

Final Architecture Design Studio

Design of Special Needs School with Bioclimatic Architecture Approaches in Yogyakarta to Optimize Sensory Quality for The Deaf Student

Perancangan Sekolah Luar Biasa dengan Pendekatan Arsitektur Bioklimatik di Yogyakarta untuk Mengoptimalkan Kualitas Sensori pada Siswa Tunarungu

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Yogyakarta untuk Mengoptimalkan Kualitas Sensori pada Siswa Tunarungu**
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Optimize Sensory Quality for The Deaf Student*

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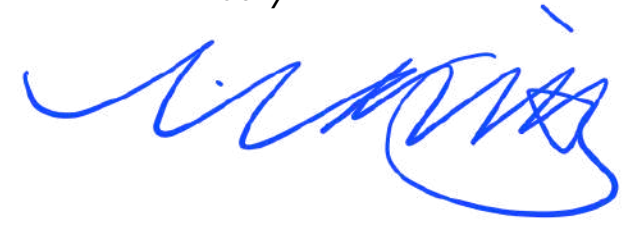
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Kualitas Sensori pada Siswa Tunarungu

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Statement of Authenticity

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I declare that this Final Architectural Design Studio Project is entirely my own work, not transfer of other people's writings or thoughts that I acknowledge as my own results or thoughts. As for any additional sources of information have been duly cited according to the norms and ethics in writing.

If later it is proven or can be proven that this final architectural design studio is completely plagiarized, I am willing to accept sanctions for such actions.

Yogyakarta, 22 Agustus 2024
Author,



Yushinta Latifa Aureliana

Foreword

Praise be to Allah SWT who has given His abundance of grace and gifts, as well as shalawat and greetings poured out to our lord the Prophet Muhammad SAW and his family and friends who have given syafa'at to his people, so that the author can complete this Architecture Design Final Studio (SADA) entitled **"Design of Special Needs School with Bioclimatic Architecture Approaches in Yogyakarta to Optimize Sensory Quality for the Deaf Student"**. The author realizes that in writing this bachelor's final project there are many obstacles and obstacles. However, not a few writers also get help, support, and input from various parties. So on this occasion, with all humility and respect, the author would like to thank:

1. Allah SWT for all His grace and mercy so that it is given ease in every process of compiling this final assignment.
2. My Beloved family, Narto (Father), Yuliyati (Mother), Bintang Ilham Pradipta (Brother), and all my other relatives for the prayer, affection, and moral support both materially and non-materially that are infinite.
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6. My beloved friends in college, Difa and Dian, who have been together through the twists and turns of the author's lectures and who always support and share stories, laughter, experiences until the end of college journey.
7. My best friends, Jilan, Farah, Syafira, Tyas, Ikrimah, Mutia and all of my friends that i cannot mention one by one, who have always provided endless support and passed the ups and downs with the author since high school.
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For all the dedication and assistance that has been given, hopefully it will be rewarded by Allah SWT. The author realizes that this design is far from perfect. However, the author hopes that the results of this Final Architecture Design Studio (SADA) design can be used as an increase in awareness of the waste issue that still exists and continues to this day. The author also hopes that the series of writings from this design can be useful and developed as a design approach in a similar context.

Yogyakarta, 22 Agustus 2024
Author,



Yushinta Latifa Aureliana

ABSTRACT

In designing a special needs school for deaf students, a bioclimatic architectural approach is the main basis for creating a sensory-optimized environment. The design integrates sustainable and environmentally friendly principles with the main goal of meeting the special sensory needs of deaf students. Through strategies such as the utilization of natural lighting, air circulation, and comfortable temperatures, this approach aims to provide adequate learning experiences and support students' sensory development.

This design is important because it provides a holistic and inclusive solution for deaf students. By focusing on sensory aspects, the design not only takes into account educational needs, but also emphasizes the overall learning experience. Through the use of bioclimatic architecture, the school plays a role in empowering deaf students to better interact with their surroundings, stimulate their senses, and facilitate a richer learning experience.

