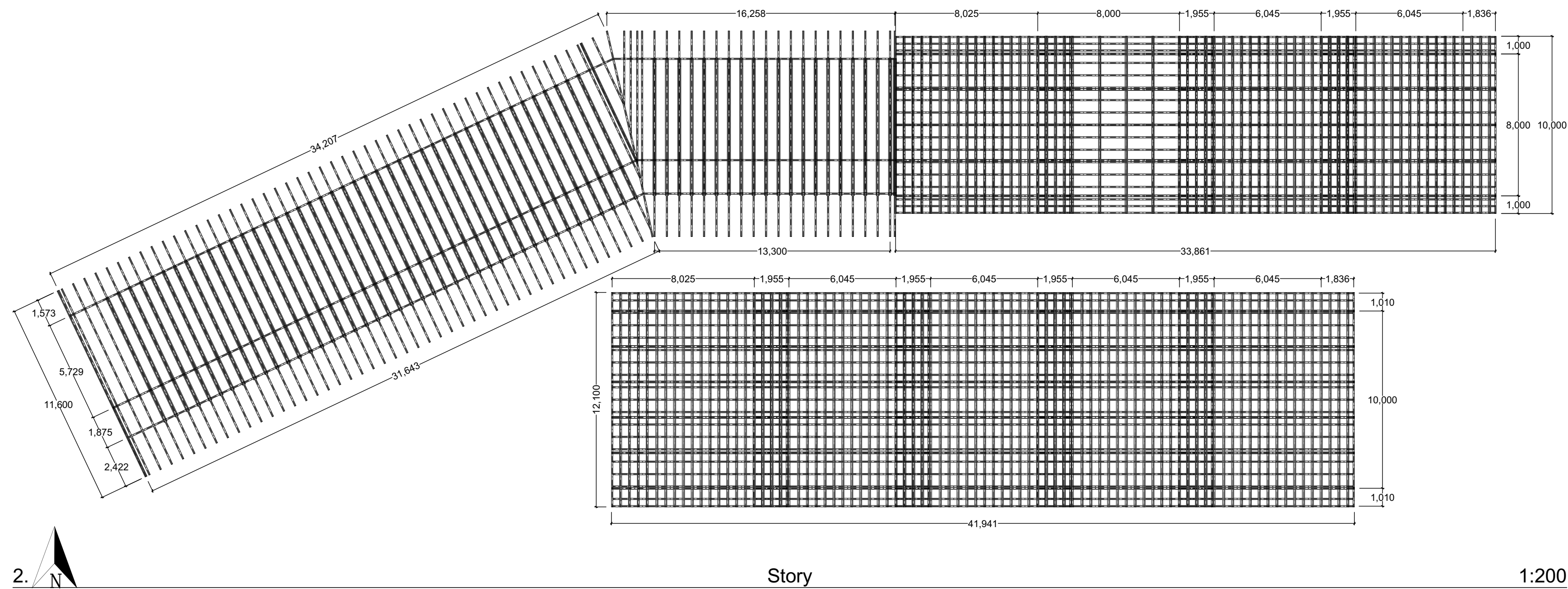
SCALE:
1:200



0.

Ground Floor

1:200



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

NIM:
18512144

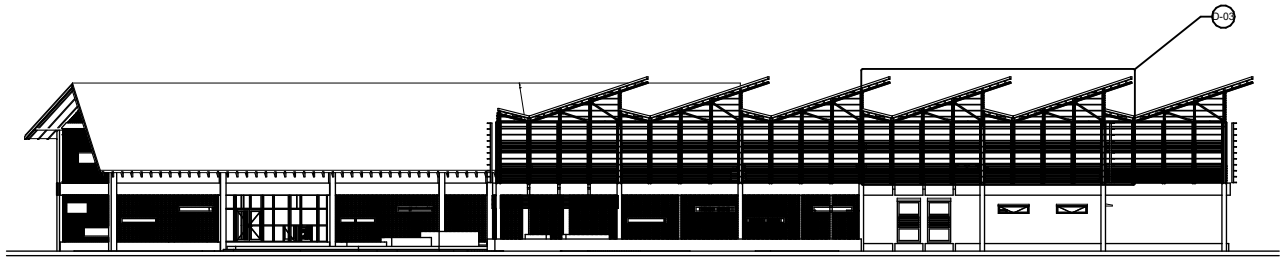
BUILDING NAME:
PORANG PERMACULTURE
BUILDING

LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

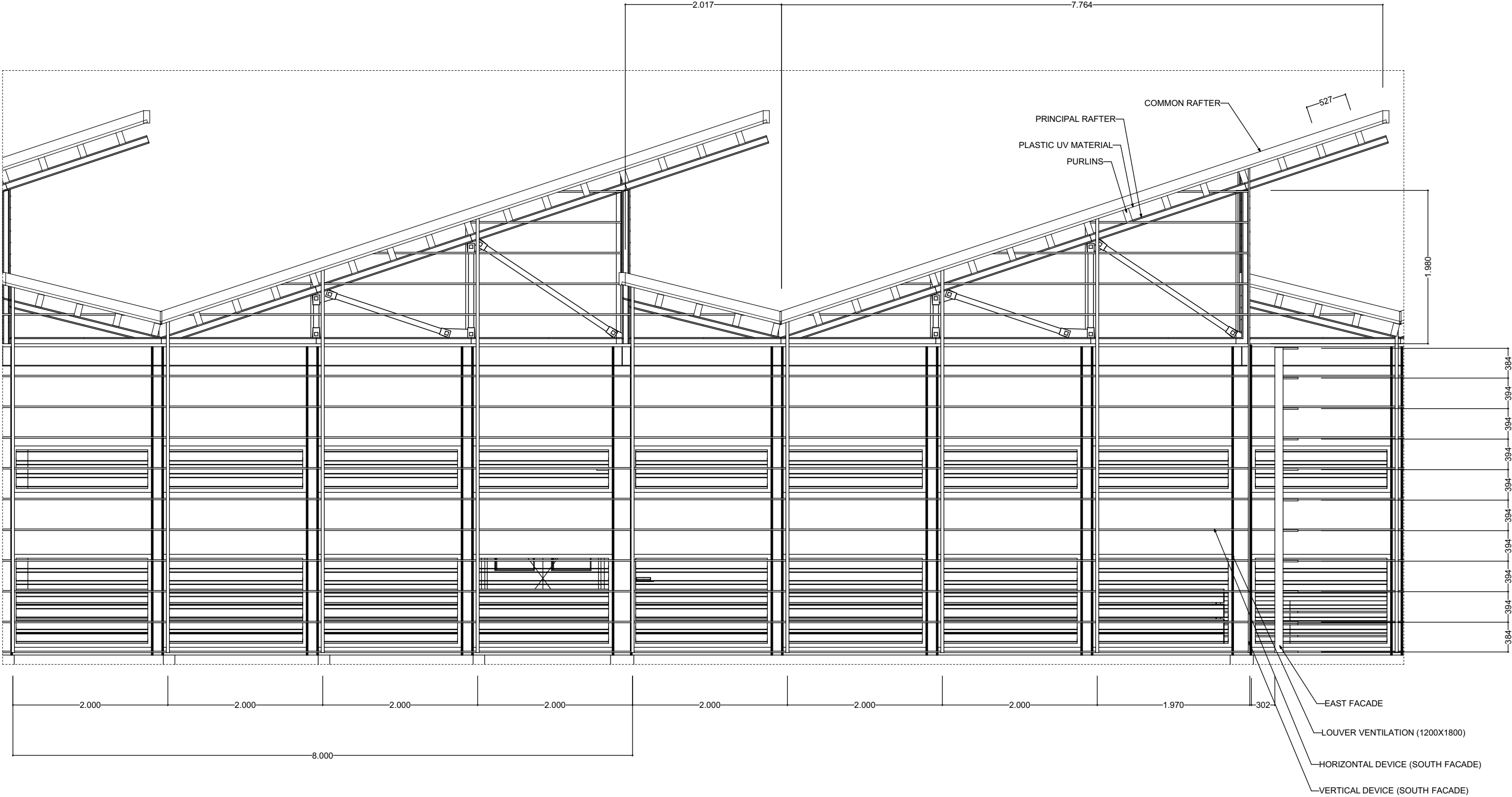
LECTURER:
Prof. Noor Cholis Idham, Ph.D.,
I.A.I

