BIOMIMICRY: FUNCTION AND AESTHETIC OF VACATION HOME, CHONBURI

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ชีวเลียนแบบ ประโยชน์ใช้สอยและความงามของบ้านพักตากอากาศ ชลบุรี

นายศุภฤกษ์ เตชะบริกิติ

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ศุภฤกษ์ เตชะบริกิติ : ชีวเลียนแบบ ประโยชน์ใช้สอยและความงามของบ้านพักตากอากาศ ชลบุรี. (BIOMIMICRY: FUNCTION AND AESTHETIC OF VACATION HOME, CHONBURI) อ.ที่ปรึกษาหลัก : รองศาสตราจารย์ ม.ล.จิตตวดี จิตรพงศ์

วิทยานิพนธ์ฉบับนี้ชื่อ “ชีวเลียนแบบ ประโยชน์ใช้สอยและความงามของบ้านพักตากอากาศ ชลบุรี” เป็นความพยายามที่จะเติมองค์ประกอบสถาปัตยกรรมของบ้านไทย เรียกว่า ฝาไหล (แปลตรงตัวว่า “flowing wall” นิยมแปลว่า “breathing wall”) ในหมวดหมู่ของความคิดเรื่อง “ชีวเลียนแบบ” ความพยายามนี้เป็นปัญหาเพราะคำว่า ชีวเลียนแบบ ในงานสถาปัตยกรรม ถูกประดิษฐ์ขึ้นเมื่อปลายศตวรรษที่ 20 ซึ่งช้ากว่าบ้านไทย สองคำนี้ ฝาไหล และชีวเลียนแบบ อยู่ต่างวัฒนธรรม ต่างเวลา นอกจากนั้น คำว่า ชีวเลียนแบบ มีการตีความที่หลายหลาย ในวิทยานิพนธ์ฉบับนี้ ผู้เขียน จำแนกหมวดหมู่การตีความดังกล่าว รวมถึงคำที่เกี่ยวเนื่องเพื่ออธิบายว่าทำไม ฝาไหล จึงสมควรอยู่ในหมวดหมู่ระหว่าง ชีวเลียนแบบ และ ชีวอากาศ นี่คือเหตุผลว่าทำไมบ้านที่ออกแบบโดย เจฟฟรีย์ บาวา จึงเป็นกรณีศึกษาของวิทยานิพนธ์นี้ บาวาเป็นที่รู้จักกันในนาม “บิดาแห่งการออกแบบเชิงชีวภูมิอากาศ” กระบวนการเรียนรู้สถาปัตยกรรมอันมีค่าคือการศึกษาแบบสถาปัตยกรรมของบาวา การเรียบเรียงที่ว่าง การใช้วัสดุท้องถิ่น ความสัมพันธ์ระหว่างที่ว่างภายในและที่ว่างภายนอกบ้าน การวาดแบบวิเคราะห์งานบ้านของบาวาเอื้อให้ผู้เขียนสังเคราะห์ เรียบเรียงสถาปัตยรรม ประเภทบ้าน ในชลบุรี ประโยชน์ใช้สอยและความงาน ณ ที่นี้ มีพื้นฐานอยู่บนการตีความของผู้เขียน ในเชิงข้ามวัฒนธรรมศึกษาระหว่างวัฒนธรรมอเมริกาและไทย

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Suparuek Techaborikiti : BIOMIMICRY: FUNCTION AND AESTHETIC OF VACATION HOME, CHONBURI. Advisor: Assoc. Prof. M.L. CHITTAWADI CHITRABONGS, Ph.D.

This thesis entitled ‘BIOMIMICRY : FUNCTION AND AESTHETIC OF VACATION HOME IN CHONBURI’ is an attempt to add an architectural element named *fah lai* (ฝาไหล literally translated as "flowing wall" popularly translated as "breathing wall") of Thai traditional house to the category of 'biomimicry'. This attempt is problematic because the term 'biomimicry' in architecture was invented in the 1990’s much later than the Thai traditional houses. These two words, fa lai and biomimicry, belong to different cultures and different times. Moreover, the term ‘biomimicry’ itself has various interpretations. In this thesis, I will classify the uses of this word ‘biomimicry’ and its related terms in architectural discourse so that it is possible to explain why *fah lai* can fit into a particular category that exists between ‘biomimicry’ and ‘bioclimatic’ design. Therefore, Geoffrey Bawa’s houses become my case studies because of this reason. Known as ‘Bioclimatic Designer’, the studies of Bawa’s architectural drawings, his space composition, the use of local materials, the relations between the inside and the outside spaces of a house, are the valuable process of learning architecture. The analytical drawings of Bawa’s houses enable me to synthesize my own architectural composition for a vacation home in Chonburi. Function and aesthetic, in this sense, are based upon my own interpretation of biomimicry in crossed cultural studies between the U.S. and Thai cultures.

Field of Study:	Architectural Design	Student's Signature .....
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I would like to thank Assistance Professor Terdsak Tachakitachon, Ph.D. for his kindness to allow the opportunity to further my study in fah lai at his Grasstonomy Café in Saladaeng. The example in studying of fah lai in his café plays a key role in the design process of this thesis in term of bioclimatic design and aesthetic. I also would like to thank Ajarn Pat Seeumpornroj, Ph.D., Assistant Professor Chonchon Fusinpaiboon, Ph.D., Assistant Professor Vorapat Inkarojrit, Ph.D., and Mr. Nicholas S. Taylor for valuable feedbacks that help shape this thesis perspective.

Finally, I would like to thank my dear family and friends who have been so supportive in my mental, physical and unique situation I've faced throughout this study. Without their immense understanding and encouragement, it would be impossible for me to complete my study.

Suparuek Techaborikiti

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Chapter 1: Introduction

As the United States Navy veteran who worked in engineer department for 6 years, I had observed every equipment on board the ship, to fix and maintain their performance to operate in optimum output. In those experiences brought my attention to understand the function of the mechanical equipment which at that time sparked my curiosity but did not know what it was. After the retirement from the service, I had a chance to go back to college and finish my degree in bachelor of fine arts in interior design. During my last year of bachelor, one of the classes I took was focusing on sustainability and that's when I realized my interest in biomimicry and its function. It was unfortunate that I didn't learn a lot about biomimicry except the basic knowledge that biomimicry is to mimicking nature in design. Because the technology and sustainability play a big part in living with environmentally friendly in the Unites States. In the study to further my education in Thailand, the changing of environment from where the ease of access in technology in the United States to agriculture-based environment in Thailand, the adaptation in design and materials should be applied to suitable environment.

Biomimicry in architecture design is a design that study from nature using method of mimicking nature surrounding environment and implement it in order to achieve close to zero waste energy consumption. This research focuses on the combination of biomimicry and aesthetic of tropical architecture into cutting edge of new era in tourism in Thailand. The research is to look into achievement of ways to design the project according to the climate of the selected site and employing the function of nature in sustainability living toward dweller or visitors in the vacation home.

1.1 Problem statement and research significance

Biomimicry or ชีวเลียนแบบ in Thai language is central to this thesis. The mimicking of life serves as a broad interpretation of the term. Generally, the mimicking of form, the mimicking of the organism movement or the mimicking of function may serve the purpose of architectural designs. They are the means to process the architectural design methods. However, this thesis takes a slightly different approach towards such general interpretations. Various interpretations of the term biomimicry in architecture are categorized in this thesis so that the readers will see my position. It is not my interests to study any animal bones and turn it into architectural design. It is also not my wish to import building materials from the Unites States and suggest high-technological construction to Thailand. I am not going to propose the study such as silk worms and their nests to try and develop them as the construction materials. This thesis focuses upon aesthetic and function of biomimicry in relation to bioclimatic architecture. As a veteran who served in Unites States Navy in engineering, coming to study architecture in Thailand, my research and design are based on the tropical climate and the Thai traditional houses in comparison to the context of my hometown Newport News, Virginia, Unites States which is a Tidewater Climate Region locating above the Tropic and Cancer region. In my contribution to the discussion on biomimicry in architecture is to add an element of Thai traditional house into the discussion for the purpose of building a vacation home in Thailand.

Architecture for good life in the tropical climate is what I am interested in. To build a house with the understanding of formal analysis of architecture. That is the balance of three-dimensional space composition in relation to the local materials, the understanding of structure and construction. The art of construction leads to aesthetic in architecture. In different cultures and different regions, human uses different method to keep comfort living such as in northern United States where the geographically in a dry, cold weather most of the time, the houses there will have double door system to prevent cold wind to come inside and a fireplace to keep

residence warm at night or sometimes during the day. Although, vice versa to tropical climate region such as Thailand. The traditional Thai house built to have a lot of open spaces and material that flexible to welcome natural ventilation in a hot climate zone. To breathe the fresh air in Thailand is comfortable, whereas breathing the cold breeze inside the house may not be desirable in the Unites States.

1.2 Purpose of Study

In the past before the invention of advance technology and air conditioning system, people live in harmonious way by using natural materials that can be found in the locals and relying on the natural ventilation to provide the comfort in their dwelling. However, in different culture and different region, people use different method to keep comfort living such as in northern United State where the geographically in a dry, cold weather most of the time, the houses there will have double door system to prevent cold wind to come in the house and fireplace to keep residence warm at night or sometimes during the day. Although, vice versa to tropical climate region such as Thailand. The traditional Thai house built to have a lot of open spaces and material that flexible to welcome natural ventilation in a hot climate zone.

Through the topic interest in further study in biomimicry the understanding of what is biomimicry interpretation in this thesis crossed meaning in Thai culture. ชีวเลียนแบบ (biomimicry) in Thai definition is the mimicking of life. The mimic of life still serves as a broad variety of interpretation in this sense, weather the mimicking of the form, the mimicking of the organism movement or the mimicking the function. In this thesis, the focal point of biomimicry will be on the interpretation of the mimicking of function. Although, the adaptation of the geographic region will imply to match the tropical climate environment and culture.

1.3 Scope of the study and research methodology

The study is on biomimicry in architecture. To scope the study, I categorized the literatures on biomimicry and its related fields. The categorization is based on different interpretations of the term biomimicry, and by doing this, my understanding of biomimicry begins to see a possibility to propose a thesis as a crossed cultural study. Chapter 2 Case Studies is important. The I began to understand the relationships between mathematical proportions of architectural elements, spaces and 3 dimensional structures from the architectural drawings of Geoffrey Bawa, known as the 'bioclimatic designer'. This basic understanding is possible through the analytical drawings, drawn by the author (Figure 28-34), of Bawa's plans and sections. It is interesting to see how Bawa brings "nature" into his spaces, how he gives the main space of a house to the sky (outdoor space), whereas the secondary spaces belong to the inside of a building. What I have leant from Bawa is to see the aesthetic of architectural space composition in relation to the environment.

Design process in this thesis is possible because of the analytical drawings. They are the results of my understanding upon architecture spaces composition. "Breathing walls" are the detail design, which cannot come before the overall organization of 3-dimensional structure. Therefore, compose the frameworks within the site, by basing the mathematical numbers with the possible length of structural materials and the aesthetic of Bawa's frameworks. The organization of the columns and the walls follow that mathematics, each element is substituted by different materials, such as brick and wooden walls. This is how "breathing walls" have their places in the design

1.4 Benefit of the study (Research outcome)

The understanding of my own position towards the general interpretation of the word biomimicry is possible only through the above-mentioned process of work. That is to, first of all, categories the literature reviews, to identify what is and what is

not my interests in biomimicry. Secondly, the study of Bawa's frameworks, composition of architectural elements and spaces is a basis for me to understand the aesthetic in architectural spaces composition and the beauty in choosing materials for construction. Thirdly, the study on elements of Thai traditional house, *fah lai*, and the contemporary method to construct it with modern material help me to understand the practicality that is specific to one's culture at a particular time. This thesis is therefore giving references to the knowledge of Thai people in the past and my objective is to maintain that knowledge for the future. A vacation home in Chonburi is only one example of the application. That is to say this process of work does not restrict itself to the design of vacation home, far from it. The thinking process itself, to me, is a valuable part of this thesis.

Chapter 2: Literature Reviews and Case Studies

2.1 Biomimicry

'Biomimicry' in architectural discourse has various interpretations dated since the term was invented in 1950's. The word biomimicry original use in scientific literature in 1962, Chemists and the School of Nature (Bensaude-Vincent, Arribart et al. 2002) which derived from the word biomimetic that first use in 1950's (Pawlyn, M. 2016). In the literature reviews of this thesis, I will classify the interpretations in order to state what is and is not my position. It is also necessary to explain the differences and the similarities between different terms in relation to biomimicry, such as bioclimatic and biomorphic architecture, because function and aesthetic in biomimicry of this thesis occupied a space in-between such interpretations.

In the architecture field today, a lot of new designs and functions of the building evolving and still growing through research and studies to keep improving for better quality in life of human beings. Because architecture field today progress in a fast pace using new technologies, research methods and most importantly the ideas of sustainability to up lift human life in every aspect and preserve what is left of the nature for later generations in the future. In those ideologies sometimes people get mix up in the definition of biomimicry and biomorphic. Biomimicry is not the same as emulate the design from nature, and so is for the materials but the analytical of natural habitat to aid in the restitution to the new research and technological question to help future achievement of function and energy consumption.

"BIO " a combining form denoting relation to, or connection with, life,

vital phenomena, or living organisms.

"MORPHOLOGY " the features, collectively, comprised in the form and structure

of an organism or any of its parts."(Alloway, 2005)

Biomimicry is often confused with the term biomorphic architecture, in the Biomorphic architecture, the building take form of, or similar to the geometric of the

nature which gives the feeling of biophilia to everyone that sees them. Because humans are naturally born and tend to have feeling that they can relate toward the nature, so concept of looking up to the nature for ideologies has always been there.

“Humans have been observing and imitating processes in nature for thousands of years” (Merchant 1980).

Leonardo da Vinci, the Wright brothers, and Buckminster Fuller, for example, are well known for their observations and innovations inspired by nature, as are many indigenous peoples.” (Schwan, 2016) In the architecture field, some of great examples of the architects that we can relate their work with biomorphic is from Santiago Calatrava, a Spanish architect born in Valencia in 1951. His design in architectures are mostly focuses on the structure which related to nature of bones and movement of living organism; in this case, human body, the Turning Torso tower in Malmo, Sweden (1999-2005). The architecture resembles of human body turning which showing the analogy of human body implement to the design of structure of the building. Standing 623 feet tall and 54 stories high, this building was the tallest building in Scandinavia when it was completed. The building divided into nine segments and in each segments housing five stories high pentagon layout. Though, when compare the relation from the ground floor to the top floor, the last segment on the top is completely 90-degree turn (Figure 1) in the relation to the ground floor, hint, the full turn of twisting of the human body (Figure 2).

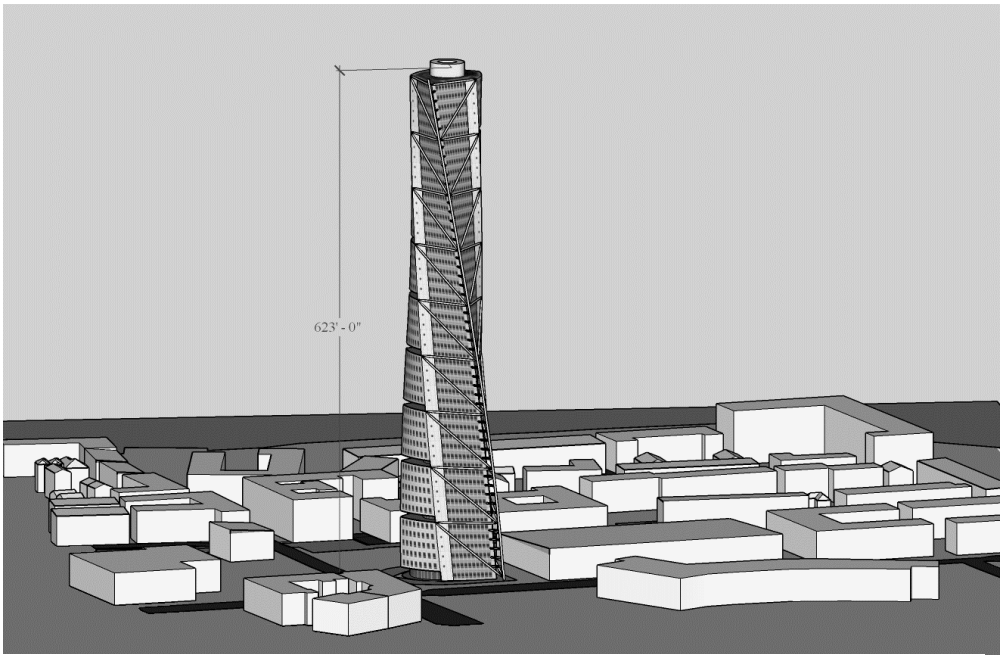


Figure 1. Turning Torso Tower Floor Plan & Structure Drawing, drawn by author.

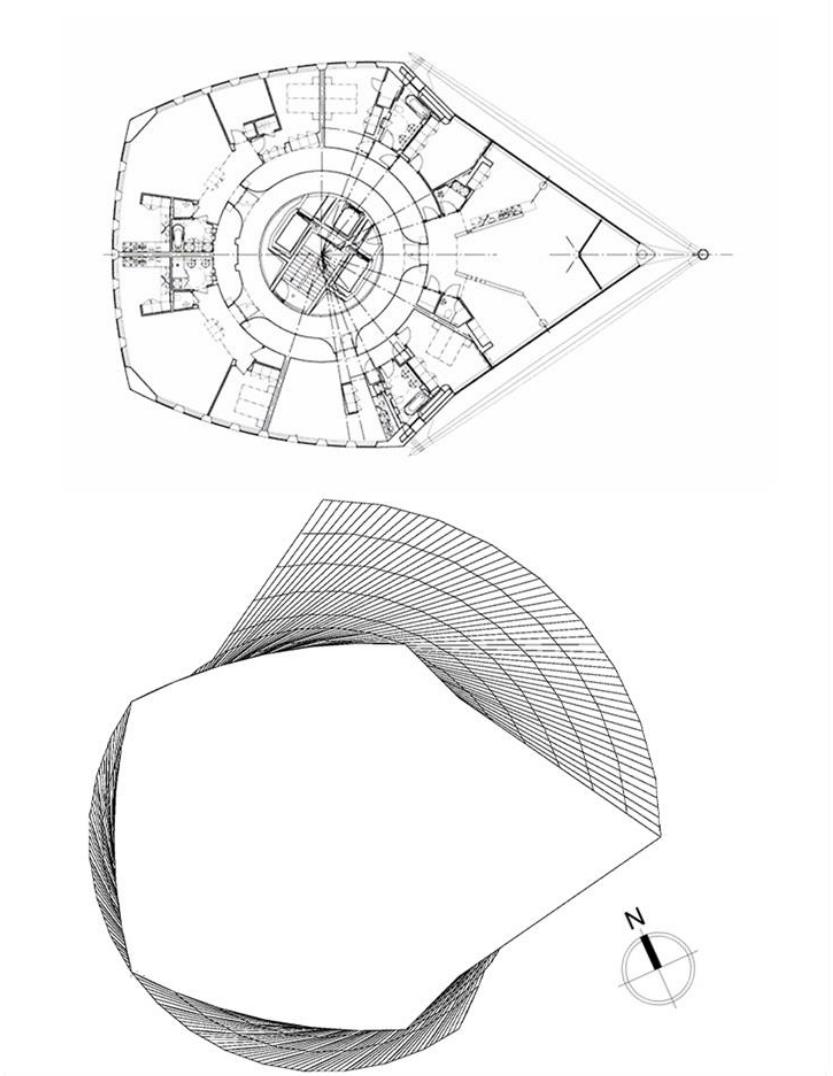


Figure 2. Turning Torso Tower, drawn by author.

There are also other buildings that uses biomorphic method such as the Bahai House of Worship designed by Iranian-Canadian architect Fariborz Sahba. The nine-sided, House of Worship Composed of exposed concrete “Shell Structure” (Delegation, 2014) with the influence from the lotus flower. This structure was built for good faith for Bahai religion as a house of worship. The Armadillo Concert Hall (Clyde Auditorium) is another example of biomorphic architecture designed by Foster and Partners. The architecture inspired from the animal species known as Armadillo. This concert hall has the ability to shift into matching the appropriate occasions such as live performance, exhibition, concerts and conferences with the capacity of housing more than 3000 seats. In addition, the geometrical form of the Lisbon Orient Train Station designed by the Spanish architect, Santiago Calatrava and Stuttgart Airport designed by Architecture group Gerkan, Mag and Partners utilizing biomorphic of tree branches style as structure and support columns to the roofs. (Tavsan et al., 2015)

In these biomorphic structures and architectures are mainly for aesthetic look. Because the lack of functionality that mimicking the nature thus, the architectures will still consume energy and produce waste back to natural habitat in one way or another. These architectures taken form inspired by nature, many people would be considering them as mimicking and being part of the nature. This is not my position in function and aesthetic of biomimicry for Thailand. The reasons are concerned with first of all, the technology of construction in Chonburi, a seaside province in Thailand, secondly, the economy of design, and lastly, the avoidance of using a metaphor between a building and a living creature in the form making process of design. There is nothing wrong with such design process, comparing a design of a port to a skeleton of a fish, but it is not how I would like to process the composition in the names of function and aesthetic in architecture.

The concept of biomimicry in sustainability living has appeared the first time by writer and science observer Janine M. Benyus in 1997 upon her curiosity of nature and technology. In her admiration of nature brought the supporter from the fellow

co-scientists together to further study in biomimicry (Tavsan, Tavsan, & Sonmez, 2015). Although, sometimes biomimicry architectures can be confusing to a lot of people in function and aesthetic. If we are to look close into the differences between function and aesthetic, we will have to understand about the purpose of biomimicry and can distinguish between, what is aesthetic in architecture and what is a true function of biomimicry.

So, what is biomimicry in this thesis? Biomimicry in this thesis has a place in between the existing interpretations of biomimicry and bioclimatic architecture. The term “biomimicry” comes from the Greek words “bios,” meaning “life,” and “mimesis,” meaning “to imitate” (Schwan, 2016). When we compare man-made materials and natural materials, we can notice that man-made materials almost always require a kind of consumption in the process of making. Although, in nature, the biological system is perfectly balanced in every living organism and produce less waste to harm nature.

In example of man-made silk versus spider silk in strength comparison. The man-made silk has to go through varies different process from the collecting of silk worms, threat extraction, dyeing method that may leave toxicity waste behind, spinning and weaving method that may use machinery which consume some sort of energy if not only from fossil fuel. Meanwhile, the spider silk is made from spider itself which has protein from their digestive system as a base through the process of their DNA function that can produce a tread that stronger than steel when comparing to the same volume and size. Also, because of the “Weight-for-weight stronger than steel, finer than human hair, more resilient than any synthetic fiber, and completely biodegradable” (Gould, 2002) in nature, spider can produce up to seven different types of webs for their function purposes. However, the most interesting type of web that researcher interesting in today is the “dragline silk” (Gould, 2002) which function in safety line and the frame for their webs. In this example we can now understand a little bit more on the advantage of studying in biomimicry and how it is important to mimic natural resources rather than exhausted them.

Biomimicry architecture is the architecture that utilize the analytical study from nature, observe, break down, and reconstruction in the process of the design to achieve less energy consumption (working toward zero energy consumption). Though, there aren't many architectures today that reach the potential of zero energy consumption but there are some architectures that developed through the analytical study from nature, to observe them, break down their functions and then implement them into the design to help saving the energy.

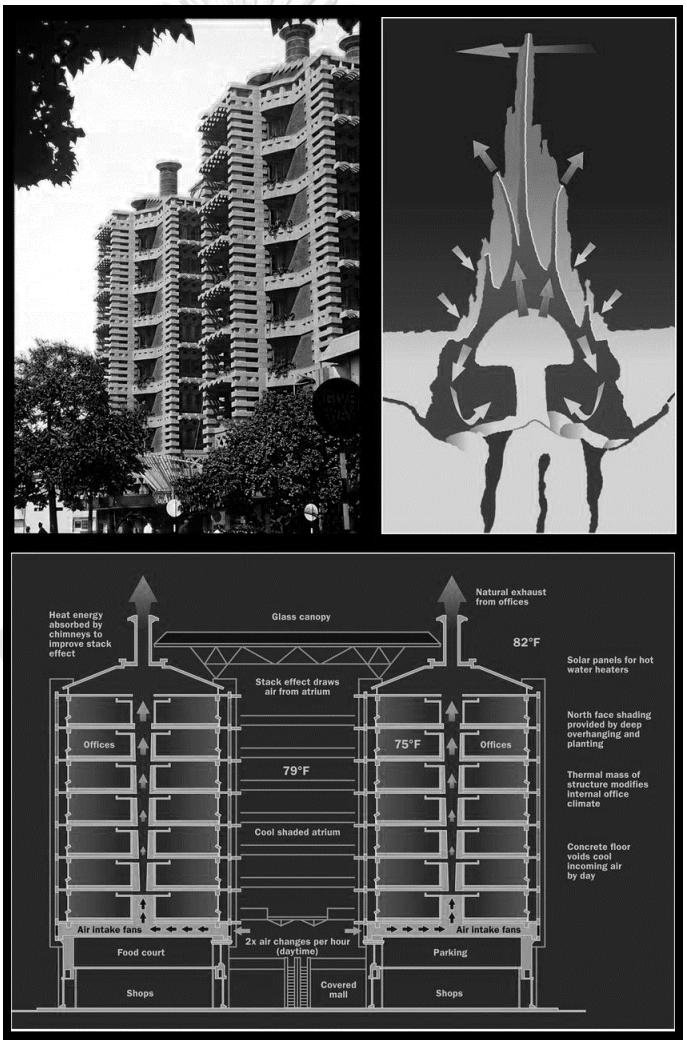


Figure 3. Showing how the Eastgate center functions.

One of the most famous and well known for the biomimicking architecture is the Eastgate Center in Harare, Zimbabwe (figure 3), which mimics the intricate ventilation tunnels of termite mounds to reduce energy costs, is perhaps the best-known contemporary example of such modeling (Schwan, 2016). “The Eastgate Centre is a shopping center and office building located in Harare, Zimbabwe. Rather than using a traditional fuel-based air-conditioning system to regulate temperature within the building, the Eastgate Centre is designed to exploit more passive and energy-efficient mechanisms of climate control. The building’s construction materials have a high thermal capacity, which enables it to store and release heat gained from the surrounding environment. This process is facilitated by fans that operate on a cycle timed to enhance heat storage during the warm daytime and heat release during the cool nighttime. Internal heat generated by the building’s occupants and appliances also help to drive airflow within the building’s large, internal open spaces, as it rises from offices and shops on lower floors toward open rooftop chimneys. Various openings throughout the building further enable passive internal airflow driven by outside winds. These design features work together to reduce temperature changes within the building interior as temperatures outside fluctuate. The $35 million building saved 10% on costs up-front by not purchasing an air-conditioning system. Rents are less expensive in this building compared to nearby buildings because of the savings in energy costs.” (Innovation Team, 2016).

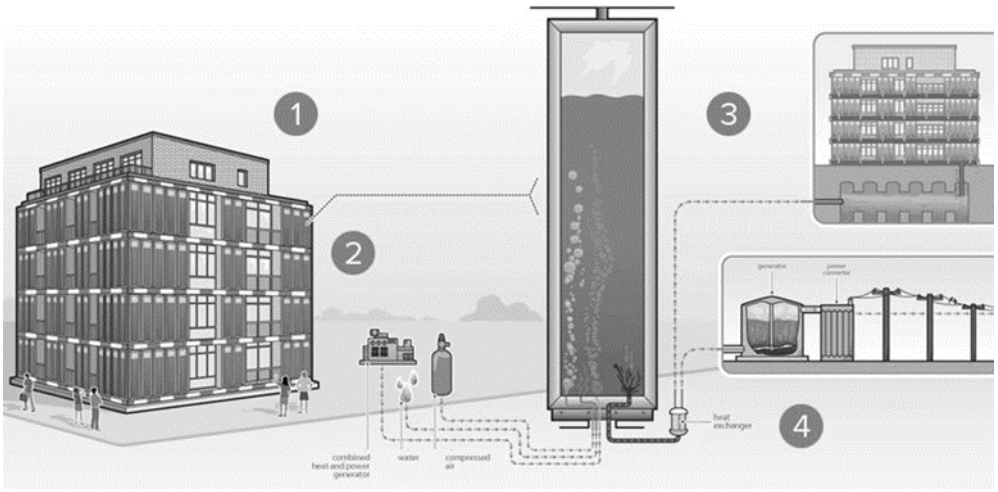


Figure 4. Algae Haus: Illustration by Brown Bird Design, retrieved from Jin Kim, 2018

Another type of architecture that uses the nature itself integrated in the building after the extensive researching on the its properties in nature and its potential to help saving energy consumption. This kind of architecture is still new to the world and is one of a kind building that truly uses biological system implemented in the building. The system that uses in this architecture is called “bioreactor façade” (Jin Kim, 2018). This architecture is the Algae House in Hamburg (figure 4), Germany. This architecture immerged as the first “Bio-Intelligent Algae house is the first algae powered building in the world” (Jin Kim, 2018).

To sum up, in my position by categorizing the interpretations of biomimicry. The approach towards function and aesthetic in biomimicry that can be applied to the composition of a vacation home in Chonburi lean towards bioclimatic architecture pioneered by Jeffrey Bawa. His architectural drawings will be studied later on in ‘Case Studies’ chapter. Now, let us turn to my contribution to a general discussion on biomimicry in architecture and explain why an architectural element of Thai traditional house named *fah lai* belongs to the same category. To do so, let us begin with the problem of language, particularly through the verbs to move, to see and to breathe.

How can one ‘moves’ a house? In the Unites States, to move a house is generally meant to cut the structure of a house, put the house on a vehicle and move it to be built elsewhere. In the distant past of the Thai culture, moving a house can mean to dissemble the architectural parts, the wooden columns, walls and floors, to be reassembled elsewhere. That is to say Thai traditional house belongs to the category of prefabrication before the category of prefabrication exists in the architectural discussion. And this is my contribution to the crossed cultural studies on biomimicry in the tropical countries like Thailand.

2.2 Case Studies

In the above review of the Eastgate Center in Harare, Zombabwe designed by Mick Pearce with the Arup construction company to build this fascinating

architecture. In the studying of termite mound, researchers from Harvard University and the Massachusetts Institute of Technology have found that fluctuations in outside temperature over the course of the day create convection currents within the mounds that ventilate the termites' living space. Termite mounds are built from compacted soil and contain a network of tunnels that transport gases from the nest to the mound surface, where they diffuse through many tiny pores that also allow outside gasses to enter the mound. Because the individual pores are so small, however, the mound resists large-scale pressure-driven airflow such as that induced by wind—the ventilation must instead be driven by some other factor. (Physics, 2014) Because ventilation from the small pores resisting the airflow, the Eastgate Center building utilized the driven airflow by fan that operates according to the time of day to help keep the warm temperature at night and cooling temperature during the day time. By doing so, the building achieves the cost effective and energy efficient comparing to other kind of building that relying on Air conditioner and heating which consume a lot of energy in the climate where Zimbabwe is.

Another project that pioneer in using biological system such as the Algae House in Hamburg, Germany. Due to the functionality of the algae, it produces biomass and heat from photosynthesis in the glass panel by absorbing the heat from solar energy. The chain reaction of this particular biomass produces another advantage to the building by using the algae which absorbing the solar energy, it can also provide shading and reducing the heat transfer into the building during the day as well. After the photosynthesis reaction the algae receive from solar energy, the algae then put to the system that installed inside the building to be harvest into biogas. With this biogas, it then distributes out to the heating cooling and electrical system inside of the building. “The bioreactor façade covers a 200m2 area and forms the heart of the energy system. It is made up of glass tanks that measure 2.6m high by 70cm wide and about 2cm deep with a capacity of about 24 liters. The tanks are filled with a culture solution enriched with nutrient salts, giving the micro-algae optimal conditions for growth. Compressed air ensures that the algae are always moving

and CO2 is continually fed into the reactor to boost their growth further. The CO2 is provided by a gas boiler. The sunlight not used by the algae also warms the reactor liquid. As with a solar energy system, this warmth is separated off into an energy unit and used to heat the building." ("The Algae House: Generating Energy from Algae").

As much as the architectural structure and biological system in biomimicry architectures that proven to be energy conservation, renewable and sustainable living. Another case study of the material in mimicking nature can also provide another route in effectiveness of conservation of energy. In the example of Prototyping a Self-Ventilating Building Skin With Smart Thermobimetals by Doris Kim Sung. The objective of the particular material which made of metals interlocking, cross patterning with each other acted as human skin that breath through temperature in hot and cold climate (figure 5 & 6). "Thermobimetals can be a combination of any two compatible sheet metals. The combinations of metals with different expansion coefficients and at various thicknesses can produce a wide range of deflection." (Sung, 2012). In the project, the material that uses consist of two types of material, the low expansion and high expansion; Invar and TM2. "The low expansion material is called Invar, which is an alloy of 64% iron and 36% nickel with some carbon and chromium. The high expansion material is a nickel manganese alloy composed of 72% manganese, 18% copper and 10% nickel. This bi-metal is also called 36-10 and the ASTM name is TM2" (Sung, 2012). The choosing of Invar and TM2 thermobimetal for this project was to examine the about of deflection in temperature range of 0-120 degrees Fahrenheit (figure 7).

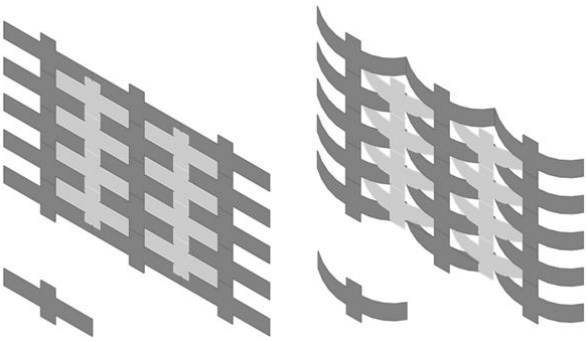


Figure 5. A lamination of two metals together with different thermal expansion coefficients simply deforms when heated or cooled

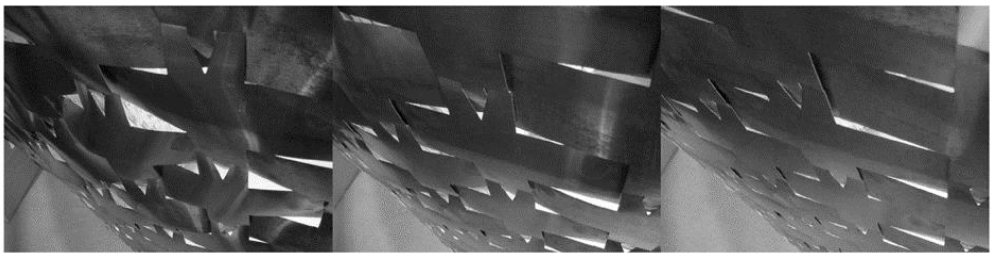


Figure 6. As temperature rises, one side of the laminated sheet will expand more than the other resulting in a curved or curled piece of sheet metal

ASTM Type	x10^(-6) Flexivity (50-200°F)	°F Low temp	°F High temp
TM22	10.2	0	300
TM9	11.5	0	300
TM24	13.1	0	300
TM11	13.2	0	300
TM12	13.7	0	300
TM36	13.7	0	300
TM20	13.8	0	300
TM13	14	0	300
TM25	14	0	300
TM14	14.7	0	300
TM26	14.7	0	300
TM27	14.7	0	300
TM15	14.8	0	300
TM28	14.8	0	300
TM16	14.9	0	300
TM1	15	0	300
TM17	15	0	300
TM35	15.2	0	300
TM8	15.6	0	400
TM29	15.8	0	300
TM31	18.9	0	300
TM33	20.8	0	300
TM34	21.4	0	300
TM32	21.7	0	300
TM2	21.7	0	400

ASTM Type	x10^(-6) Flexivity (50-200°F)	°F Low temp	°F High temp
TM22	10.2	0	300
TM9	11.5	0	300
TM24	13.1	0	300
TM11	13.2	0	300
TM12	13.7	0	300
TM36	13.7	0	300
TM20	13.8	0	300
TM13	14	0	300
TM25	14	0	300
TM14	14.7	0	300
TM26	14.7	0	300
TM27	14.7	0	300
TM15	14.8	0	300
TM28	14.8	0	300
TM16	14.9	0	300
TM1	15	0	300
TM17	15	0	300
TM35	15.2	0	300
TM8	15.6	0	400
TM29	15.8	0	300
TM31	18.9	0	300
TM33	20.8	0	300
TM34	21.4	0	300
TM32	21.7	0	300
TM2	21.7	0	400

Figure 7 The amount of deflection varies dependent on the size of the sheet, the air temperature, the position of clamping and the thickness of the material

The further research study focusing on the local materials that breathable and moveable mimicking in relation to the found case study of thermobimetals project. In the research of Breathing Facades: a New Concept to Create Dynamic Thermal Ambiances in building located in hot climates by Mahmoud Elghawaby followed the depiction of Hassan Fathy in traditional construction that they are breathing building in according with the Bedouins logic to thermal comfort. “These constructions have the ability to absorb moisture form the air and allow the passage of airflow through the entire surface, thereby reducing the temperature by evaporative cooling, with guarding its ability to prevent direct sunlight.” (Elghawaby, 2012). Elghawaby design concept on breathing wall consists of three layers to minimizing direct sunlight and allowing cooling temperature inside the building. In the external layer the priority of the function is to minimizing the high temperature casing from sunlight by using “materials that has the ability to absorb the moisture and allowing the air flow to pass through such as natural textile, clay, wood or reeds.” (Elghawaby, 2012). In the middle layer, the function is similar of epidermis of human skin that control airflow. In the final layer or “internal layer contains controlled ventilation outlets managed by both building management system and occupancy desire to create the requested internal thermal ambiances.” (Elghawaby, 2012). Similar to breathing is a sign of having a life. It is an order that we naturally abide and hardly think about the process of how-to breath. What is interesting about taking a breath in architecture is mainly about the climate whereby the building is situated, how freezing the wind is, how comfortable of oneself to breathe the fresh air inside one’s house. In the tropical countries like Thailand, it has been taught that natural ventilation is desirable. That is to say the wind is the intangible architectural elements, like light, shade and shadow, that architects should consider perhaps together with the air-condition system. Unlike in the United States, the cold breeze is not always desirable thus, the rotating

door, double door is a clear example of how to capture the wind before it reaches the interior of a building.