This design is significant because it attempts to address a number of issues faced by special schools, especially for deaf students:

1. Sensory Limitations: Deaf students face sensory limitations that require special attention in the design of the learning environment to ensure a stimulating and effective learning experience.
2. Optimization of Learning Experience: Through a bioclimatic architectural approach, this design aims to provide an adequate learning experience, stimulate all the senses, and facilitate a thorough understanding of the subject matter.

This design also has an impact on society, which is giving a community awareness. The design has a positive impact in raising public awareness of the importance of aligning the learning environment with the special needs of deaf students.

keyword: *Special needs school, deaf student, bioclimatic architecture*

ABSTRAK

Dalam merancang sekolah berkebutuhan khusus untuk siswa tuna rungu, pendekatan arsitektur bioklimatik menjadi dasar utama untuk menciptakan lingkungan yang dioptimalkan untuk indera. Desainnya mengintegrasikan prinsip-prinsip berkelanjutan dan ramah lingkungan dengan tujuan utama untuk memenuhi kebutuhan sensorik khusus siswa tuna rungu. Melalui strategi seperti pemanfaatan pencahayaan alami, sirkulasi udara, dan suhu yang nyaman, pendekatan ini bertujuan untuk memberikan pengalaman belajar yang memadai dan mendukung perkembangan indera siswa.

Desain ini penting karena memberikan solusi yang holistik dan inklusif bagi siswa tunarungu. Dengan berfokus pada aspek sensorik, desainnya tidak hanya mempertimbangkan kebutuhan pendidikan, tetapi juga menekankan pengalaman belajar secara keseluruhan. Melalui penggunaan arsitektur bioklimatik, sekolah ini berperan dalam memberdayakan siswa tunarungu untuk berinteraksi lebih baik dengan lingkungan mereka, merangsang indera mereka, dan memfasilitasi pengalaman belajar yang lebih kaya.

Desain ini sangat penting karena mencoba untuk mengatasi sejumlah masalah yang dihadapi oleh sekolah khusus, terutama untuk siswa tuna rungu:

- 1.Keterbatasan Sensorik: Siswa tunarungu menghadapi keterbatasan indera yang membutuhkan perhatian khusus dalam desain lingkungan belajar untuk memastikan pengalaman belajar yang menstimulasi dan efektif.
- 2.Optimalisasi Pengalaman Belajar: Melalui pendekatan arsitektur bioklimatik, desain ini bertujuan untuk memberikan pengalaman belajar yang memadai, menstimulasi semua indera, dan memfasilitasi pemahaman yang menyeluruh tentang materi pelajaran.

Desain ini juga memiliki dampak positif dalam meningkatkan kesadaran masyarakat akan pentingnya menyelaraskan lingkungan belajar dengan kebutuhan khusus siswa tunarungu.