TITLE:
ROOF STRUCTURAL PLAN

SCALE:
1:200



SOUTH Elevation 1:500

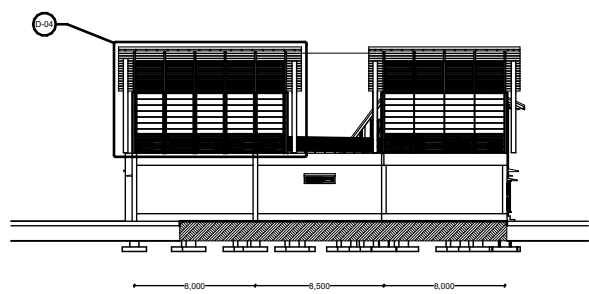


D-03 Detail 1:50

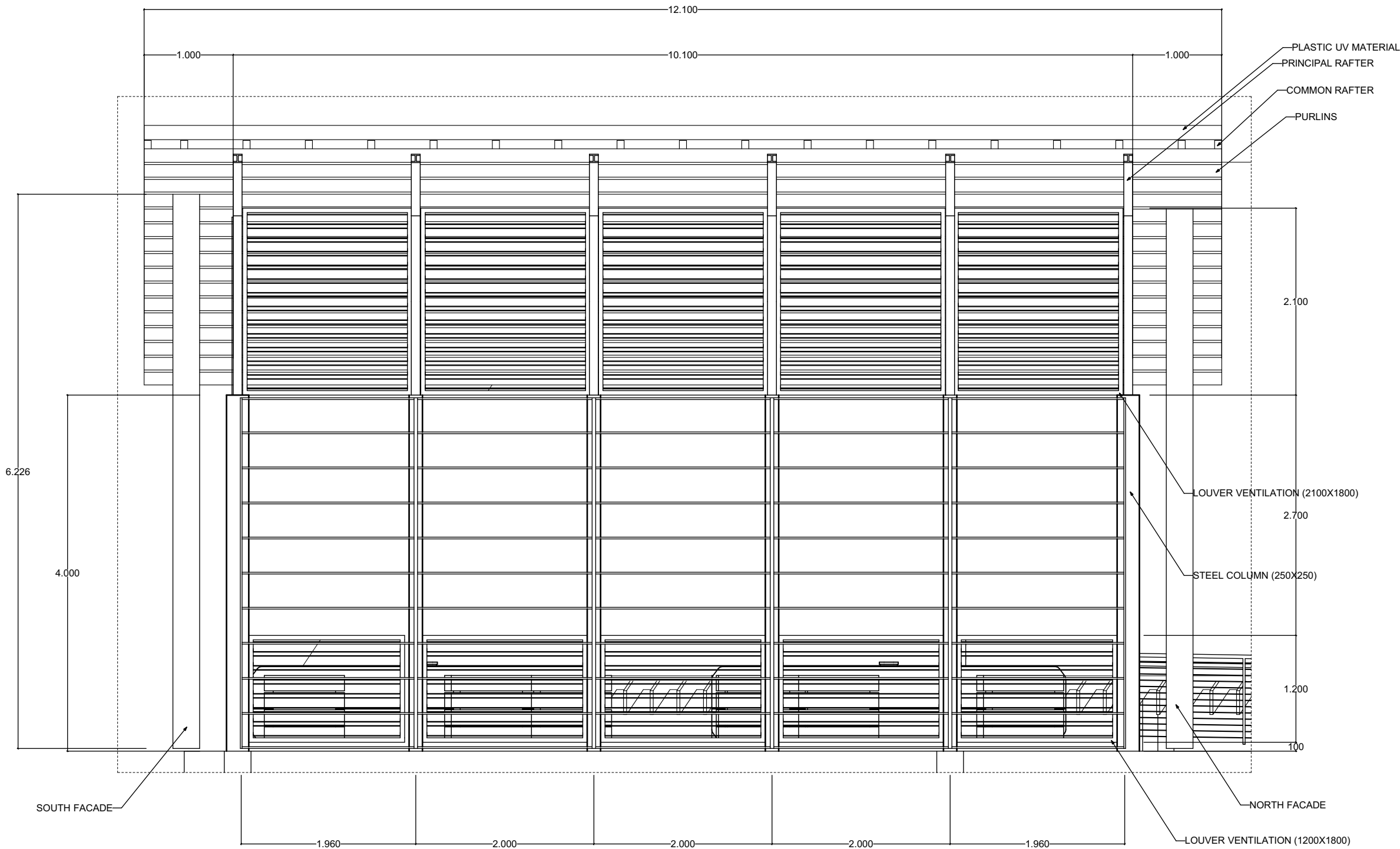
<div><p>FINAL ARCHITECTURAL DESIGN STUDIO</p></div>	<div><p>NAME: SALSABELLA</p><p>NIM: 18512144</p></div>	<div><p>BUILDING NAME: PORANG PERMACULTURE BUILDING</p></div>	<div><p>LOCATION: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243</p></div>	<div><p>LECTURER: Prof. Noor Cholis Idham, Ph.D., I.A.I</p></div>	<div><p>TITLE: PLANTING ROOM SOUTH FACADE DETAIL (D-03)</p><p>SCALE: 1:50</p></div>
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D-01	Detail	1:20
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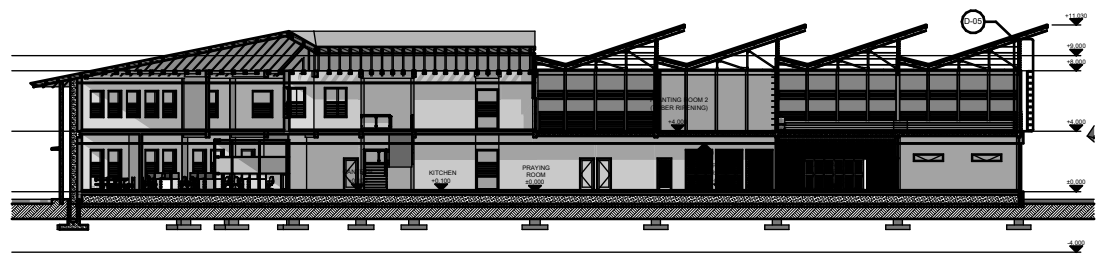


EAST Elevation 1:500

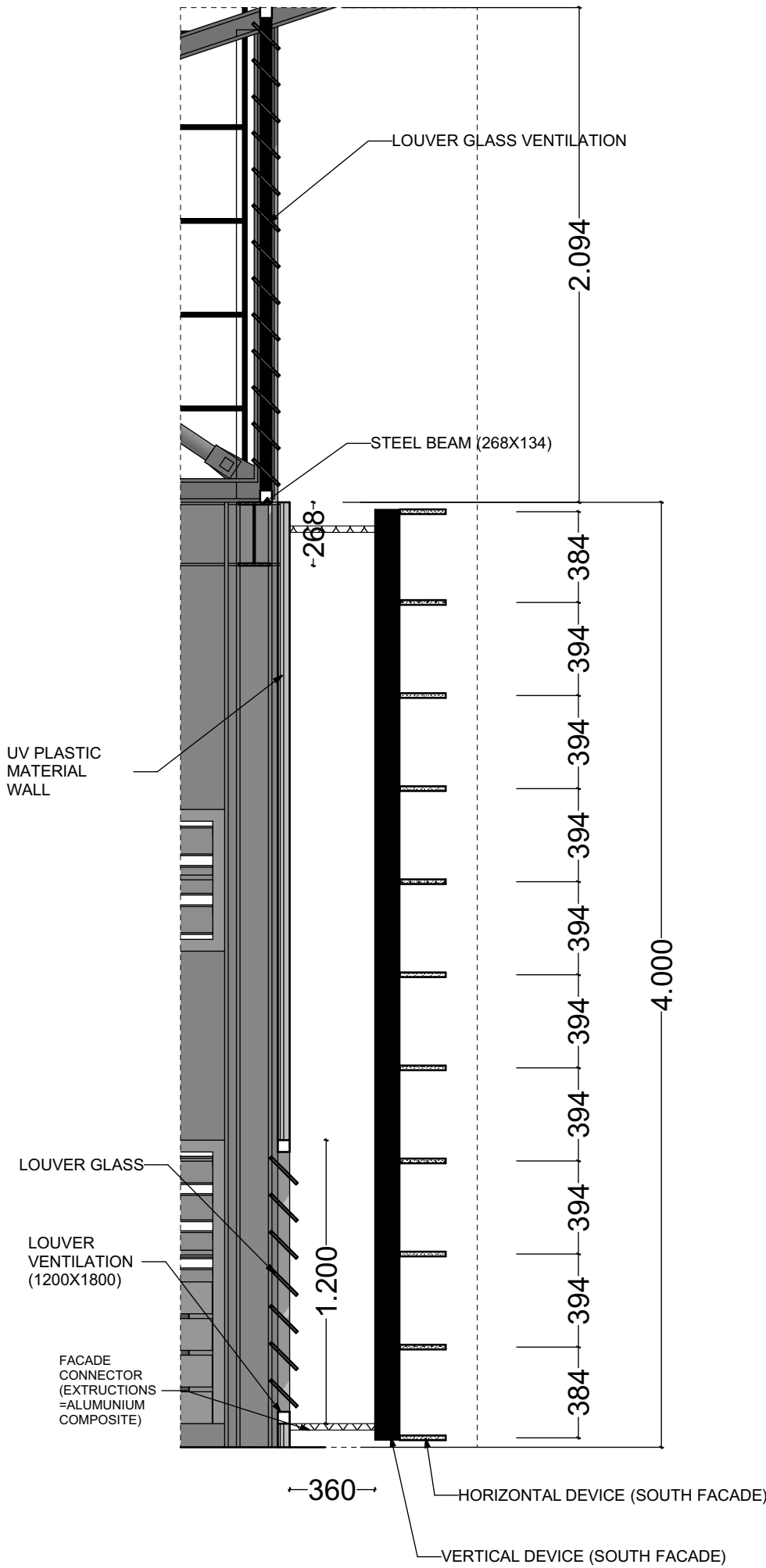


D-04 Detail 1:50

 <p>FINAL ARCHITECTURAL DESIGN STUDIO</p>	<p>NAME: SALSABELLA</p> <p>NIM: 18512144</p>	<p>BUILDING NAME: PORANG PERMACULTURE BUILDING</p>	<p>LOCATION: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243</p>	<p>LECTURER: Prof. Noor Cholis Idham, Ph.D., I.A.I</p>	<p>TITLE: PLANTING ROOM EAST FACADE DETAIL (D-04)</p> <p>SCALE: 1:50</p>
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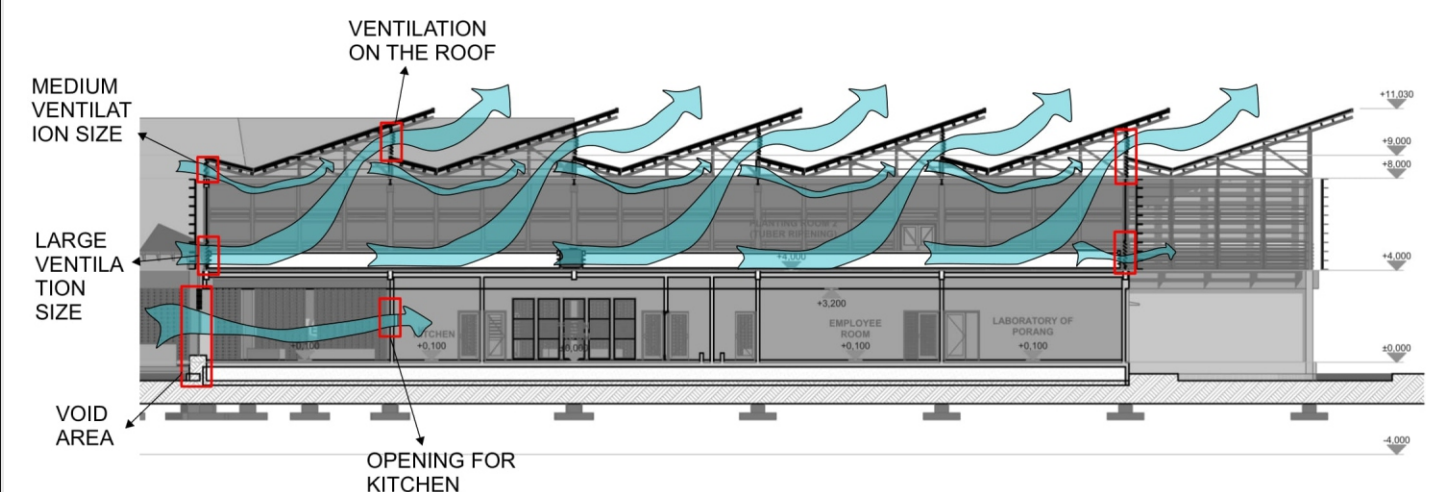