Figure 8. Detail showing the sliding panel type of window in Muang Pon Village, Mae Hong Son

While searching for the inspiration of biomimicry project in Chonburi, the realization of the differences in the languages from the English in United States to Thai language plays a big part which lead to the categorizing of biomimicry in Thai traditional house. Through the research from Doris Kim Sung and Elghawaby, the realization of mimicking in human skin had been implemented in Thai traditional northern style house for a long time. The traditional Thai house (Ruen Thai) in this case is the Kalae house, built using wood which can be found in the local area, the plan of the house very resemblant to the ruen mai bua and ruen mai ching with the differences in details of craftmanship imbedded in the architecture (Ruethai, Somchai et al. 2002). Through the information from Lanna Traditional House Museum, Chiang Mai University, the Kalae house can trace back to the year 1890 when it was built with original owner, while the concept of biomimicry has just been immerged in 1950's through the observation of nature. The point I have learnt is about various dimensions of life that reflect upon architectural design that is

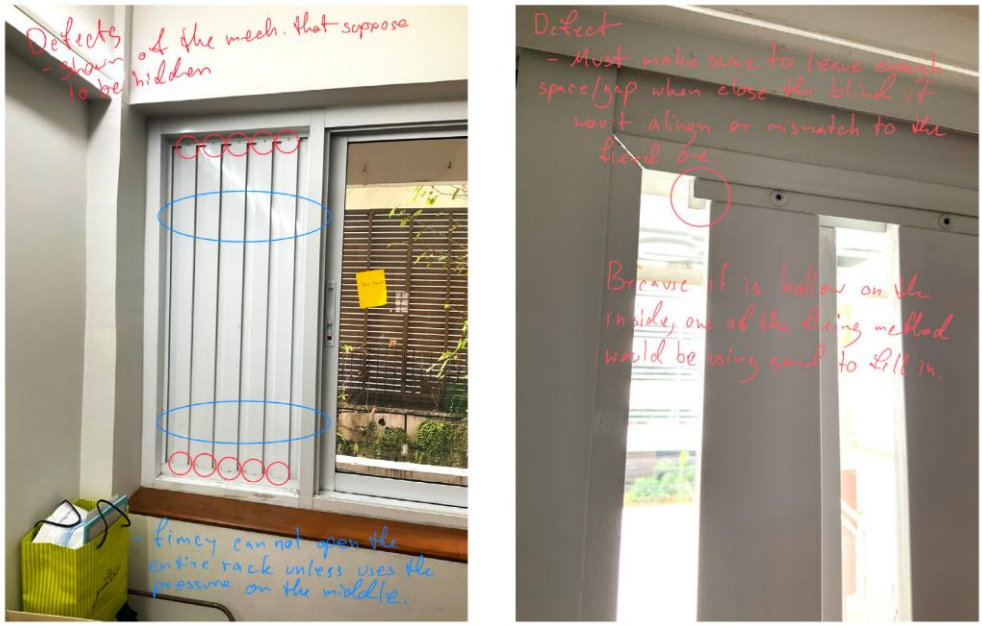
fundamental to the practice of architecture. In the Kalae house, the most interesting lies in the ventilated system of the house that similar of human skin pores in term of ventilated the spaces inside the house. The system builds in as a sliding panel (figure 8) in the wall which open and close according to how much ventilated in the space the user wants widely known as *fah lai*. Through the local material that use in the same region, the *fah lai* resembling as external layer acted as epidermis in the human skin to prevent solid debris and direct contact to the outside climate that can fluctuating temperature in the building and as the same time acted as mimicking of human skin pores that can be open and close to adjust and regulate the temperature inside the building.

In the further study and analysis of *fah lai* brought me to the café called Grasstonomy located in Saladaeng road, Bangkok, Thailand for modern *fah lai* design in the cafe. With the permission and privileges granted from Assistance Professor Terdsak Tachakitkachorn, Ph.D. who allowing this opportunity in further study in *fah lai* that he implemented into his café design has played a major role in the breathing wall developing for the project in the selected site. The materials of the modern *fah lai* in the café were made from hollowed, light weighted aluminum. The function of the *fah lai* acted as window and sliding panel in the café. In the window part, the frame of the window that *fah lai* located is fixed with the window frame but there was a regular window next to it in the window frame which can be operate just like regular window (Figure 9). The *fah lai* provided more privacy in the space because when it's fully closed, it becomes solid object just like a wall. With the experiences provided from Assistance Professor Terdsak Tachakitkachorn, Ph.D., he mentioned that the *fah lai* panel is used in regulating the air flow into space and can let some lights into the space when he doesn't want too much lighting (Figure 9). In the similar function of *fah lai* in window frame, the sliding panel that developing

from the *fah lai* and implemented into the café also providing the same function that the *fah lai* window above (Figure 9).

The observation of the modern *fah lai* in Grasstonomy Café and with the feedback of Assistance Professor Terdsak Tachakitkachorn, Ph.D., the problem arose from the design of the modern *fah lai* and the materials that uses. The defects in the design in the aesthetic part showing the mechanism that supposed to be hidden in the movable section to the fixed rail of *fah lai* (Figure 10). Another problem of the movable panels is the trim that attached to the top and bottom of the sliding panels. In the designing to slid the panels to close the gap, the design of the pocket to receive the movable panels is too deep thus, Assistance Professor Terdsak Tachakitkachorn, Ph.D. had to install a trim to the top and bottom of movable panels so when they close, they are aligned to the fixed panel in continuous to become solid panel (Figure 10). In addition of the aesthetic concern and gaping of the pocket panels, another issue from both window and sliding panels are the materials and the dimension of *fah lai* moveable panels. Because using the light weighted aluminum, when the intention of moving the panels to open or close the movable panels, the panels won't move simultaneously. Sometimes, the top part got stuck and will not move and sometimes, the same thing happening to the bottom part when the user apply the pressure in the top or bottom to move the panels. Also, because the moveable panel are hollow and long, when putting too much pressure to slide the panels, the pressure can cause the panels to dent or bend in that matter.

Figure 9. Modern Fah Lai design from Glasstonomy Café from top to below, 1. Fah Lai in fully close position, 2. Fah Lai in half close-open position, 3. Fah Lai in fully open position, 4. Modern Fah Lai sliding panel, photograph by author.



1 2

Figure 10. Analysis notes modern Fah Lai in Glasstonomy Café from left to right, 1. Window Fah Lai in fully close position, 2. Fah Lai sliding in open position, photograph by author.

Nevertheless, as biomimicry architecture field still discovering and expanding, humanity cannot deny that biophilia toward human emotion is still lingering due to the “fact that the brain evolved in a biocentric world” (Joye, 2006). Because of that reason human prefer and found of “vegetation-rich landscapes” (Joye, 2006) more than city setting with concretes and buildings. Therefore, the study of Geoffrey Bawa houses is the closest examples explanation of my position toward function and aesthetic in biomimicry. In one of the houses designed by Geoffrey Bawa to his old friend, Cecil and Chloe; the de Soysa house demonstrated the connection of human biophilia toward dwelling. The de Soysa house was a project that placed on family long owned with large garden subdivided plots between the daughters and their parents. The project started in 1985 but due to unexpected of Cecil’s sudden death,

Figure 11. Entrance to de Soysa house, Robson & Bawa, 2004

the project was completed by Chloe in 1991. The de Soysa house is a square plan measuring 14.5 meter to a side with the 3,000 Sq ft. (approx. 278 Sqm,) maximum circulation of the plan. In the de Soysa house, Bawa's personal note to Chloe mentioned "The roof is part pergola and part open to the moon and starts – and a view over the neighboring trees. Hope you like it!" (Robson & Bawa, 2004). In Bawa new design concept of the living in density area was to invite the openness "by inward-looking, open to the sky courtyards…" (Robson & Bawa, 2004) (Figure 11) to expand the spatial viewpoint in density area toward outside which somehow connect to nature within reach. Bawa design concerned the excellent of human comfort leads to bioclimatic instinct to the design for his clients (Figure 12).

Figure 12. The de Soysa house façade, Robson & Bawa, 2004

Beside the de Soysa house, another challenging project of Geoffrey Bawa was the house for Osmund and Ena de Silva. The de Silva desired to build a house in Colombo on a plot of corner land approximately 750 square meters. Although, Ena de Silva interviewed many architects to design the house, she could not determine who to choose. Eventually, Bevis Bawa suggested his brother to her, Geoffrey Bawa. At the initial meeting between Geoffrey Bawa and the de Silva, many requests have been made to the design, “she demanded a house that would incorporate traditional Kandyan features – an enclosing wall, opening sided rooms, verandahs, courtyards, a shrine room – but she also wanted a modern house with an office for her husband, a studio for her son, and a guest wing for visitors.” (Robson & Bawa, 2004). Bawa designed the plan based on the introspective of the de Silva desire to give more privacy to the family as the movement advancing away from the street (Figure13 & 14).

> “The first pavilion, which contains the office and studio, the garage and a guest suite, looks onto a large central court occupying the heart of the plan, surrounded on four sides by an opening loggia. The courtyard is finished in a combination of cobbles and gravels with four huge plumeria. Beyond is the main living accommodation: a two-storey pavilion with living and dining areas at the ground level separated by a stair tower and shrine room, with bedrooms above. Running down the side of the complex is the service tract: two long walls define the servants’ rooms and kitchens, each separated by small court, and, at the intersection with the first pavilion, the garage.” (Robson & Bawa, 2004) (figure 13 & 14).

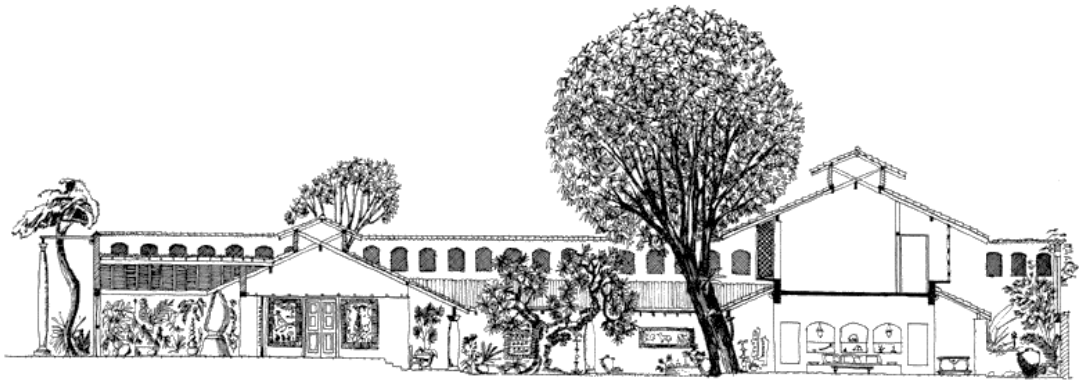


Figure 13. House for Osmund and Ena de Silva Elevation Plan

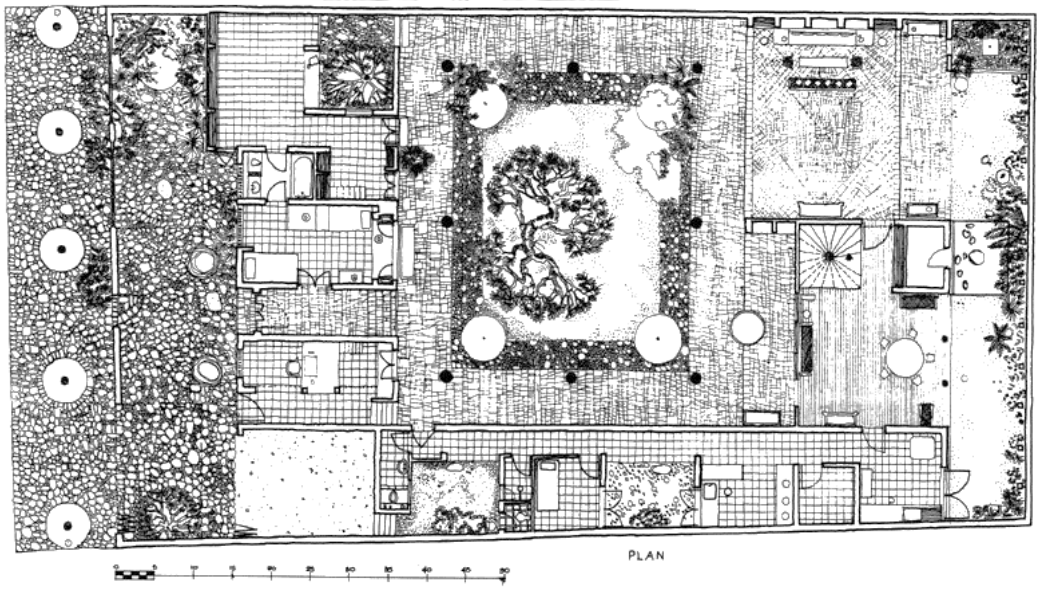


Figure 14. House for Osmund and Ena de Silva Floor Plan, Robson & Bawa, 2004

Much like other Bawa's early projects, the house was built with limited condition on materials. Due to the restriction of importing on materials; highly expensive glass, metals and incapable acquiring of modern fittings for the project redirecting Bawa's intuitive to be inventive and utilized local materials thus, creating vernacular impression to the project. In addition, beside materials, the space organization of the floor plan also play a role of bioclimatic to the resident there with the "series of

indoor and outdoor rooms to create the illusion of infinite space" (Robson & Bawa, 2004). Ena de Silva desired natural ventilation throughout the spaces without air-conditioning and without glass. The outcome of the decision from Ena de Silva desire made "projecting bay windows boxed out with diagonal timber lattice, raised ventilating ridges formed by extended crossover rafters, polished satinwood columns raised on elegant granite bases, deep overhanging eaves." (Robson & Bawa, 2004), resulting the new inside look of the house on a finite of urban site that can separately define by the usage of the rooms and yet resemblant.

Bawa's design his project to accommodate the maximum usage of spaces to fit the desire of his client and also subconsciously aware of bioclimatic throughout the spaces. This creating user comfort in the confine spaces to the dwellers and in the conceptual world of bioclimatic architecture, it "is to take advantage of local bioclimatic conditions with the benefit of the natural and built environment." (Widera, 2015). Even though, Geoffrey Bawa is praised to be "by instinct, a bioclimatic designer" (Robson & Bawa, 2004) as mentioned in the literature review chapter, a lot of his projects in the early years were limited to local materials thus creating vernacular passion. When vernacular meets bioclimatic, the fine line to distinguish the different between those are the observation of the technique. Often that vernacular and bioclimatic architecture resemblant each other, "First of all both of the ideas are characterized by the proper adaptation of the building to the climate specifics. Second issue is the concept of living in a balance with the natural environment which is very obvious in vernacular structures and consciously created in bioclimatic edifices." (Widera, 2015). However, what makes bioclimatic differentiate from vernacular is the exhaustive understanding of systematic complexity in ecosystem and technology like the function of biomimicry in architecture. Thus, my approach to biomimicry in architecture collide with a discussion with the bioclimatic architecture.

Chapter 3: Site

3.1 Chonburi

“ทะเลงาม ข้าวหลามอร่อย อ้อยหวาน จักรสานดี ประเพณีวิ่งควาย”

“Beautiful Beaches, Delicious Khao Lam, Sweet Sugar Cane, Delicate Basketry Products and Buffalo Racing.” (สำนักงานการท่องเที่ยวและกีฬา, 2020)

Chonburi, a popular destination for seaside scenery, variety of goods, food and tourist attraction activities with wide range of options to stay in the province. From beach bungalows to small hotels, luxury hotels, high-end residences and low to medium price range apartments has made Chonburi one of the destinations that tourists and Thais embark their journey for relaxation as one of their vacation destinations. “Chonburi province, the significant port city on the east coast of the Gulf of Thailand, it is 140 kilometers from Bangkok which can be accessed by driving along the expressway, train or air plane.” (Tadthiemrom, 2013) (Figure 15).

In the late 1950s, Chonburi was only known for fishing village until American troops came to Pattaya during the Vietnam war for get away and relaxation. Since the event of American veterans occupied in Pattaya, the city has been known for must visit destination for vacation because of the lively town that never sleeps, countless restaurant that serve good food to choose from and attractions for tourists through days and nights. Pattaya became “self-governing municipal city” (Tadthiemrom, 2013) and expanded in growth of industrial businesses and estates for tourism.

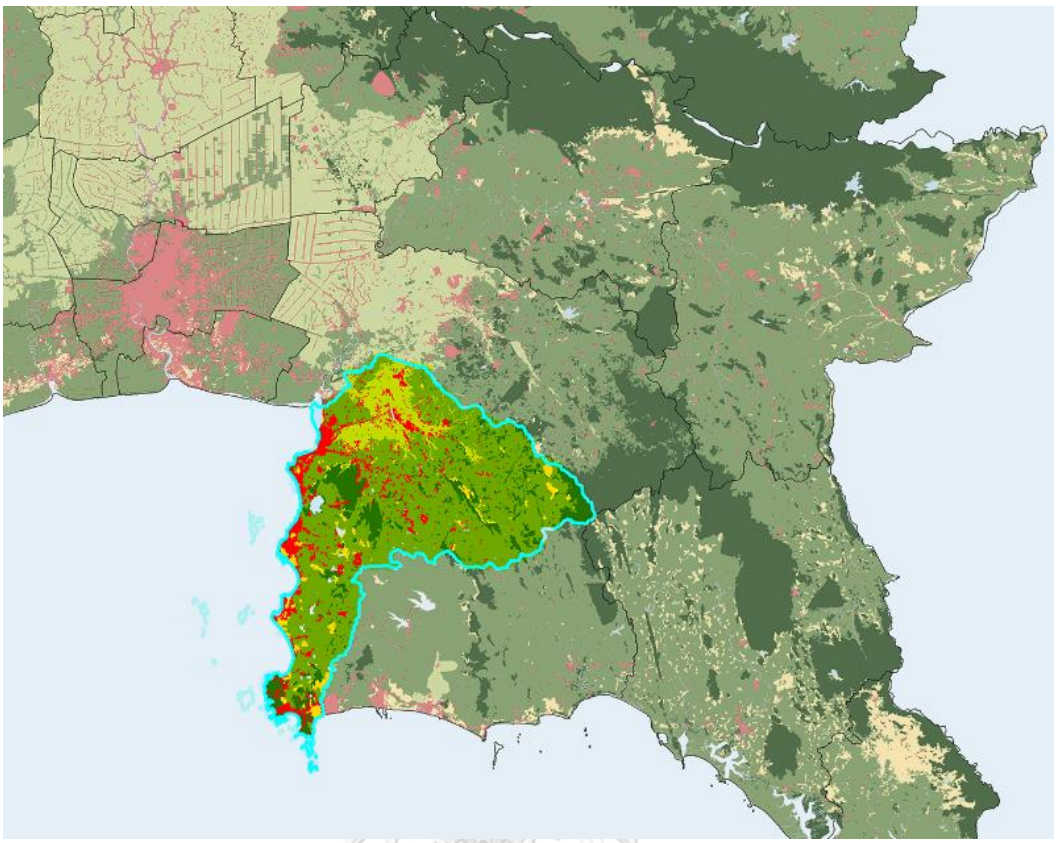


Figure 15. Map of Chonburi drawn by author using GIS Mapping Lat.13.361043, Long.100.983246.

3.2 Pattaya

From the choices of floating market, tiger zoo, submarine aquarium, sky diving with the wild night life of famous Tiffany or Alcazar shows and the scenery of beautiful beach for family, friend and couples to get away from the city. Today, Pattaya city has been developed into a more of traveling destination that alleviate the business of city life to spend time with family, friends and for romantic couples with variety of activities that ligature the love ones during the visit to help them reconnect and enjoy relaxation.

In the architecture world today where sustainability and the concern of energy consumption are a new trend of urban architecture. In the project of biomimicry in Chonburi vacation home is to set an architectural design for vacation in Thailand for a new way of sustainability life style and invitation to new economy

attraction to tourists. In this research topic, the study of environmental, climate, along with the site analysis are to find the affordable price and construction materials that can be found within the area. The analytical of identifying the problem from the statistic of tourists and Fine Particle Matter (PM 2.5) in the area has become highly increase over the past few years.

Figure 16. Statistic of Tourists Visiting Chonburi

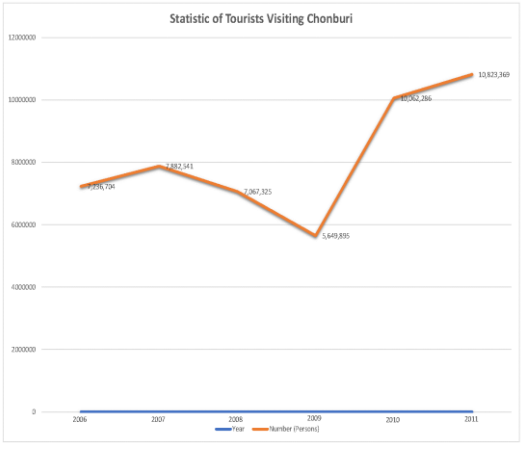


Figure 17. Statistic of Tourists Visit in Thailand 2009-2018.

Chonburi, one of the vacation destinations for tourists who wish to embark in experience of culture, tradition and relaxation in Thailand. There are many places for tourists to visit during the day such as Mini Siam, Sanctuary of Truth, Underwater World Pattaya, Pattaya Floating Market, Tiger Park, Nong Nooch Tropical Garden and to the famous Pattaya Walking Street during the night time. According to the National Statistical Office (NSO) of tourist visit in Thailand (Figure 16), in the recent statistics of 2018 the number of tourists climbed to 38,174,194 persons during that year. With the latest statistic data in 2011 From Thailand Regional Dataset (Figure 17) of tourist who visited Chonburi, the amount of traveler there reaches 10,823,369 persons in one province. When comparing to the NSO data of tourists who came to Thailand during 2011, the number is 19,230,470 persons who entered Thailand that year. Because the number of tourists who visited Chonburi made up 56.28% of all the tourists who travel to Thailand has brought the economic opportunity in

Chonburi. With the economic opportunity from tourists in Chonburi, many locals and investors are prone to establish their ground to intrigue and invite more tourists such as vacation resorts, hotels and vacation homes.

From the map of Pattaya area (Figure 18), the research in certain type of vocational facilities; vacation homes. The suggested of the price for vacation homes are varies in the area appearing on the map. However, the pricing becomes more expensive when the area is closer to beachfront though, it is not always all the case. In certain area that the price can almost be the same as the one in the beachfront due to their amenities in the areas and the structure of the vacation home itself. Also, further look into the tourist attraction area can be one of the factors as well (Figure 19). The mapping indicates the pinpoint of tourist area which close to the chosen site in the project due to the distant of travel and pricing that affordable rage to tourists.

Figure 18. Pattaya Map – Price Range Vocational Residences; Red: 3,500 - 7,000 Baht/night, Orange: 1,500 – 2,500 Baht/night, Green: 750 – 1,500 Baht/night, drawn by author.

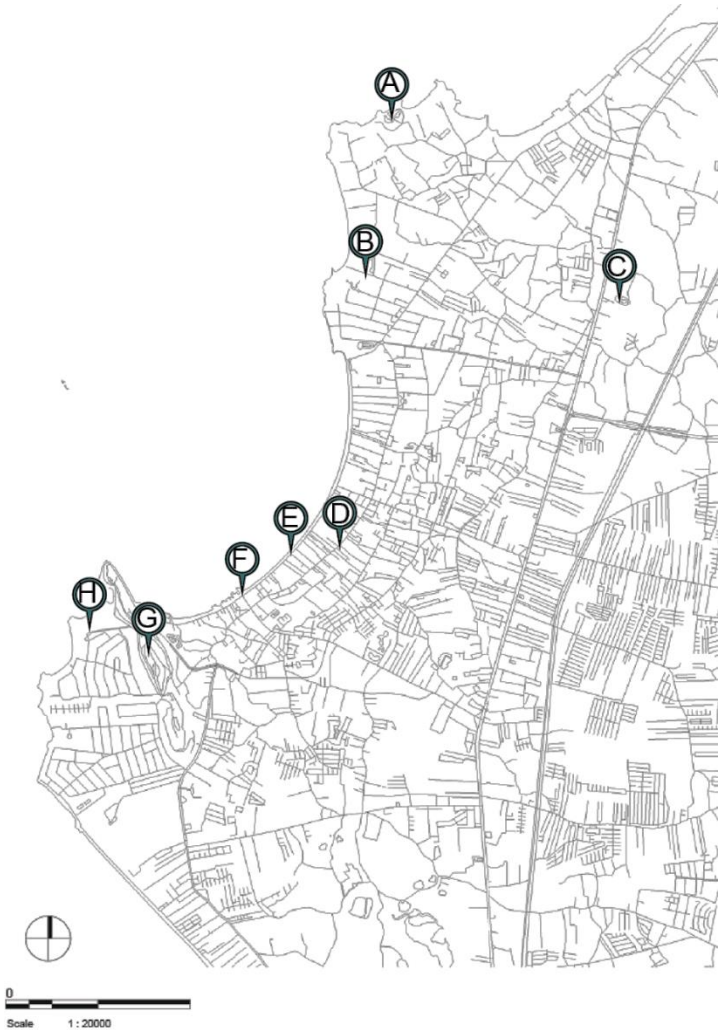


Figure 19. Pinpoint of Tourist Attractions in Pattaya: A. Sanctuary of Truth, B. Art in Paradise, Teddy Bear Museum, Alcazar Cabaret Show, C. Mini Siam, D. Pattaya Night Bazaar, E. Pattaya Beach, F. Pattaya Walking Street, G. Phra Tamnak Moutain (Phrabat Moutain), drawn by author.

With the increasing of the tourists that visit Chonburi, the city has grown in Gross Provincial Product (GPP) and allowing the locals to invest in the tourism, housing and other activities. Therefore, with the city growing and investment to develop the city, resulting in the increasement of constructions and other activities that manifest pollution due to developments. In order to overcome the current state that post risks to anyone living there, the new way of sustainable living must be implemented.

This design-base site is located in south Pattaya (Figure 20) area from the collected data and personal site visit was performed prior the pandemic of COVID-

19. From the mapping of Pattaya site in Figure 20, the pricing of the site was determined to be in the average pricing area according to the zoning categorize in the price range mapping in Figure 18.

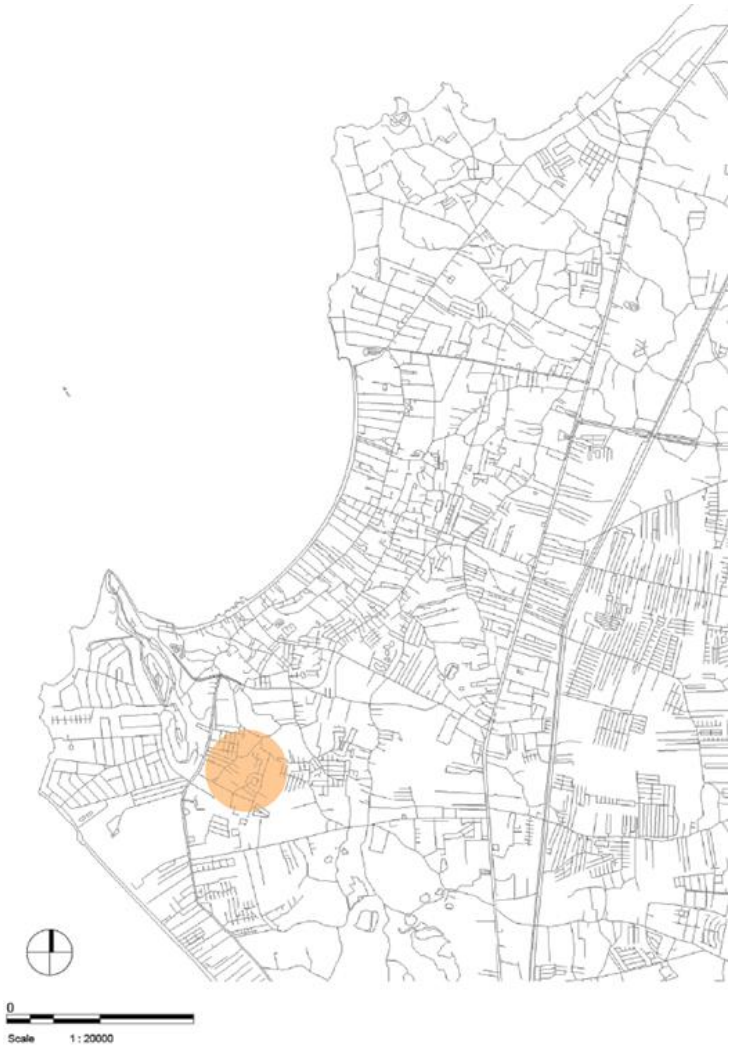


Figure 20. South Pattaya Site, drawn by author using Revit.

Furthermore, another fact of determination for base-site gathered from the information of surrounding familiar facilities in the area; vacation homes, pool villas. According to the raw research data of vacation homes, pool villas in the area of the selected site from Airbnb.com (Table 1), the average price to stay per night is significantly affordable for anyone to stay for a short time visiting Pattaya. The pricing varies from 1,722 baht to the maximum of 6,642 baht. The average of people

the vacation home, pool villas can accommodate is between 6 to 12. In each vacation home, pool villas provided similar amenities such as the basic essentials; towels, bed sheets, soaps, toilet papers, dishes, silverwares, cooking utensils and cooking seasoning. Even though, the essential is a must in the decision when choosing vacation home, pool villas to stay, another fact that will help narrowing down to the best interest for one who will be staying depends on varies of the other amenities and features or key features of that place. In determination of what the other amenities are such as parking on premises, Wi-Fi (Wireless Fidelity), A/C or Heating, refrigerator, stove, friendly working space, television and cable television. On another hand, the features or key features may help further to cut the tie in choosing vacation home, pool villas such as the outdoor facilities of the place; patio, balcony, garden or backyards with barbeque grill. Other features or key features may be focus on the safety of occupants such as carbon monoxide alarm, smoke alarm, first aid kit, and fire extinguisher on the premises. Lastly, in some cases, vacation home, pool villas may offer family features such as baby bath, baby sitter, children's books, stair gates, game console, baby changing table, crib and travel crib for any family with children.

Table 1. Raw data on June 4th -6th 2020, drawn by author.

Name	Location	Type of Residence	Guests	Bedroom	Bath	Toilet	Bedroom Details	Amenities	Outdoor	Safety Features	Family Feature	Price / Night (Baht)
Private Pool Villa	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	8	3	2		1 queen bed each room	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, TV, Cable TV, Essentials (towels, bed sheets, soap, and toilet paper), Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics (Pots, pans, oil, salt and pepper)	Garden backyard, BBQ Grill, Patio or balcony	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher		1,772
Villa 3 Bedroom with Private Pool near Walking Street	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	8	3	2		#1 to 3- Queen Bbed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials (towels, bed sheets, soap, and toilet paper), Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics (Pots, pans, oil, salt and pepper)	Garden backyard, BBQ Grill, Patio or balcony	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher	Children's books and toys, Baby bathtm Babysitter recommendations	1,772
Amazing Thai Style Family Home Tropical Vibe	Muang Pattaya, Chang Wat Chon Buri, Thailand	House	9	3	3		#1- King bed, #2 &3- Queen Bed, Common Spaces- 1 King bed, 1 Single bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, TV, Cable TV, Essentials (towels, bed sheets, soap, and toilet paper), Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics (Pots, pans, oil, salt and pepper)	Garden backyard, BBQ Grill, Patio or balcony	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher		2,000
Hideaway Pool Villa	Muang Pattaya, Chang Wat Chon Buri, Thailand	House	6	2	1		#1 & 2- Queen bed, Commonspace- Sofa bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, TV, Cable TV, Essentials (towels, bed sheets, soap, and toilet paper), Hot water, Hot tub, Pool, Parking on permises, Kitchen, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics (Pots, pans, oil, salt and pepper)	Garden backyard, BBQ Grill	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher		2,260
Villa Hosted by Nicolas	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	8	4	5	2	#1&2- 1 queen, 1 counch, #3&4- 1 queen	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, TV, Cable TV, Essentials (towels, bed sheets, soap, and toilet paper), Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics (Pots, pans, oil, salt and pepper)	Patio or balcony, Garden or Backyard	Carbon monoxide alarm, Smoke alarm		2,301

Name	Location	Type of Residence	Guests	Bedroom	Bath	Toilet	Bedroom Details	Amenities	Outdoor	Safety Features	Family Feature	Price / Night (Baht)
Grand Condotel Villa Rose	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	4		#1- King bed, #2- Queen bed, #3- Double bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony	Smoke alarm, Carbon monoxide alarm		2,500
Swiss House III	Bang Lamung District, Chon Buri, Thailand	House	10	4	4		#1 to 4- double bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony			2,500
Villa Hosted by Vicky	Bang Lamung District, Chon Buri, Thailand	Villa	6	2	3		#1- King bed, #2- double bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony	Smoke alarm		2,700
Pattaya Thabali Villa*	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	4		#1 to 3- King Bbed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}		Fire extinguisher		2,800
Paradise Beach Garden	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	3		#1 to 3- King bed, Common Space- 1 couch	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard	Smoke alarm		3,000

Name	Location	Type of Residence	Guests	Bedroom	Bath	Toilet	Bedroom Details	Amenities	Outdoor	Safety Features	Family Feature	Price / Night (Baht)
Villa Near Walking Street	Muang Pattaya, Chang Wat Chon Buri, Thailand	House	6	3	2		#1,3- King bed, #2- Queen beds	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard		Crib	3,500
Swiss House II	Muang Pattaya, Chang Wat Chon Buri, Thailand	House	10	5	5		#1 to 4- Double bed, #5- Queen beds	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard	Carbon monoxide alarm		3,800
Soi 1 Luxury Pool Villa 1	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	3.5		#1 & 2- King bed #3- Queen bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Dishwasher, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard	Smoke alarm, Carbon monoxide alarm		4,000
Villa La Ibiza	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	2		#1- Double bed, #2,3- Queen beds	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}		First aid kit		4,000
Villa with Private Pool #16	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	2	2		#1- Double bed, Sofa bed #2- Double bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Patio or balcony		Crib, high chair	4,100

Name	Location	Type of Residence	Guests	Bedroom	Bath	Toilet	Bedroom Details	Amenities	Outdoor	Safety Features	Family Feature	Price / Night (Baht)
Aliz Pool Villa	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	3		#1 to 3- King bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony	First aid kit		4,134
Villa with private pool #65	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	2	2		#1- Double bed, sofa bed #2- Double bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony		Crib, high chair	4,250
Villa for 6 people	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	2	2.5		#1- King bed, #2- queen bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony			4,500
Walking Street & Beach Villa	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	10	4	4		#1- Double bed, #2- Queen bed, single bed, #3, 4- Queen bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher	Pack'n Play/ Travel crib, Crib, Children's books and toys, Room-darkening shades, high chair	4,567
Villa hosted by Jany & Kanittha	Beachfront	Villa	10	4	4		#1- King bed, #2 to 4- Queen bed, Common Space- 1 single bed, 1 sofa bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, BBQ Grill, Patio or balcony	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher	Pack'n Play/ Travel crib, Crib, Children's books and toys, Room-darkening shades, high chair	4,602

Name	Location	Type of Residence	Guests	Bedroom	Bath	Toilet	Bedroom Details	Amenities	Outdoor	Safety Features	Family Feature	Price / Night (Baht)
5 Bedroom Poll Villa	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	11	5	2		#1 & 5- Doube bed, #2, 3, 4- Queen. Common space- sofa bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, BBQ Grill, Patio or balcony	First aid kit		4,663
Luxury Villa Palmc15	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	3.5		#1&2- Double bed, #3- Queen bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony	Smoke alarm, Carbon monoxide alarm	Bathtub, Room-darkening shades	5,000
Thai garden luxury villa	Beachfront	Villa	6	3	3.5		#1 to 3- King bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, BBQ Grill, Patio or balcony	Smoke alarm, Fire extinguisher		5,531
Luxury Villa Palmc7	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	6	3	3.5		#1 to 3- Queen bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, BBQ Grill, Patio or balcony	Smoke alarm, Carbon monoxide alarm		5,775
357/101A Pattaya Center, Phra Hill	357/101A Pattaya Center, Phra Hill, Beachfront	House	8	4	4.5		#1 to 4- King bed, Common Space- 3 sofa beds	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, Patio or balcony	First aid kit, Smoke alarm, Carbon monoxide alarm, Fire extinguisher	Stair gates, Babysitter recommendations, Game console, Window guards, Outlet covers, Changing tablle, Children's dinnerware, bathtub, Children's books and toys, room-darkening shades	5,800

Name	Location	Type of Residence	Guests	Bedroom	Bath	Toilet	Bedroom Details	Amenities	Outdoor	Safety Features	Family Feature	Price / Night (Baht)
Entire house hosted by Nathan	Muang Pattaya, Chang Wat Chon Buri, Thailand	House	12	6	6		#1 to 5- King bed, #6- Queen bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, BBQ Grill, Patio or balcony	N/A		6,227
Mona Villa	Muang Pattaya, Chang Wat Chon Buri, Thailand	Villa	8	4	4.5		#1 ,2- King bed, #3- 2 Single beds, #4- King bed, sofa bed	Wifi, Ethernet connection, A/C, Heating, Laptop-friendly working space, Iron, Washer, Dryer, TV, Cable TV, Essentials {towels, bed sheets, soap, and toilet paper}, Hot water, Hot tub, Pool, Parking on permises, Kitchen, Oven, Microwave, Coffee maker, Refrigerator, Dishes and silverware, Stove, Cooking basics {Pots, pans, oil, salt and pepper}	Garden backyard, BBQ Grill, Patio or balcony	Fire extinguisher		6,642

At the location of design-base site, traveling from the main road Thapphraya to Thappharaya 15 Alley. Along the road in the alley is noticeable by residence signs such as Baan Souy Resort, Isaree Resort and Sala Villas which are vacation home, pool villas that vacancy for everyone who'd want to enjoy their vacation time in privacy with highly decorated and full-service amenities. Traveling from the Northeast from main road down to the southwest to the intersection of Thappharaya 15 Alley and the Thep Prasit 12 Alley. From there, traveling to the northwest from the intersection will lead to the design-base site (Figure 21) according to the Department of Lands in the image search system of land plots, the design-base site area is 712 Square meters (Figure 21 & 22). Along the path from my personal encounter of the area before the start of COVID-19 Pandemic, a new pool villa project is being built to accommodate future tourists and people who seek private, yet extravagance experience to Pattaya.

Figure 21. Design-base Site (Scale 1:3000), drawn by author using SketchUp

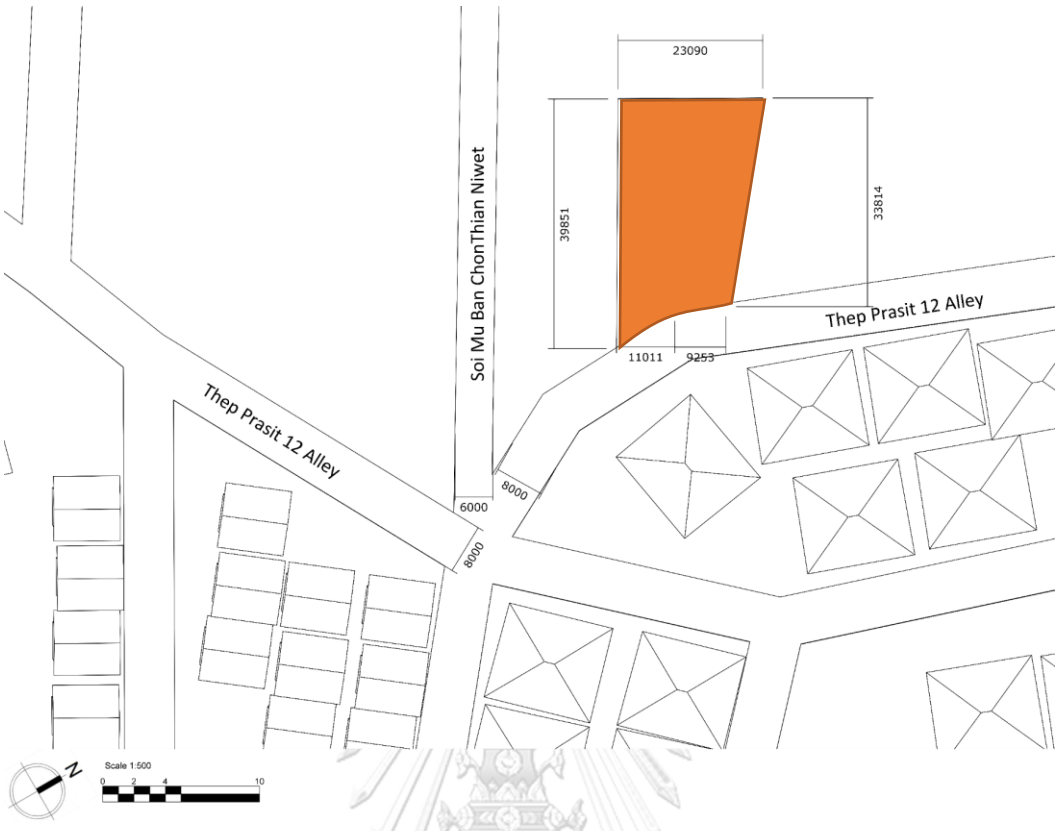


Figure 22. Design-base Site (Scale 1:500), drawn by author using SketUp.