keyword: Special needs school, deaf student, bioclimatic architecture

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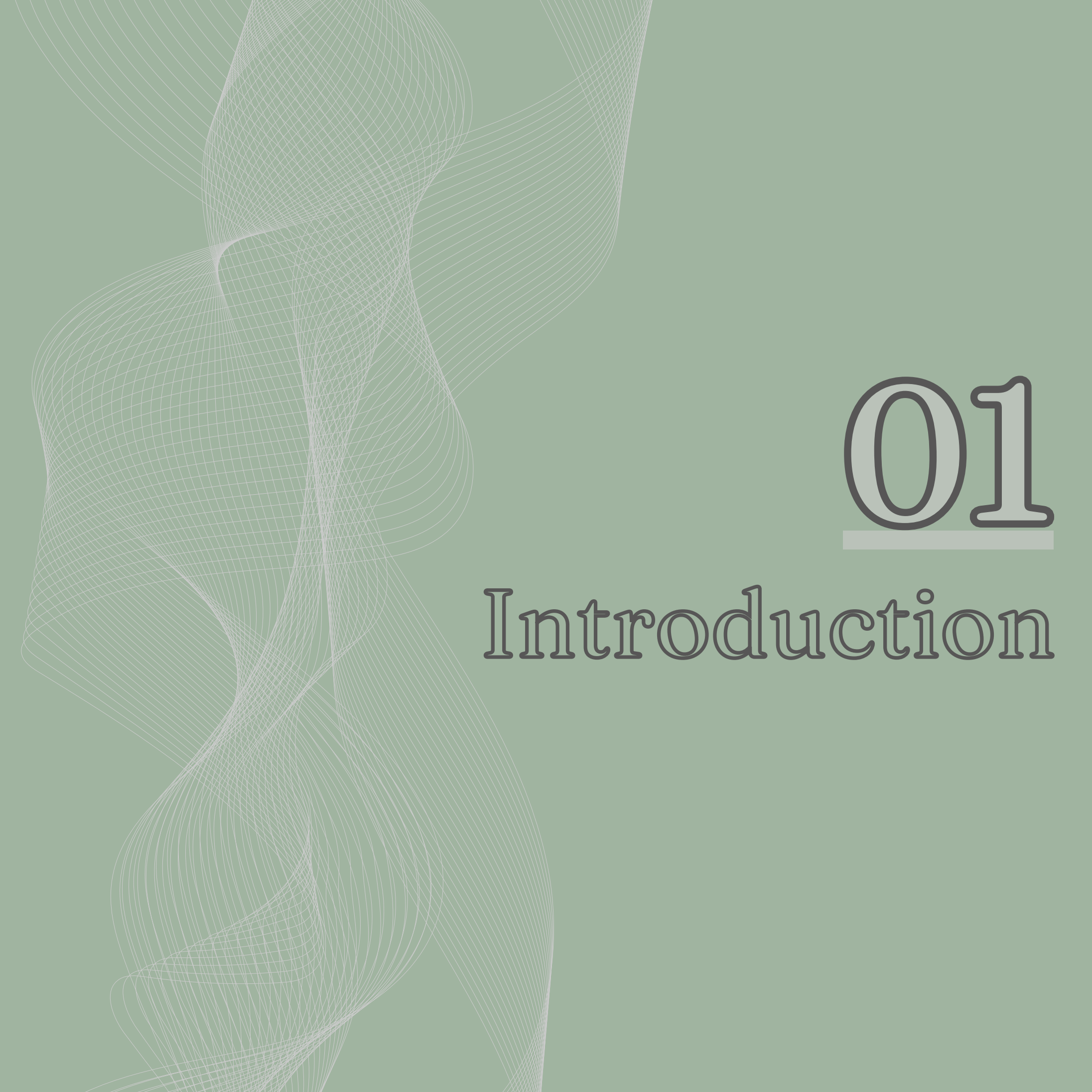
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01

Introduction

1.1 BACKGROUND

1.1.1 Deaf People

Deaf individuals, or those with hearing loss, make up a diverse group of characteristics in terms of their ability to hear and communicate. The degree of deafness can vary from mild hearing loss to total deafness. In general, there are three main levels of deafness: mild, moderate and profound. Mild deafness is when a person can't hear 30-40db of sound, while moderate deafness is when a person can't hear up to 40-60db. Severe deafness is when a person cannot hear sounds 60-80db (Ministry of Health, 2019).

Within the deaf community, there are several terms that are important to understand as they reflect distinctive identities, experiences and ways of communicating. These definitions illustrate how these words are used throughout the deaf community and in different fields (Hansel Bauman, 2010):



Figure 1.1 Deaf children using sign language
Source: Pinterest

- **Deafness** - describes the condition of reduced or total absence of hearing in a person whether significant or total. The term is used by the community as a cultural identity, not just to refer to a physical condition.
- **Deaf** - “Deaf” with a capital 'D'. Used to describe an individual or group of individuals for whom being deaf is central to cultural identity. Sign language is used as the primary language.
- **Hard of Hearing** - describes the condition of having a certain level of hearing often given to those who can hear and speak on the phone. People with mild to moderate hearing loss are often referred to as “hard of hearing.” The abbreviation of the term is HoH
- **Hearing Impaired** - describes someone with decreased or no hearing ability. The implication is that this condition is a barrier to one's social life and health.