A Building Section 1:500

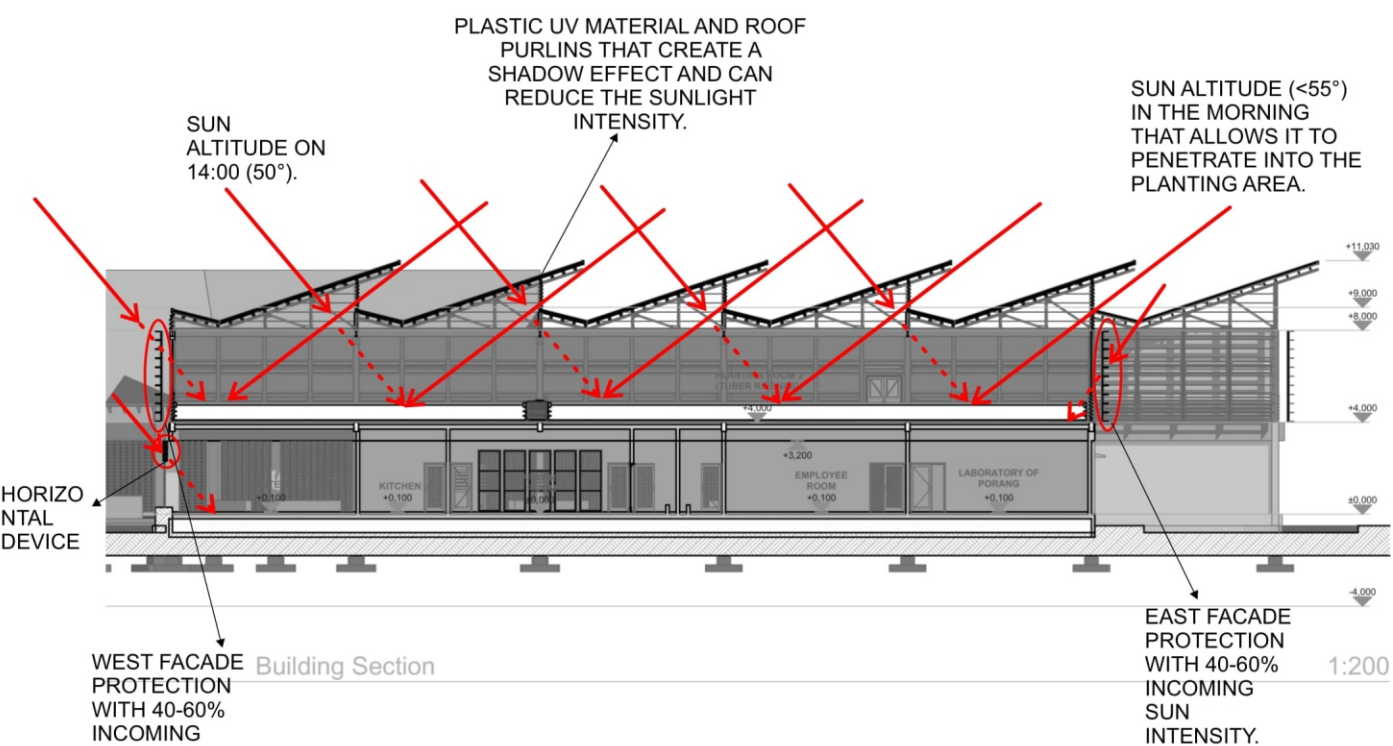


D-05 Detail 1:25

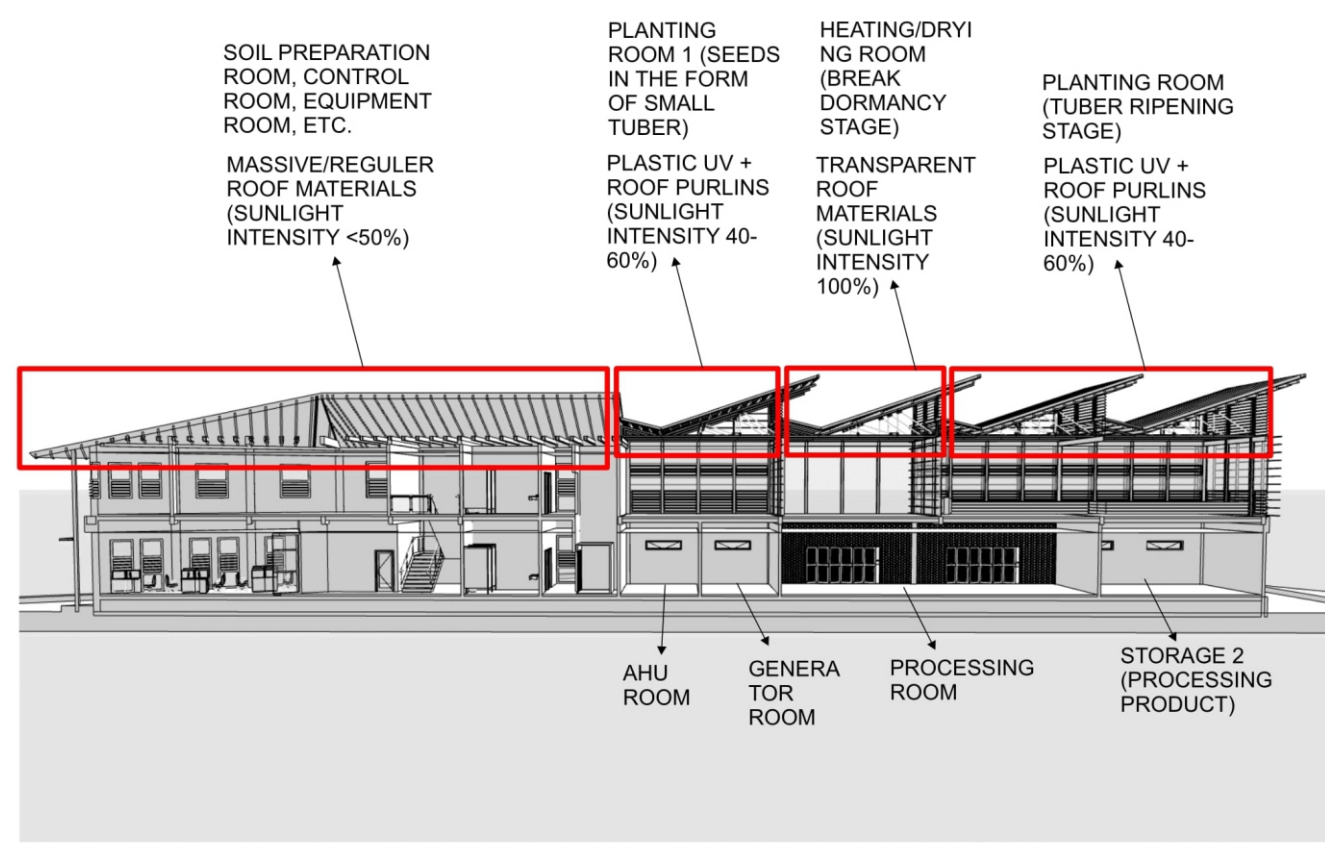
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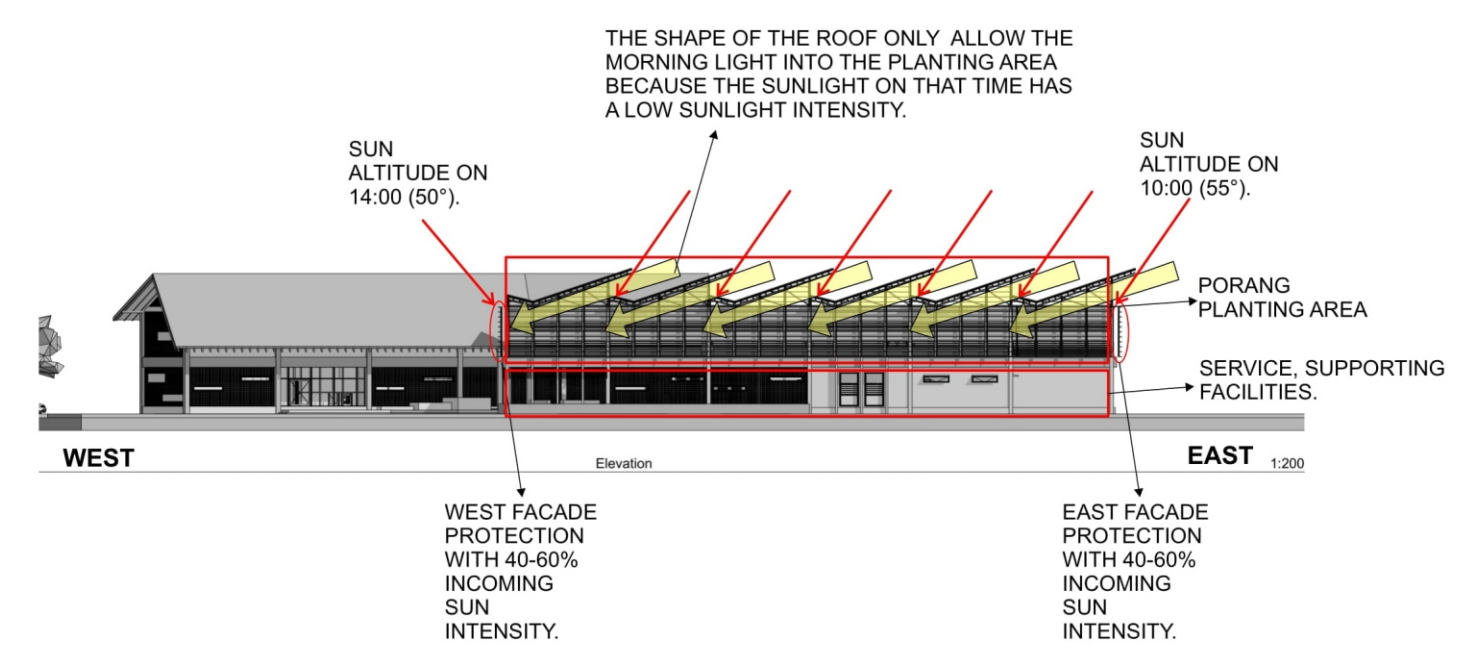
AIR CIRCULATION IN PORANG PLANTING ROOM



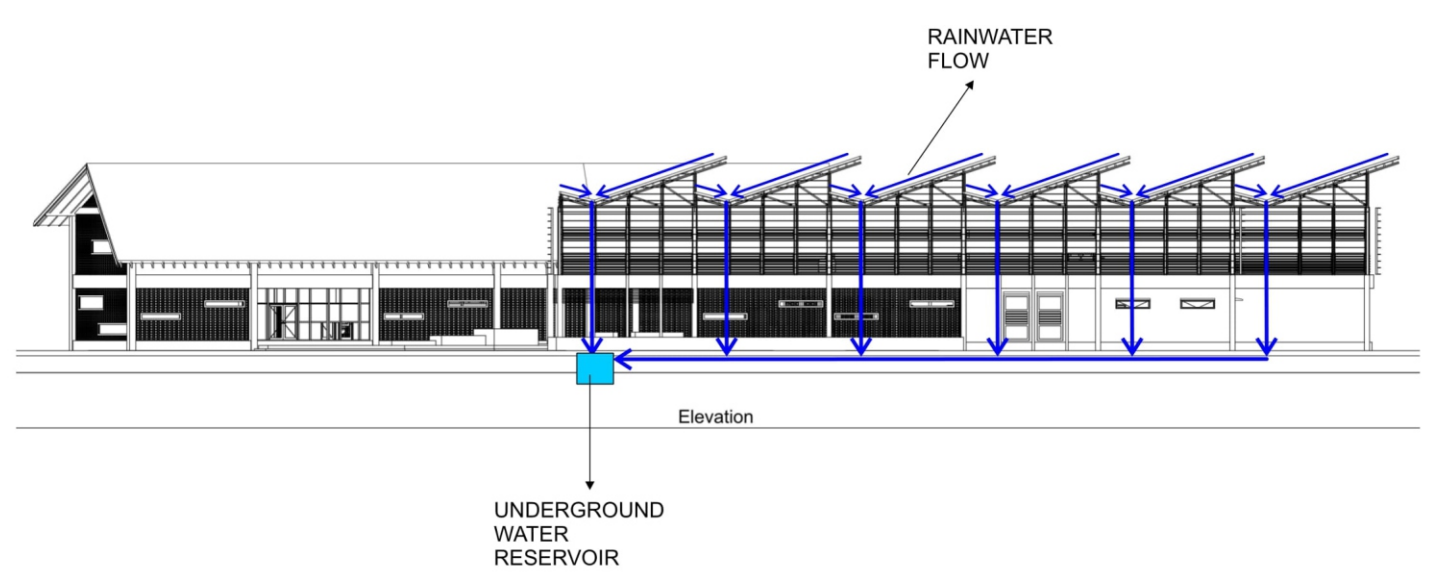
SUNLIGHT POSITION IN THE PORANG PLANTING ROOM