3.3 Home (บ้าน), Vacation Home

“บ้าน

น. ที่อยู่ เช่น เลขบ้าน เจ้าบ้าน, สิ่งปลูกสร้างสำหรับเป็นที่อยู่อาศัยเช่น บ้านพักตากอากาศ บ้านเช่า, บริเวณที่เรือนตั้งอยู่ เช่น เขตบ้าน,หมู่บ้าน เช่น ผู้ใหญ่บ้าน, ถิ่นที่มีมนุษย์อยู่ เช่น สร้างเป็นบ้านเป็นเมือง” (พจนานุกรม, 1999)

“Home

n. a house, apartment, or other shelter that is the usual residence of as person, family, or house hold. The place in which one’s domestic affections are centered.” (Dictionary, 2020)

In the definition translated from Thai dictionary, home (baan); address such as house number, construction for dwelling such as vacation home, rent home, area where home is at such as site, village such as village chief, habitat area for human such as city. In this translated version of home from Thai dictionary and English dictionary we can agree on the common word that define home as a type of construction that made for human dwelling. Though, from the great Dutch architect and urbanist, Aldo van Eyck eyes “once remarked that ‘architecture must facilitate man’s homecoming’. A beautiful house is no guarantee that it will also be a home.” (McGillick, 2017). Though, a home today is a place where one’s emotionally retreat from noisy and hectic everyday intrusive world. A home is a place where psychologically placed to emotion of comfortable, cozy and safe as Frank Lloyd Wright said “a home needed to offer refuge and prospect.” (McGillick, 2017).

Vacation home as mentioned in Thai dictionary of the word home (baan), construction for dwelling such as vacation home. Later, since 1995, Vacation Rentals by Owner (VRBO) became popular and introduced widely in the United States. VRBO was the first to embark on the vacation rental website and well known before new generation of vacation rentals websites such as TripAdvisor and Airbnb today. In the rapidly grow

of economic today and the life style that congest individuality in the city created density in the city and pollution. “When city dwellers have sufficient means to escape the frenetic pace of life in the city, they acquire a site some distance from the city to build a second home.” (Powell & Lim, 2012) -vacation home.

3.4 Survey

In recent survey to determine the program on this project the question has been sent out to 65 people which separate into two focus group of people. The first group targeting Thai nationality people in varies age group and their information on vocational ideal. On the other hand, with the same questions are focusing on foreigner group on their vocational ideal.

From the first group, 45 responses of Thai people who did the survey (Figure 23) the age between 21-73 years old which majority of them 46% are married, 15% are in relationship and 37% are single spending time for vacation on the average of 10 days per year. Besides the most of the responses of the number for 2 persons for vacation, the most answers in the survey are between 4 to 10 people. In the chronological order, most of the responses focusing on the bedroom, scenery of the place, privacy, amenities, walking distance to the nearby attractions, security system, prices, etc.

From the second group, 20 responses from foreigner who did the survey (Figure 24) are between the age of 21-63 years old in the majority of them are 45% single, 30% married and 25% in a relationship spending time for their vacation on the average of 10 to 20 days per year. The highest number of people who going on vacation are 2 persons and 5 persons in the responses which in the order, the decision for them to choose a place to stay are as follow, amenities, scenery, privacy, walking distance to the attractions, bedroom and safety feature of the facilities.

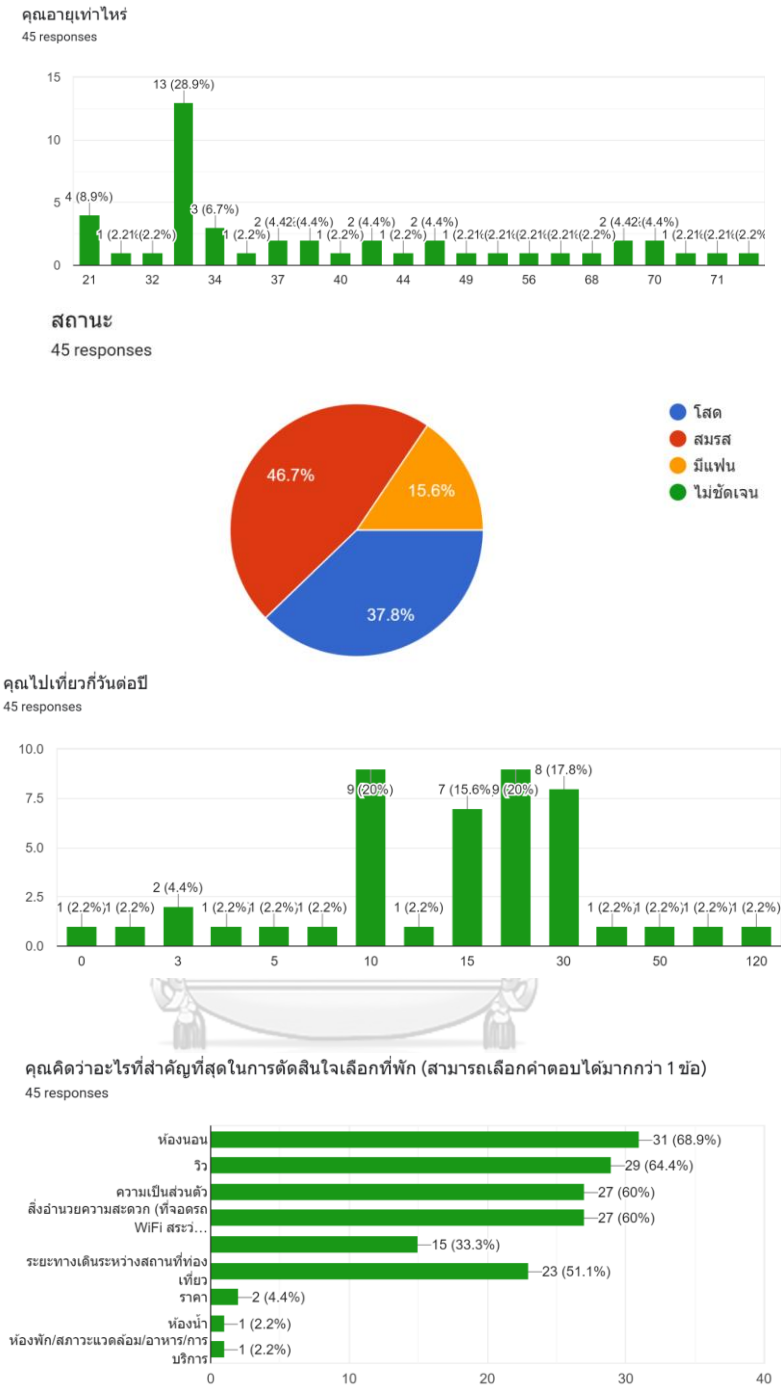


Figure 23. Survey Vacation + Sustainability (Thai Version), collected from google form by author.

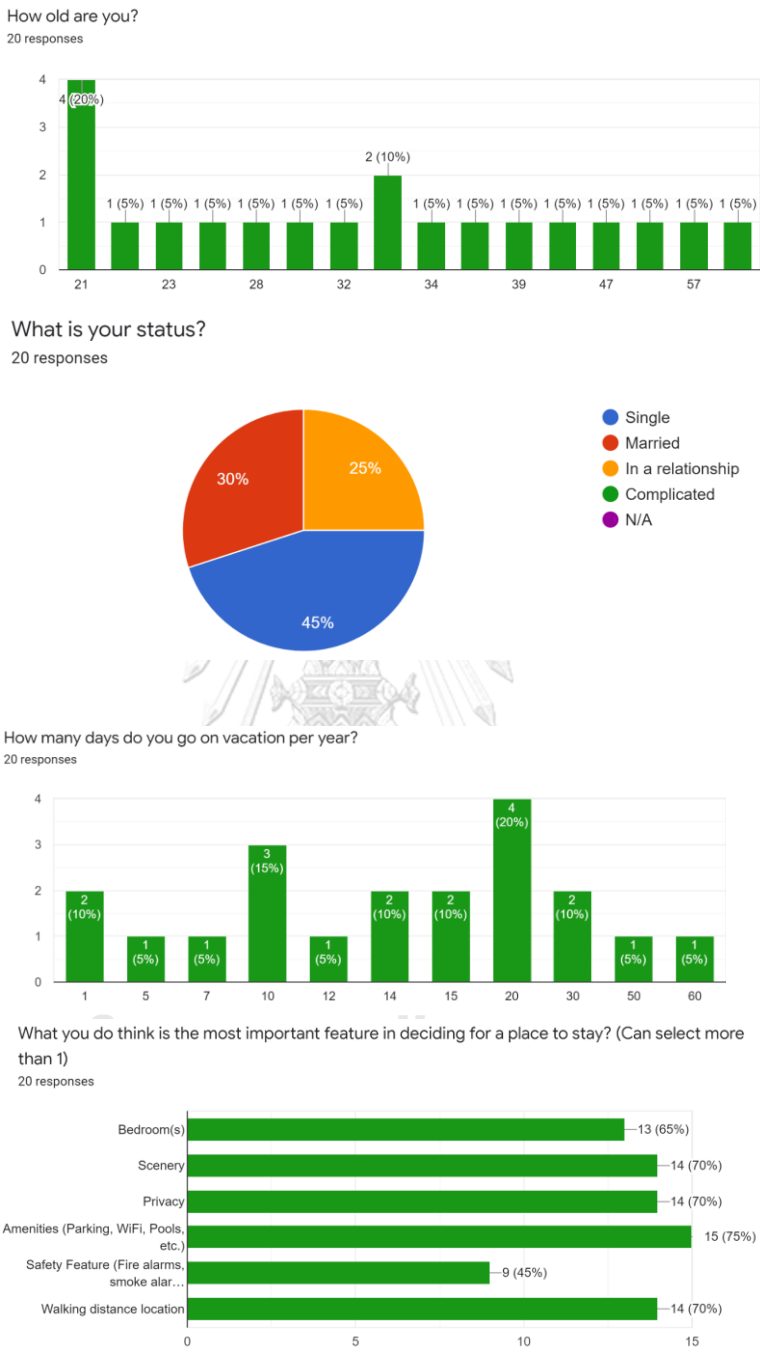


Figure 24 Survey Vacation + Sustainability (English Version), collected from google form by author.

In the survey the section about sustainability covers the individual awareness and perforation of the place they will stay. In the first group, about 4% that prefer to stay in the place with natural ventilation with 15% of the people who did the survey rather stay in the facility that has A/C while the majority of 80% prefer both natural ventilation and A/C. For the second group, the percentage on natural ventilation is slightly higher than the first group which is 10%. Though, the percentage of people on second group that want to stay in the facility that has A/C has risen up to 25% comparing to the first group that only 15%. Which bring to the left-over number of 65% of the people in the second group that prefer the facility that provide both ventilations (Figure 25). Although, when asked the question on how do they care about the environment surrounding, the result showing that more than 50% of the people taking the survey are caring about the environment (Figure 26). While the question of if they know the place, they are staying focuses on sustainability, would they prefer to stay in the place? The result surprisingly came out that the first group, for more than 70% of the people who took survey would rather stay in the place while only 50% or people in the second group would like to stay in the place that care about sustainability (Figure 27). In the summary of this survey toward the program of the selected sight, the decision based on collected raw data (Table 1) and survey data (Figure 21-27), the program will focus on bedrooms in the facility to the best scenery with privacy in the facility while the selected site is being close in the walking distance to the tourist attractions.

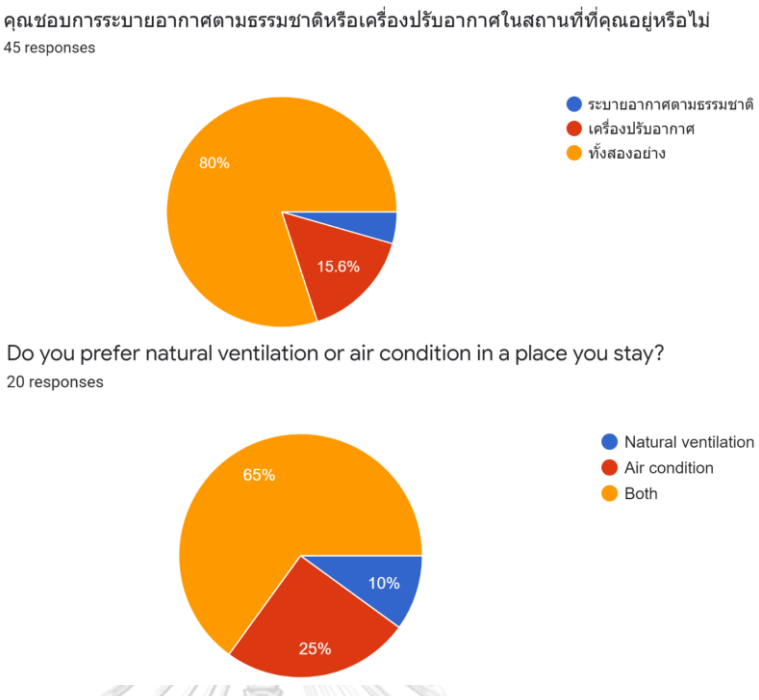


Figure 26. Ventilation Survey, collected from google form by author.

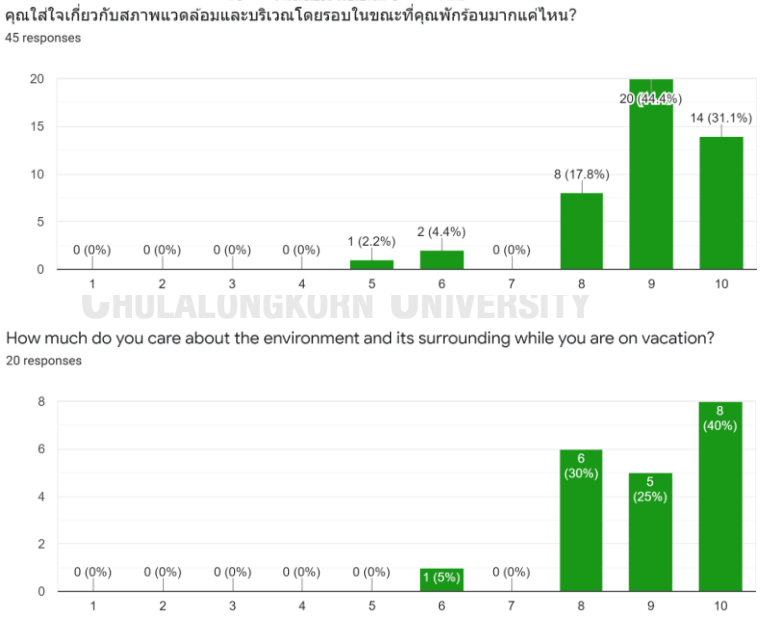


Figure 25. Environmental Awareness Survey, collected from google form by author.

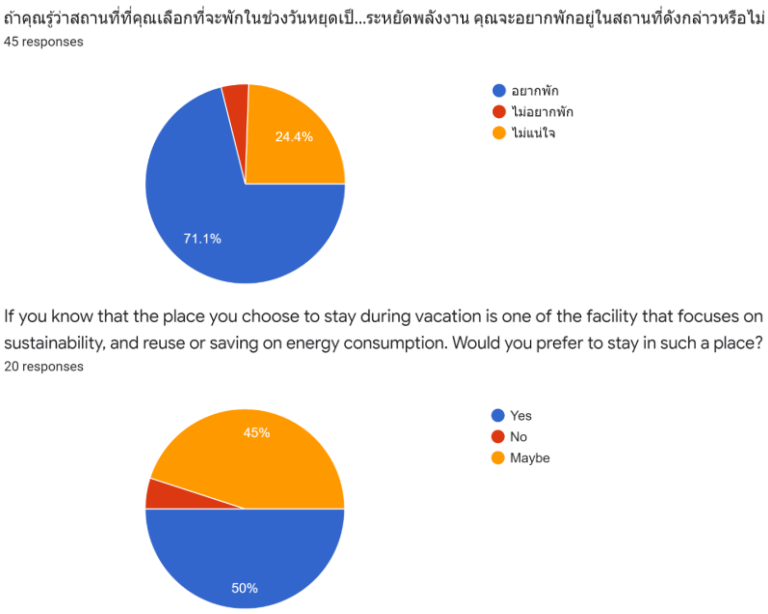


Figure 27. Sustainability Place Survey, collected from google form by author.

3.5 Conclusion of the program

From the responses data above in the survey and the data collected from Thai and English version (Figure 23 & 24) indicate that people who are going on vacation from 2- 4 person as regular family size are made up of 50% of all the responses. In addition, another high percentage group of people who are going on vacation are between 5-7 persons which is 30% of all the responses. Due to this outcome of the percentage data, the program for this selected site will accommodate of 5 bedrooms with bathroom included to make sure that each individual or couples in the family will be able to enjoy their privacy while on vacation. The program will include large living room for family and guests for indoor activities, with fully function kitchen in the house, outed space for Thai style kitchen and barbeque for those who love to grill and those who enjoy downtime preparing food. The spaces in the selected program will accommodate, encourage the use of both ventilation system: AC and natural (Table 2). According to the Act of Parliament B.E. 2558 states that the selected site area for this project allowed

building height for homes, and townhomes which cannot exceed 9 meters. Therefore, this project program will be two story single home for vacation renting.

Single Home for Vacation (712 Sqm.)		
Rooms	Area (Sqm.)	Quantity
Living Room	60	1
Bedroom + Bath	50	5
Kitchen + Dinning	20	1
Swimming Pool	24	1
Parking	64	1
Toilets	8	2

Table 2. Single Home for Vacation Program, drawn by author.

Table 3. Survey Data (Thai and English), collected from google form by author.

Timestamp	How old are you?	What is your status?	If married, how many children do you have?	How many days do you go on vacation per year?	How many people (including yourself) usually go on vacation?	What kind of place would you prefer to stay during your vacation?	What you do think is the most important feature in deciding for a place to stay? (Can select more than 1)	Do you prefer natural ventilation or air condition in a place you stay?	Do you cook while on vacation? (If such a place allow cooking)	How much do you care about the environment and its surrounding while you are on vacation?	If you know that the place you choose to stay during vacation is one of the facility that focuses on sustainability, and reuse or saving on energy consumption. Would you prefer to stay in such a place?	Please describe your ideal vacation of a place you'd want to stay in tropical region.
7/29/2020 15:48:22	37	โสด		15	4	โรงแรม	วิว, ความเป็นส่วนตัว, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	9	ไม่แน่ใจ	ธรรมชาติ รถเข้าถึง
7/29/2020 16:09:22	33	มีแฟน	1	20	2	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนคาวัน , ถังดับเพลิง	ทั้งสองอย่าง	อาจจะ	10	ไม่แน่ใจ	ชอบความเงียบสงบ ร่มรื่น มีต้นไม้ร่ายล้อม
7/29/2020 16:32:20	34	มีแฟน		3	2	โฮมสเตย์	สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...)	ทั้งสองอย่าง	ไม่ทำ	6	ไม่แน่ใจ	สบายๆ
7/29/2020 16:40:10	34	โสด		15	2	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนคาวัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	อาจจะ	8	ไม่แน่ใจ	ธรรมชาติ สบาย ทะเล ลูเขา น้ำตก
7/29/2020 16:49:13	33	โสด		10	2	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...)	เครื่องปรับอากาศ	ไม่ทำ	10	อยากพัก	ที่พักสบาย
7/29/2020 16:49:28	33	โสด		15	2	โรงแรม	วิว, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	อาจจะ	9	อยากพัก	เหมาะสมทั้งด้านเวลา ราคา ความสะดวกสบาย
7/29/2020 16:55:15	33	โสด		20	10	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนคาวัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ทำ	10	อยากพัก	-
7/29/2020 18:11:13	34	สมรส	2	30	4	โฮมสเตย์	ห้องเตียน, วิว, ความเป็นส่วนตัว, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	อาจจะ	9	อยากพัก	ฟักริมน้ำ
7/29/2020 18:23:28	33	โสด		10	2	โรงแรม	วิว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว, ราคา	ทั้งสองอย่าง	ไม่ทำ	9	ไม่แน่ใจ	ไปแบบไม่ได้วางแผน ขับรถไปเรื่อยๆ ค่ำไหน นอนนั่น
7/29/2020 19:07:38	33	สมรส		20	2	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว	ทั้งสองอย่าง	ทำ	9	อยากพัก	สบาย
7/29/2020 19:35:42	33	โสด		10	3	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนคาวัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	9	ไม่อยากพัก	มีความเป็นส่วนตัวและสภาพแวดล้อมดีเป็นการผ่อนคลาย
7/29/2020 21:11:15	33	สมรส	0	3	5	บ้านพัก	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...)	เครื่องปรับอากาศ	ไม่ทำ	9	อยากพัก	ปิ่นเขา
7/29/2020 21:48:38	32	มีแฟน	1	20	2	โรงแรม	ห้องเตียน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนคาวัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	อาจจะ	9	อยากพัก	ต้องการอยู่กับธรรมชาติ
7/29/2020 21:51:55	33	มีแฟน	0	15	8	โฮมสเตย์	ห้องน้ำ	ทั้งสองอย่าง	อาจจะ	8	อยากพัก	เน้นธรรมชาติและวิถีชาวบ้าน
7/29/2020 22:04:35	28	Single		1	3	Hotel	Bedroom(s), Scenery, Amenities (Parking, WiFi, Pools, etc.), Walking distance location	Both	No	9	Maybe	Hotel near beach

7/29/2020 22:07:57	33	สมรส	0	10	2	โรงแรม	วิว	ทั้งสองอย่าง	ไม่ทำ	9	อยากพัก	ที่พักสงบ มีความเป็นส่วนตัว สิ่งอำนวยความสะดวกครบ โดยไม่ต้องออกจากที่พัก
7/29/2020 23:40:02	32	Married	0	10	2	Hotel	Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Both	Maybe	8	Yes	Somewhere on the beach
7/30/2020 1:14:22	30	In a relationship		7	5	Villa / House	Privacy, Amenities (Parking, WiFi, Pools, etc.), Walking distance location	Natural ventilation	Maybe	10	Maybe	Sun, sea, wind, juice, beautiful scenery, and tree by the way.
7/30/2020 3:48:24	35	สมรส	0	30	2	บ้านพัก	ห้องนอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบล็อนคีน , ถังดับเพลิง	ทั้งสองอย่าง	ทำ	9	อยากพัก	เป็นสถานที่ เหมาะกับการพักผ่อนจริงๆ
7/30/2020 3:48:24	37	Single		15	4	Hotel	Scenery, Privacy, Walking distance location	Both	No	9	Maybe	Nature and easy access
7/30/2020 7:35:09	33	In a relationship	1	20	2	Hotel	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.)	Both	Maybe	10	Maybe	Privacy with nature surrounding
7/30/2020 7:35:09	33	มีแฟน	1	30	7	โฮมสเตย์	ห้องนอน ,ความเป็นส่วนตัว	ทั้งสองอย่าง	อาจจะ	10	อยากพัก	เงียบ สงบ ใกล้ชิดธรรมชาติ
7/30/2020 13:44:18	34	Single		15	2	Hotel	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Both	Maybe	8	Maybe	Nature with mountain or water fall
7/30/2020 13:44:18	33	โสด		10	2	โรงแรม	วิว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว, ราคา	ทั้งสองอย่าง	ไม่ทำ	9	ไม่แน่ใจ	ไปแบบไม่ได้วางแผน ขับรถไปเรื่อยๆ คำไหน นอนนั่น
7/31/2020 19:37:37	23	โสด		4	5	โรงแรม	ห้องนอน	ทั้งสองอย่าง	ไม่ทำ	9	ไม่แน่ใจ	-
7/31/2020 19:37:37	21	Single		30	6	Hotel	Privacy, Amenities (Parking, WiFi, Pools, etc.), Walking distance location	Both	Maybe	9	Maybe	The location to stay should be within walking distance
8/1/2020 12:30:59	21	โสด		30	6	โรงแรม	ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	อาจจะ	8	อยากพัก	อยากได้ที่พักที่ไม่ห่างจากสถานที่เที่ยวมาก แต่ก็สามารถพักผ่อนอยู่ในที่พักได้ ไม่ต้องออกไปเที่ยวตลอดเวลา
8/1/2020 12:30:59	21	In a relationship	2	10	10	Hotel	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Both	Maybe	8	Yes	Beautiful and cheap
8/1/2020 12:31:09	21	โสด		20	5	โรงแรม	ห้องนอน, วิว, ความเป็นส่วนตัว, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ระบายอากาศตามธรรมชาติ	อาจจะ	8	อยากพัก	การไปสถานที่ต่างๆ ชมความสวยงามของธรรมชาติ และพักผ่อน จากชีวิตประจำวัน
8/1/2020 12:31:09	33	Married	1	12	7	Hotel	Bedroom(s)	Air condition	Yes	6	No	
8/1/2020 12:31:23	23	Single		1	9	Hotel	Bedroom(s), Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Both	Yes	10	Yes	Green, local, but comfortable to stay
8/1/2020 12:32:32	21	In a relationship		60	2	Hotel	Scenery, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Air condition	No	8	Yes	english available, clean, safe, not expensive and something impressive activity
8/1/2020 13:48:45	22	Single		14	5	Hotel	Bedroom(s), Scenery	Air condition	No	10	Maybe	A hotel room with a nice beach view

8/2/2020 7:35:02	21	มีแฟน	2	10	10	โรงแรม	ห้องนอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	อาจจะ	8	อยากพัก	Natural and peaceful
8/2/2020 7:35:02	63	Single	1	5	40	Hotel	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Both	No	10	Maybe	
8/3/2020 10:52:56	39	Married	2	20	5	Hotel	Bedroom(s), Scenery, Amenities (Parking, WiFi, Pools, etc.), Walking distance location	Both	Yes	10	Yes	I'd like to be close to local and do what local do
8/3/2020 10:52:56	33	สมรส	1	10	7	โรงแรม	ห้องนอน	เครื่องปรับอากาศ	ทำ	6	ไม่อยากพัก	สวย ถูก
8/3/2020 18:58:29	71	โสด	3	0	4	โรงแรม	ห้องนอน, ความเป็นส่วนตัว, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	5	อยากพัก	แหล่งท่องเที่ยวที่ไม่ใช่ทะเล
8/3/2020 18:58:29	47	Married	1	20	5	Hotel	Amenities (Parking, WiFi, Pools, etc.)	Air condition	No	10	Yes	
8/3/2020 19:21:11	21	Single		20	5	Hotel	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Walking distance location	Natural ventilation	Yes	9	Yes	
8/3/2020 19:21:11	63	สมรส	1	5	40	โรงแรม	ห้องนอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	10	ไม่แน่ใจ	คงไม่มี
8/3/2020 19:25:32	57	Married	2	14	10	Hotel	Privacy	Both	Maybe	8	Yes	
8/3/2020 19:25:32	39	สมรส	2	20	5	โรงแรม	ห้องนอน, วิว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ทำ	10	อยากพัก	ท่องเที่ยวทางวัฒนธรรม
8/3/2020 19:30:01	55	Single		30	2	Hotel	Bedroom(s), Scenery, Privacy, Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Both	No	9	Yes	being close to nature
8/3/2020 19:30:01	46	สมรส	1	20	5	โรงแรม	สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...)	เครื่องปรับอากาศ	ไม่ทำ	10	อยากพัก	สะอาด สงบ สะดวกสบาย
8/3/2020 19:30:29	43	Married	2	50	4	Hotel	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.)	Both	No	10	Maybe	
8/3/2020 19:30:29	21	โสด		20	5	โรงแรม	ห้องนอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ทำ	9	อยากพัก	สะดวกสบาย มีทุกอย่างอำนวยความสะดวก
8/3/2020 19:33:11	56	สมรส	2	14	10	โรงแรม	ความเป็นส่วนตัว	ทั้งสองอย่าง	อาจจะ	8	อยากพัก	ธรรมชาติ
8/3/2020 19:58:08	55	โสด	0	30	2	โรงแรม	ห้องนอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	9	อยากพัก	อยู่กับธรรมชาติให้มากที่สุด
8/3/2020 20:14:44	44	สมรส	2	50	4	โรงแรม	ห้องนอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...)	ทั้งสองอย่าง	ไม่ทำ	10	ไม่แน่ใจ	Green, ที่โปร่ง, ธรรมชาติ, สวย, สะอาด บริการดี
8/3/2020 20:16:22	43	โสด		15	4	บ้านพัก	ความเป็นส่วนตัว	ทั้งสองอย่าง	ทำ	9	อยากพัก	สถานที่สำหรับพักผ่อนปลดปล่อยตัวเองจริงๆ
8/3/2020 20:19:38	43	สมรส	1	70	4	โรงแรม	ห้องนอน, วิว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...)	เครื่องปรับอากาศ	ไม่ทำ	10	อยากพัก	มีที่เที่ยว,ทำบุญใกล้ไปกัน

8/3/2020 20:34:16	69	สมรส	2	30	10	โรงแรม	ห้องแอน, วิว, สิ่งอำนวยความสะดวก (ที่จอครถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง	ทั้งสองอย่าง	ทำ	9	อยากพัก	อิสระ เป็นส่วนตัว อาหารอร่อย ทัศนียภาพดี มีอุปกรณ์ให้เลือกเช่นที่นอนหมอน มีทั้งนุ่มและแข็งเป็นต้น(อายุมากเริ่มจุกจิก อาาาา)
8/3/2020 21:16:41	37	สมรส	1	10	7	โรงแรม	ห้องแอน	ระบายอากาศตามธรรมชาติ	ไม่ทำ	10	อยากพัก	บรรยากาศเย็น ร่มรื่น
8/3/2020 21:42:51	46	สมรส	2	15	4	โฮมสเตย์	ความเป็นส่วนตัว, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ทำ	9	อยากพัก	สะดวกสบายปลอดภัย
8/3/2020 22:15:23	70	สมรส	0	120	4	โรงแรม	ห้องฟิก/สถาวะแวดล้อม/อาหาร/การบริการ	ทั้งสองอย่าง	อาจจะ	8	ไม่แน่ใจ	ไม่เข้าใจคำถามข้อนี้ ?
8/3/2020 22:26:11	39	โสด		15	2	โรงแรม	ห้องแอน, สิ่งอำนวยความสะดวก (ที่จอครถ WiFi สระว่ายน้ำ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	เครื่องปรับอากาศ	ไม่ทำ	8	ไม่แน่ใจ	อากาศดี ไม่ไกลจากบ้านมาก สามารถขับรถไปได้
8/3/2020 22:49:16	70	สมรส	2	30	10	โรงแรม	ห้องแอน, ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	9	อยากพัก	เดินทางไปสะดวก ห้องน้ำในที่พักสะอาด
8/3/2020 23:33:59	49	โสด	2	8	10	บ้านพัก	ห้องแอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอครถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง	ทั้งสองอย่าง	ไม่ทำ	10	อยากพัก	สบาย ปลอดภัย สะอาด สอาสาย
8/4/2020 5:03:11	40	มีแฟน		30	2	โรงแรม	ห้องแอน, วิว, สิ่งอำนวยความสะดวก (ที่จอครถ WiFi สระว่ายน้ำ...)	ทั้งสองอย่าง	อาจจะ	10	อยากพัก	ธรรมชาติ สะดวกสบาย เข้าถึงอินเตอร์เน็ต
8/4/2020 7:11:06	73	สมรส	1	30	10	โรงแรม	ห้องแอน, ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง	เครื่องปรับอากาศ	ไม่ทำ	10	อยากพัก	สะดวก ปลอดภัย เป็นธรรมชาติ
8/4/2020 14:35:52	70	สมรส	2	10	6	โรงแรม	ห้องแอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอครถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	9	อยากพัก	สบาย สะดวก ปลอดภัย มีโอกาสจ่ายตังบ้าง
8/4/2020 21:04:33	69	สมรส	3	20	5	บ้านพัก	ห้องแอน, วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอครถ WiFi สระว่ายน้ำ...), ระบบความปลอดภัย เช่น ระบบเตือนไฟไหม้ , ระบบเตือนควัน , ถังดับเพลิง, ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	10	อยากพัก	ชอบบ่องเที่ยวสถานที่ตามธรรมชาติและด้านประวัติศาสตร์
8/4/2020 23:37:50	25	In a relationship		10	4	Villa / House	Bedroom(s), Scenery, Privacy, Amenities (Parking, WiFi, Pools, etc.), Safety Feature (Fire alarms, smoke alarms fire extinguisher, etc.), Walking distance location	Air condition	No	8	Yes	Normally if I am home our family always go on trips together maybe more than four times per year. My father is a government officer so when he gets holidays more than two or three days we are planning to go on a vacation trip. I have never experience a trip without my family before I came here. So when we are thinking to go on vacation we always like to stay at a place that is peaceful, convenient, provide enough facilities, and of course also environment and surroundings are the important facts in it.
8/11/2020 18:18:03	68	สมรส	2	2	5	โรงแรม	วิว, ความเป็นส่วนตัว, สิ่งอำนวยความสะดวก (ที่จอดรถ WiFi สระว่ายน้ำ...), ระยะทางเดินระหว่างสถานที่ท่องเที่ยว	ทั้งสองอย่าง	ไม่ทำ	9	อยากพัก	สดวก ปลอดภัย ประหยัด

Chapter 4: Design Process

The design process of thesis consists of 3 parts. The first part is the study of 3-dimensional frameworks on 3 different houses designed by Geoffrey Bawa, the 'Father of Bioclimatic Design'. The objective is to see the mathematical frameworks of Bawa's three-dimensional space composition, especially the proportions and the relations between the inside and the outside spaces. Most of Bawa's residential designs were focuses on openness of the space to bring the nature element such as sky, fresh breeze, and trees into his architecture. It is my intention to follow Bawa's design approach.

The second part is the study of interior walls framework in each house of Bawa's design. The study of framework on houses designed by Geoffrey Bawa conducted through the series of analysis on each house framework using taxonomy to find the proportional of the design with the axis of circulation and division of the spaces on the floor plans (Figure 28-33). The redrawn of the original plans was to study and understand the space composition of Bawa's design in relation to the framework study. Lastly, the composition of series on selected site based upon the shape of the site to create taxonomy diagram toward the structure placement of the project.

The last part of the design process in this thesis is the synthesis of the above analytical drawings onto the selected site in Choburi. It includes the composition of frameworks, proportions of interior and exterior spaces, the orders of the columns and the walls, the composition of circulation spaces. Figure 35 shows my composition of the columns, the brick and the wooden walls in relations to the main circulation spaces. All compositions focus on the approach from the main road towards the building, the axis of the project, the balance of spaces, both interior and exterior. Within the series of selected site composition, the chosen composition developing the analysis of the circulation with structure framework and floor plan layer to show the symmetrically

composition of the structure and floor plan in the project design (Figure 36-37). I have generated the possibilities of architectural elements compositions then choose one direction to be developed toward the final design of vacation home in Chonburi.

The overall composition of walls has its hierarchy. That is the order to brick walls (signified by black color in Figure 36-37) and the order of wooden walls (signified by red color in figure 36-37), which would later on be substituted by the 'breathing wall' or *fah lai*. The organization of the brick walls has its functions, first of all, to identify space, secondly, to protect sound and lastly to preserve privacy. The organization of the breathing wall is more ambiguous. It allows natural ventilation when the mechanism moves the wooden planks of the walls to the one side. When closed, it become like a lightweight partition, so it functions is also to identify space and to protect the privacy of the guests from the surrounding context.

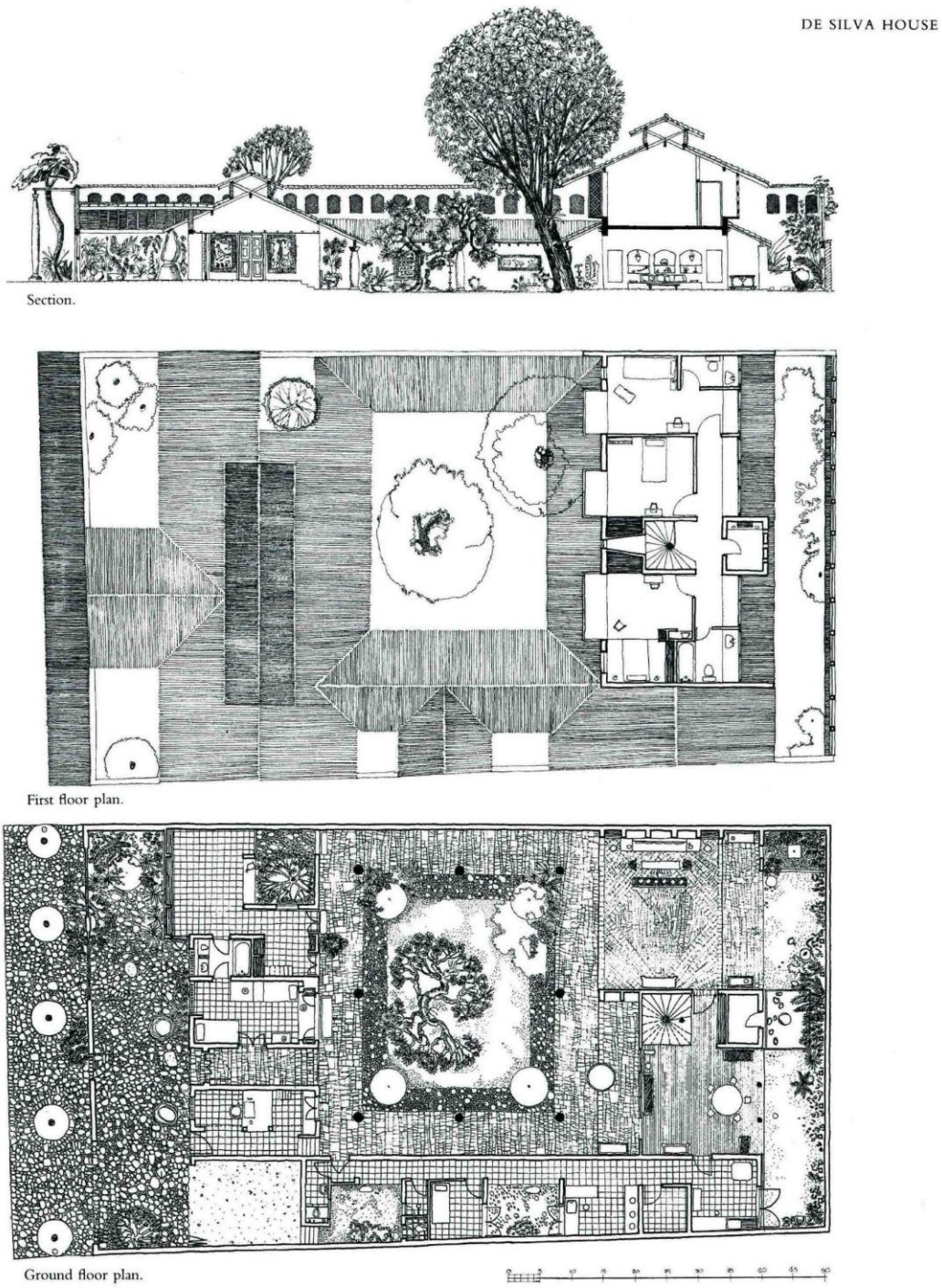


Figure 28. Framework on De Silva House designed by Geoffrey Bawa, Retrieved from Robson & Bawa, 2004.