It is widely regarded as an unacceptable term among members of the Deaf and Hard-Of-Hearing communities.

- **Deafened** - describes people who have lost the ability to hear during part of their lives sometimes from birth.
- **Oralist / Oralism** - Deaf/Deaf individuals who communicate by lip reading and/or listening with the help of technological devices. Primarily uses spoken language. Oralism is an educational philosophy that considers the acquisition of speech as the primary pedagogical goal.
- **Signers** - People who acquire and use sign language as a primary means of communication.
- **C.I. / Ciers** - Stands for Cochlear Implant. Individuals who use cochlear implants.
- **Hearing** - A term that describes people who hear and speak. Some hearing people acquire sign language and place themselves among the Deaf community socially and often by profession.

1.1.2 Deaf People and Special Needs School Facility in Yogyakarta

Deaf people, as a group with hearing disability and often speech impairment, often face some challenges that affect their daily lives. In Yogyakarta, as one of the cities with high cultural and social diversity, it is important to ensure that deaf people get enough attention and support to reach their full potential. It was noted that in 2022, there were 2,078 deaf and speech impaired people in Yogyakarta (BAPPEDA, 2023). This means that 7.7% of all people with disabilities in Yogyakarta are deaf, speech impaired, and deaf-speech impaired. **The small number of deaf people and the absence of specific physical characteristics that indicate their identity, causes many people to neglect to provide special facilities for them, especially in access to information and education.**

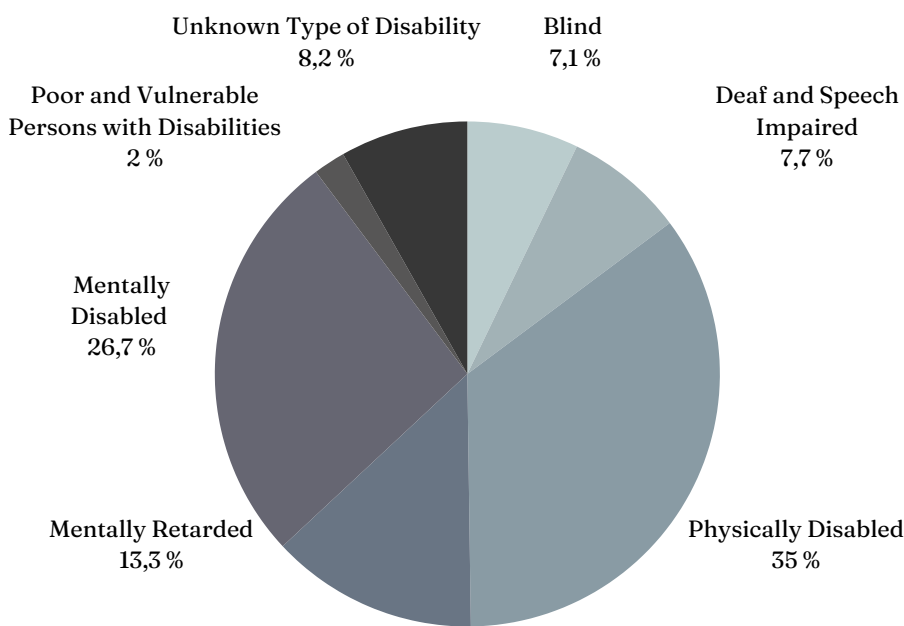


Diagram 1.1 Diagram of people with disabilities in Yogyakarta in 2022
Source: Author with data from bappeda.jogjaprov.go.id