THE DIVISION OF THE SOLAR INTENSITY ZONE



THE SHAPE OF THE ROOF ONLY ALLOW THE MORNING LIGHT TO PENETRATE INTO THE PLANTING ROOM



RAIN WATER HARVESTING SYSTEM IN THE ROOF DESIGN



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

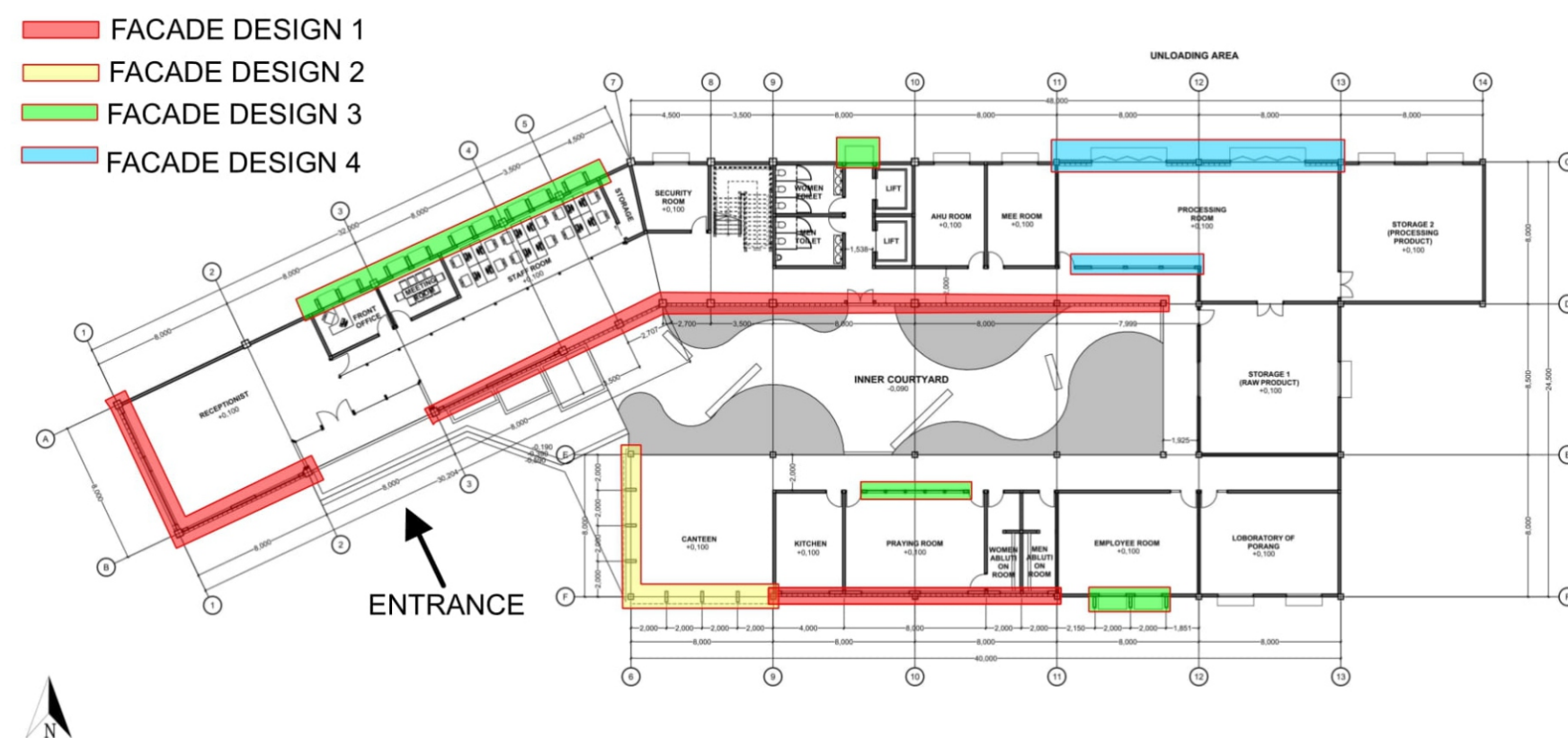
NIM:
18512144

BUILDING NAME:
PORANG PERMACULTURE
BUILDING

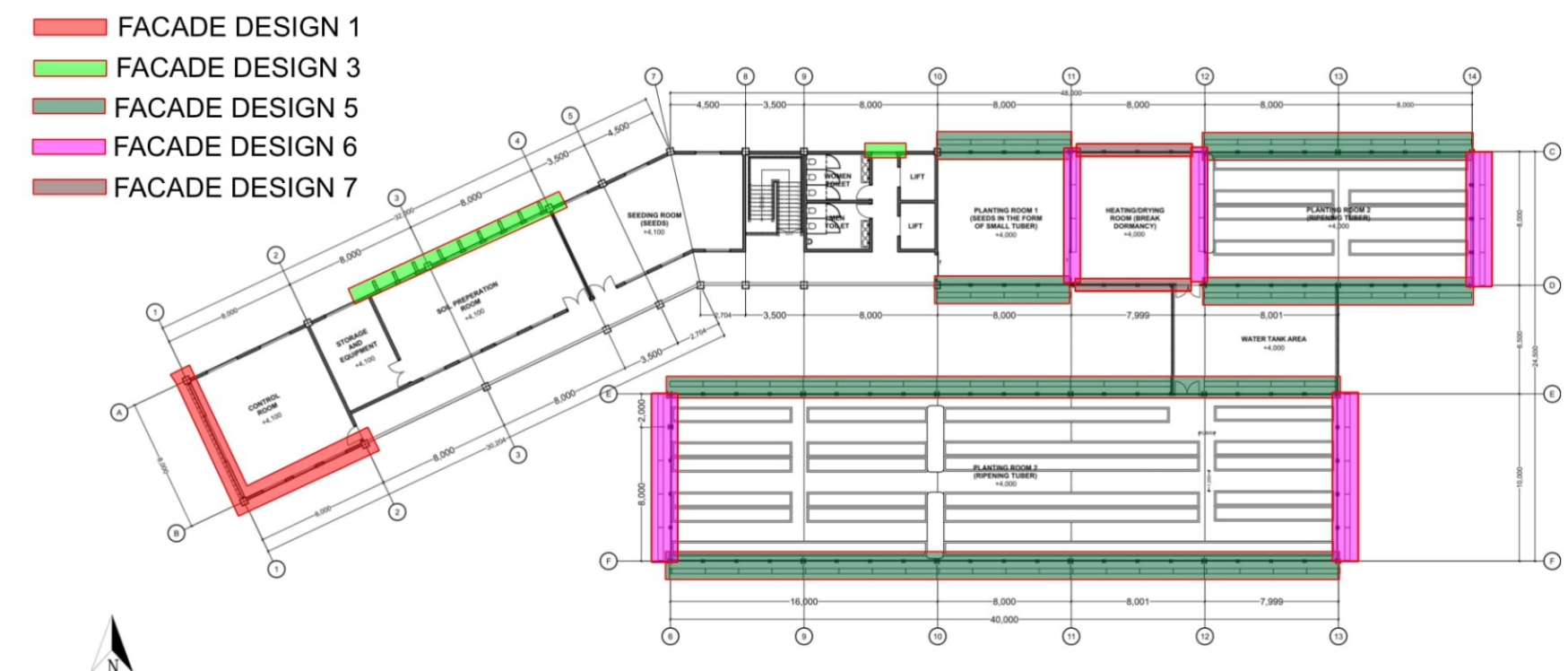
LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

LECTURER:
Prof. Noor Cholis Idham, Ph.D.,
I.A.I

TITLE:
SPECIAL
ARCHITECTURAL
DETAILS



GROUND FLOOR PLAN



1ST FLOOR PLAN



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

NIM:
18512144

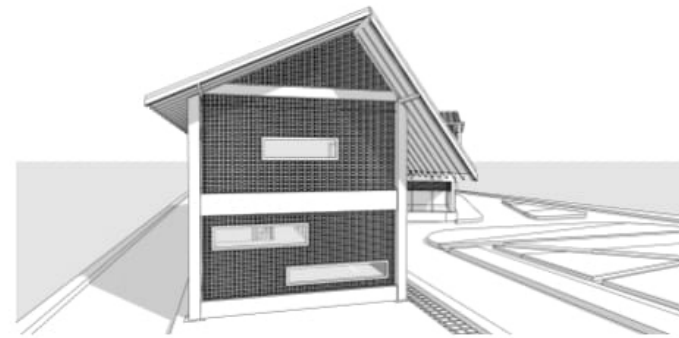
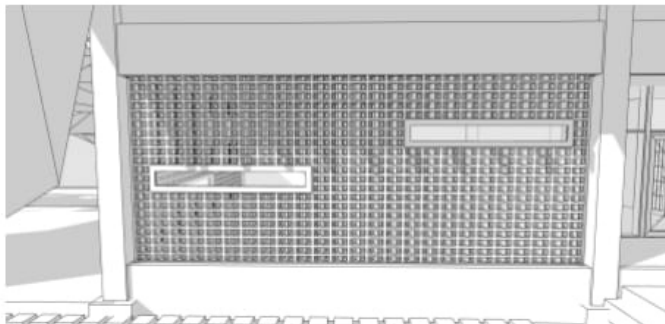
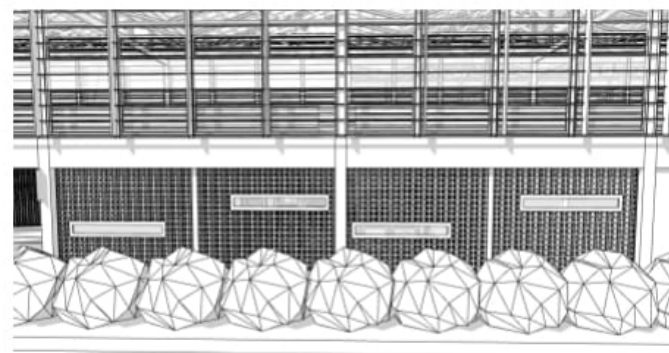
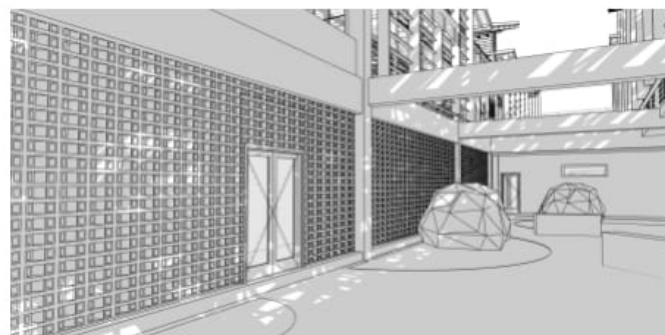
BUILDING NAME:
PORANG PERMACULTURE
BUILDING

LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

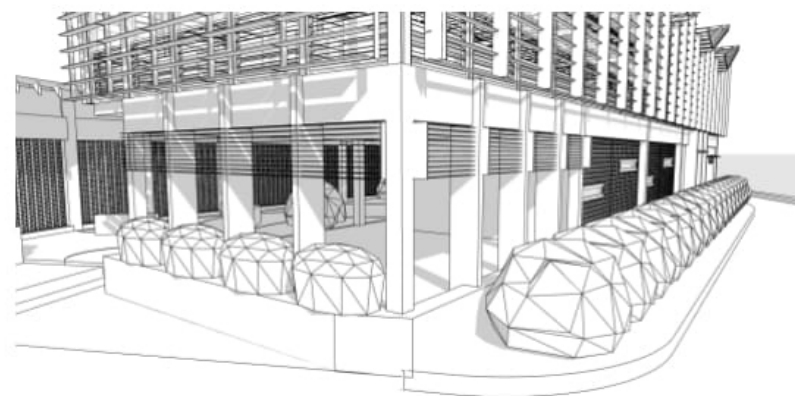
LECTURER:
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I.A.I