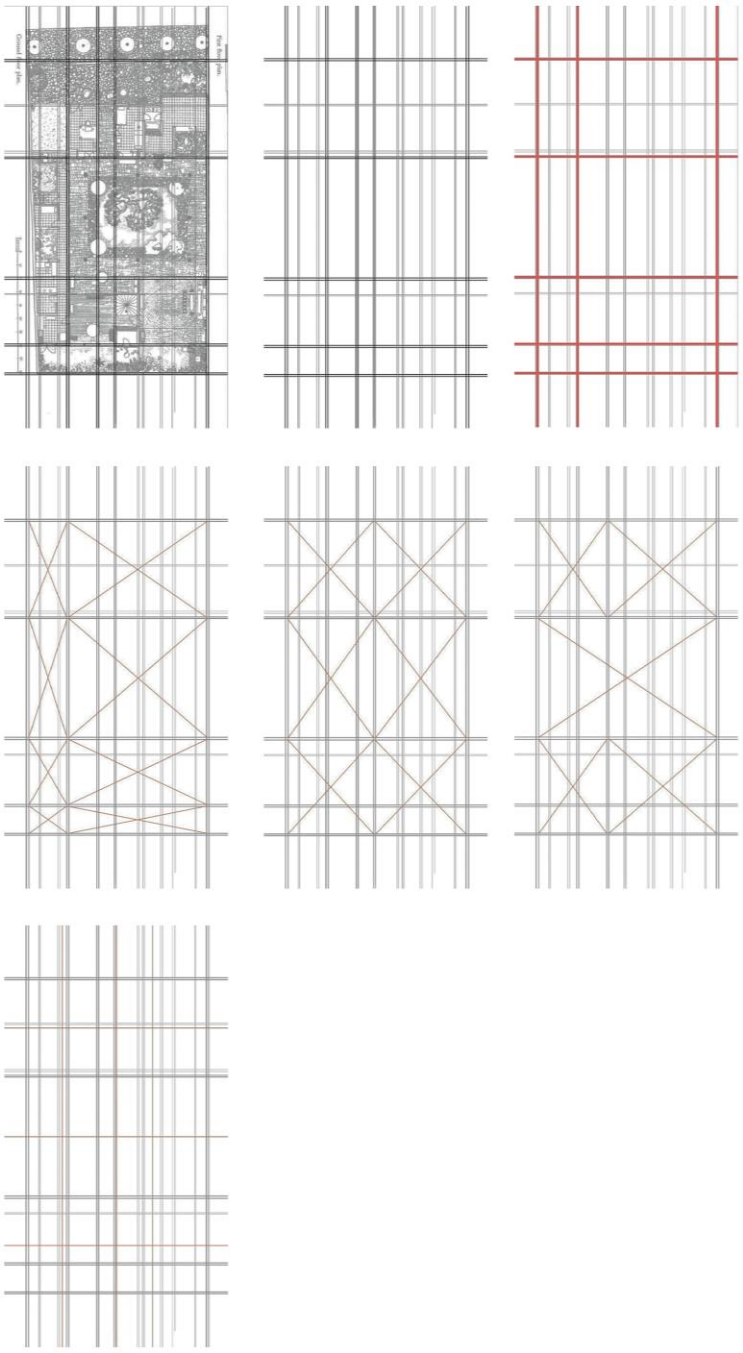


Figure 29. Study of framework on De Silva House designed by Geoffrey Bawa, redrawn by author.

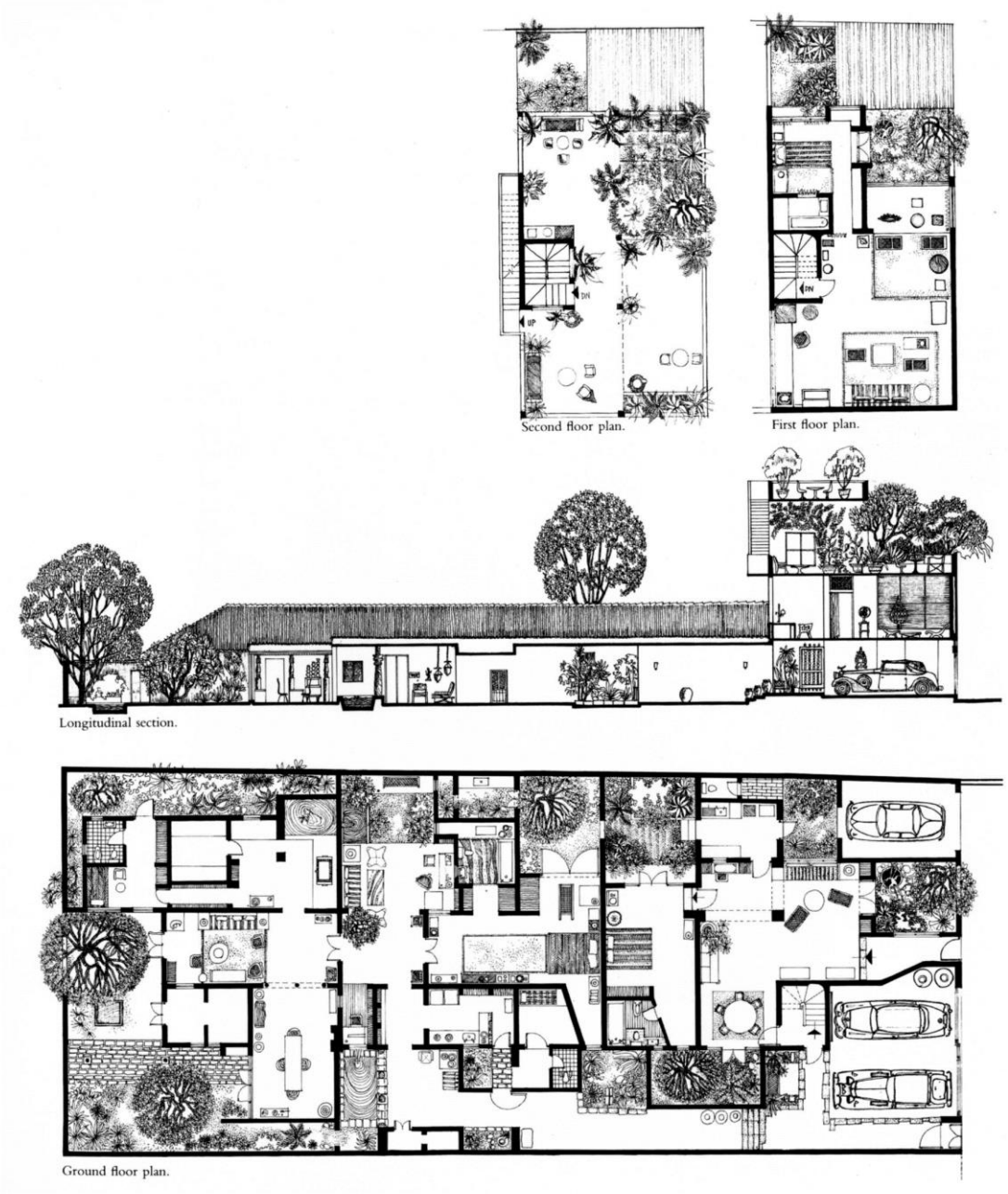


Figure 30. Framework on 33rd Lane House designed by Geoffrey Bawa, retrieved from Robson & Bawa, 2004.

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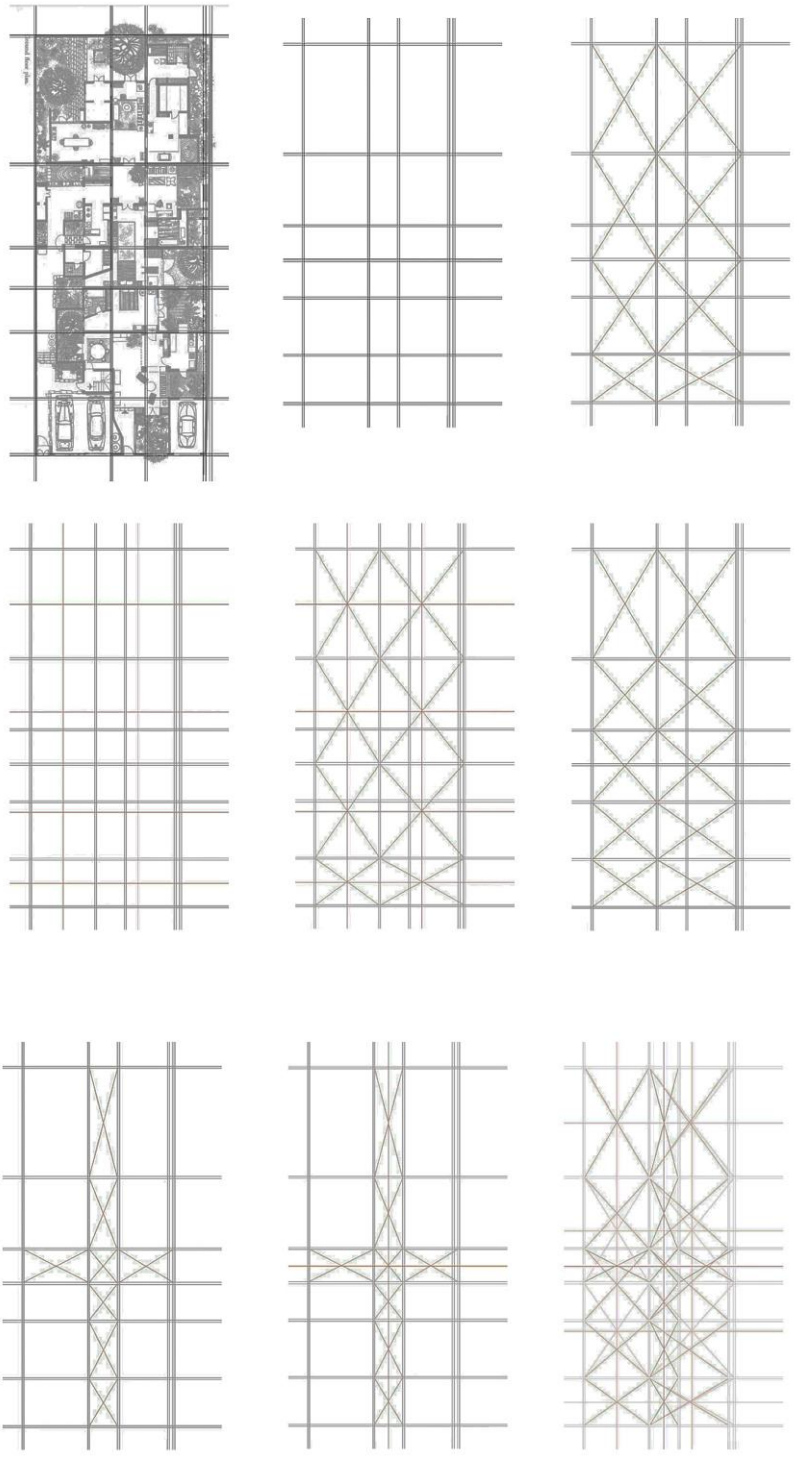


Figure 31. Study of framework on 33rd Lane House designed by Geoffrey Bawa, Redrawn by author.

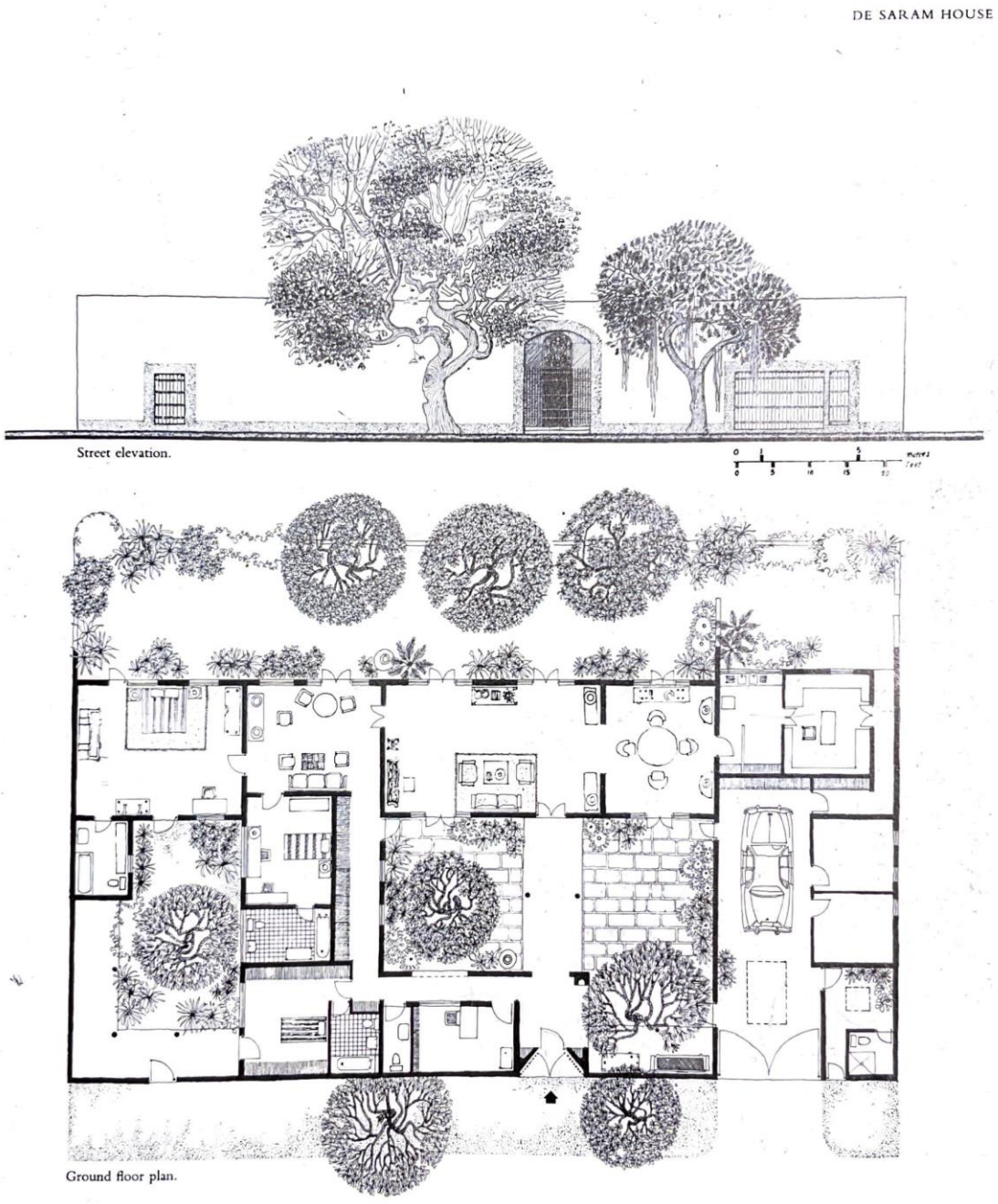


Figure 32. Framework on De Saram House designed by Geoffrey Bawa, Retrieved from Robson & Bawa, 2004.

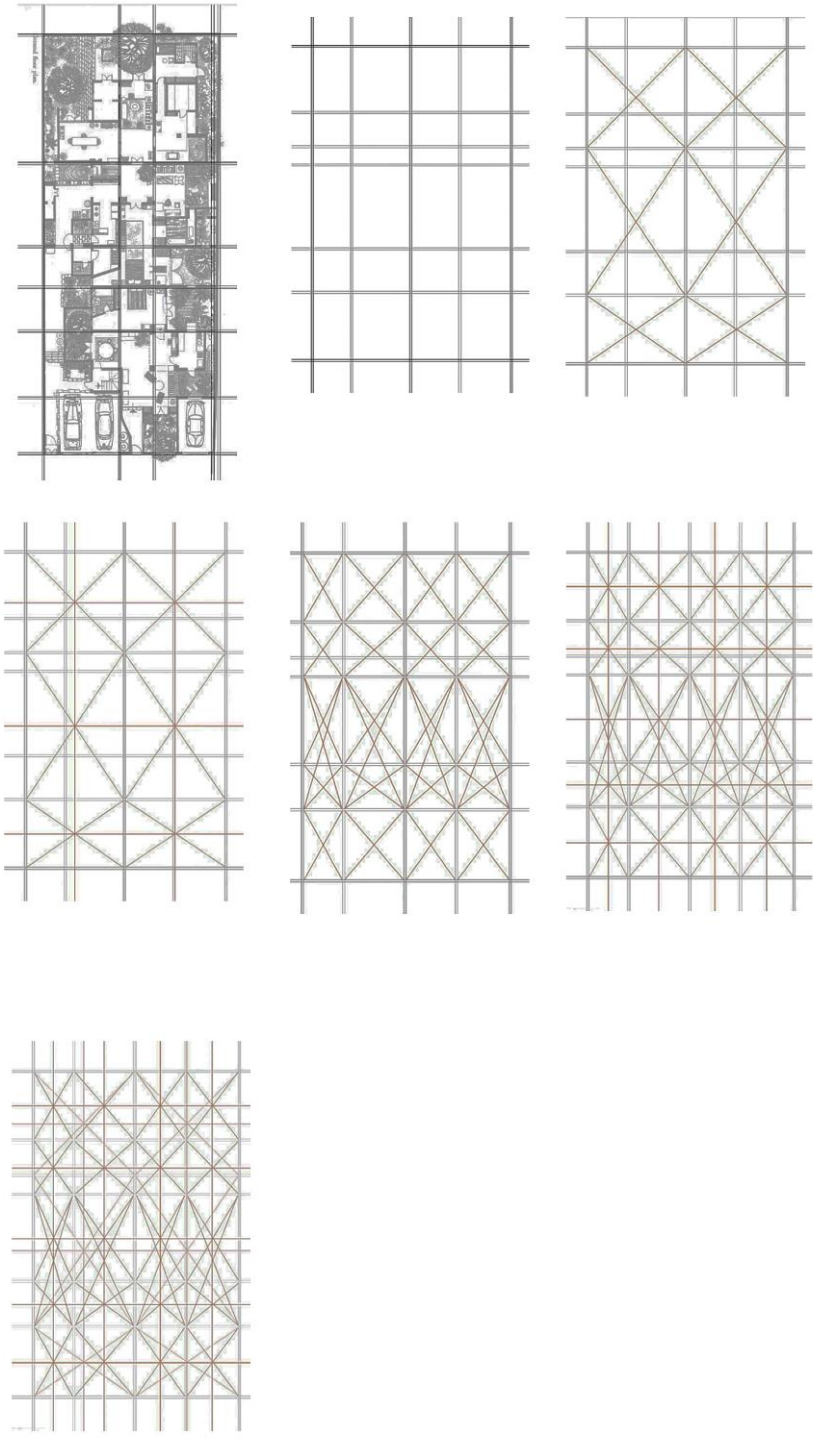
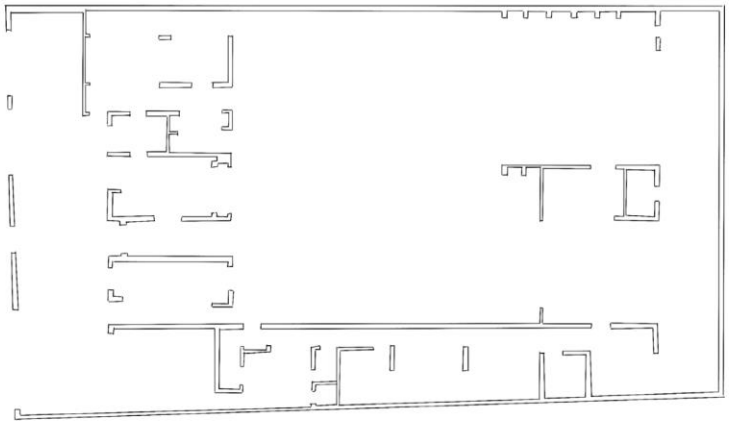
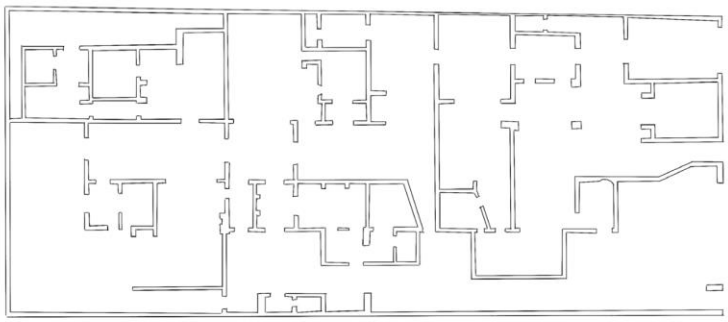


Figure 33. Study of framework on Stanley De Saram House designed by Geoffrey Bawa, redrawn by author.



1



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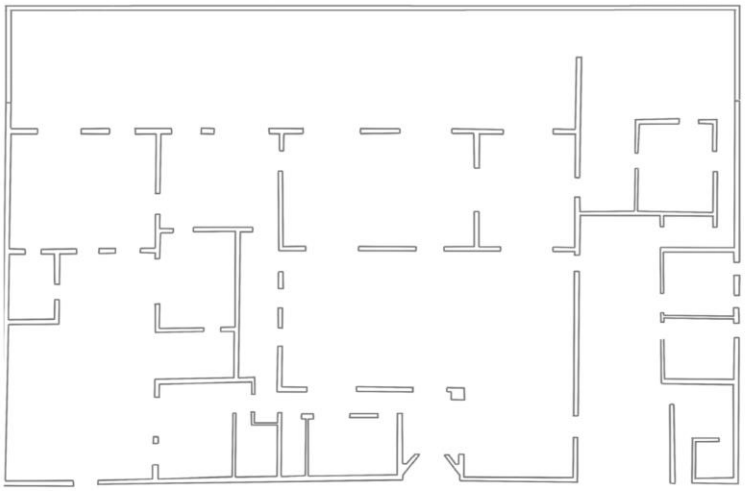

3

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Figure 34. Study of interior walls framework designed by Geoffrey Bawa,

Retrieve from Robson & Bawa, 2004, redrawn by author

From top to below 1. De Silva House 2. 33rd Lane House 3.Stanley De Saram House.

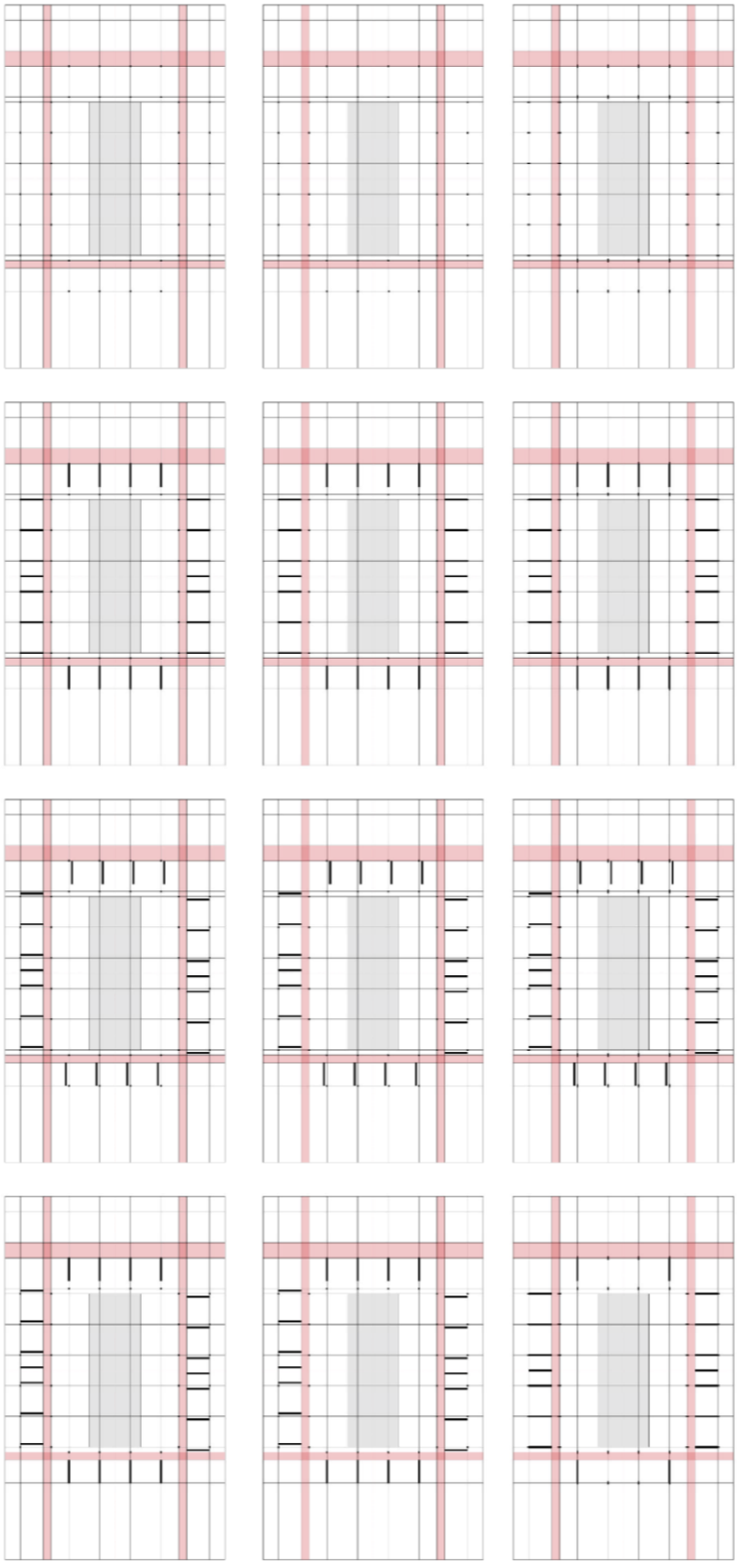

Figure 35. Composition of framework on selected site, drawn by author.

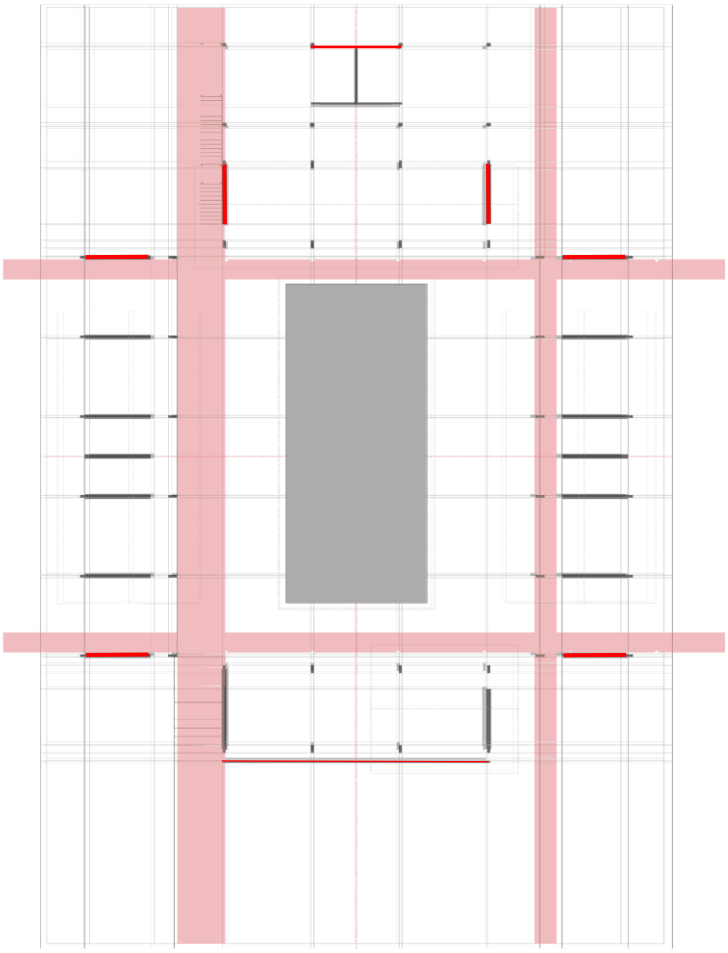

Figure 36. Circulation analysis over structure framework, drawn by author.

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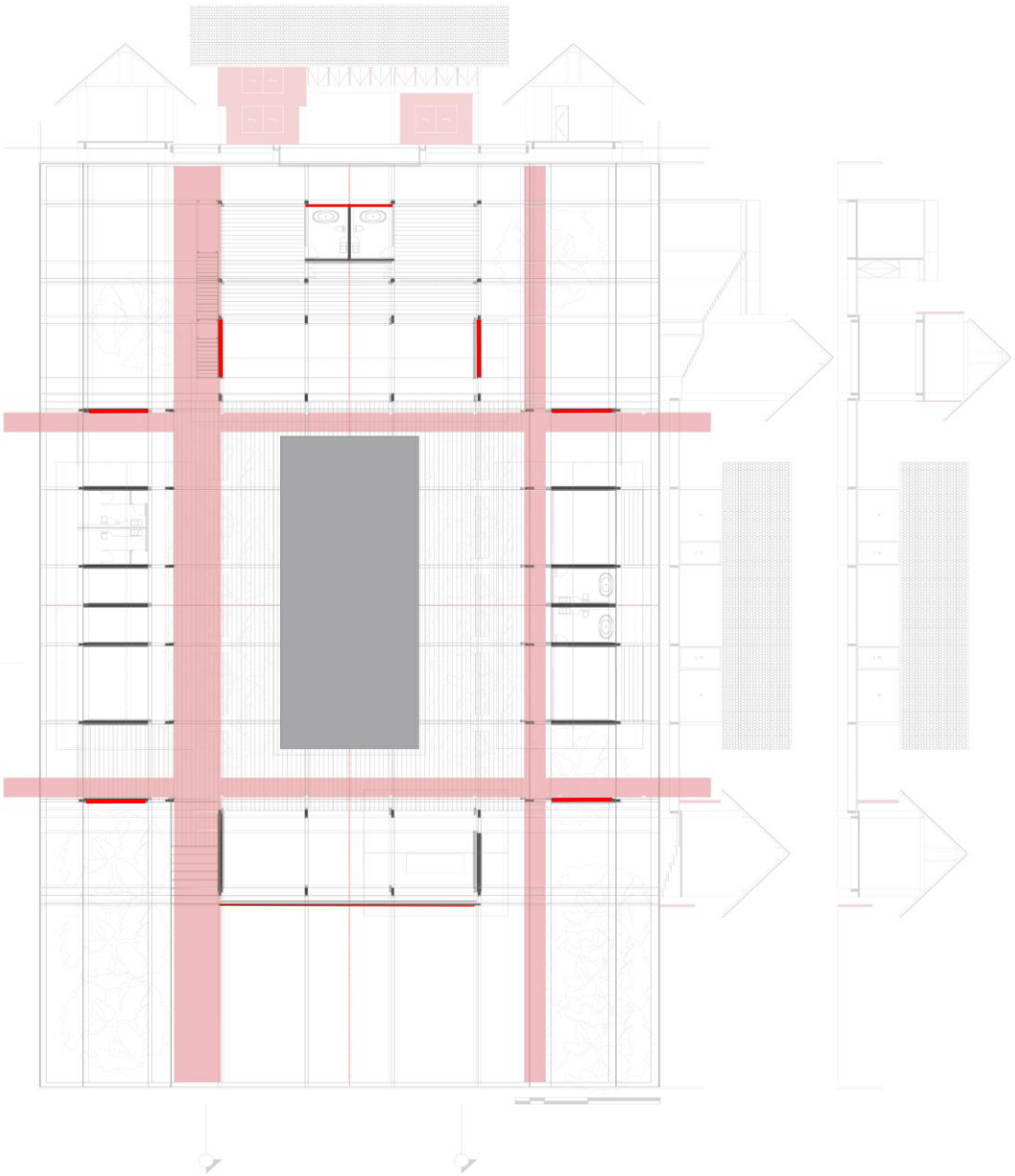


Figure 37. Circulation analysis over structure framework and floor plan layer, drawn by author

Chapter 5: Final Architectural Drawings: The Compositions of Architectural Elements, Structure and Materials under the Organization of 3 Dimensional Spaces

Final architectural drawings, as shown in this chapter, is based on the analysis and the synthesis of the collected surveys data. It concerns the composition of architectural elements especially the columns and the walls, structure, and the selected materials to differentiate the organization of 3-dimensional spaces. The collected data include case studies of bio-climatic architectural designs of Geffrey Bawa, the conclusion of program of vacation home in Chonburi, and the synthesis process to generate possibilities of spaces, structures, materials with a basic understanding of hierarchy of spaces, including circulation spaces, under the organization of 3-dimensional structure. After generating the possibilities of spaces, the final architectural composition is chosen according to thoughts on biomimicry that have been analyzed in the Literature Review and Case Studies Chapters. The objective of this thesis is to propose function and aesthetic, through the study of biomimicry, of a vacation home in Chonburi.

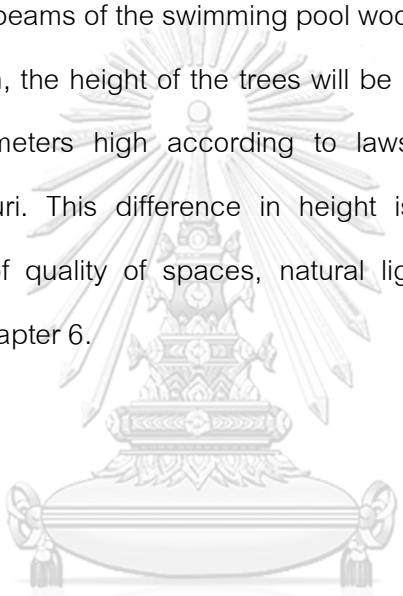
The structural of the vacation home in this project elevated first floor above ground level to encounter flooding situation just like traditional Thai house which is common in Thailand. Using the local material similar in Thai house such as wood and material that easily found in the local such as cement or concrete for aesthetic and integrity of the structure. Approaching the vacation home from the main entrance ensuring the privacy of the residence from the greeting of the extending breathing wall in the front of the property. Engulf in privacy yet allowing sensual of openness from the breathing wall that acted similar to human skin in regulating the ventilation. The serenity of the main floor after getting through the main entrance allow the residences to experience an openness of the space. Through the encounter with main floor of each building in the property providing spacious bedrooms, bathrooms and common areas where the residences can enjoy

gathering and cook out while being uninterrupted from the outside. Along each corner of the property, bedrooms and bathrooms walls, the breathing walls integrated to provide and help with air flows in the spaces to regulate the wind flows and ventilation.

The composition of this vacation home project refers back to the pervious chapter through the design process and the hierarchy of architectural spaces composition. The architectural elements in structure and materials based mainly on the composition of columns and walls, which can be divided into two categories; main architectural elements such as reinforce concrete column, brick walls and the subordinate architectural elements such as steel column and wooden walls or what is called in this thesis “breathing walls”. In the main architectural elements, the columns that made from reinforce concrete are placed as the main structure of the project. The brick walls, labelled in diagonal hatch marks (in the drawing Figure 39-46), provide indicating the room separation for the purpose of privacy in relation to sound. In the category of subordinate architectural elements, the steel columns are placed for the firmness of the main stairs structure. The breathing walls, labelled in red color (in the drawing Figure 39-46), act as similar to human skin in the bioclimatic design and at the same time, the composition of the breathing walls signify the boundary between public and private spaces. They can be closed, meaning that the residents can have a sense of privacy through a more enclosed space.

The structure details of breathing wall derive from the analysis in chapter 2 where the improvement addressed of material problem by using more solidify material such as wood structure instead of hollow aluminum. The address of the problem in chapter 2 where the sliding panel poses difficulty to move uniformly when open or close, the solution to that problem is to provide a railing guide from the top and below where housing the movable pranks with one piece of prank attach in horizontal from top and bottom of moveable pranks so they can move uniformly with equal force distribution to

open and close breathing wall (Figure 56-58). The trees, named Kaena (แคนา, Dolichandrone serrulata), are one of the architectural elements in this project. They are medium sized trees, up to 20 meters tall. The flowers are white and the flowering months are between December and January. These trees are local to Chonburi. The composition of these trees is similar to the composition of main columns. That is, they are based upon square framework in relation to the diameter of the leaves. When overlay the order of trees with the order of beams, the framework is shifted diagonally in order to avoid the steel beams of the swimming pool wooden deck. (Figure 40-58) When the trees are fully grown, the height of the trees will be 11 meters higher than the main building, which is 9 meters high according to laws and regulations of building construction in Chonburi. This difference in height is thought to be parts of the composition in terms of quality of spaces, natural light, shade and shadow to be described later on in Chapter 6.



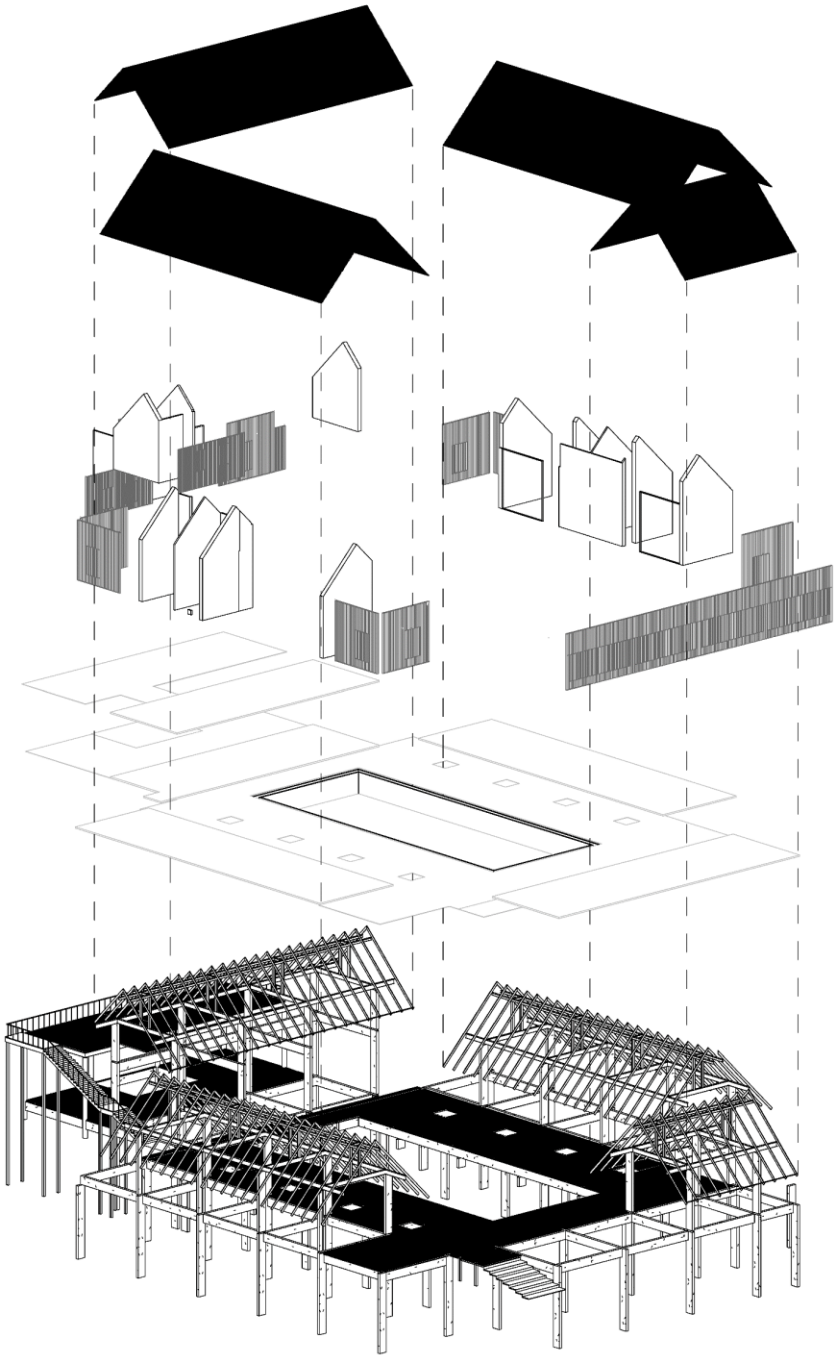


Figure 38. Exploded view of vacation home, drawn by author.