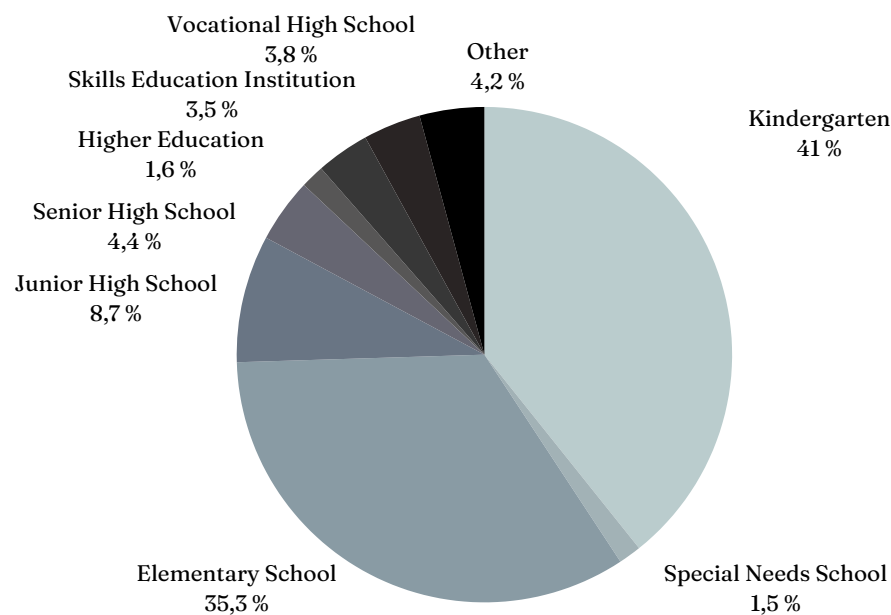


Diagram 1.2 Diagram of number of schools in Yogyakarta in 2023
Source: Author with data from bappeda.jogjaprov.go.id

Yogyakarta, which holds the title as a city of education, has various types of educational institutions from various levels of education. In 2023, there were 5,473 units of different educational institutions in the city. From that number, 81 of them are Special Needs Schools (SLB), including both public and private schools (BAPPEDA, 2023). The number of schools spread across 5 districts/cities includes the number of kindergartens, daycares, elementary schools, junior high schools, and high schools and classified according to the type of disability of the students.

Schools for the disabled-especially the deaf-have different standards from regular schools. Based on PERMENDIKNAS No. 33/2008, SLB for the deaf requires special learning spaces with certain standards. The special learning rooms needed in SLB B are the sound and rhythm perception room and the speech development room. In the sound and rhythm perception room, they are trained to develop "listening" skills by maximizing their remaining hearing ability and especially their sense of tactile to feel and respond to vibrations from various sound sources. While the speech development room functions to develop communication skills through lip reading and facial expressions. This makes deaf people rely heavily on visual communication that requires sufficient lighting and does not cause distraction in the form of glare, backlight, direct sunlight, etc (Hansel Bauman, 2010). This is because these forms of light can interfere with them in understanding sign language and lip reading their interlocutors. Therefore, good lighting is one aspect in helping them communicate. However, lighting is only a supporting aspect of their special needs, which is their special needs and most importantly is the need for a space with good sensory quality, especially visual quality.

Many facilities related to information and education are still only in audio form, which is a challenge for deaf people to access. Although they have hearing impairments, it does not mean they cannot access information from their surroundings. According to Heimler et al., the auditory cortex - the part of the brain responsible for hearing - in deaf people can participate in processing other senses, which means the deaf person's other senses can function as well or even better.

In deaf people, the auditory cortex is activated when performing visual tasks such as seeing movement (Shiell et al., 2016), detecting change (Bottari et al., 2014), and peripheral vision (Bavilier & Naville, 2002). **As well as increased visual ability, deaf people can also process vibrotactile,** which is the perception of vibration through touch (Karns et al., n.d.). Therefore, deaf people really need special facilities that they can sense, both visually and tactilely.