TITLE:
SPECIAL
ARCHITECTURAL
DETAILS

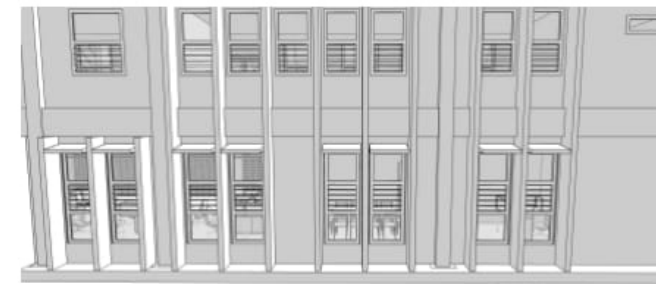
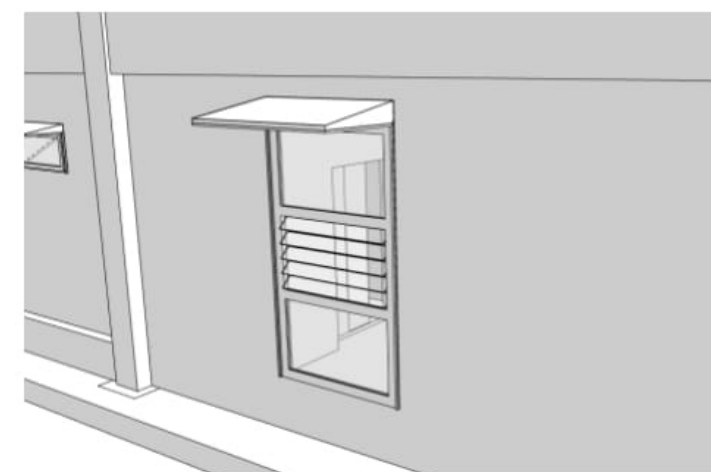
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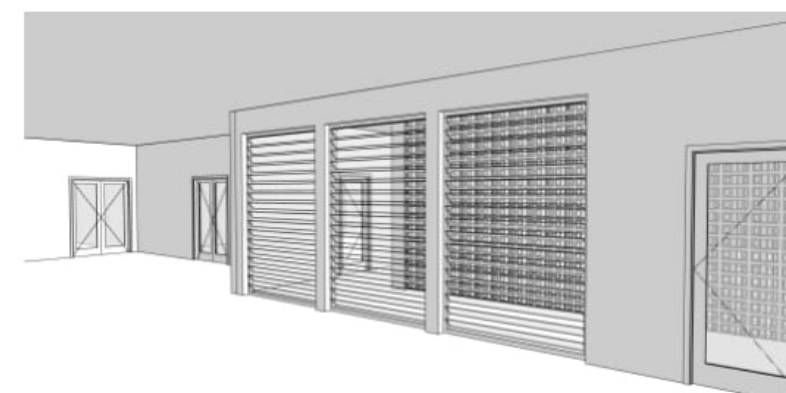
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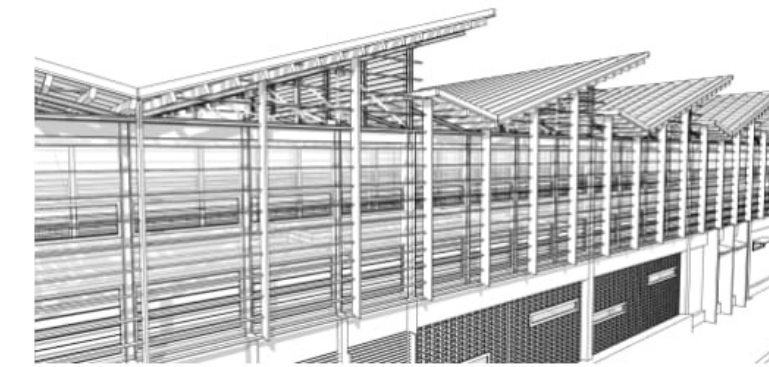
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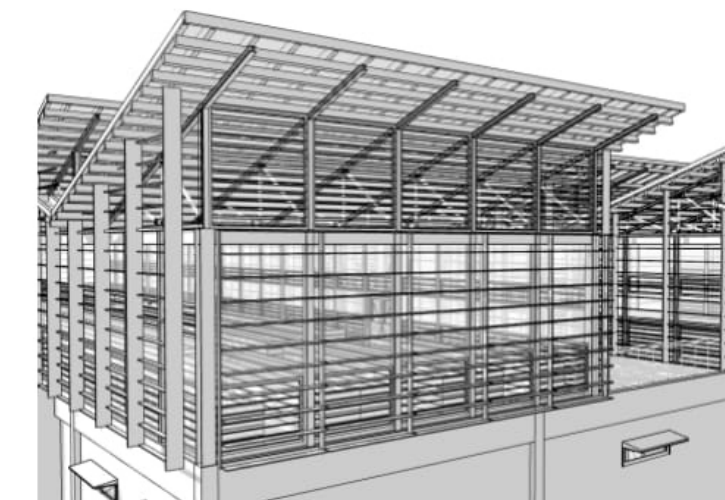
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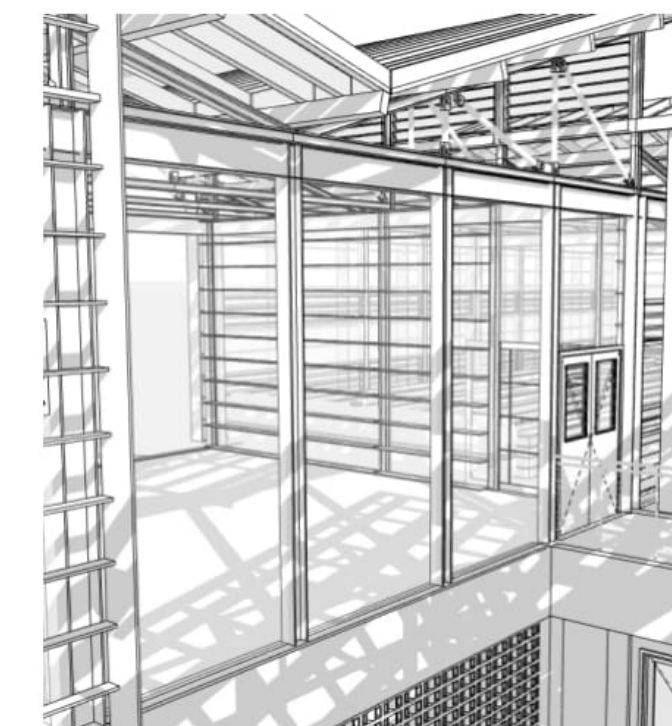
FACADE DESIGN 5