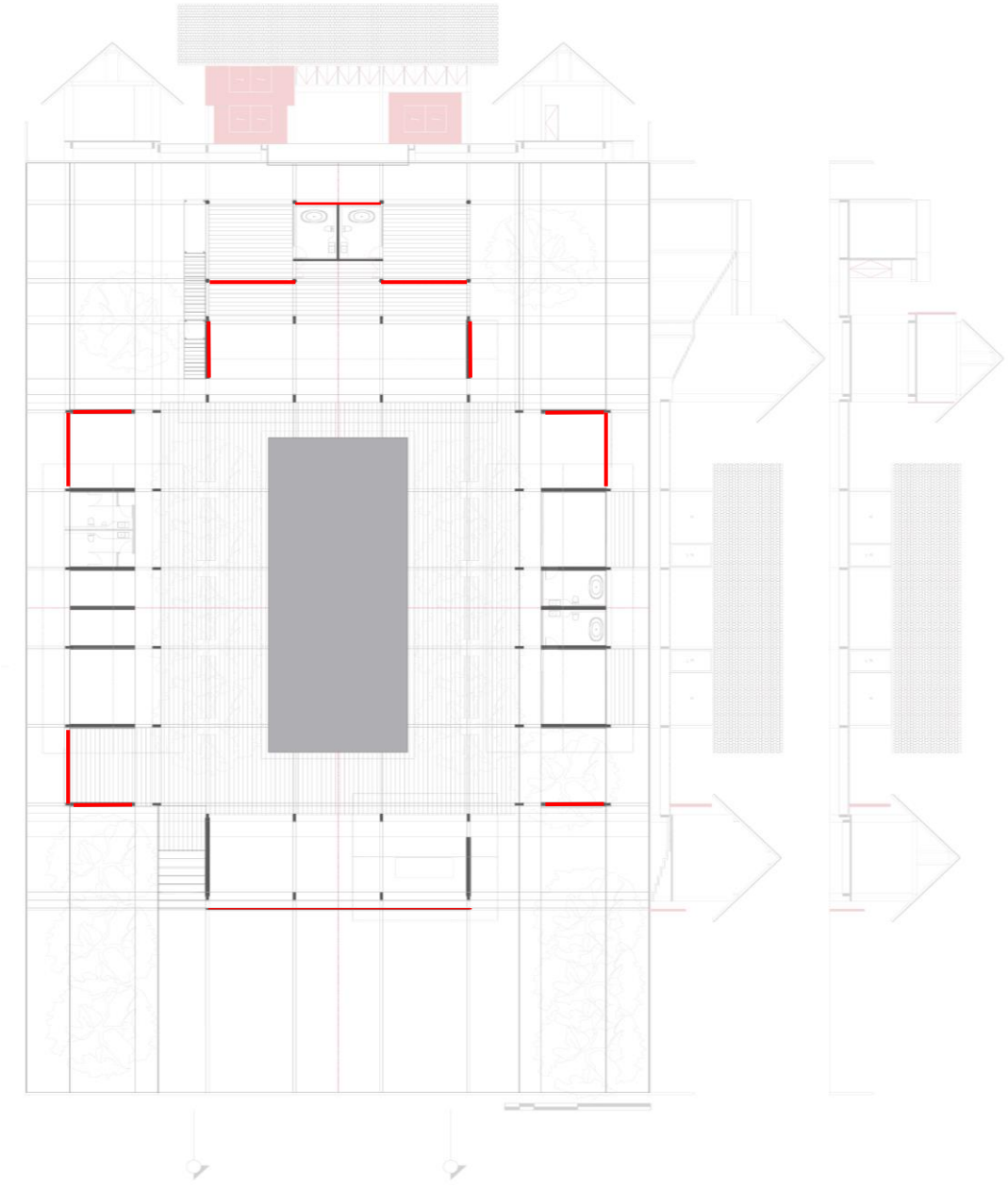


Figure 39. First floor plan framework over finished floor plan layer. Drawn by author.

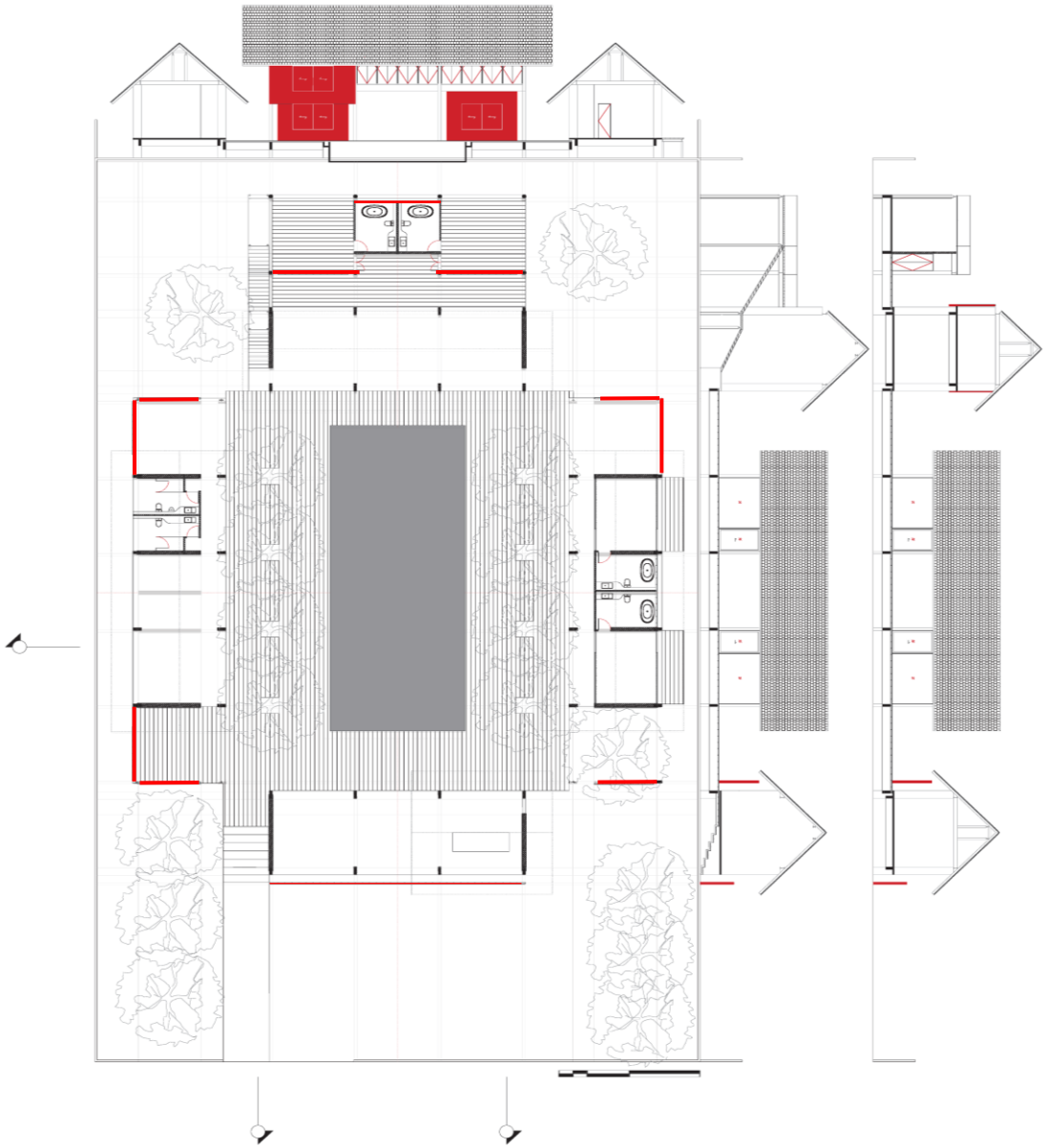


Figure 40. First floor plan with section views, drawn by author.

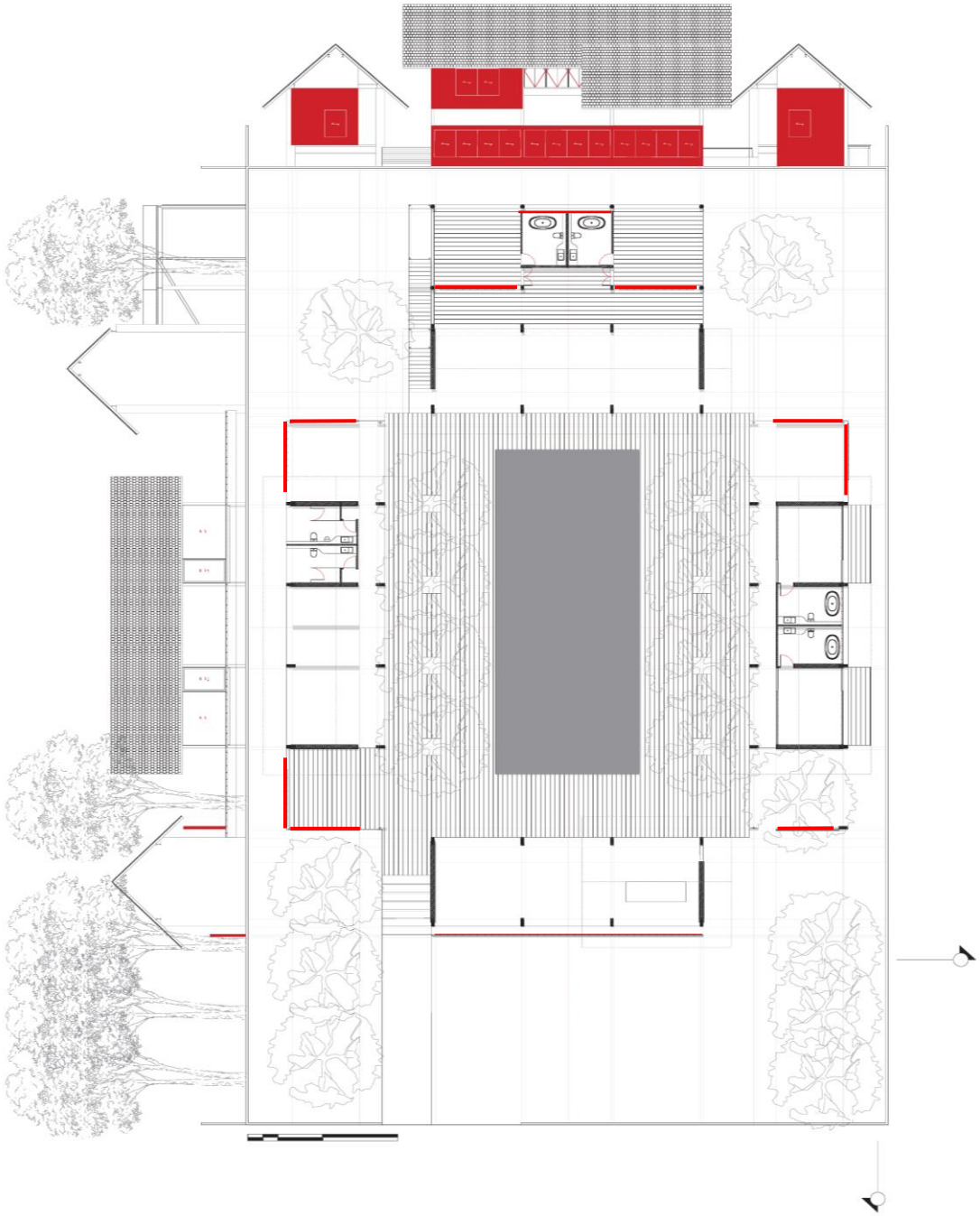


Figure 41. First floor plan & elevation views, drawn by author.

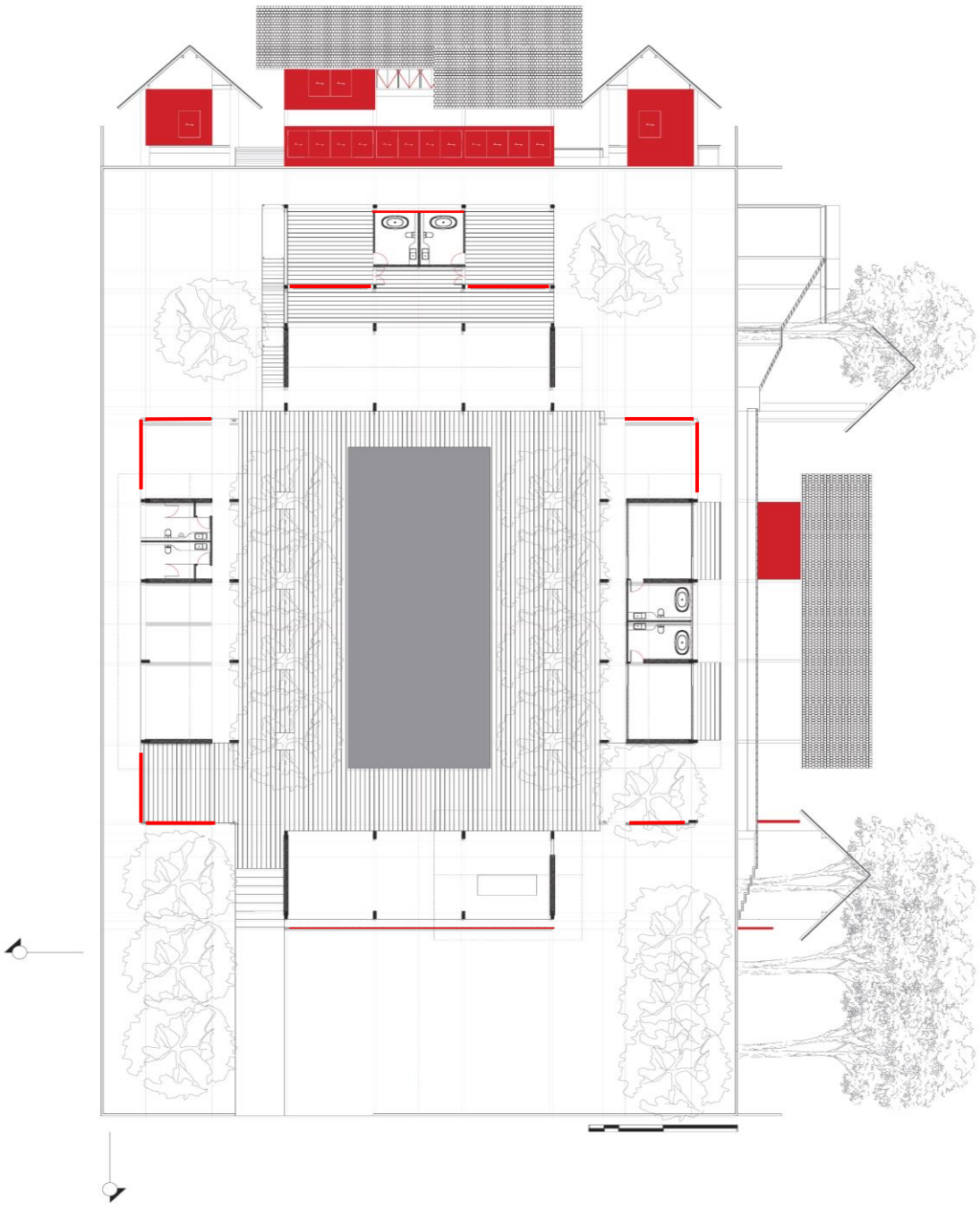


Figure 42. First floor plan & elevation views, drawn by author.

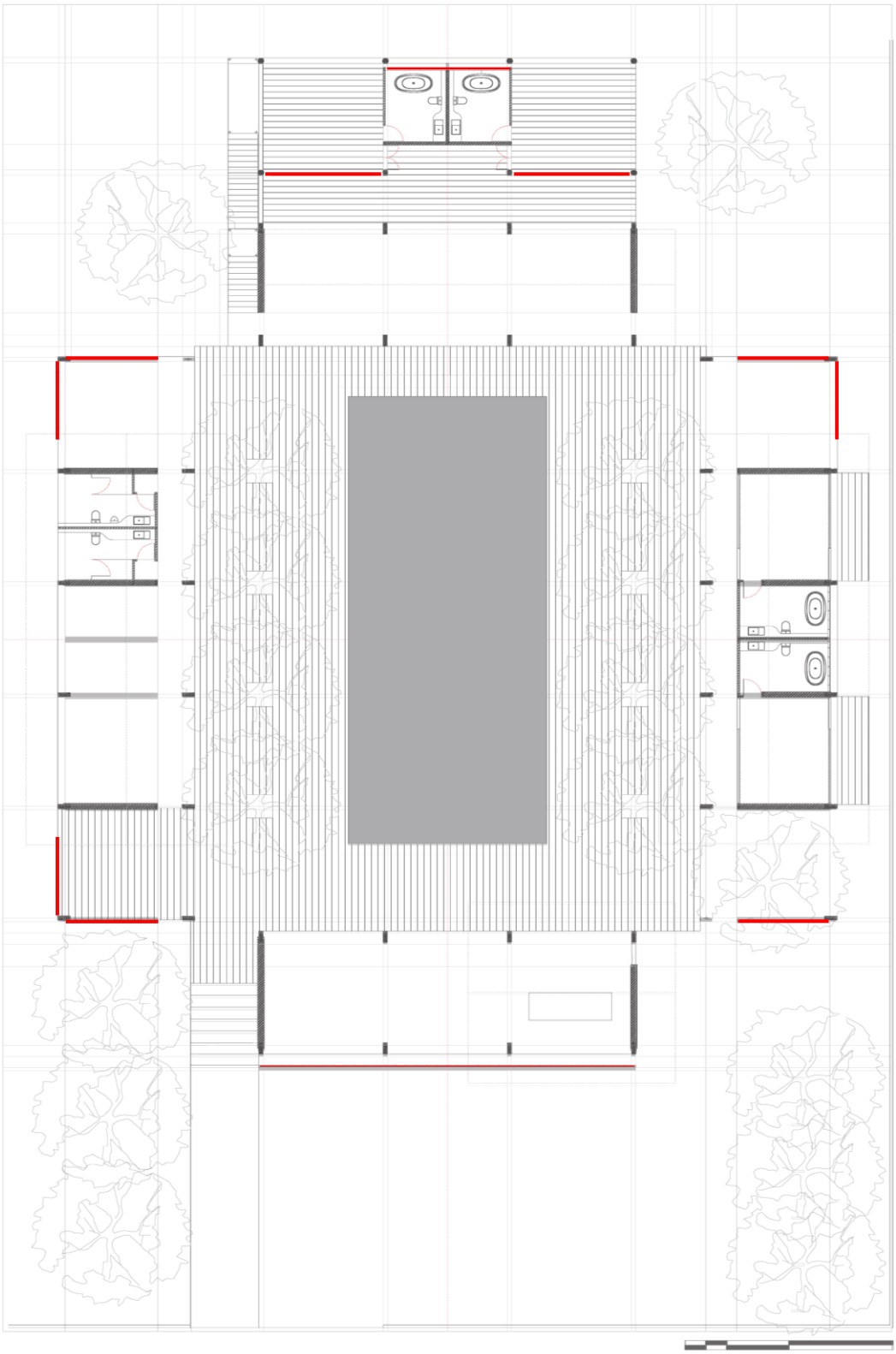


Figure 43. First floor plan structural, drawn by author.

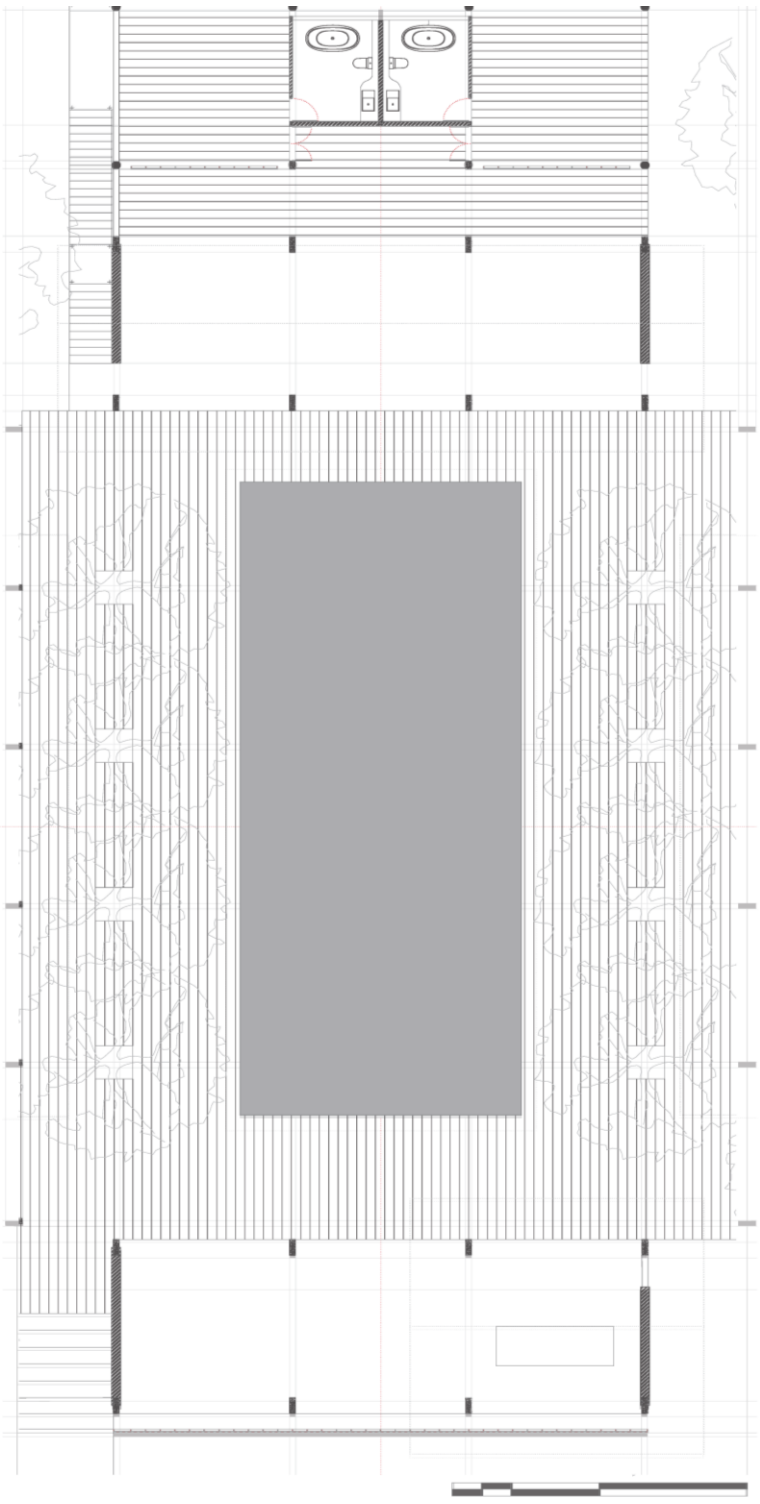


Figure 44. First floor plan structural enlarged main floor, drawn by author.

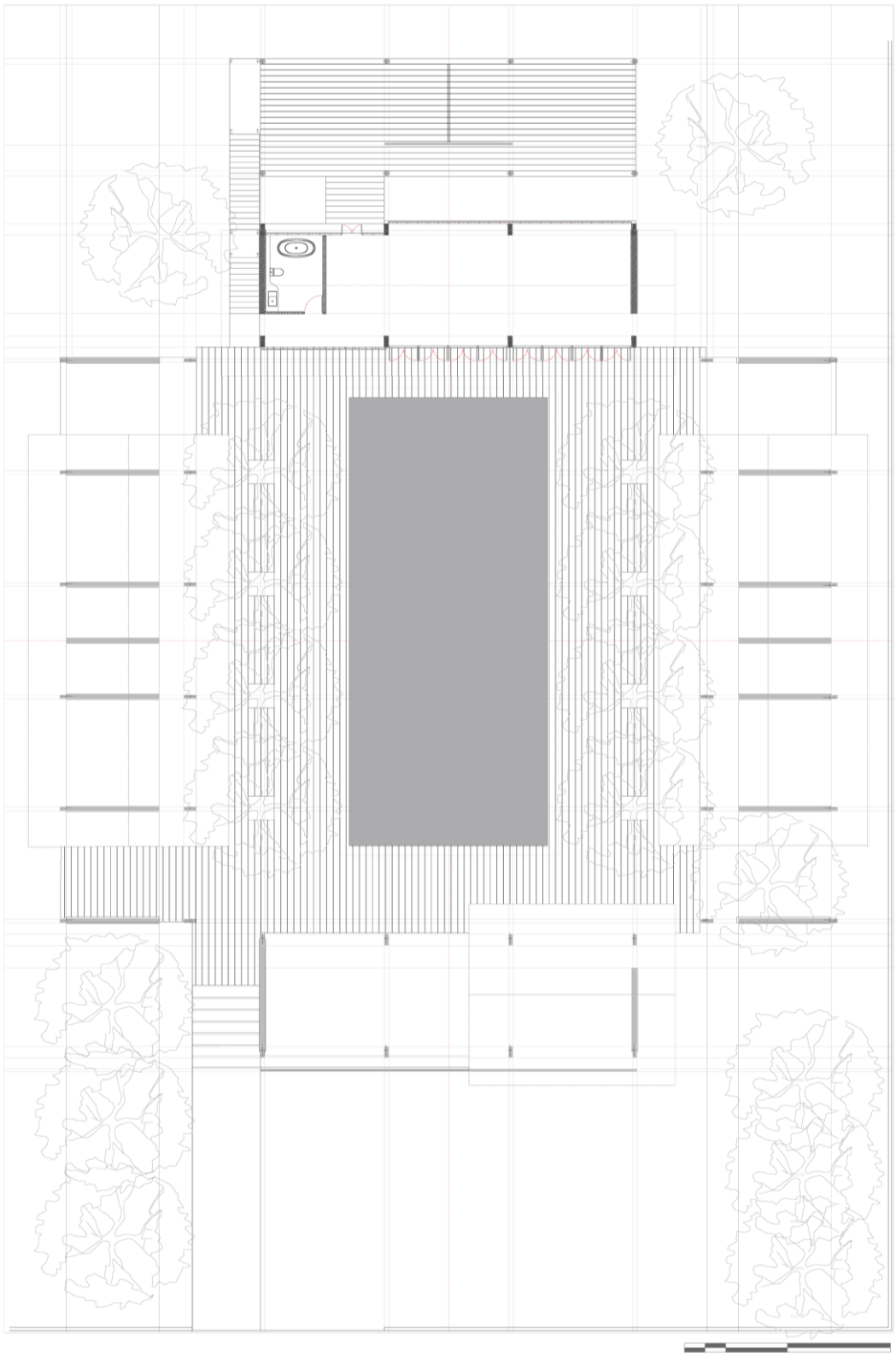


Figure 45. Second floor plan structural, drawn by author.

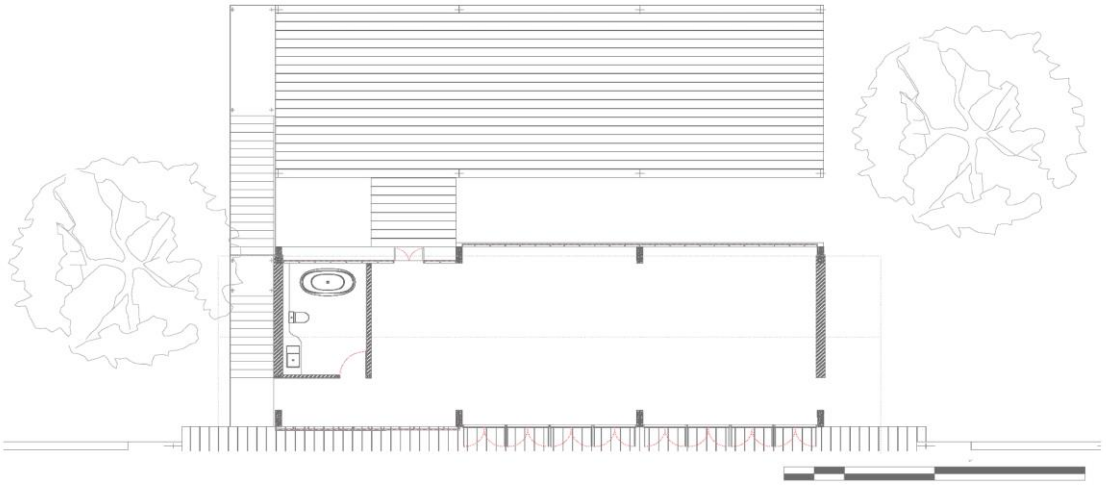


Figure 46. Second floor plan structural enlarged, drawn by author.

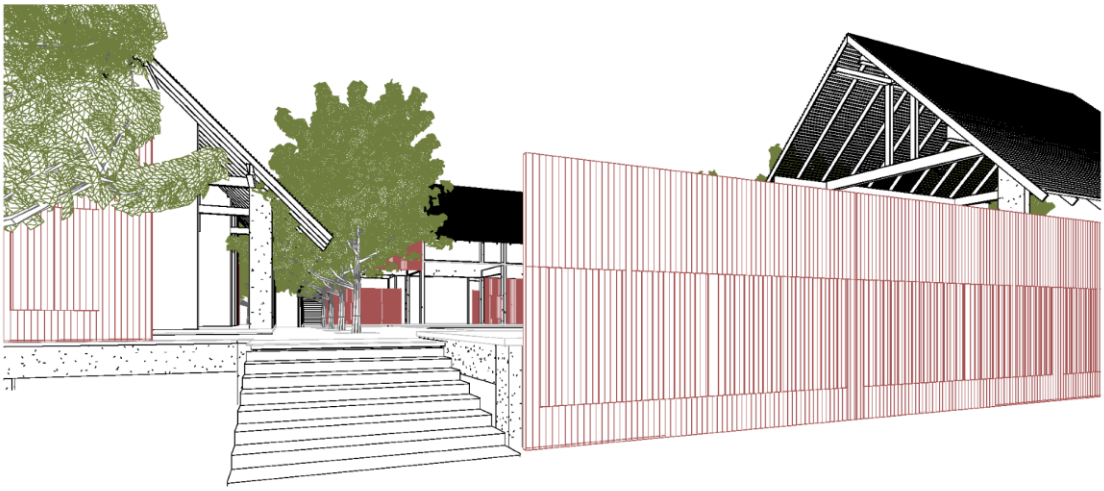


Figure 47. Perspective view (front), drawn by author.

Figure 48. Perspective view (back), drawn by author.

Figure 49. Perspective view first floor opening space, drawn by author.

Figure 50. Perspective view first floor under the roof, drawn by author.

Figure 51. Perspective view first floor under the roof, drawn by author.

Figure 52. Perspective view first floor with breathing walls, drawn by author.

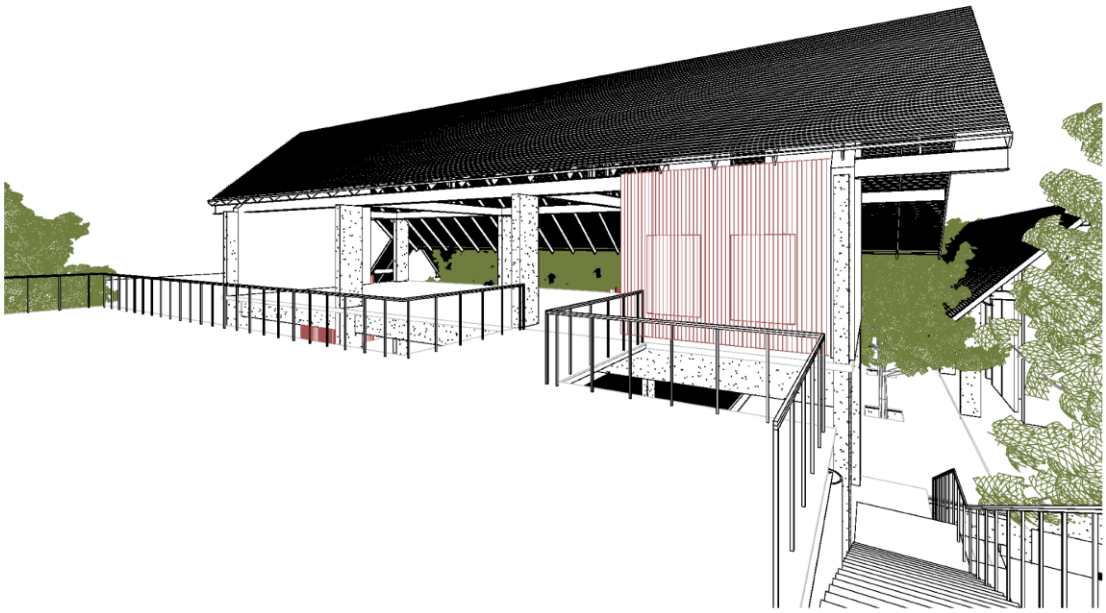


Figure 53. Perspective view second floor from the stair, drawn by author.

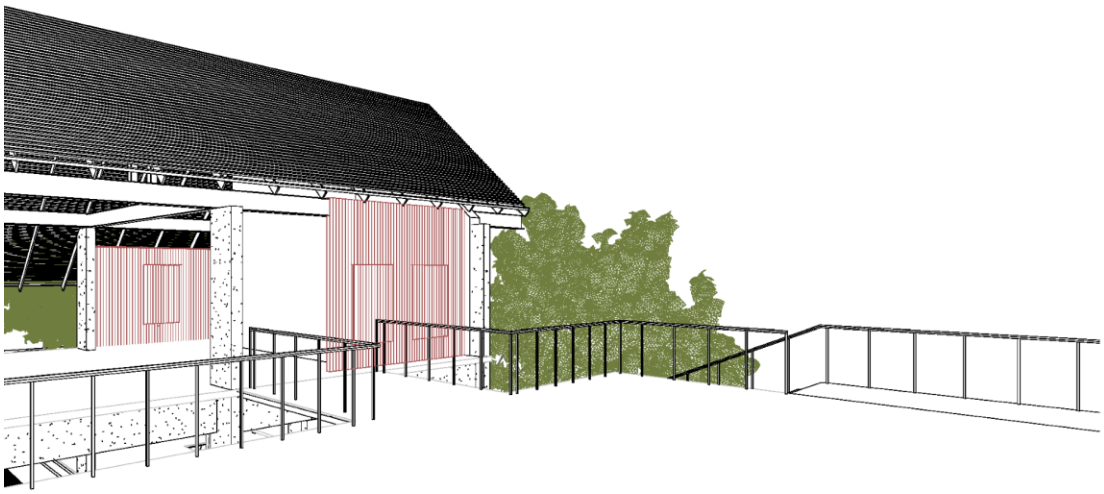


Figure 54. Perspective view second floor toward stair, drawn by author.

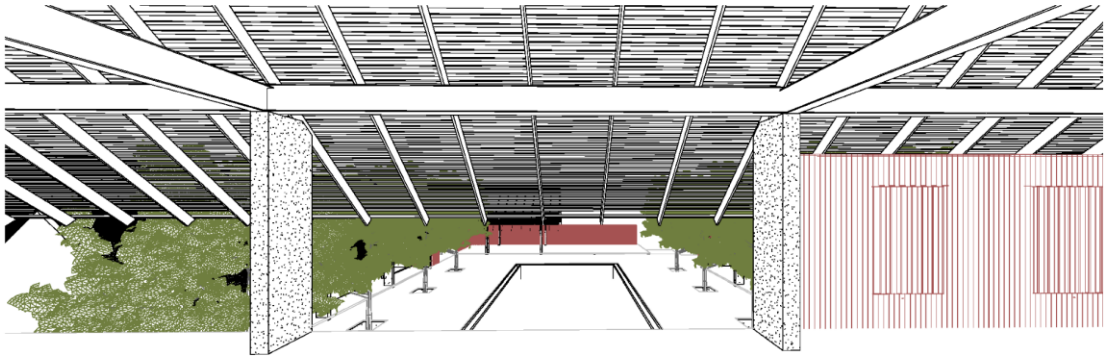


Figure 55. Perspective view second floor under the roof to main floor view, drawn by author.

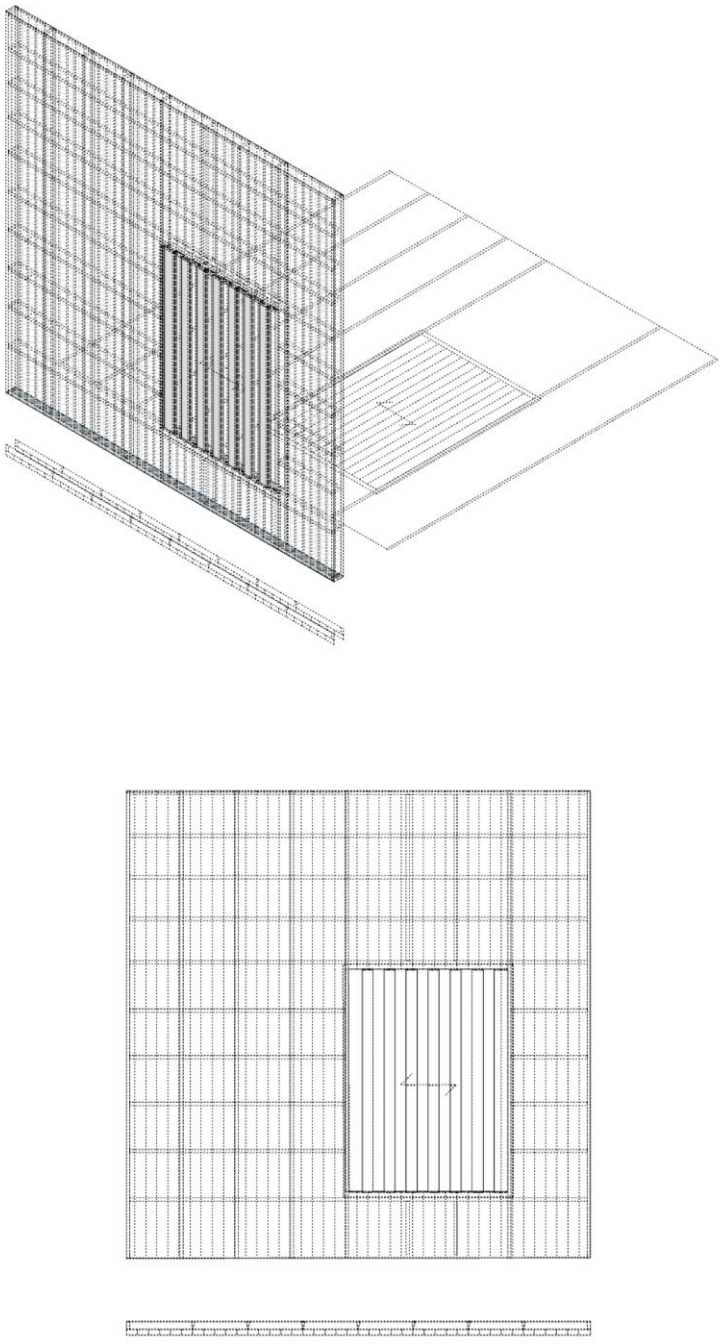


Figure 56. Breathing wall framework, drawn by author.

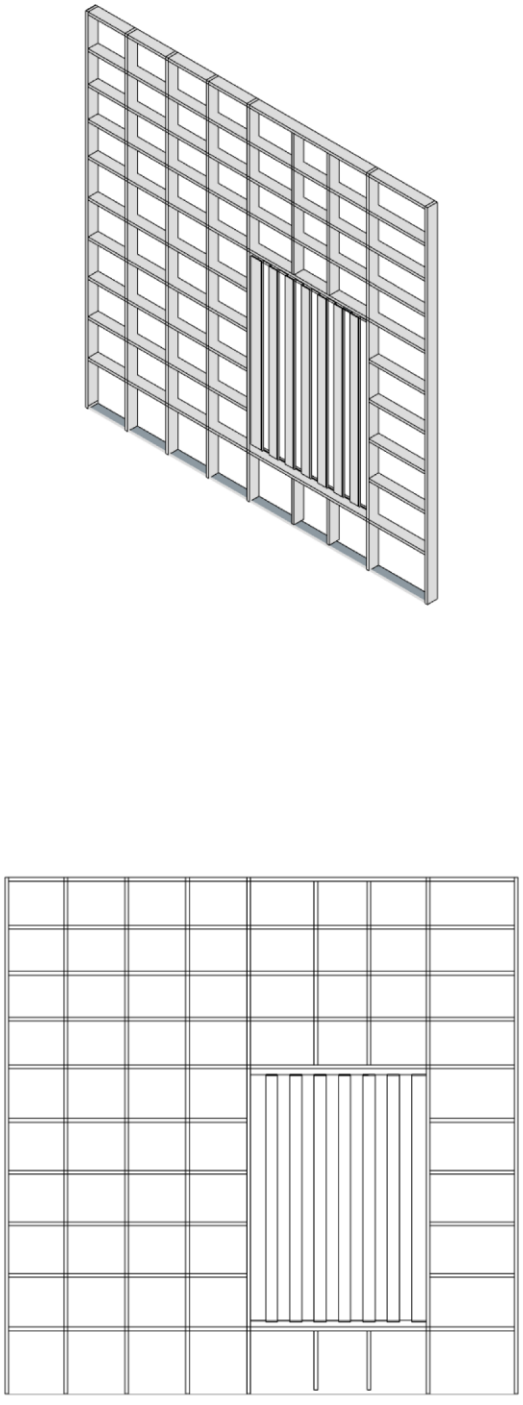


Figure 57. Breathing wall structure, drawn by author.

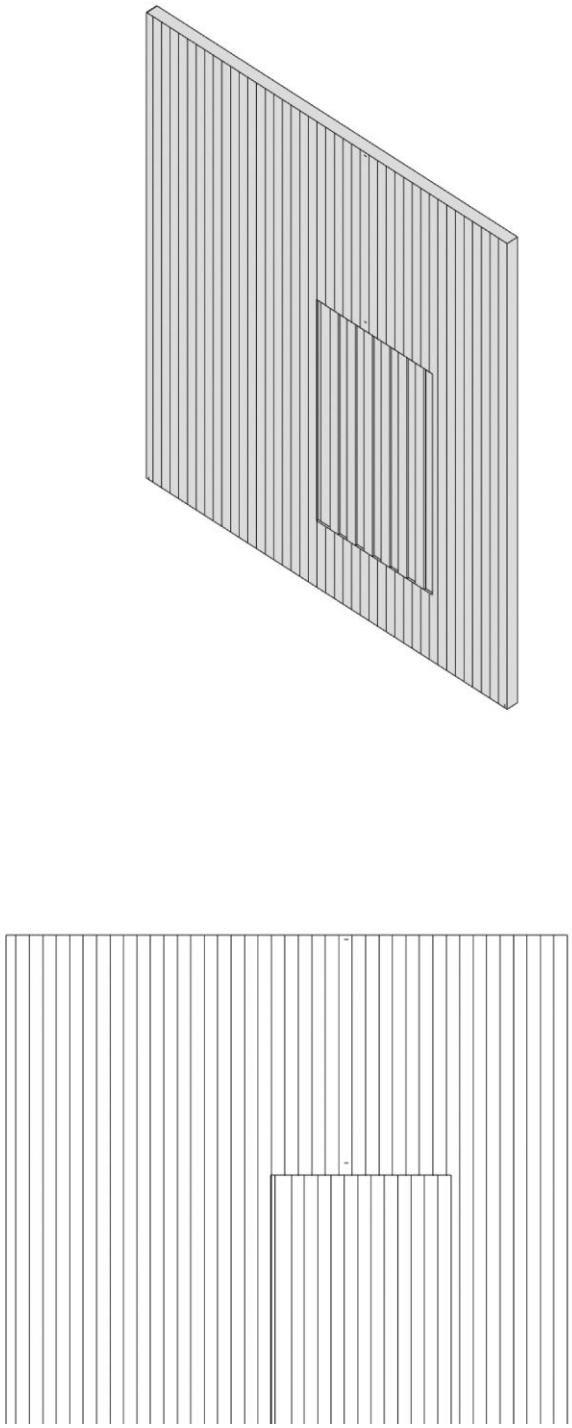


Figure 58. Breathing wall perspective and front view, drawn by author.

Chapter 6: Analytical Drawings: Natural Light, Shades, Shadows and Wind

The composition of architectural elements in this thesis does not include only the tangible materials, such as the reinforced concrete columns and the brick walls. It also includes the intangible elements of nature, such as natural light, shades, shadows, and wind. The objective of the analysis is to understand the interrelationships between intangible elements, spaces, 3 dimensional structures in architecture. My position towards biomimicry and bioclimatic design is an attempt to combine function and aesthetic in architectural spaces composition. It is also an attempt to add an architectural element in Thai traditional house called *fah lai* (ฝาไหล, breathing walls) to the discussion of biomimicry through the central of this thesis on the problem of language that exists in different cultures and perhaps at different times.

The studying of this chapter is divided into 2 parts. Part 1 is a series of tests by Revit Program to study natural light, shades, and shadows, including shades and shadows of the planted trees that are projected upon the walls and the floors of different material textures. The time frames of this test are based on important dates of the year. Those are Winter Solstice, Summer Solstice, Spring Equinox, and Fall Equinox. The orientation of spaces, structures, and architectural elements such as walls is tested together with the orientation of natural light, in the direction of North, South, East, West, Southeast, Southwest, Northeast and Northwest of the vacation home in Chonburi (Figure 59-84).

Part 2 of this chapter is the study of wind through an Autodesk Flow Design software. Again, the objective of the study is to understand the correlation between wind, architectural elements such as the walls, spaces under the organization of 3 dimensional structures in architecture. Using the Beaufort Wind Force Scale (Table 4) to read the simulation of wind speed in the Autodesk Flow Design (Figure 85-86)

to understand the travelling of wind direction and windspeed throughout the spaces in relation to the elevated floor plan, structural of brick walls and breathing walls. The simulation providing windspeed that set to 10 meter per second (m/s) according to Beaufort Wind Force Scale, considered as “fresh breeze” while any number that higher than 10m/s is considered as “strong wind”. Through the Beaufort Wind Force Scale, the perception of the windspeed and direction can relate to land description such as the “fresh breeze” can be described as “Small trees in the leaf begin to sway”.

To conclude, it is important to study natural light, shades, shadows, and wind for the composition of vacation home in Chonburi because the study enables me to begin to understand aesthetic and function of architectural spaces composition under the organization of 3-dimensional structure in relation to intangible elements of nature. All these analytical drawings allow me to see the possibilities of changes in human’s perception. I realize that the simulations may be partly true because this vacation home has not yet been built, but the simulations demonstrate how human may perceive different spaces at different times through seasonal changes, lights, shadows, and perception of wind movement. Human is central to architecture. This basic understanding is to see the possibilities, the relationships and the interrelationships between the tangible and the intangible elements is therefore important

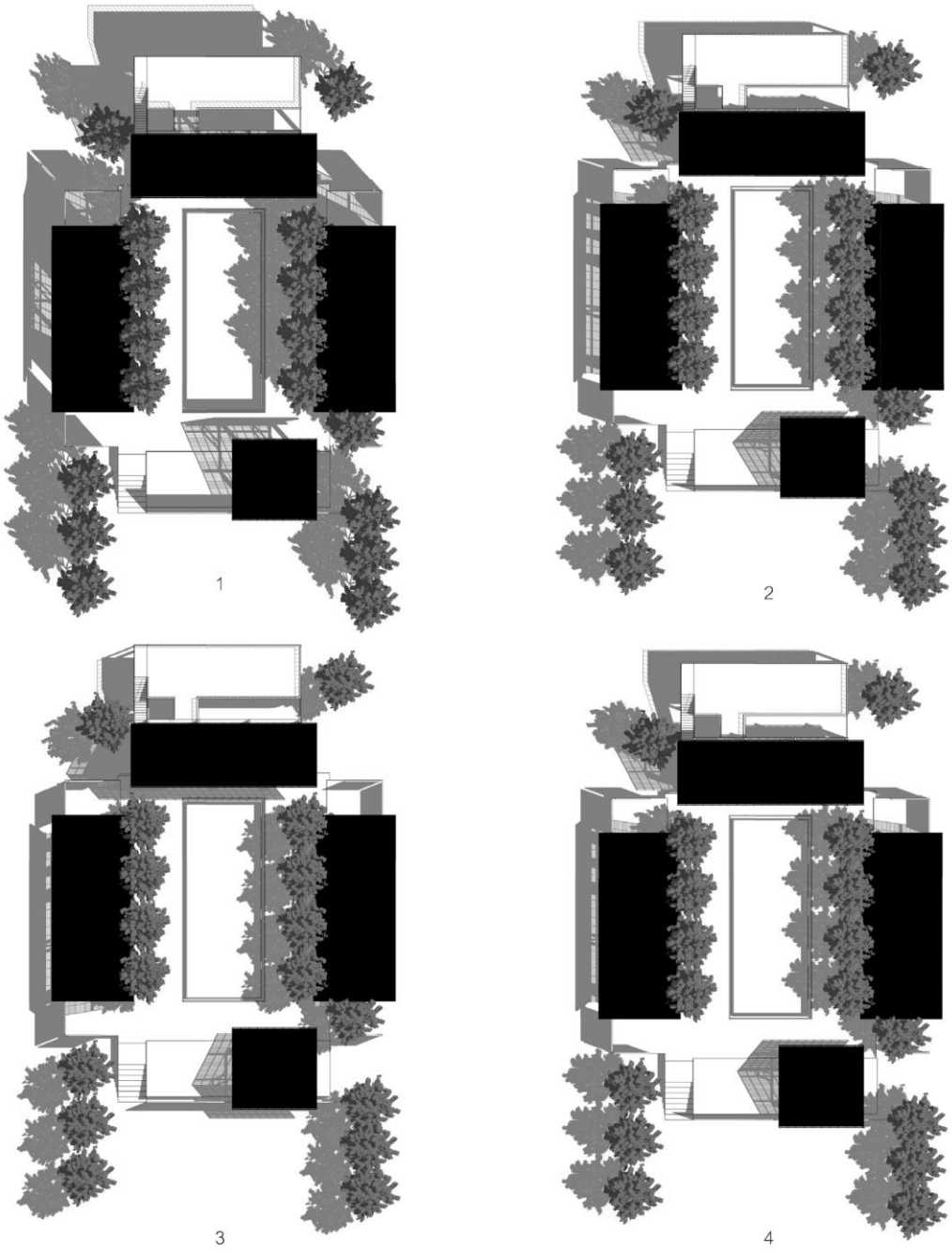


Figure 59. Light & Shadow diagram from top to below

1. Winter Solstice (21st December 10AM), 2. Spring Equinox (21st March 10AM), 3. Summer Solstice (21st June 10AM), 4. Fall Equinox (21st Sept. 10AM) plan views drawn by author.

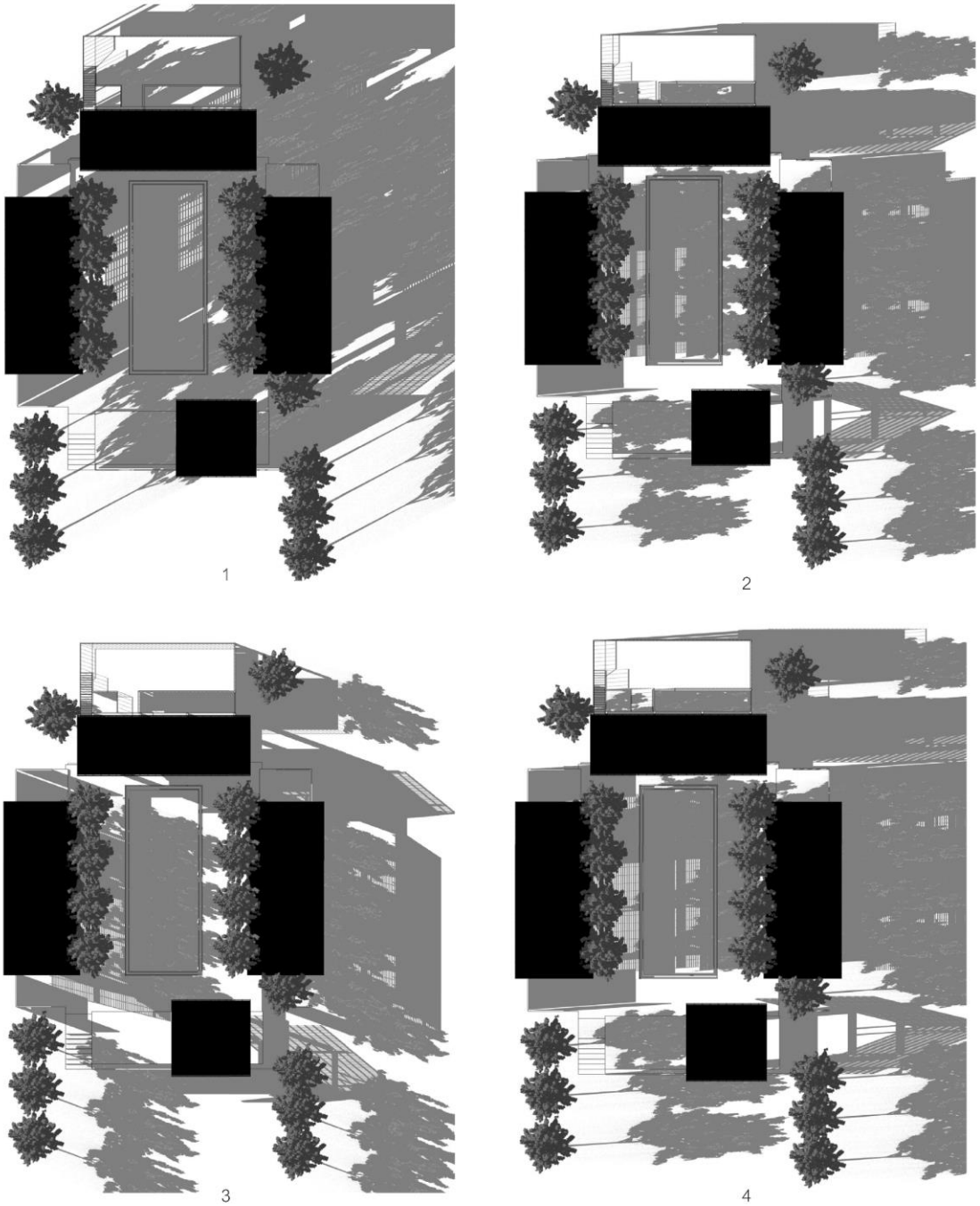


Figure 60. Light & Shadow diagram from top to below

1. Winter Solstice (21st December 5PM), 2. Spring Equinox (21st March 5PM),

3. Summer Solstice (21st June 5PM), 4. Fall Equinox (21st Sept. 5PM) plan views

drawn by author.

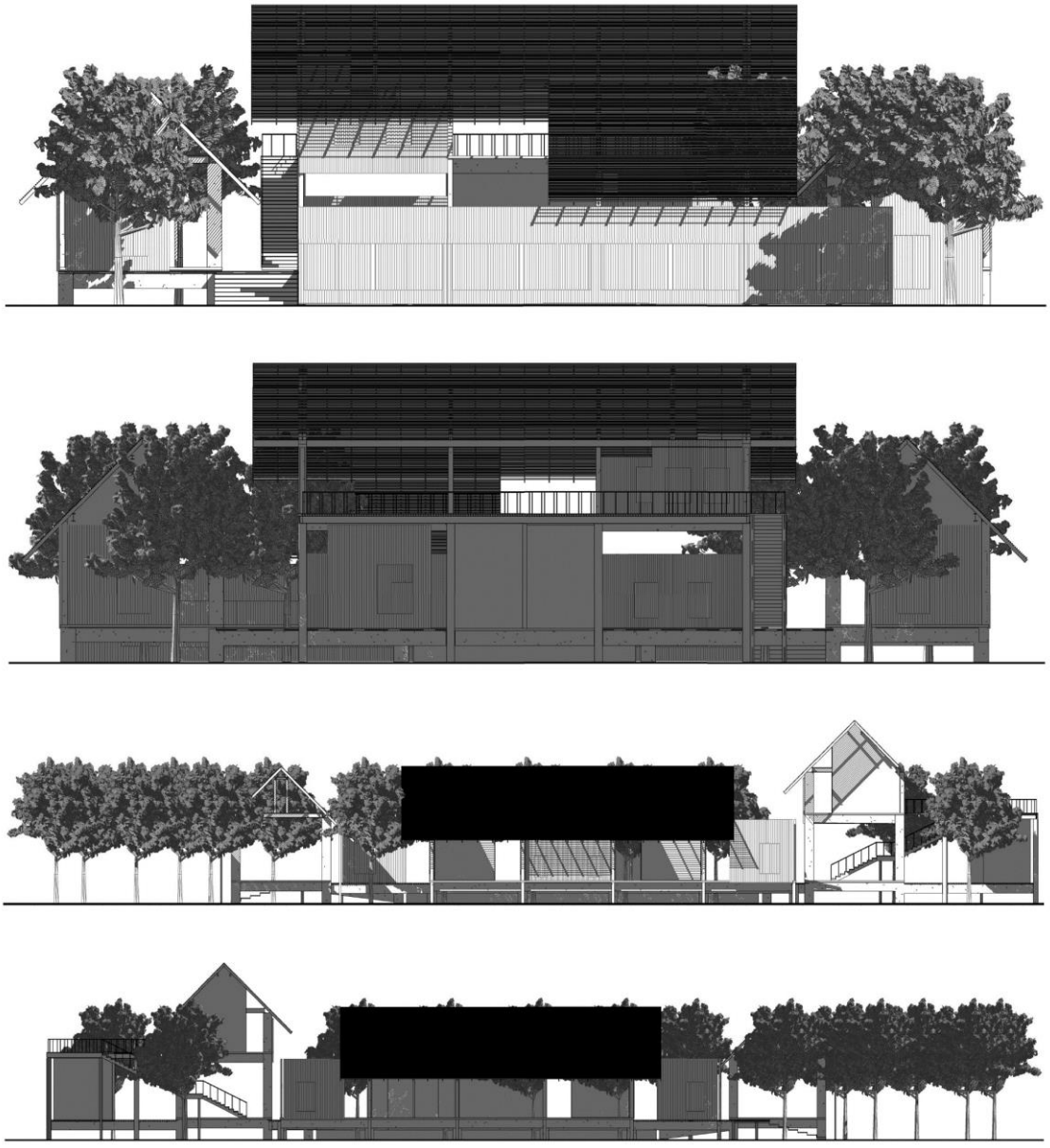


Figure 61. Light and shadow diagram on Winter Solstice (21st December 10AM) North, South East West Elevations, from top to below, drawn by the author.

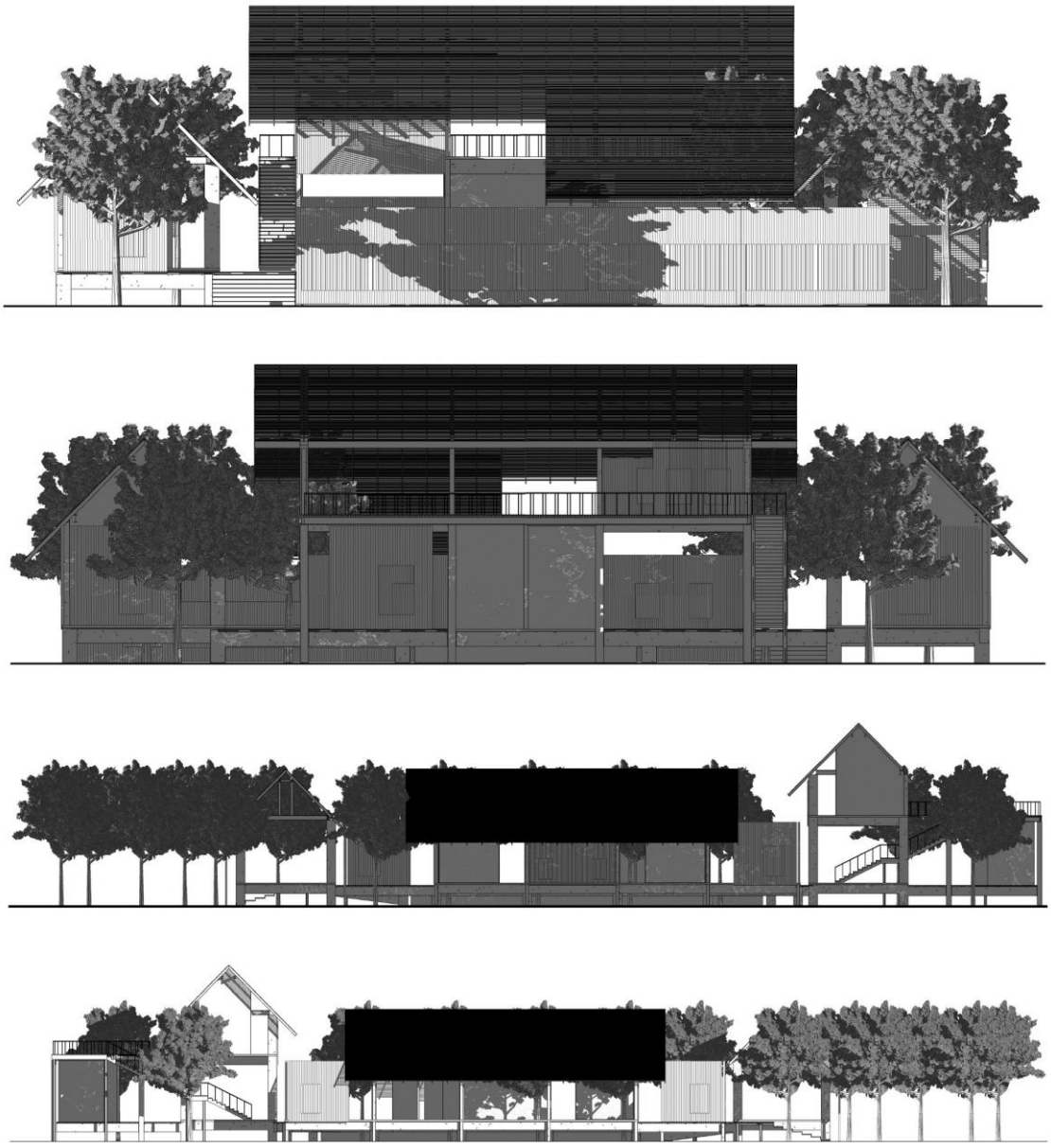


Figure 62. Light and shadow diagram on Winter Solstice (21st December 5PM) North, South East West Elevations, from top to below, drawn by the author.

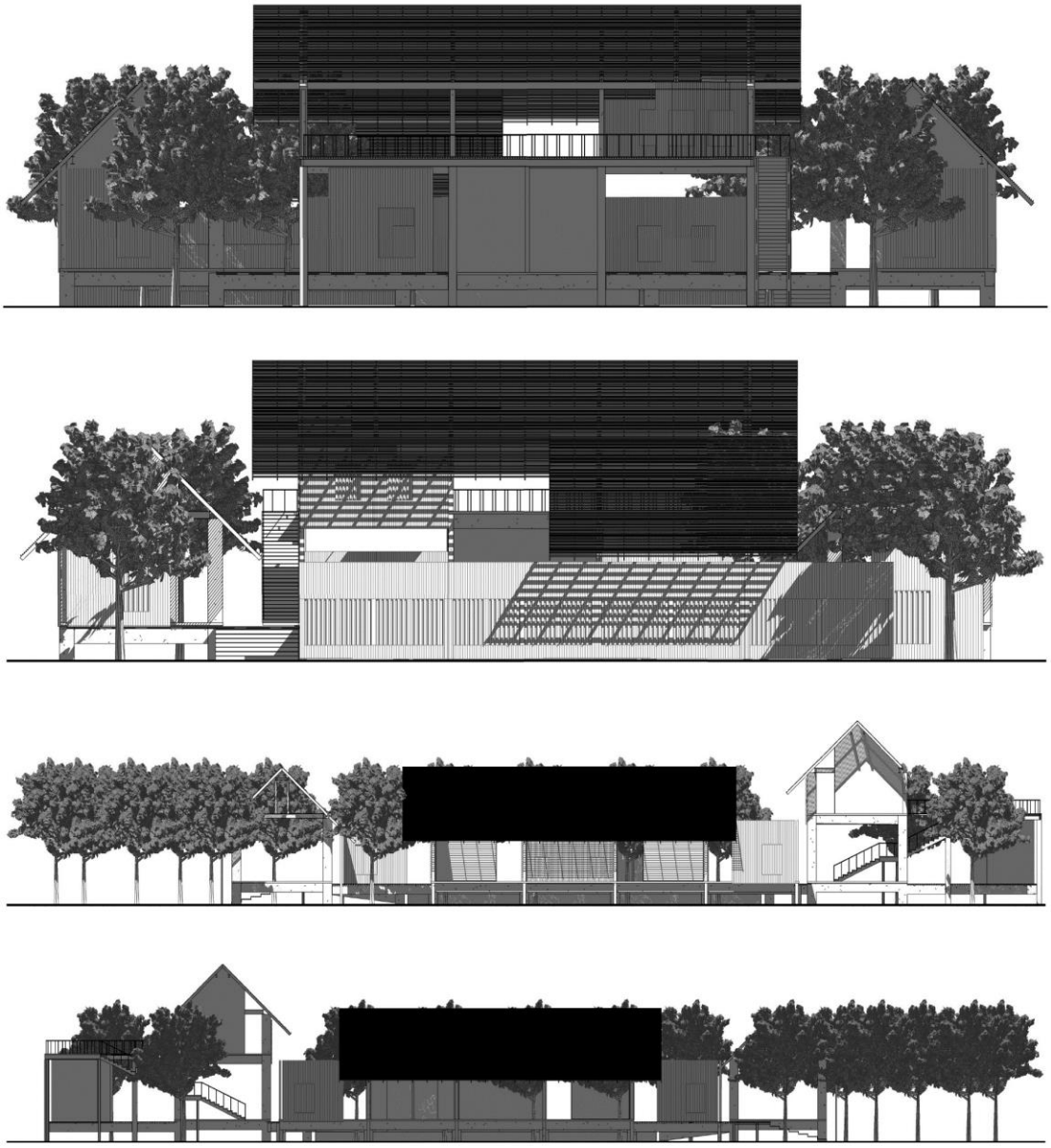


Figure 63. Light and shadow diagram on Spring Equinox (21st March 10AM) North, South East West Elevations, from top to below, drawn by the author.

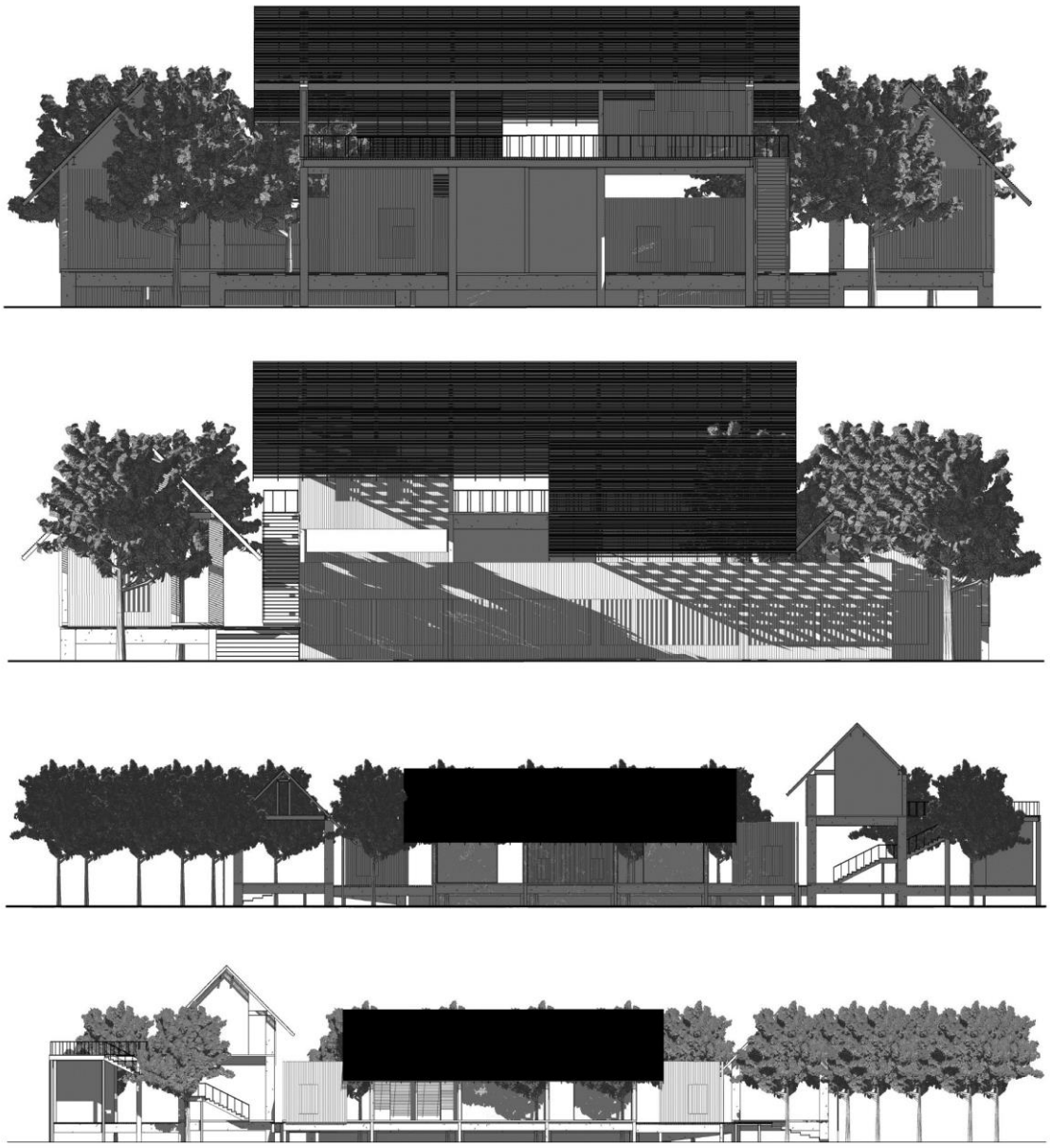


Figure 64. Light and shadow diagram on Spring Equinox (21st March 5PM) North, South East West Elevations, from top to below, drawn by the author.

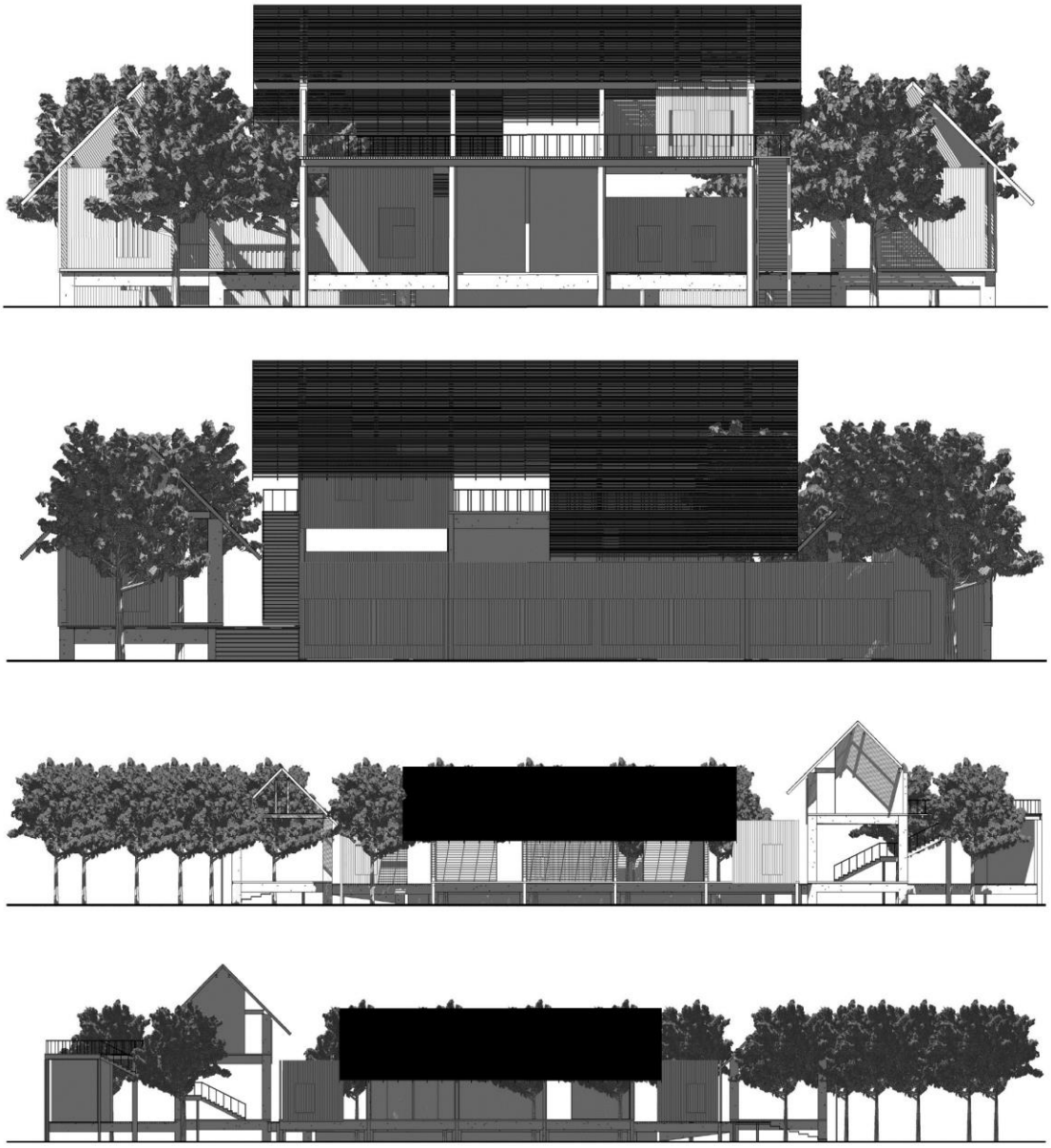


Figure 65. Light and shadow diagram on Summer Solstice (21st June 10AM)

North, South East West Elevations, from top to below, drawn by the author.

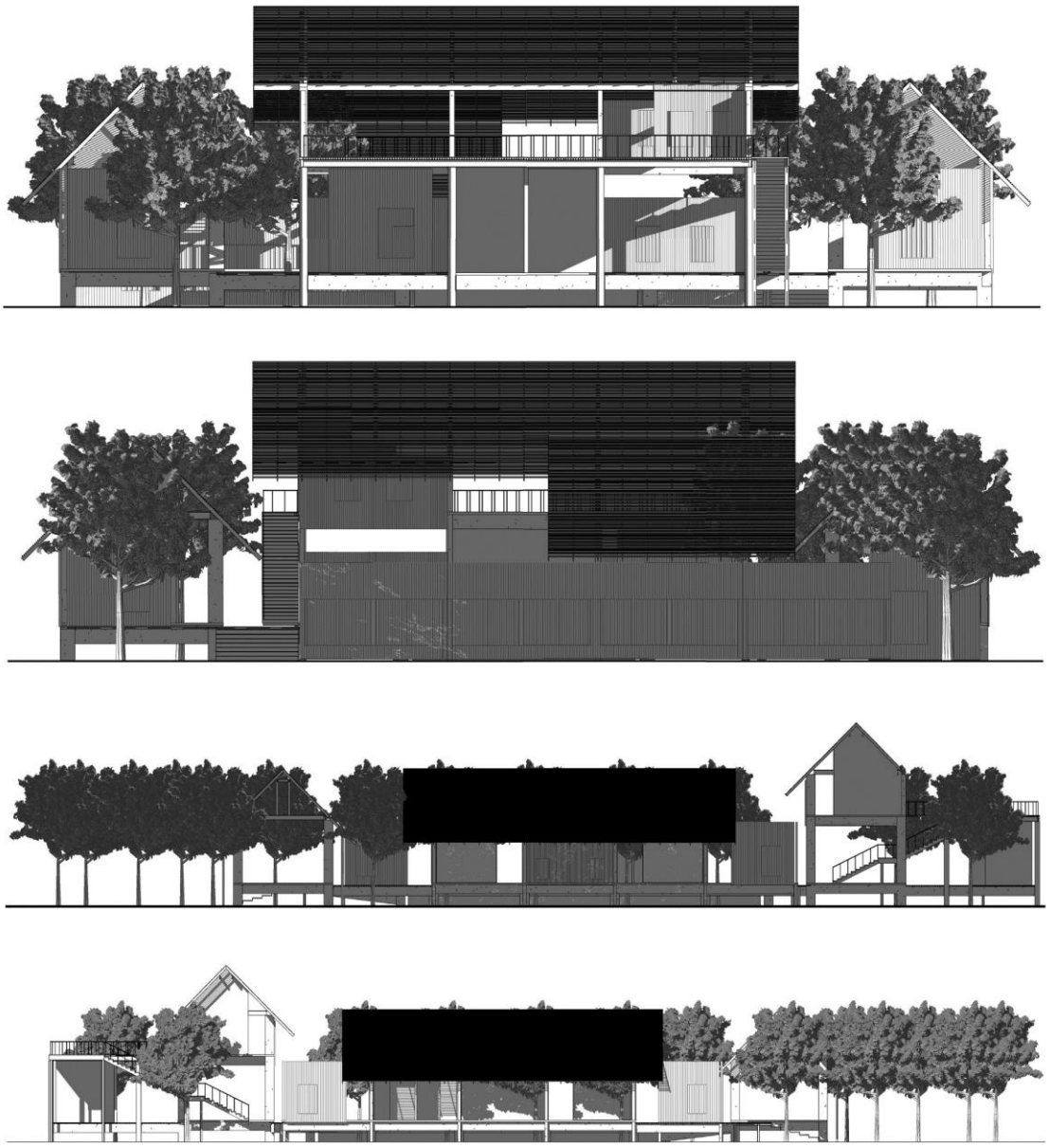


Figure 66. Light and shadow diagram on Summer Solstice (21st June 5PM)

North, South East West Elevations, from top to below, drawn by the author.