FACADE DESIGN 6



FACADE DESIGN 7



FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
SALSABELLA

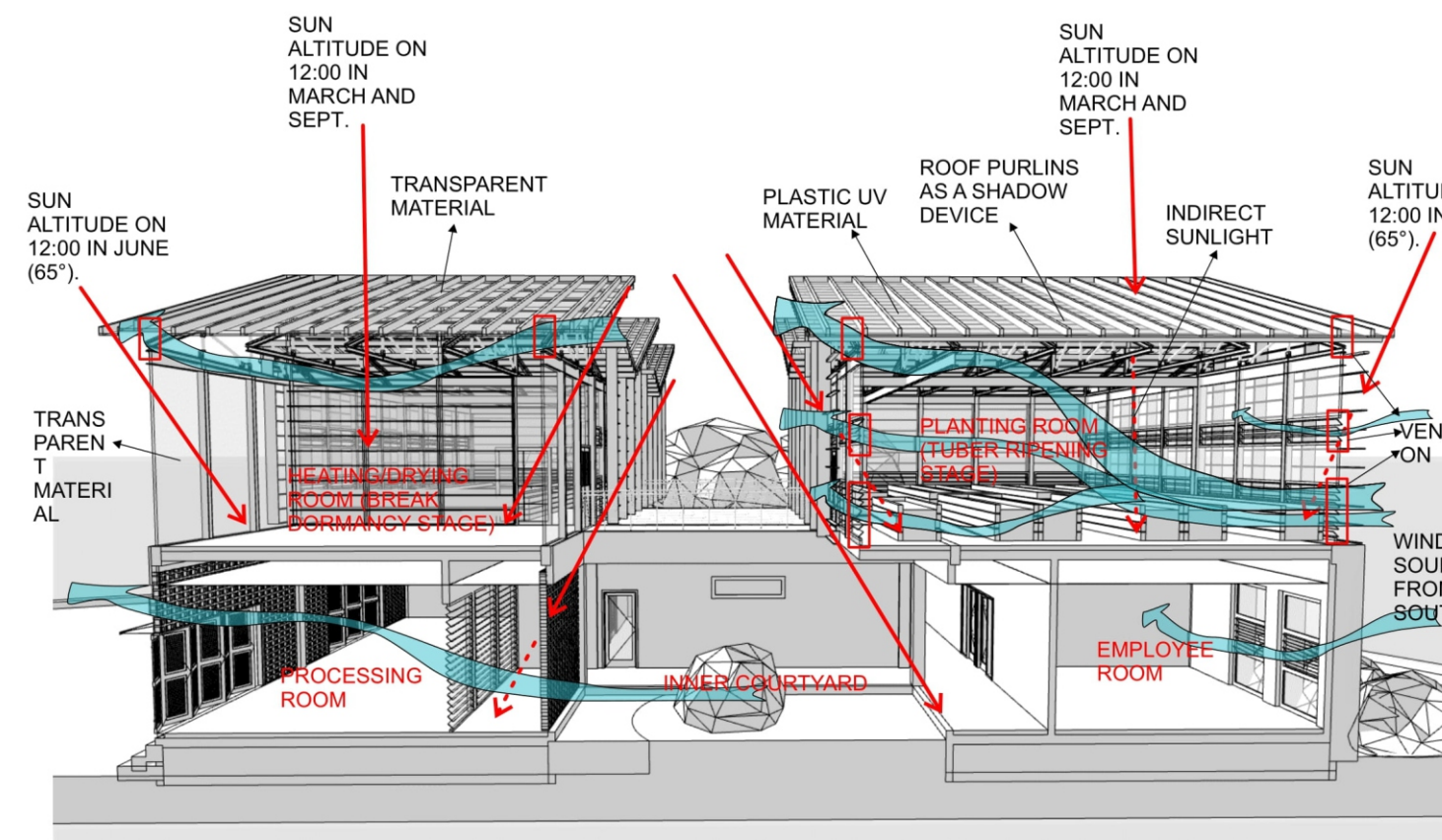
NIM:
18512144

BUILDING NAME:
PORANG PERMACULTURE
BUILDING

LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243

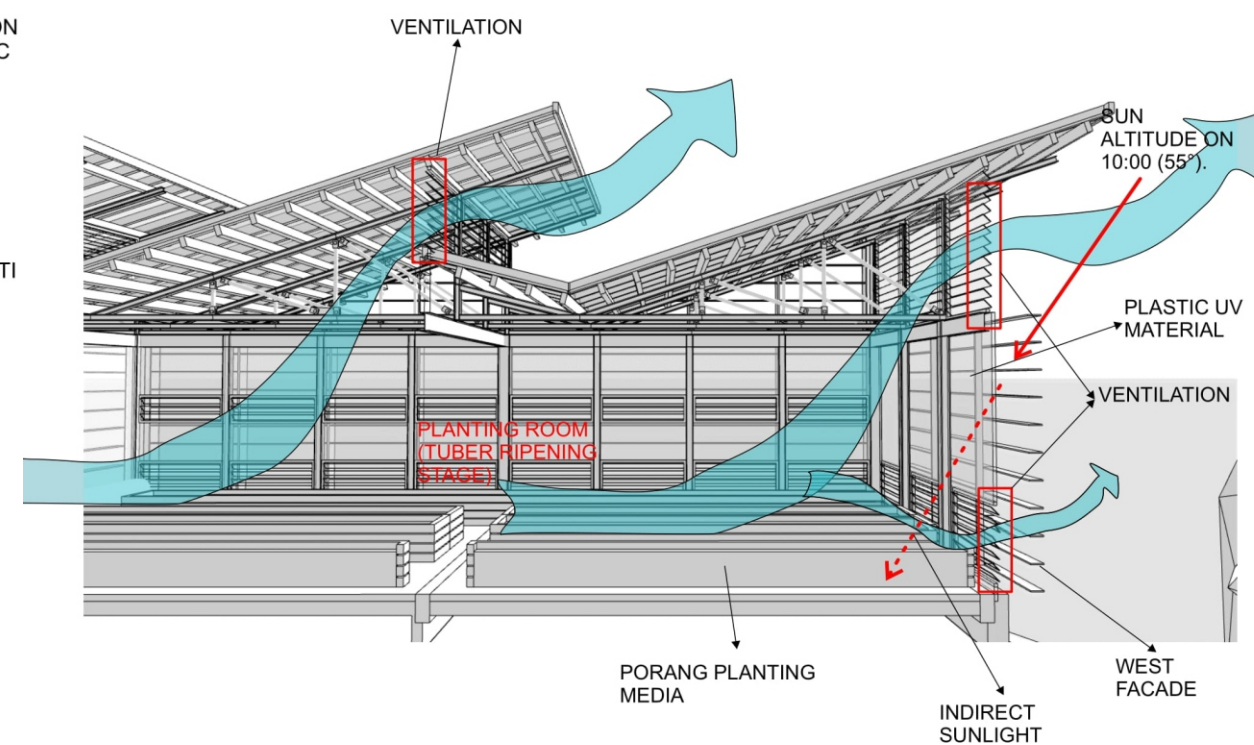
LECTURER:
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TITLE:
SPECIAL
ARCHITECTURAL
DETAILS

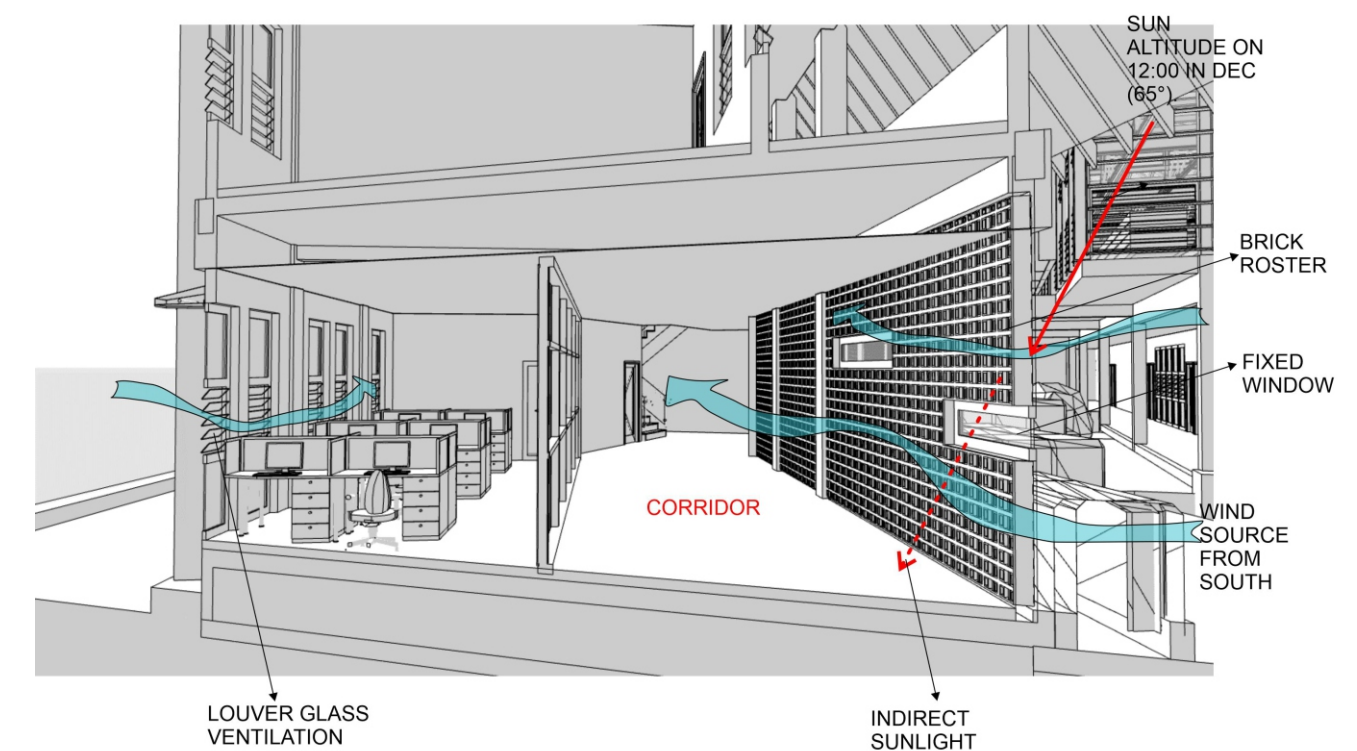


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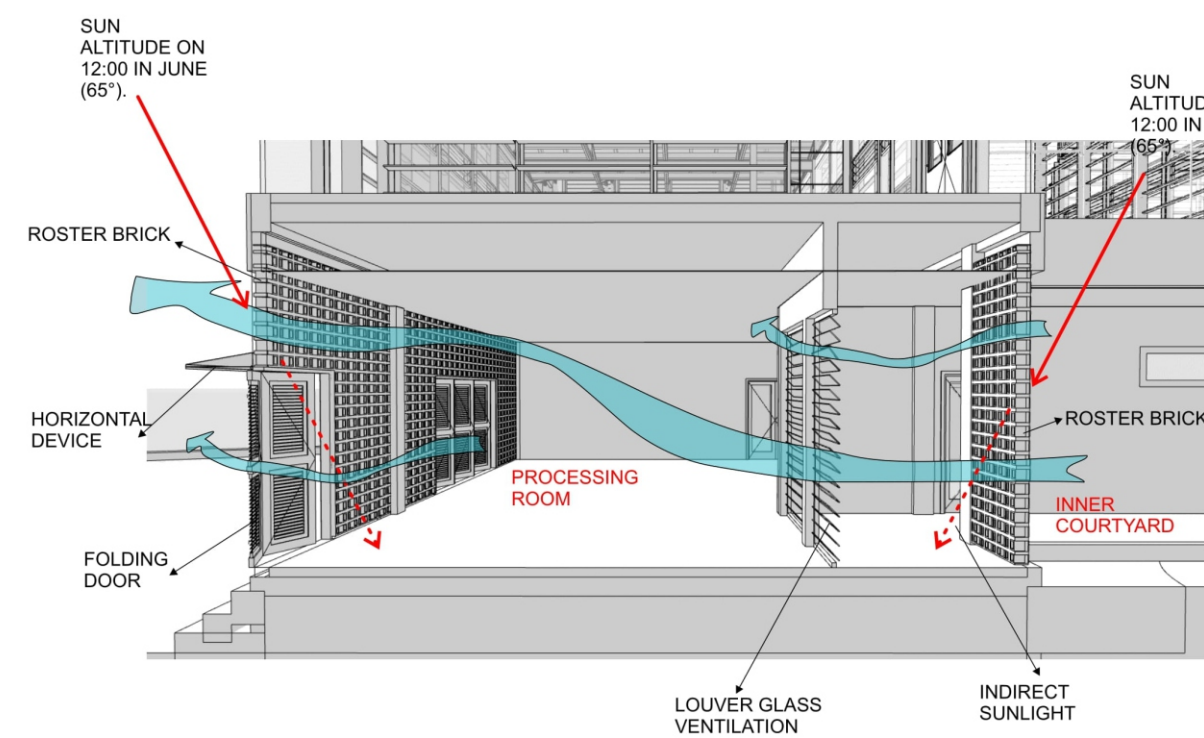
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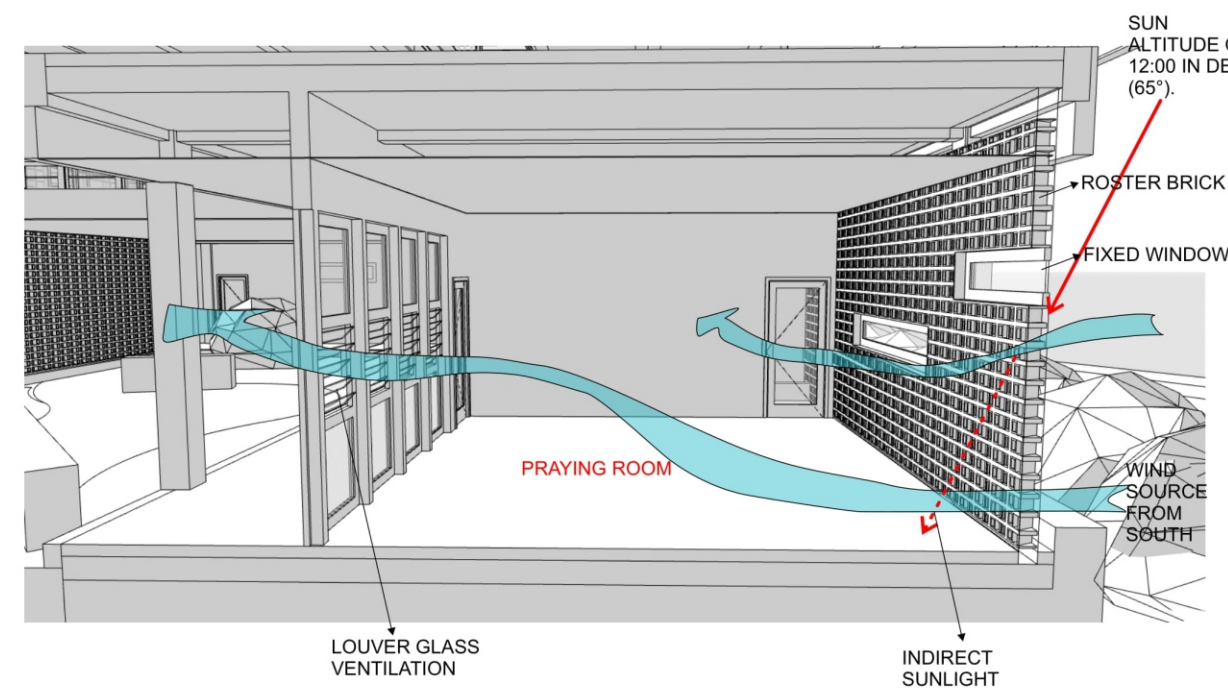
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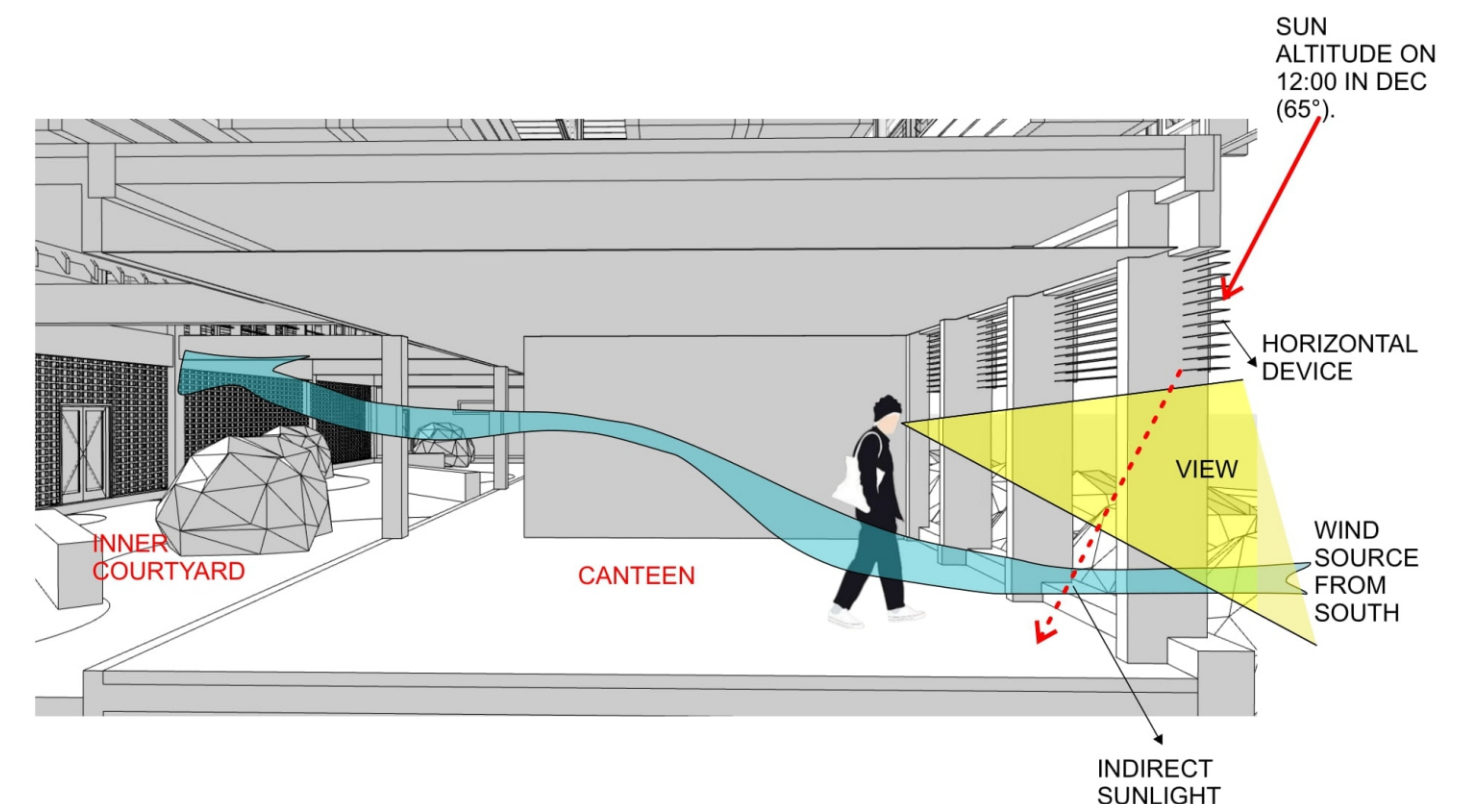
FACADE DESIGN 1