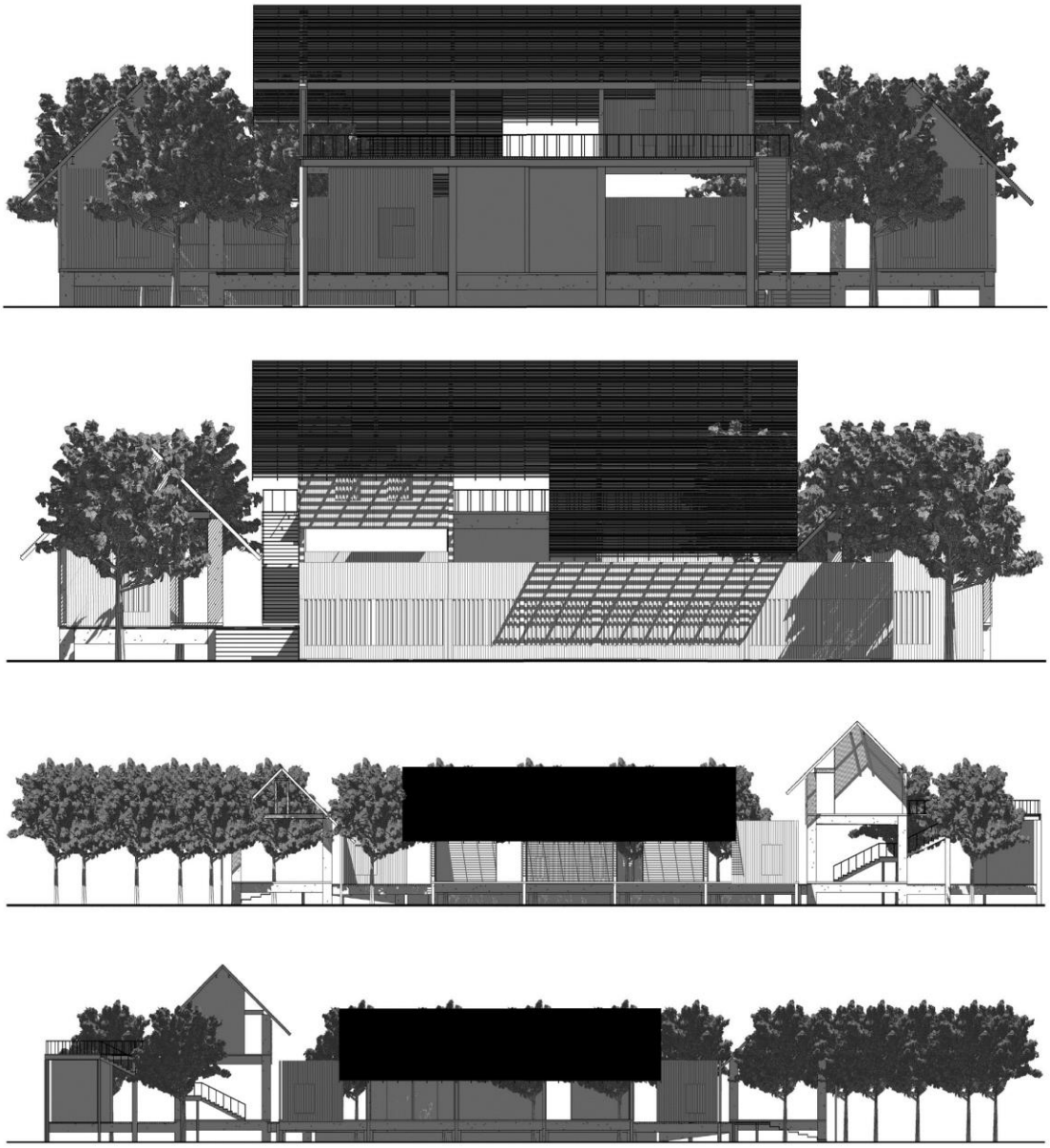


Figure 67. Light and shadow diagram on Fall Equinox (21st September 10AM) North, South East West Elevations, from top to below, drawn by the author.

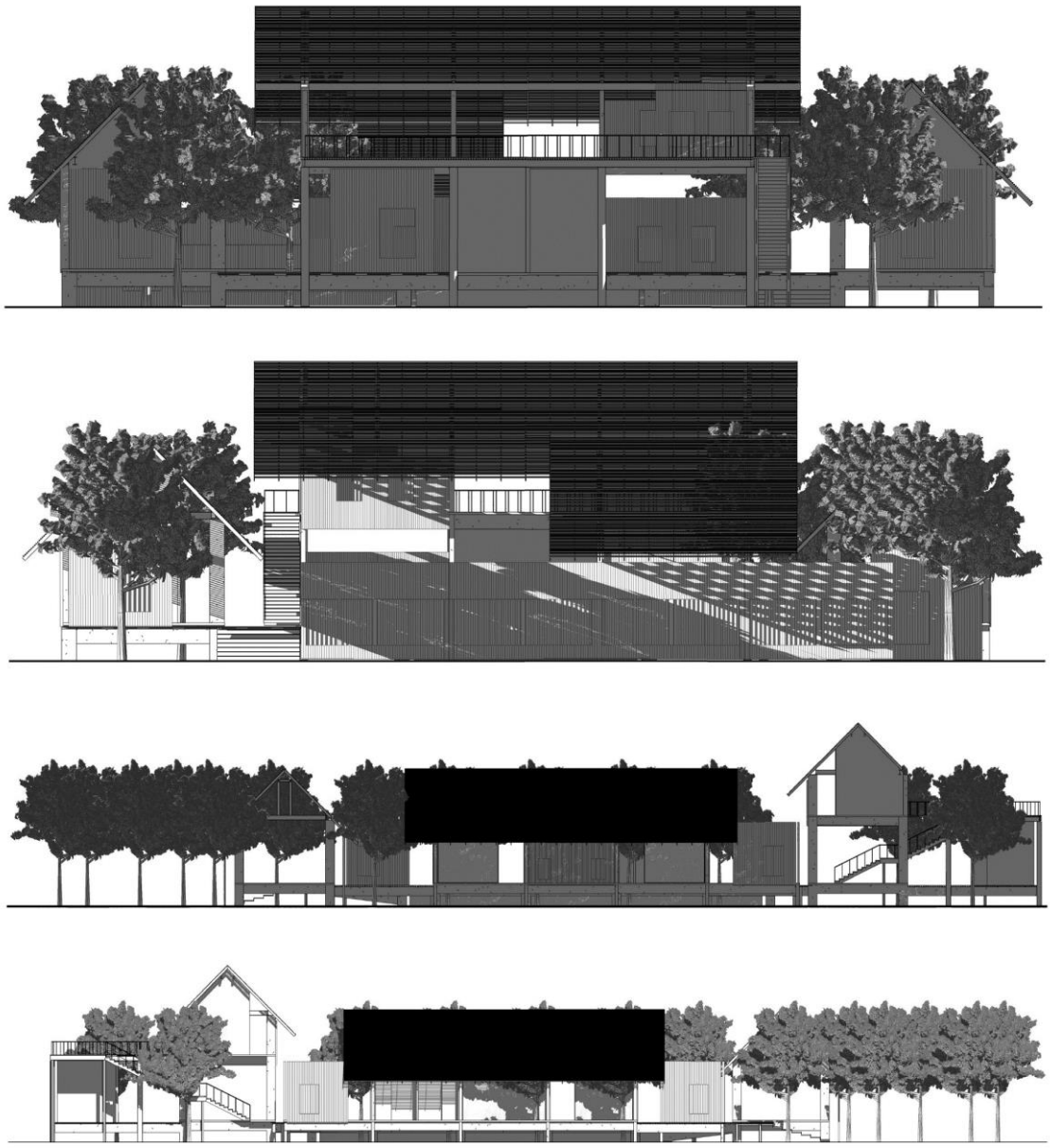


Figure 68. Light and shadow diagram on Fall Equinox (21st September 5PM) North, South East West Elevations, from top to below, drawn by the author.

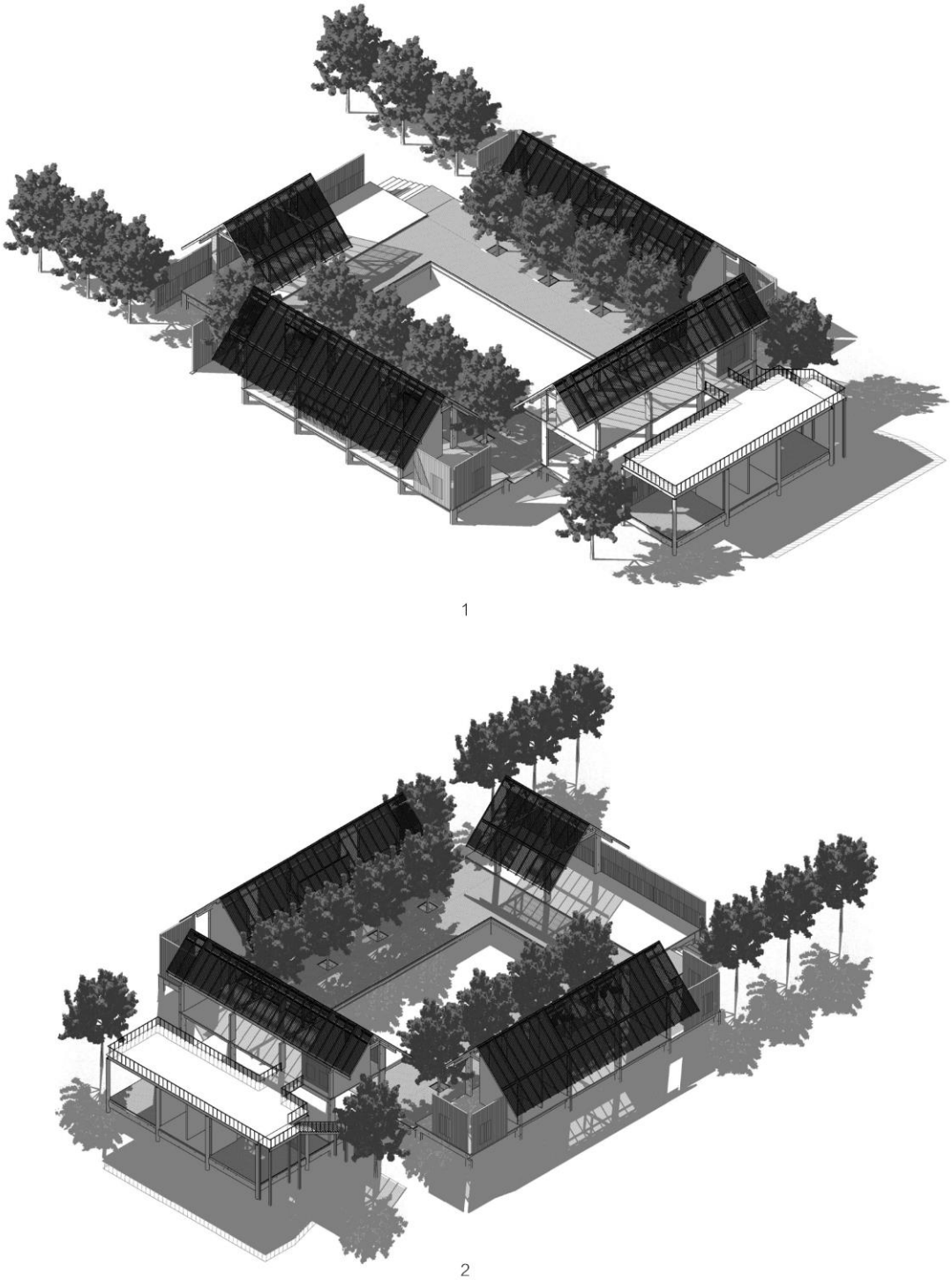


Figure 69. Light and shadow diagram from top to below, Winter Solstice (21st December 10AM) 1. North East, 2. North West, Isometric views, drawn by the author.

Figure 70. Light and shadow diagram from top to below, Winter Solstice (21st December 10AM) 1. South East, 2. South West, Isometric views, drawn by the author.

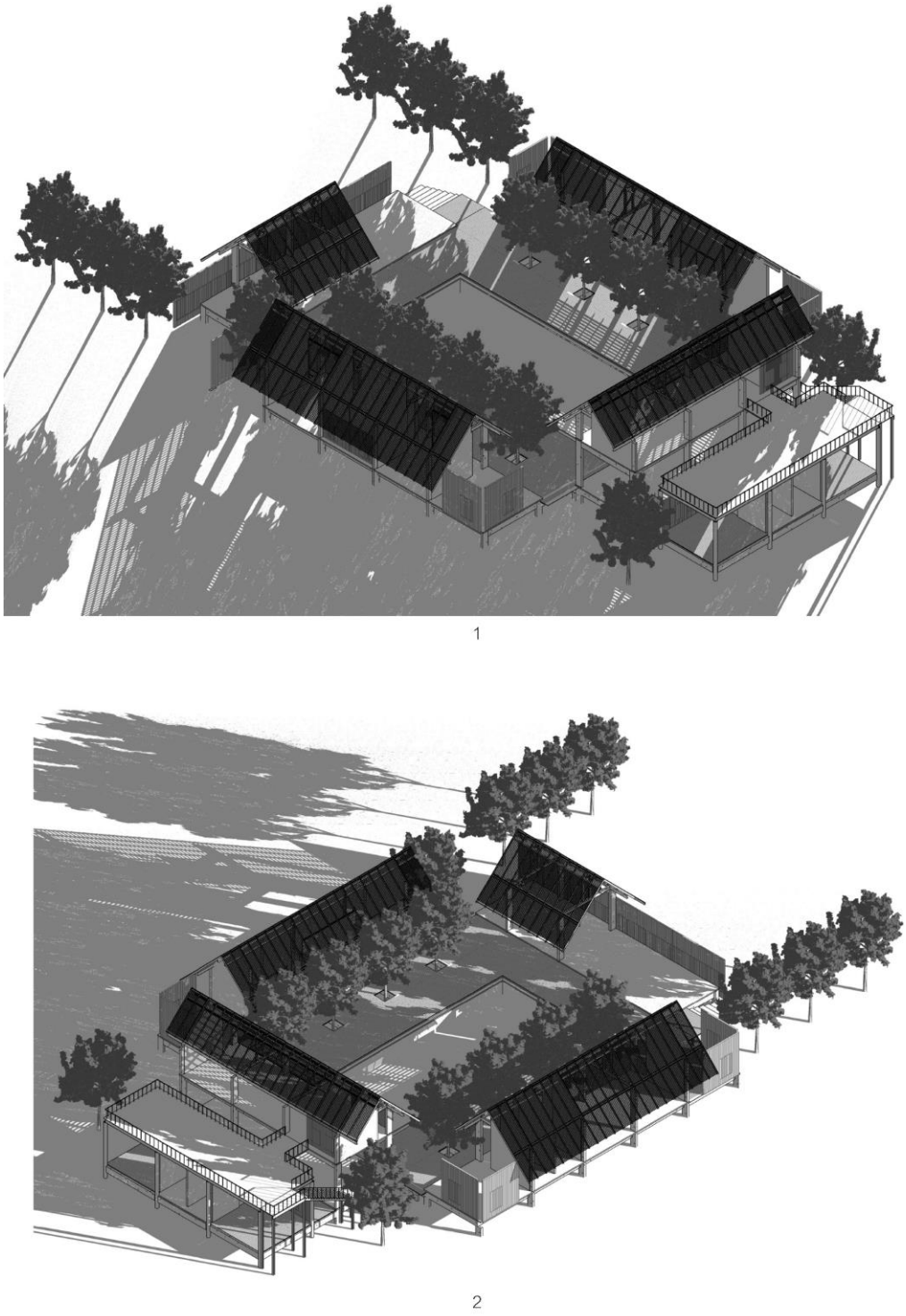


Figure 71. . Light and shadow diagram from top to below, Winter Solstice (21st December 5PM) 1. North East, 2. North West, Isometric views, drawn by the author.

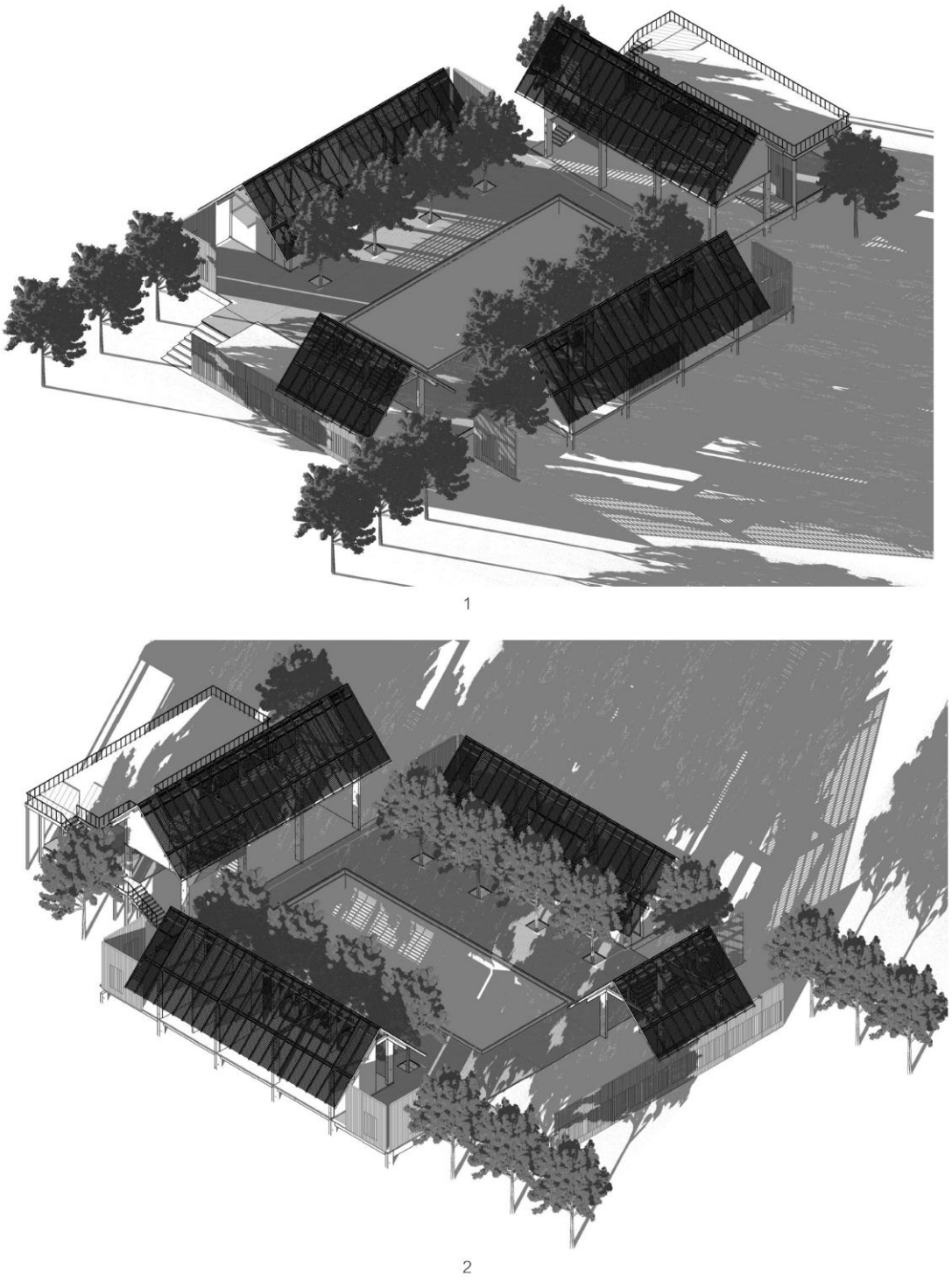


Figure 72. Light and shadow diagram from top to below, Winter Solstice (21st December 5PM) 1. South East, 2. South West, Isometric views, drawn by the author.

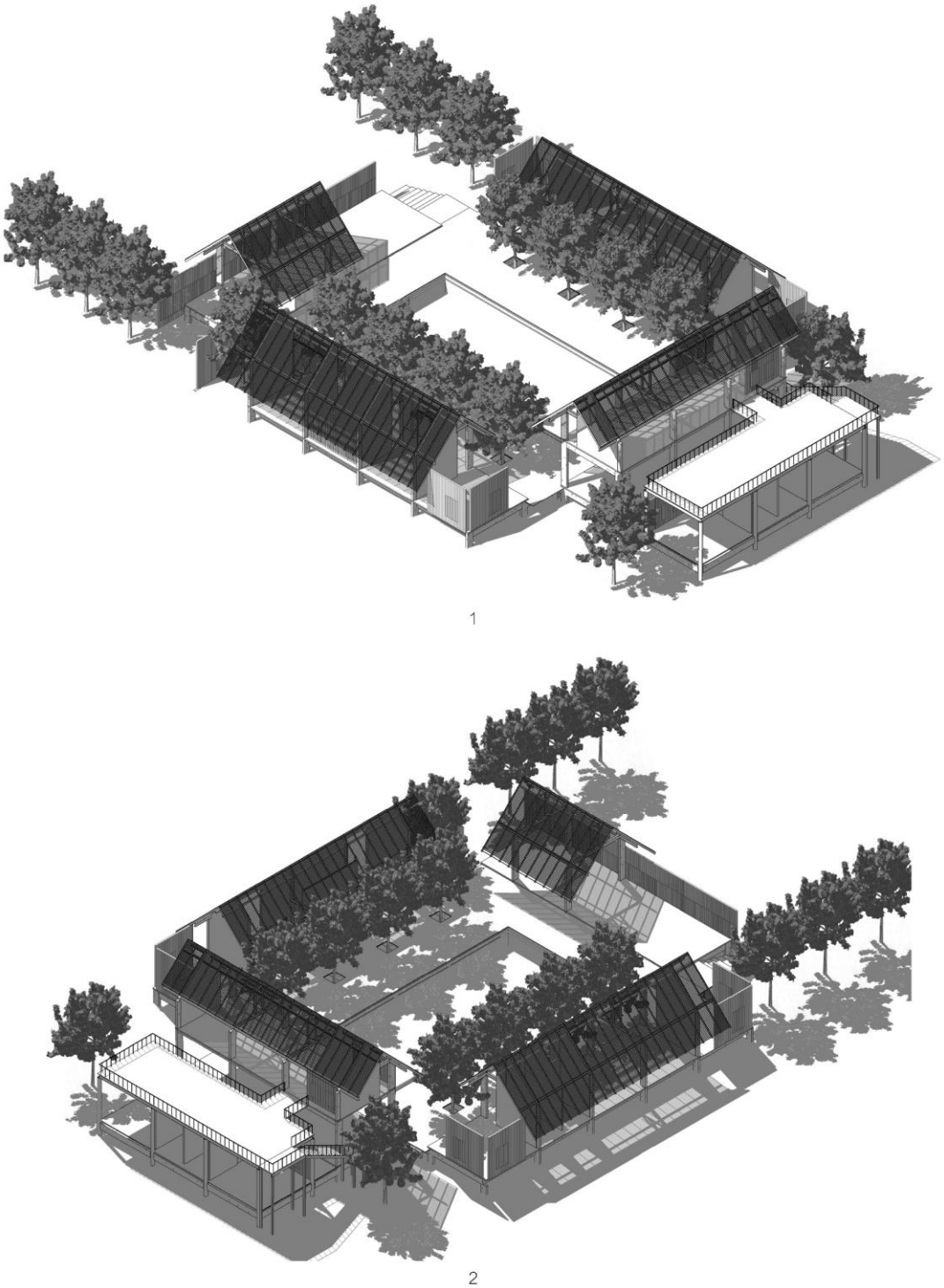


Figure 73. Light and shadow diagram from top to below, Spring Equinox (21st March 10AM) 1. North East, 2. North West, Isometric views, drawn by the author

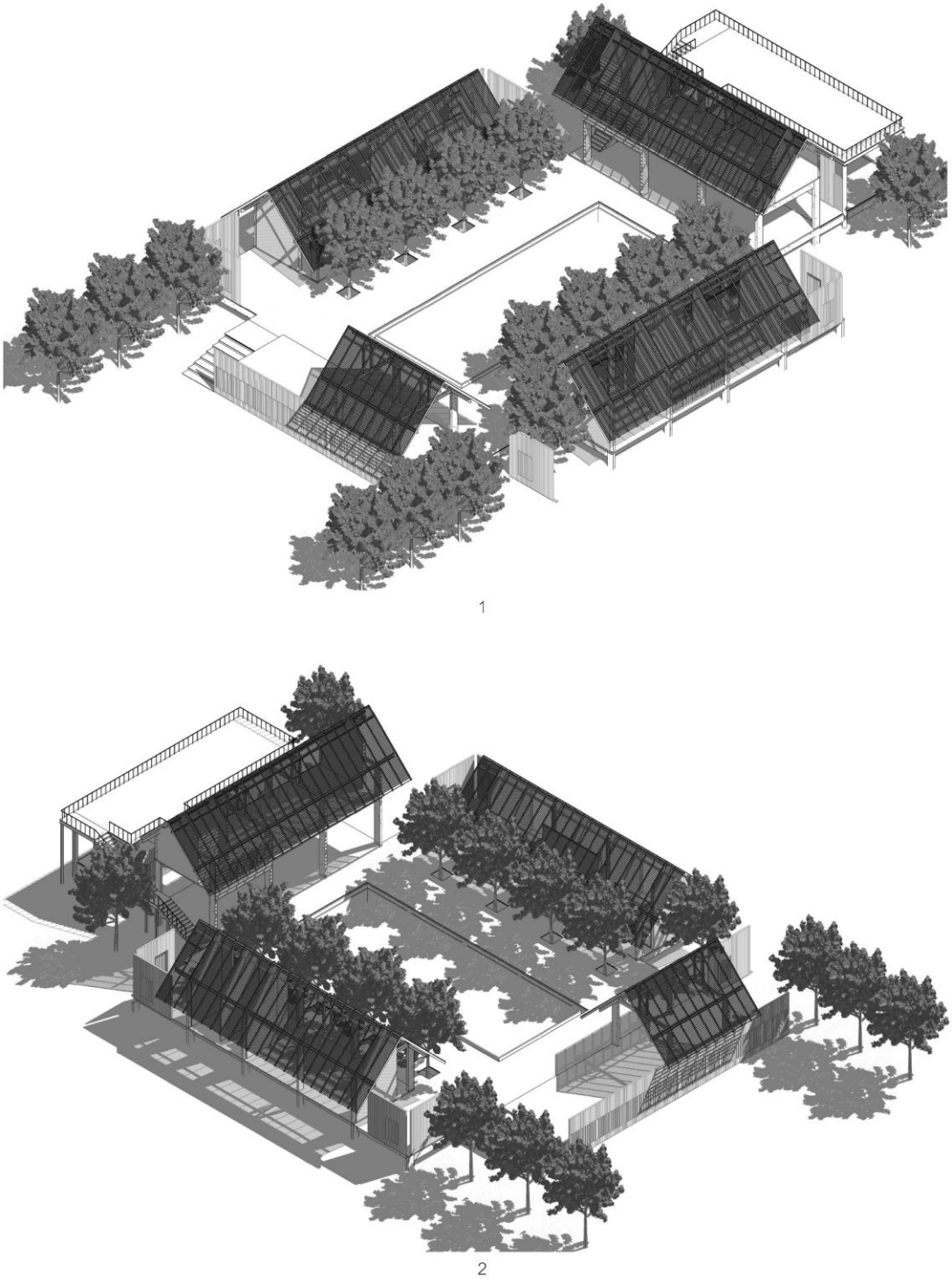


Figure 74. Light and shadow diagram from top to below, Spring Equinox (21st March 10AM) 1. South East, 2. South West, Isometric views, drawn by the author.

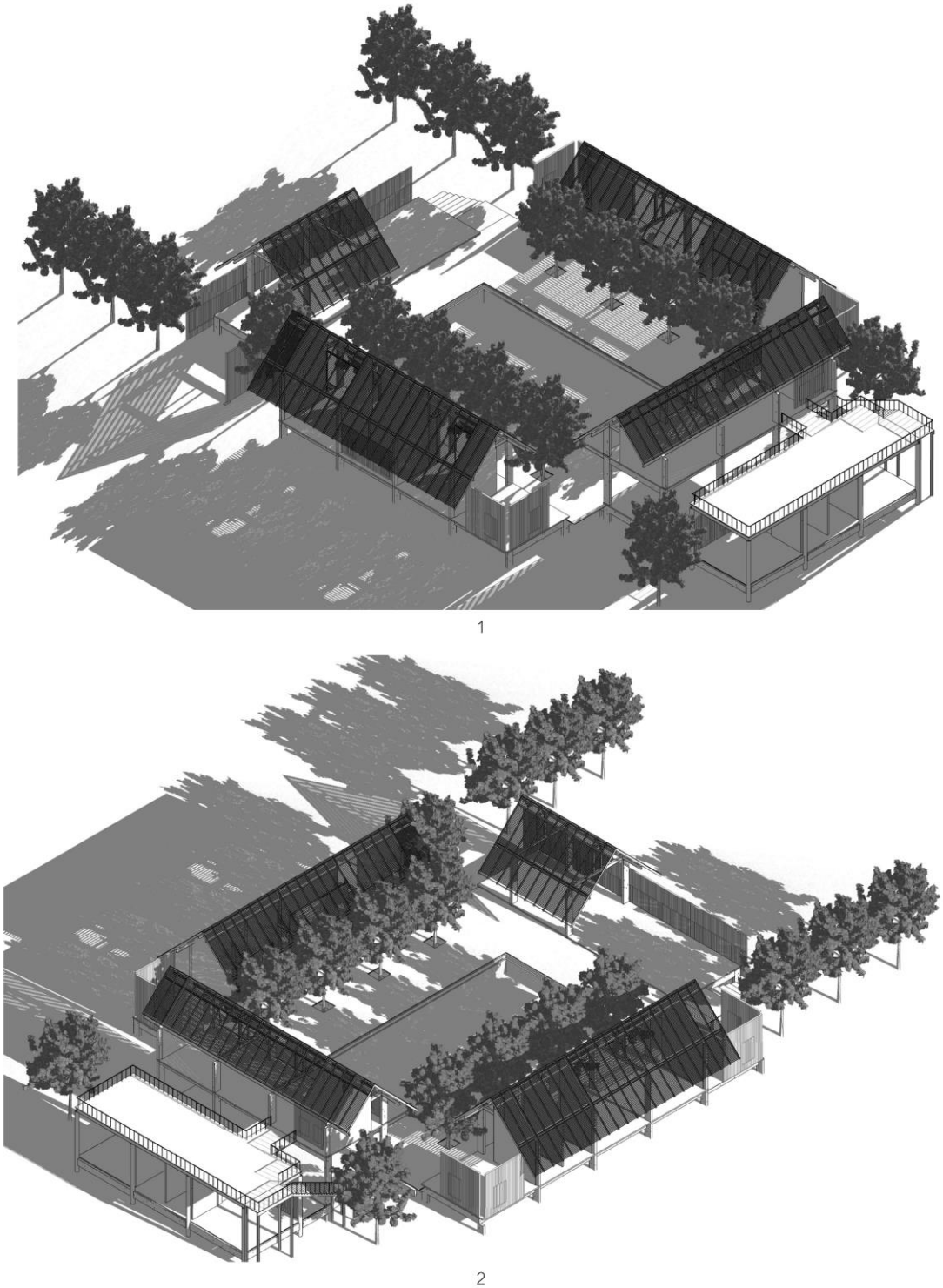
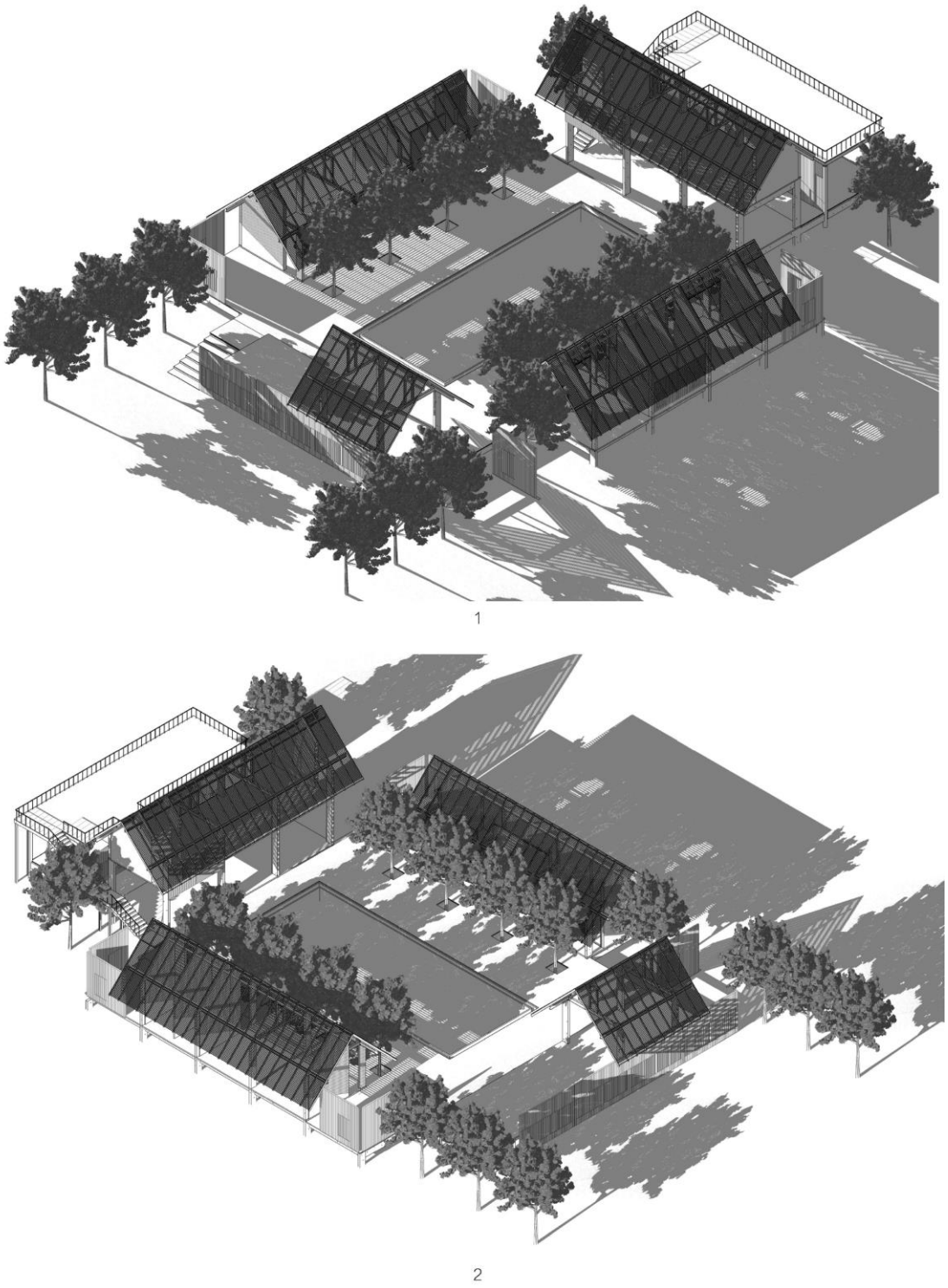


Figure 75. Light and shadow diagram from top to below, Spring Equinox (21st March 5PM) 1. North East, 2. North West, Isometric views, drawn by the author.



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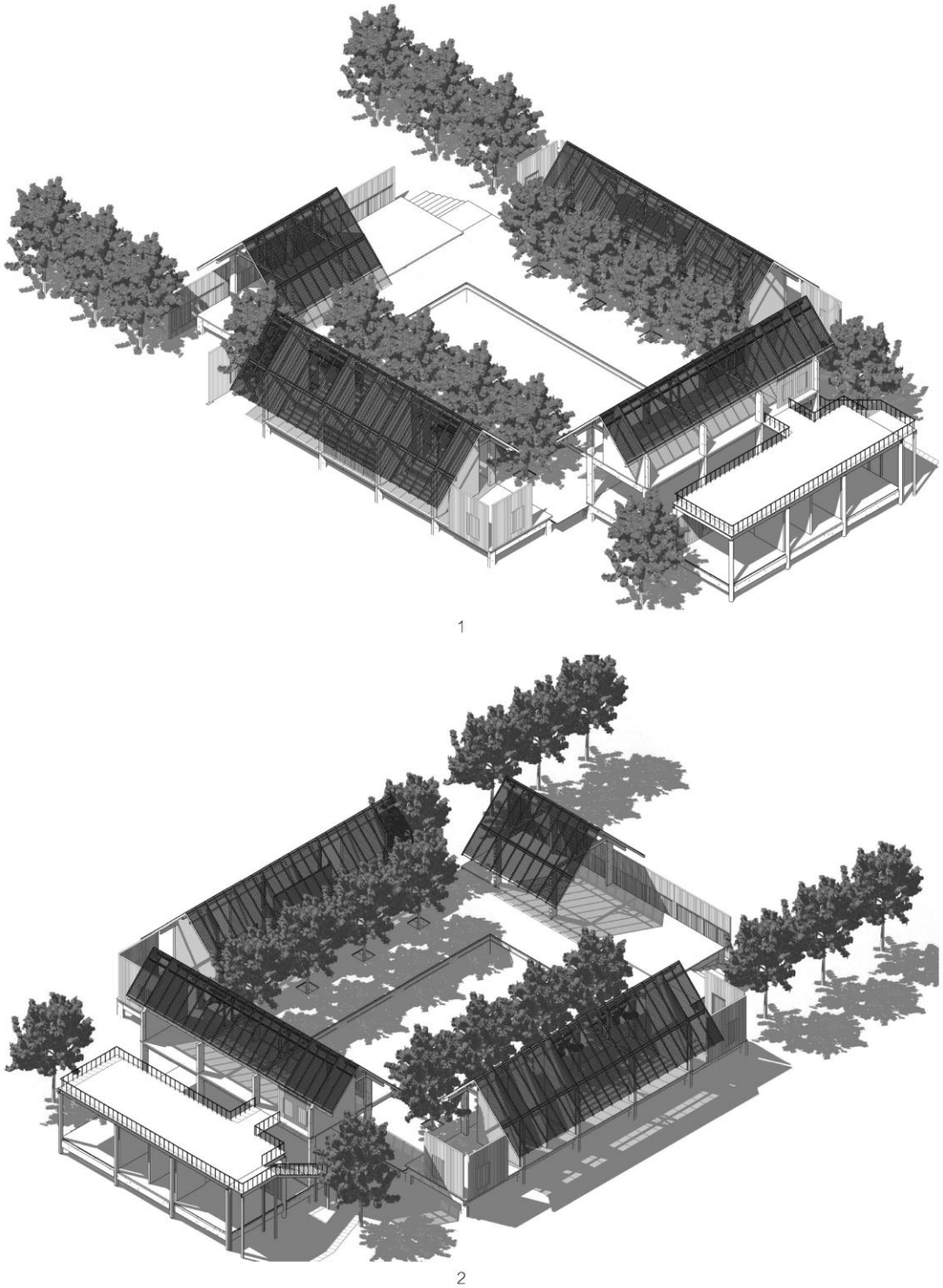

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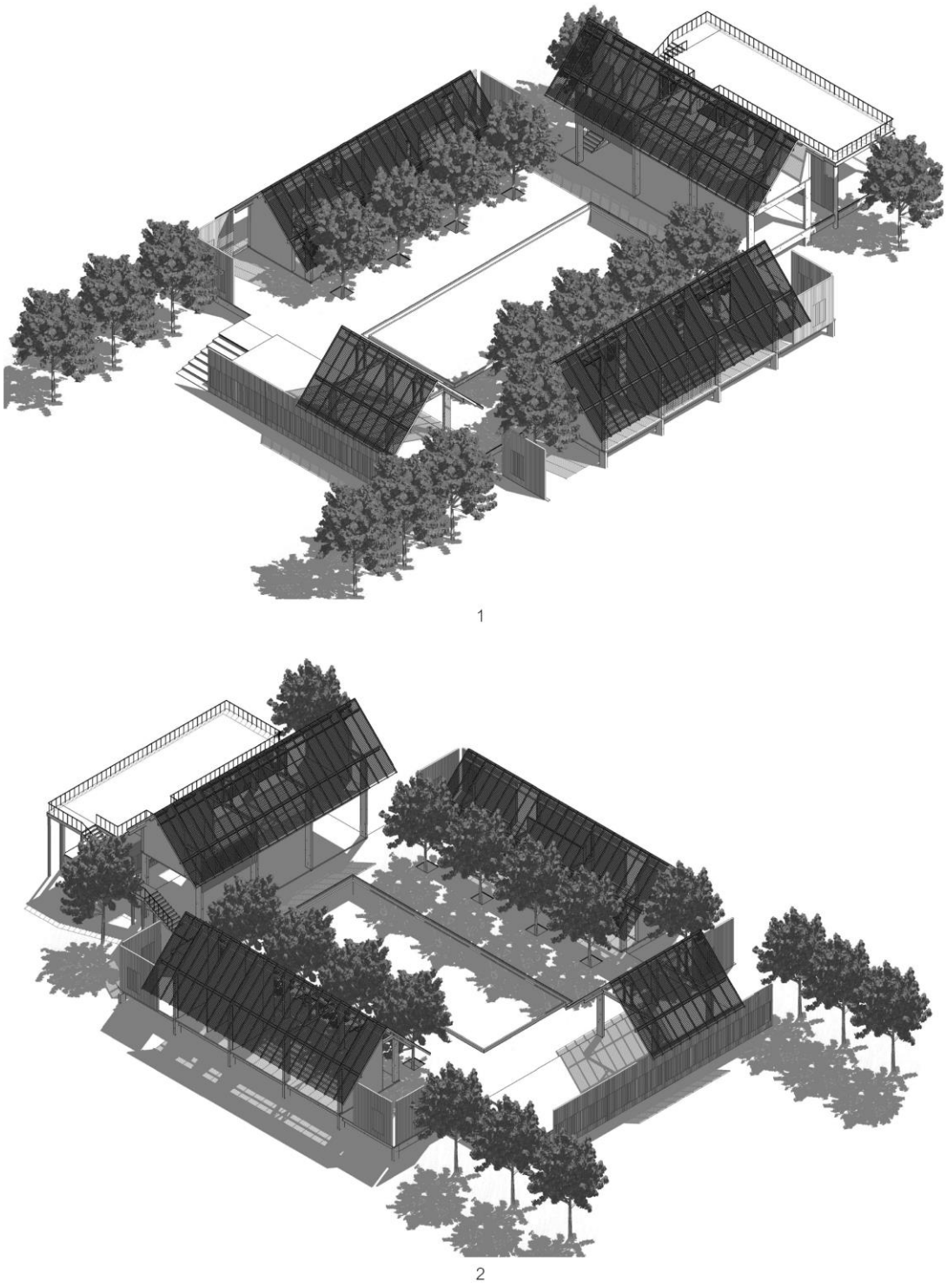


Figure 78. Light and shadow diagram from top to below, Summer Solstice (21st June 10AM) 1. South East, 2. South West, Isometric views, drawn by the author.