FACADE DESIGN 4



FACADE DESIGN 3



FACADE DESIGN 2



**FINAL ARCHITECTURAL
DESIGN STUDIO**

**NAME:
SALSABELLA**

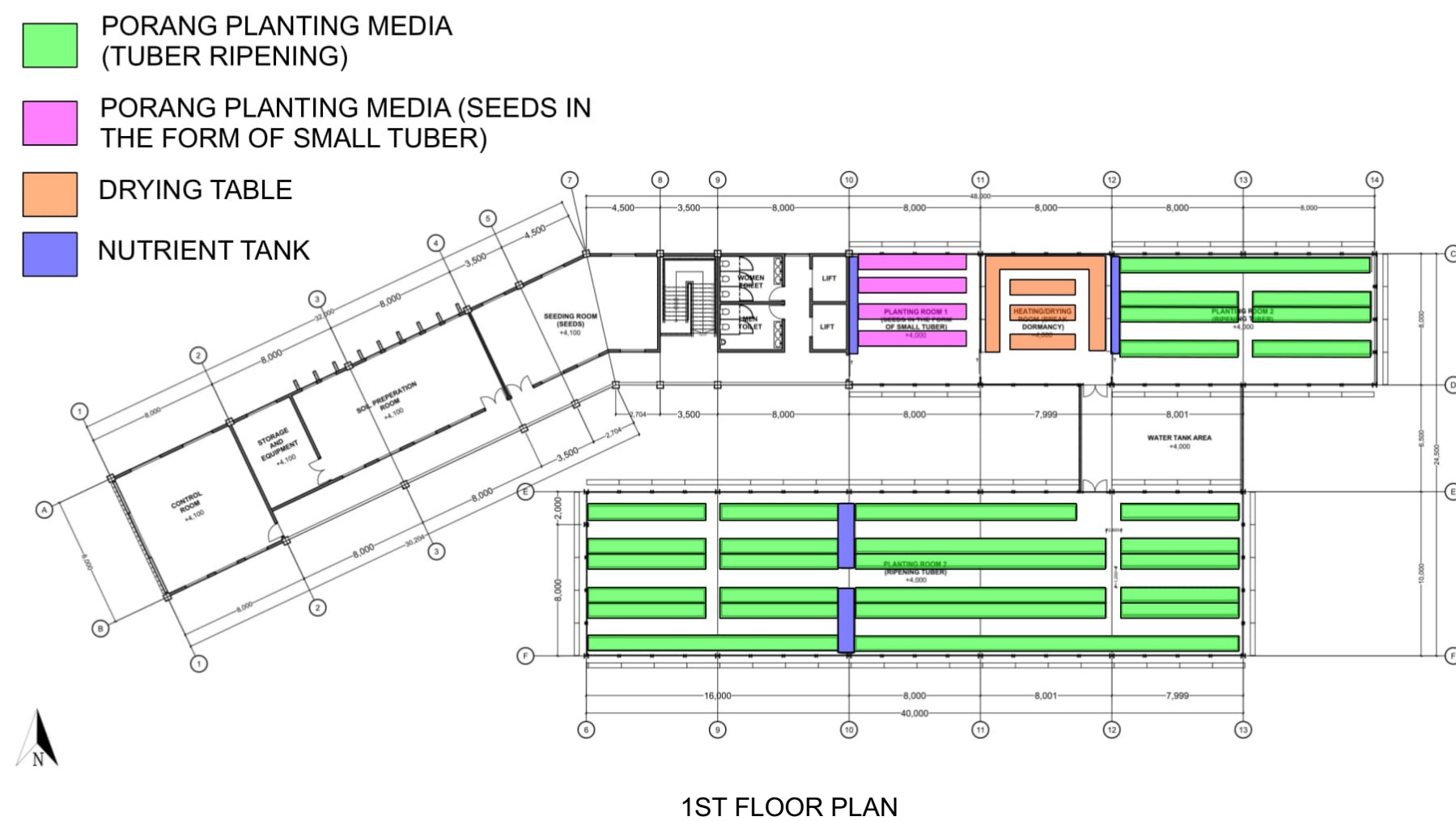
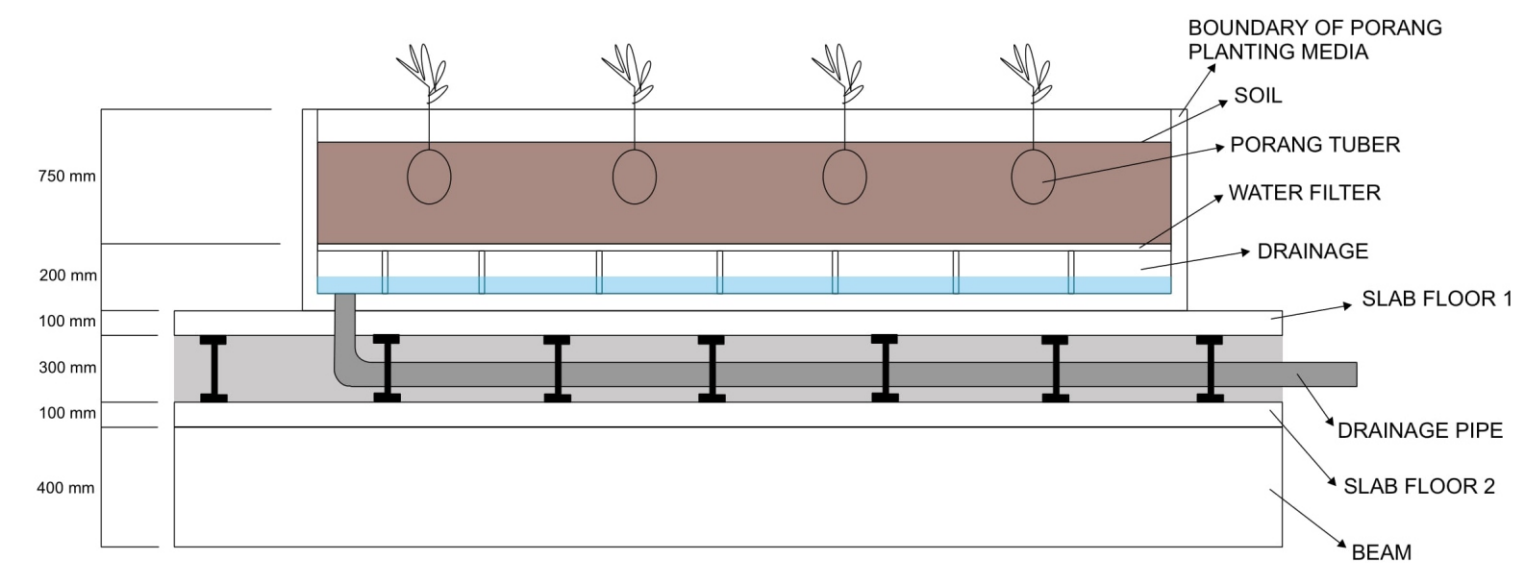
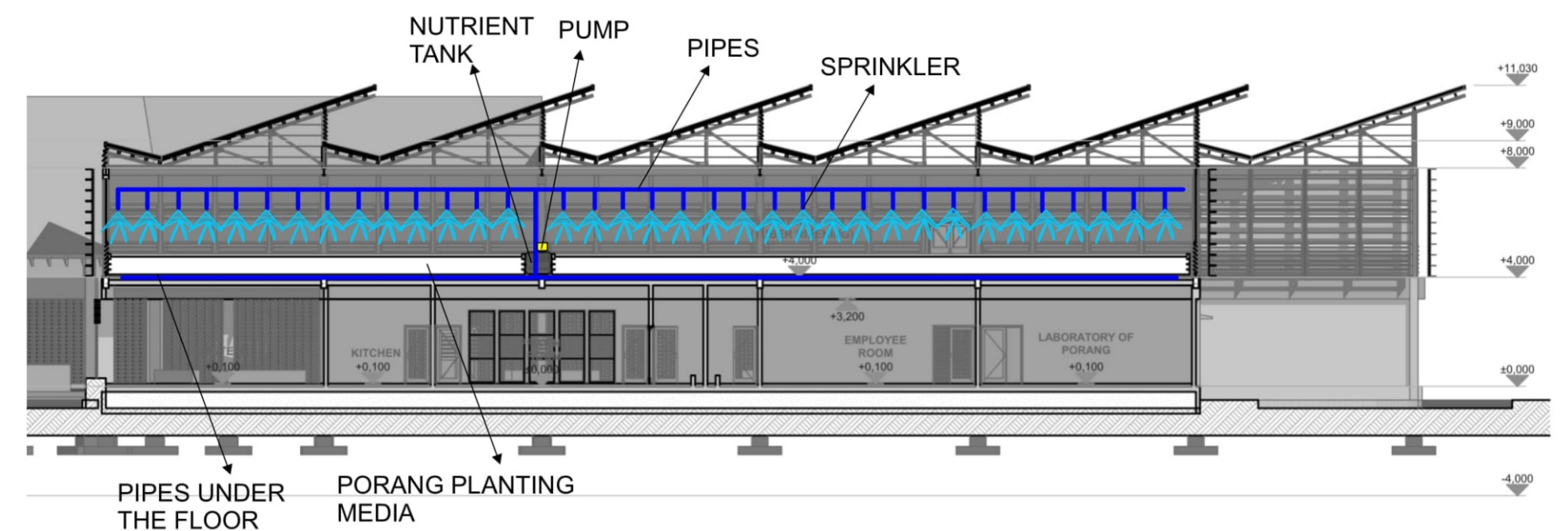
**NIM:
18512144**

**BUILDING NAME:
PORANG PERMACULTURE
BUILDING**

**LOCATION:
Jl. Tanjung Pura 142-174,
Benua Melayu Laut, Kec. Pontianak
Sel., Kota Pontianak, Kalimantan
Barat 78243**

**LECTURER:
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FINAL ARCHITECTURAL
DESIGN STUDIO

NAME:
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18512144

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LECTURER:
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I.A.I

TITLE:
SPECIAL
ARCHITECTURAL
DETAILS



PORANG PLANTING ROOM 1 (SEEDS IN THE FORM OF SMALL PORANG TUBER STAGE)



SOIL PREPARATION ROOM



INNER COURTYARD



PORANG PLANTING ROOM 2 (TUBER RIPENING STAGE)



CORRIDOR



MANAGER AND ADMINISTRATION ROOM



HEATING ROOM (BREAK DORMANCY STAGE)



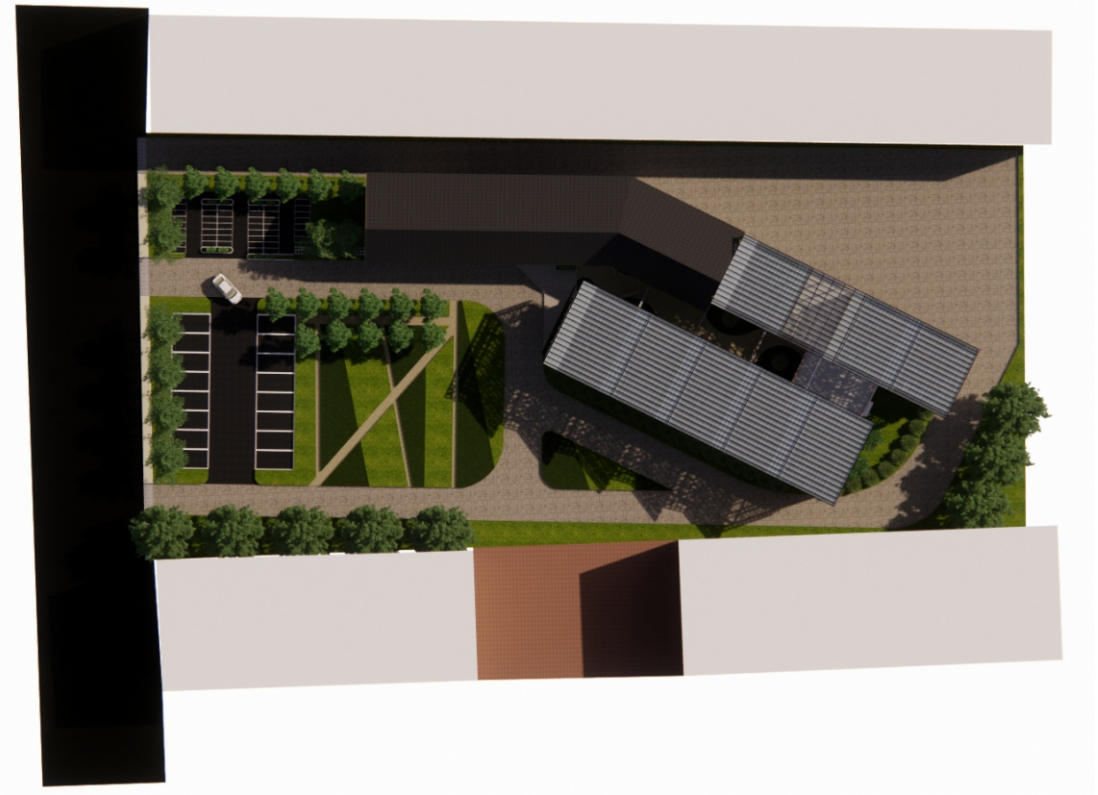
CANTEEN



AXONOMETRIC



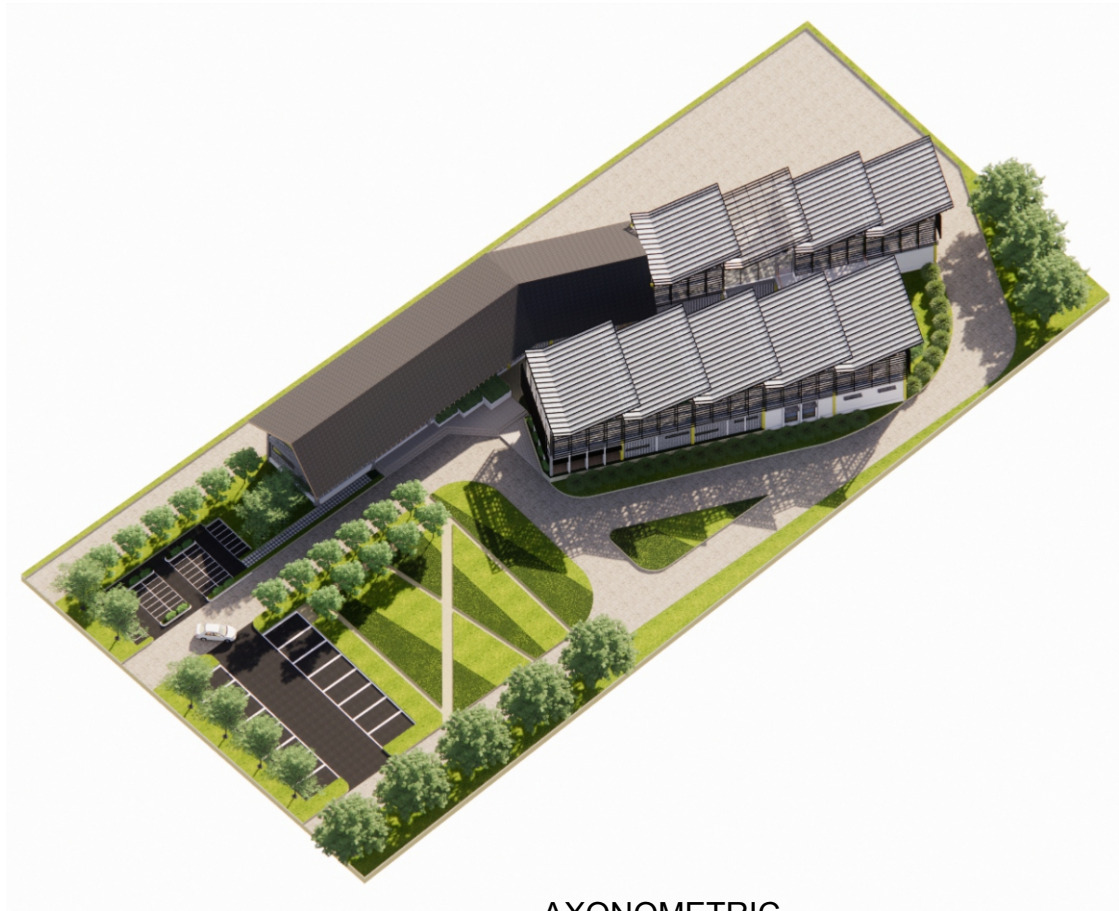
TOP VIEW OF SITE PLAN



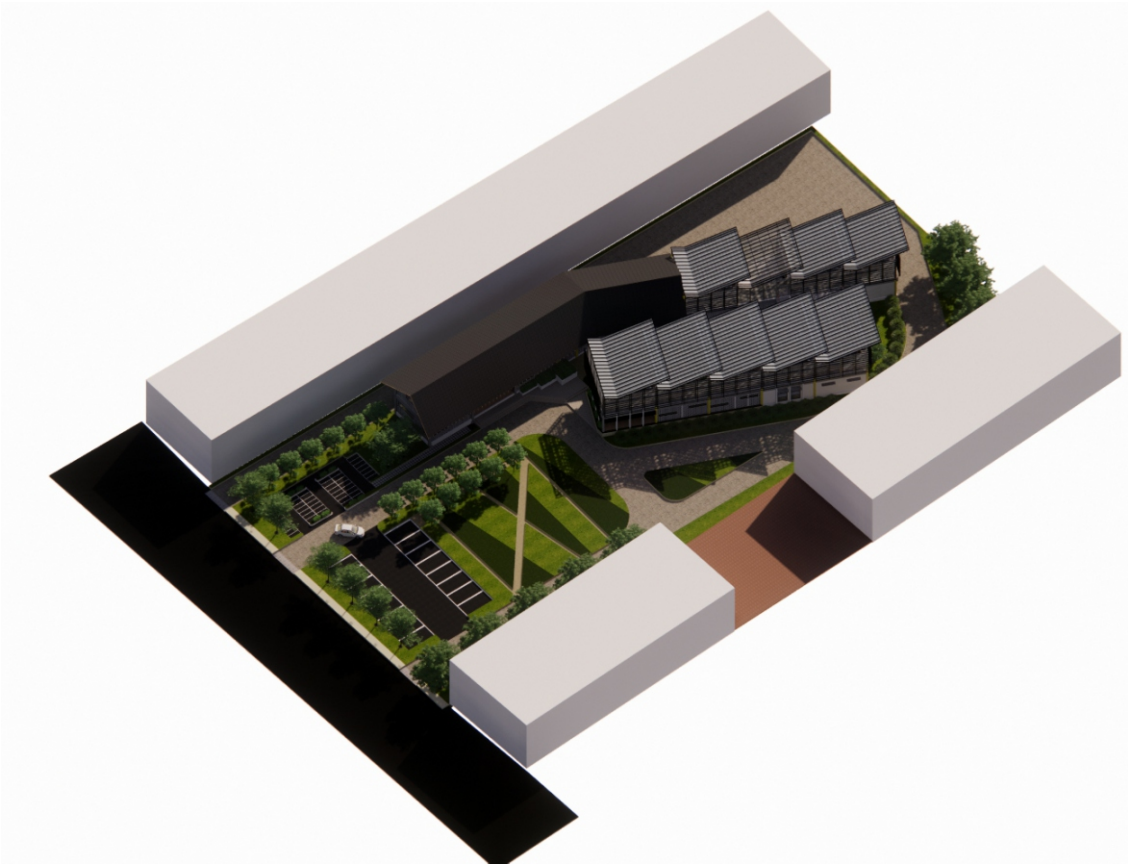
TOP VIEW (SITUATION)



AXONOMETRIC



AXONOMETRIC



AXONOMETRIC (SITUATION)

 <p>FINAL ARCHITECTURAL DESIGN STUDIO</p>	<p>NAME: SALSABELLA</p> <p>NIM: 18512144</p>	<p>BUILDING NAME: PORANG PERMACULTURE BUILDING</p>	<p>LOCATION: Jl. Tanjung Pura 142-174, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat 78243</p>	<p>LECTURER: Prof. Noor Cholis Idham, Ph.D., I.A.I</p>	<p>TITLE: BUILDING EXTERIOR</p>
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