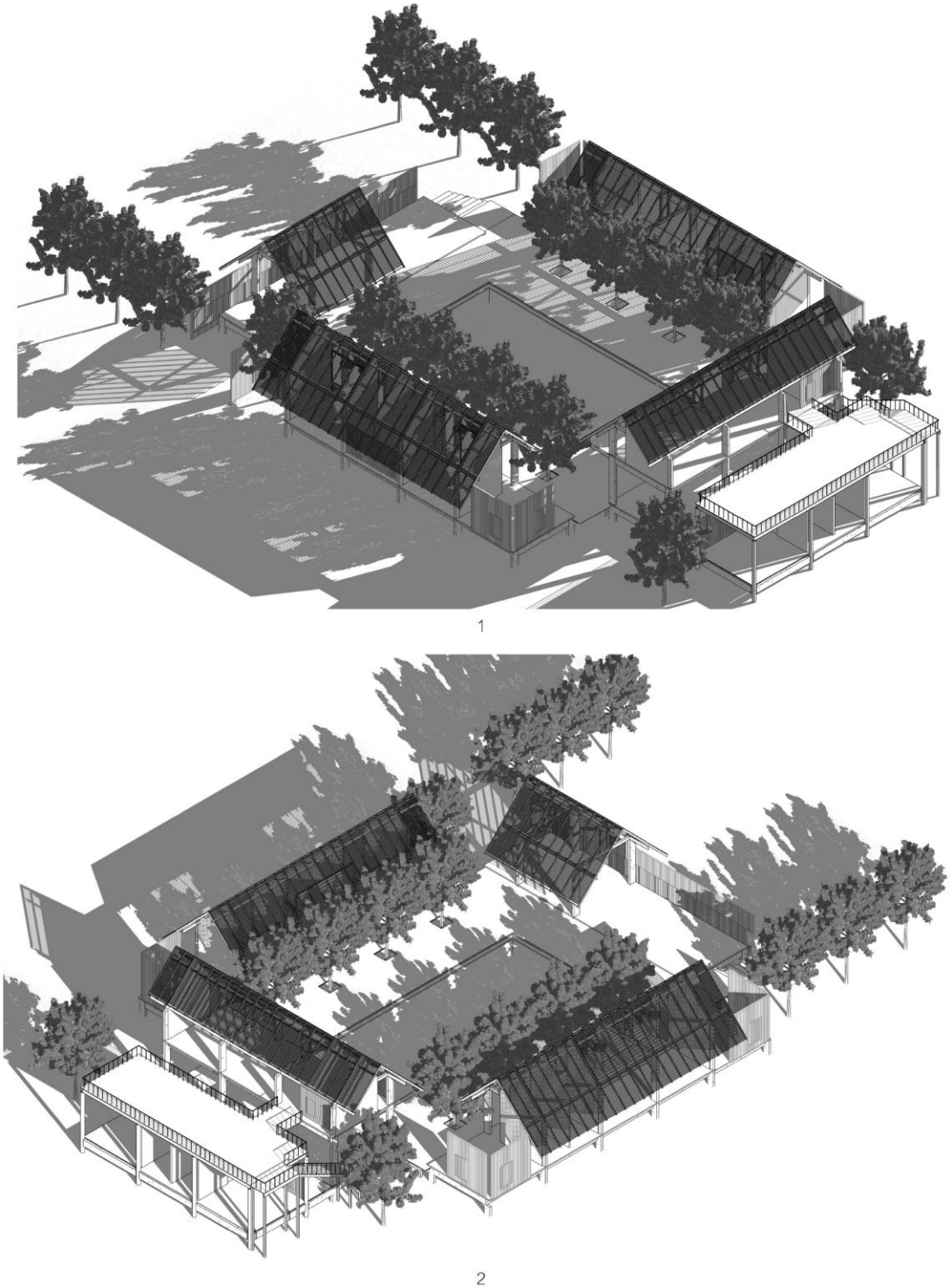


Figure 79. Light and shadow diagram from top to below, Summer Solstice (21st June 5PM) 1. North East, 2. North West, Isometric views, drawn by the author.

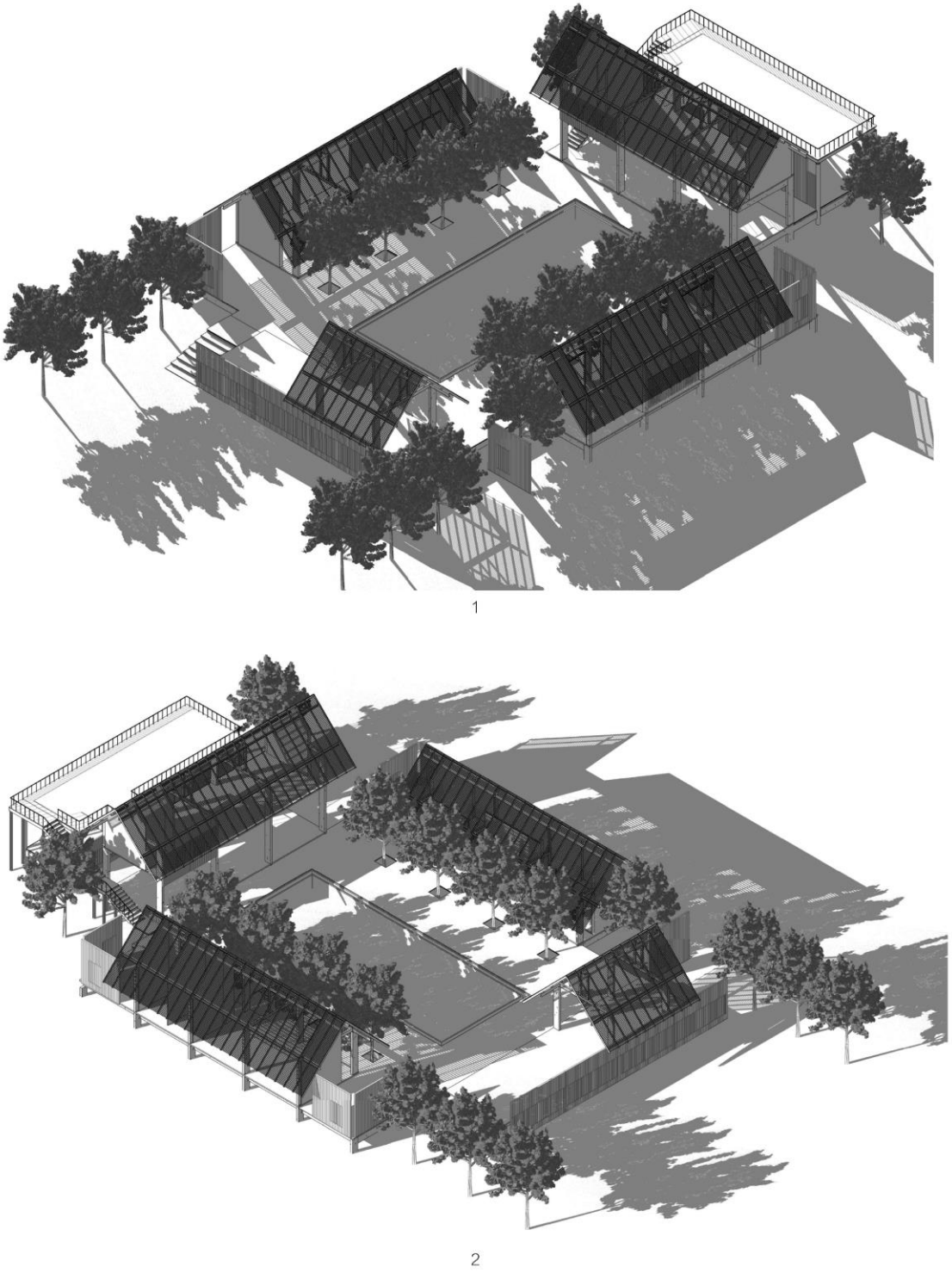


Figure 80. Light and shadow diagram from top to below, Summer Solstice (21st June 5PM) 1. South East, 2. South West, Isometric views, drawn by the author.

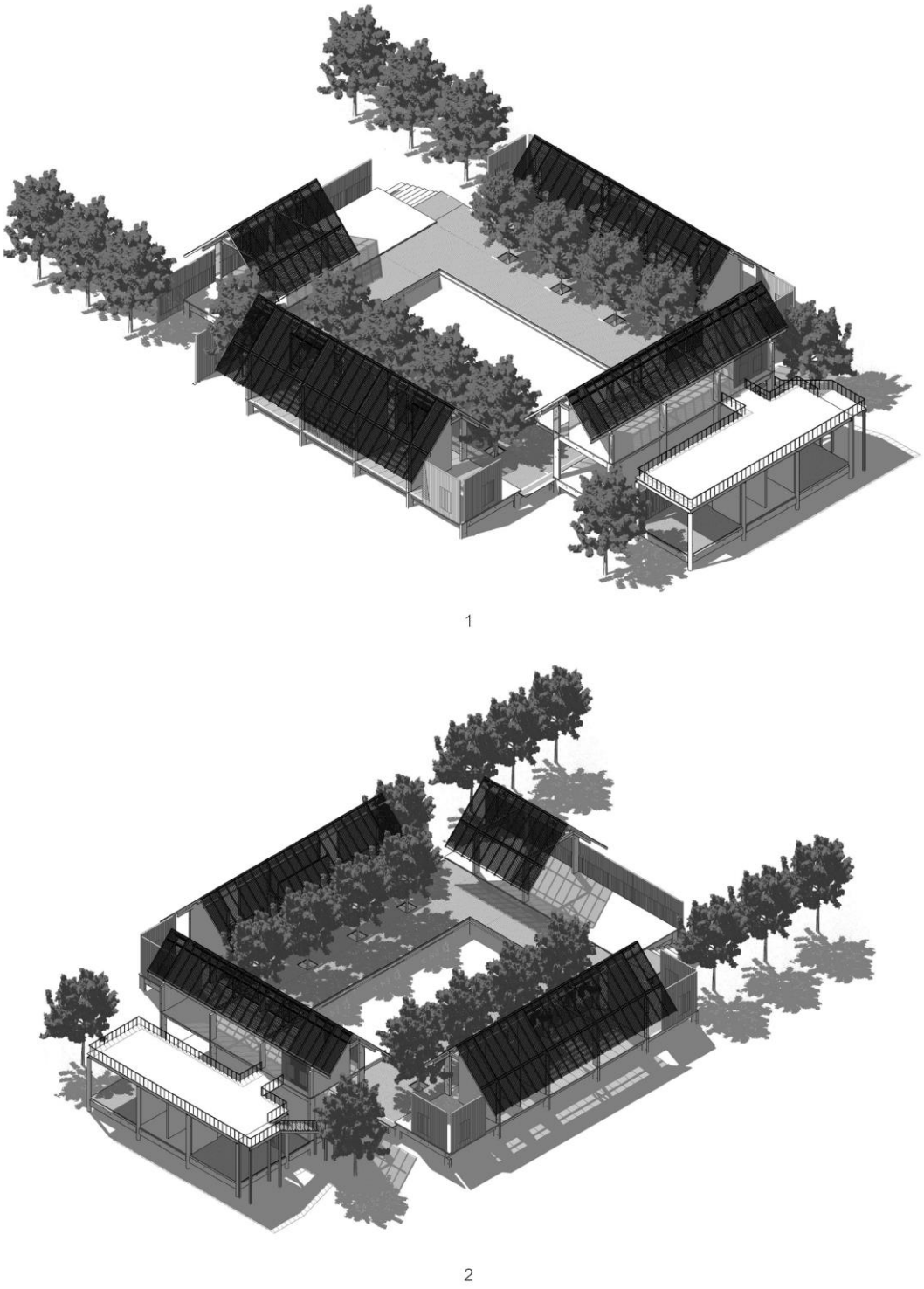


Figure 81. Light and shadow diagram from top to below, Fall Equinox (21st September 10AM) 1. North East, 2. North West, Isometric views, drawn by the author.

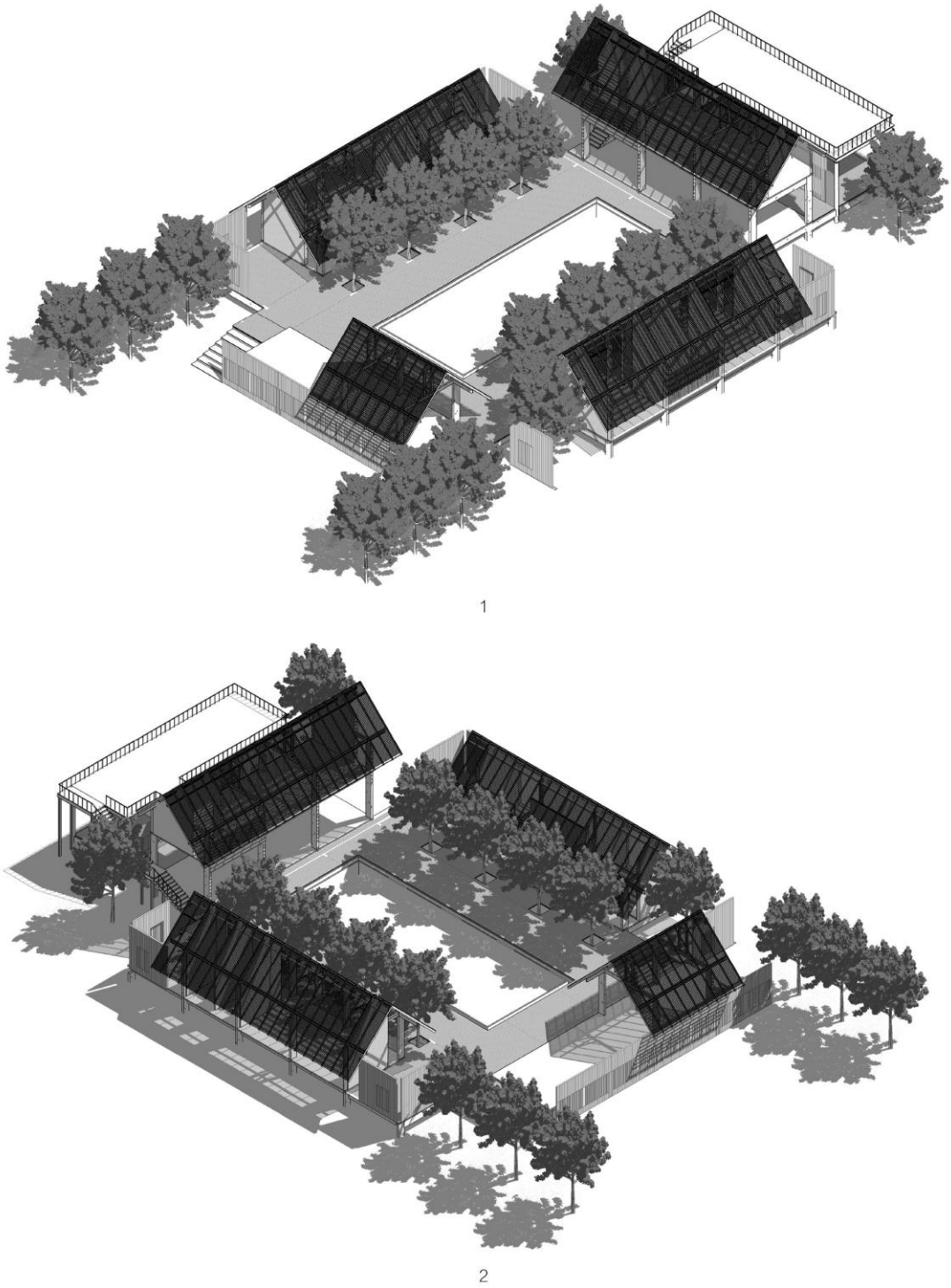


Figure 82. Light and shadow diagram from top to below, Fall Equinox (21st September 5PM) 1. South East, 2. South West, Isometric views, drawn by the author.

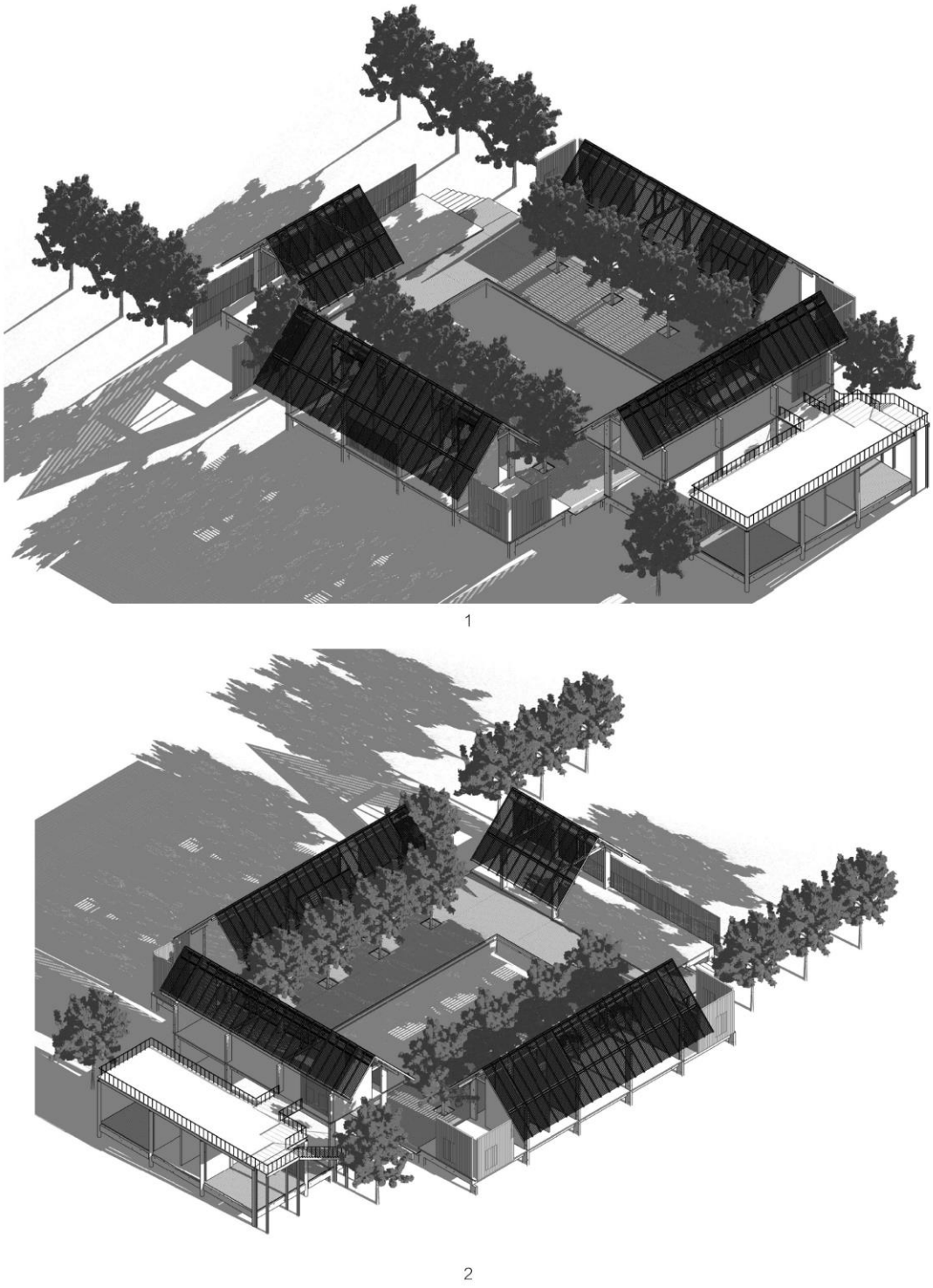


Figure 83. Light and shadow diagram from top to below, Fall Equinox (21st September 5PM) 1. North East, 2. North West, Isometric views, drawn by the author.

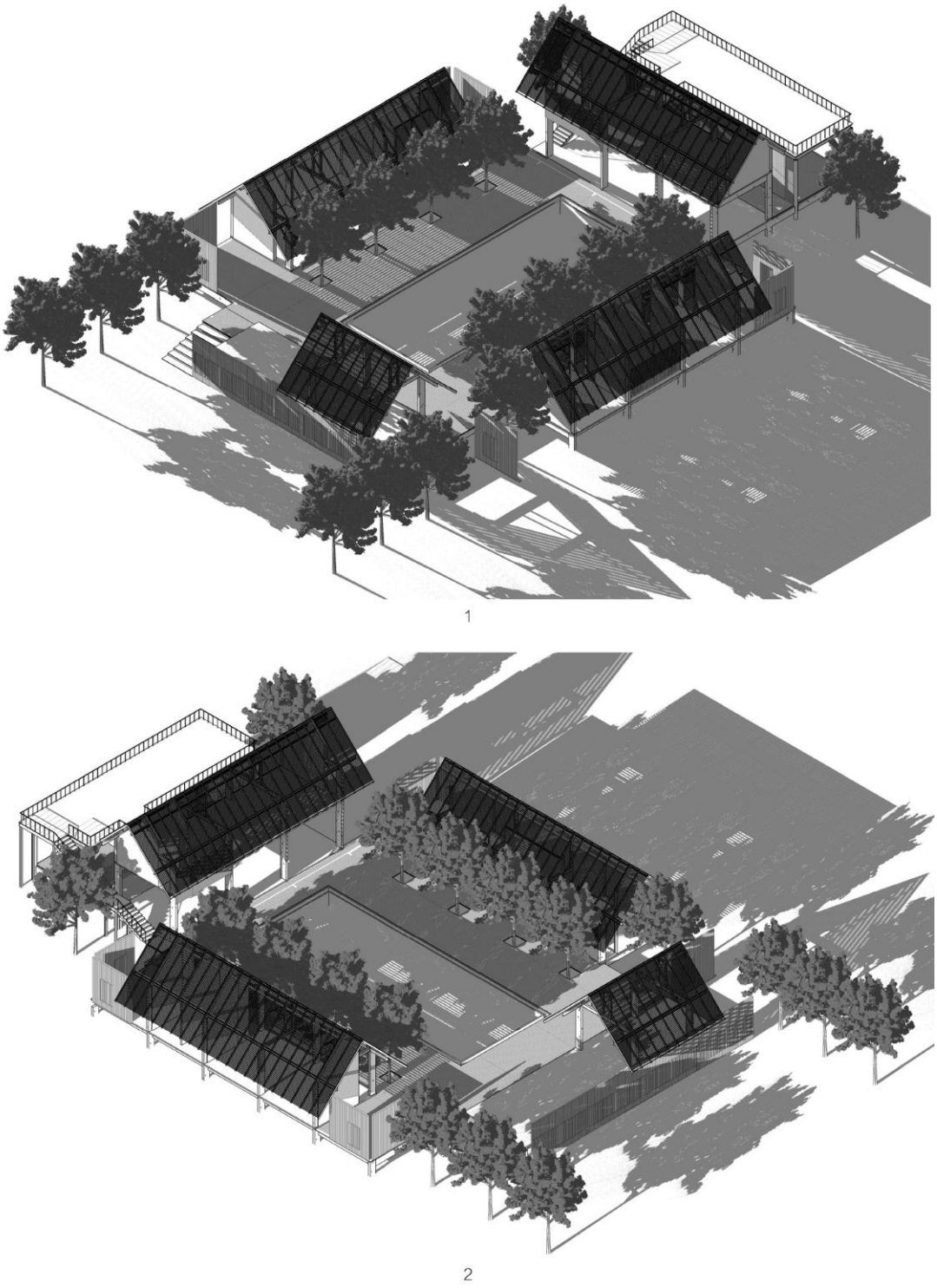
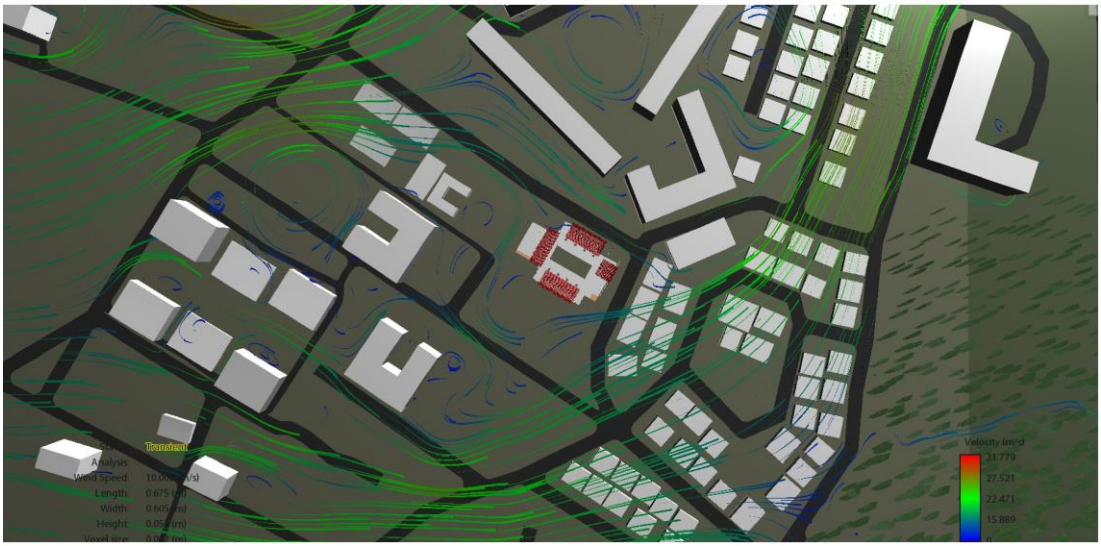


Figure 84. Light and shadow diagram from top to below, Fall Equinox (21st September 5PM) 1. South East, 2. South West, Isometric views, drawn by the author.

Beaufort Wind Force	Wind Average	Speed Range	American term	British term	Land Description
0	0	<1 mph 0-0.2 m/s <1 km/h	Light	Calm	Smoke rises vertically.
1	2 mph 0.8 m/s 3 km/h	1-3 mph 0.3-0.5 m/s 1-5 km/h	Light	Light air	Direction shown by smoke but not by wind vanes.
2	4-7 mph 2.4 m/s 6-11 km/h	4-7 mph 1.6-3.3 m/s 6-11 km	Light	Light breeze	Wind felt on face; leaves rustle; ordinary vane moved by wind
3	10 mph 4.3 m/s 16 km/h	8-12 mph 3.4-5.4 m/s 12-19 km/h	Gentle	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	16 mph 6.7 m/s 24 km/h	13-18 mph 5.5-7.9 m/s 20-28 km/h	Moderate	Moderate breeze	Raises dust and loose paper; small branched are moved
5	22 mph 9.3 m/s 34 km/h	19-24 mph 8.0-10.7 m/s 29-38 km/h	Fresh	Fresh breeze	Small trees in the leaf begin to sway
6	28 mph 12.3 m/s 39-49 km/h	25-31 mph 10.8-13.8 m/s 39-49 km/h	Strong	Strong breeze	Large branches in motion; inconvenience felt when waking against the wind.
7	35 mph 15.5 m/s 56 km/h	32-38 mph 13.9-17.1 m/s 50-61 km/h	Strong	Near gale	Whole trees in motion; inconvenience felt when walking against the wind.
8	43 mph 18.9 m/s 68 km/h	39-46 mph 17.2-20.7 m/s 62-74 km/h	Gale	Gale	Breaks twigs off trees; generally impedes progress.
9	51 mph 22.6 m/s 82 km/h	47-54 mph 20.8.24.4 m/s 75-88 km/h	Gale	Strong gale	Slight structural damages: chimneypots and slates removed.
10	59 mph 26.4 m/s 96 km/h	55-63 mph 24.5-28.4 m/s 89-102 km/h	Whole gale	Storm	Trees uprooted; considerable structural damage.
11	68 mph 30.5 m/s 110 km/h	64-72 mph 28.5-32.6 m/s 103-117 km/h	Whole gale	Violent storm	Widespread damage; very rarely experiences.
12	78 mph n/a 124 km/h	72-82 mph >= 32.7 m/s 118-132 km/h	Hurricane	n/a	Countryside is devastated.

Table 4. Beaufort Wind Force Scale redrawn by author.



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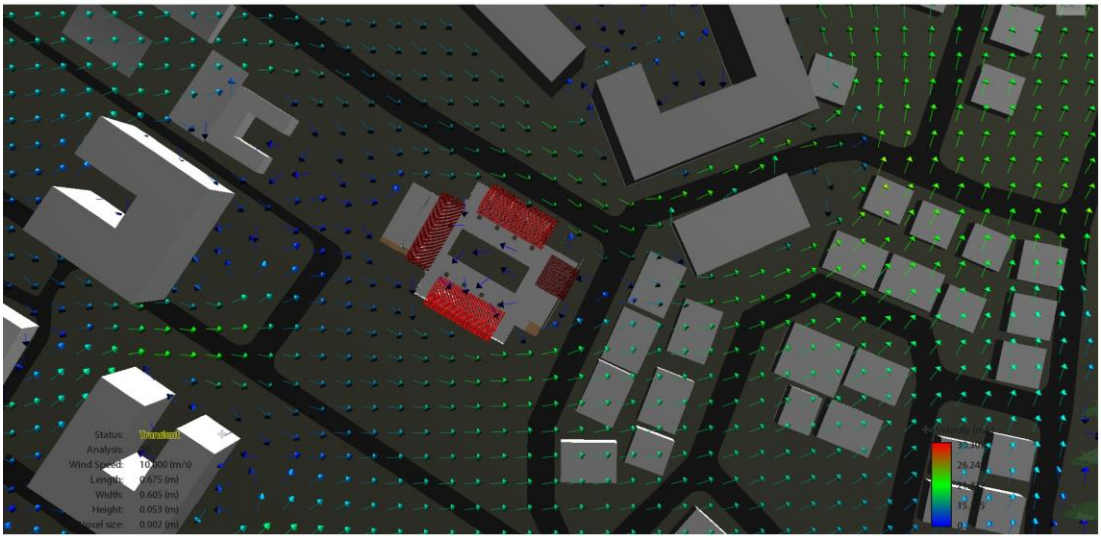
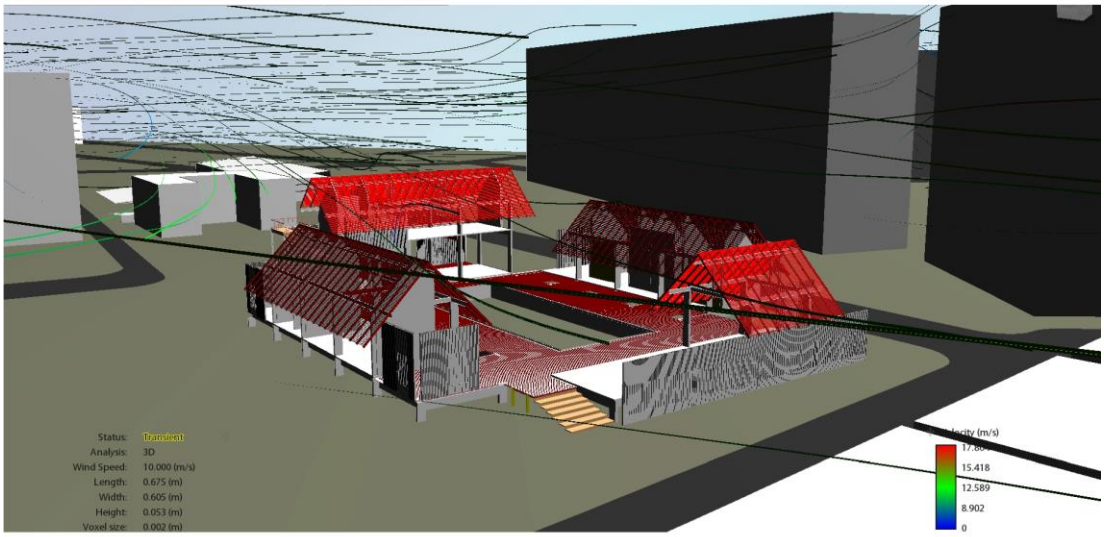


2

Figure 85. Wind analysis in plan view from top to below

1. Analysis of virtual wind flow, 2. Analysis of virtual wind direction, drawn by author.



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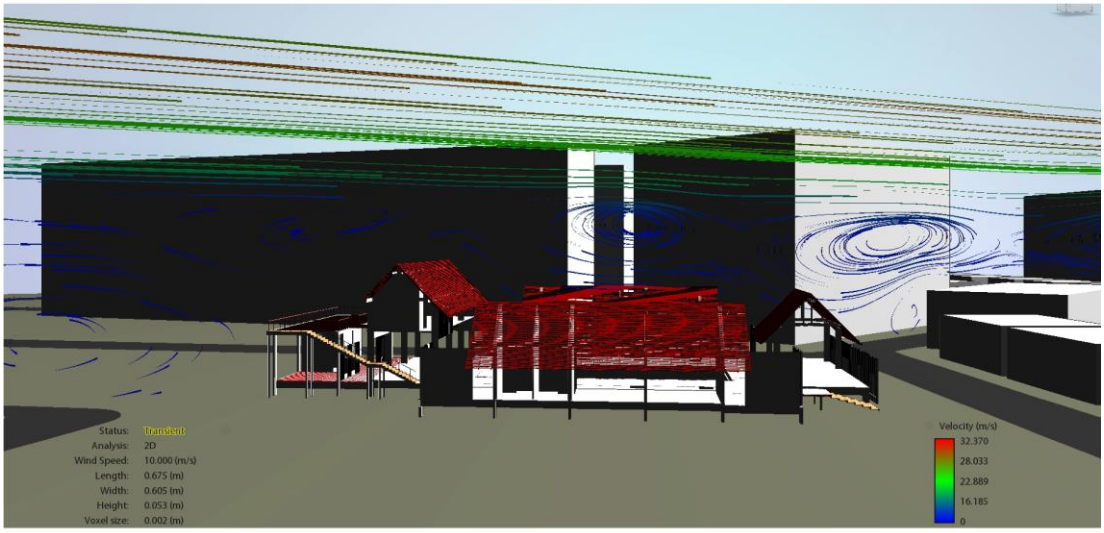

2

Figure 86. Wind analysis in 3D from top to below

1. Analysis of virtual wind flow around the site, 2. Analysis of virtual wind tunnel, drawn by author

Chapter 7: Conclusion

A discussion on BIOMIMICRY in architecture began in the United States, where the author had lived for 20 years. My intention is to contribute through the understanding of Thai culture back to such discussion. As a former engineer in United States Navy, the standard of living in industrial world exposes my curiosity. My attention is placed on the equipment design details taken from nature while observing, fixing and maintaining mechanical equipment. By saying “taken from nature”, it is mainly meant the geometrical structures that can be seen through the study of nature such as the hexagon. A honeycomb filter, worth multi-million dollars, helps distribute the heat exhaust from the system module to the design of turbine engine blades that can move in angles simultaneously, mimicking closing and opening of human skin for the air intake to provide compressed air before the ignition chamber. These observations are the beginning of the journey for the author to further study biomimicry, its function and its aesthetic, in architecture and its related field.

BIOMIMICRY, as a category, is often confused with the biomorphic architecture, which is not the author position to implement into the design process. The intention of this thesis is to use biomimicry in bioclimatic architecture, based mainly upon Jeffrey Bawa’s “bioclimatic” architecture, especially in terms of architectural space composition, geometrical proportion, circulation, materials and construction. Through conducted research in biomimicry in tropical region, the adaptation from the Tidewater region where the author came from in Virginia, United States brought an attempt to add architectural element name *fah lai* in Thai traditional house to biomimicry category in bioclimatic design. Whereas interpretation of the word biomimicry in Thai which translate to mimicking of life serve as general idea, however, the approach of understand the word biomimicry through author

interpretation in this thesis offering the element of Thai traditional house in building biomimicry; function and aesthetic of a vacation home in Chonburi.

In Chapter 2, “Literature Reviews and Case Studies”, the author has learned various interpretations of BIOMIMICRY, categorized by “form making” and “mimicking of function”. My interest is not in the category of form making. It rather tips towards mimicking of function and the way in which architectural spaces may be composed to emphasize the aesthetic. Basic understanding upon architectural composition, structure, material and construction is therefore required. This is how Geoffrey Bawa architectural drawings have the important role in Chapter 2. Three houses designed by Bawa are chosen because of the similarity of site dimensions in comparison to my selected site in Chonburi, the climate and environment factors, and most importantly, aesthetic in space composition. Lastly, in Chapter 2, the author studies the detailed element of *fah lai* “breathing walls” from real life, at Gasstonomy Café in Saladeng, Bangkok. The findings are:

1. Material, in this case, is rectangle based hollow aluminum structure. When the material is too light and too long, it tends to bend so the operation of the breathing wall is still insufficient. The author has measured the structure, bearing in mind that the structural framework of chosen material is important for the design. Material attributes must be studied beforehand, such as wood.
2. Forces in Structure. When the breathing wall panel has uneven distribution of loads, it bends and cannot be moved uniformly. So, the distribution of loads and forces in the structure is important.
3. The appearance of aluminum structure is cold. Those materials that are closer to nature, such as wood and stone, are perhaps more appropriate for “home” in a haptic sense.

All in all, the author presents another edition of fah lai in Chapter 4, Design Process, based on the above findings. Detailed designs follow the organisations of structure and architectural spaces within the site, so fah lai is categorized as a secondary wall whereas brick wall is the primary one.

“Design Process”, Chapter 4, is divided into 3 parts. The first part focuses on the study of 3-dimensional frameworks on 3 different houses designed by Geoffrey Bawa to find the space composition, and proportion in relation between inside and outside spaces. Analytical drawings, drawn by the author, are the studies of framework, circulation, taxonomy of proportion of the selected houses (Figure 28-34). The second part of the design process was to analyze the framework of each houses using taxonomy to find the axis of circulation and division of the spaces. With the redrawn of each floor plans by author to understand Geoffrey Bawa space composition in the study of frameworks. Lastly, the synthesis of drawing on the selected site through the analytical of previous drawing. The composition of circulation, columns, brick walls and wooden walls focuses on the approach from main road to building in hierarchy.

My intention is to add *fah lai* “breathing wall” into a discussion on biomimicry. This is a problem of language that exists in different culture and different time. The author learned that in these analytical drawing, human perception changes through the different spaces in the composition of the simulation on tangible, intangible elements such as natural lights, shades, shadows, and wind into 3-dimensional structure. Through the central point of this thesis that focus on biomimicry crossed culture between United States and Thailand, there may be other existing architectural elements out there that has yet to define as biomimicry due to their crossed culture study or simply the existence before such a time of the term itself.

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