1.1.3 Bioclimatic architecture as design approach

Bioclimatic architecture is a building design approach that takes into account local climate and environmental conditions to create comfortable and energy-efficient buildings. It uses natural elements, such as sunlight, wind, temperature and humidity, to improve thermal comfort and reduce reliance on artificial heating, cooling and lighting systems. The main principle of bioclimatic architecture is to maximize energy efficiency and sustainability through design that is compatible with the natural environment.

Basically, the term “bioclimatic” according to Hyde (2008) and Olgyay (1963) relates to the relationship between climate and living organisms or the study of bioclimatology, which combines the fields of biology, climatology and architecture. In the context of buildings, especially houses, it involves the relationship between three main factors: living organisms, climate, and building forms and materials (retrieved from Handoko & Ikaputra, 2019).

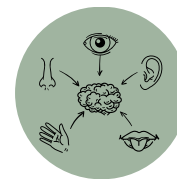
Bioclimatics is the science that examines the relationship between climate and life, especially the impact of climate on health and daily activities. Ken Yeang (1994) some important reasons for applying bioclimatics in design, namely: reduction of energy consumption in building operation, the desire to experience the external climate typical of a place, and concern for the ecological environment (retrieved from Handoko & Ikaputra, 2019). Related to this. Almusaed (2011), states that bioclimatic architecture incorporates sustainability, green, natural, organic environmental awareness, and responds to land characteristics, environmental context, local microclimate, and topography.

According to Karyano (1996), a work of architecture must achieve one of the main objectives, namely that the building must be able to provide comfort, both psychologically and physically, to its occupants (retrieved from Handoko & Ikaputra, 2019). Comfort in architecture includes two main aspects.



Psychic Comfort

This comfort is related to beliefs, religion, customs, and other personal aspects. It is qualitative in nature and cannot be measured quantitatively.



Physical Comfort:

Physical comfort is more universal and can be measured quantitatively. This includes spatial comfort, visual comfort, audio comfort, and thermal comfort.

Diagram 1.3 Comfort in architecture
Source: Author with data from Handoko & Ikaputra, 2019

Through this explanation of the bioclimatic architectural approach, the bioclimatic concept can be applied to this project of a special needs school for the deaf. This is because this concept provides closeness to the surrounding environment which can provide both psychological and physical comfort. This closeness to the environment is what deaf students need, because they can train their other four senses to recognize the surrounding environment. In addition, maximizing elements of the local climate can help facilitate their learning process, such as maximizing natural lighting to improve visual quality.

1.2 PROBLEM STATEMENT AND OBJECTIVE

))) General Problem Statement

From the above background, building design with a bioclimatic concept is needed to improve the sensory quality of deaf students. There are many important aspects needed to improve sensory quality. However, the sensory quality needed, especially visual quality which tends to have an open and wide range, must face the challenges of the tropical climate in the form of rain and the sun's heat. For this reason, it is important to design a special needs school for deaf students with a bioclimatic architectural approach in order to meet the needs of the students and respond to the challenges of the tropical climate.

))) Specific Problem Statement

How to apply a bioclimatic architectural approach to buildings to maximize the sensory quality of deaf students.

))) Objective

The purpose of the design of this special school for the deaf is to provide educational facilities by paying attention to the character of the deaf and can also improve the sensory abilities of deaf children by applying a bioclimatic architectural approach.

))) Design Limitation

In addition to providing special education facilities for the deaf, this facility will have an additional function as a place of learning for the public. This is because this facility is open to people who may not have access to special education for the deaf or for hearing people who want to learn about the Deaf world. In order not to interfere with the main learning activities, the public facilities will only be conducted during the weekend. During the weekend, these additional facilities can be used for other purposes at school such as meeting rooms and so on.

))) The Users



Primary user
Deaf student



Secondary user
Teacher and staff



Third user
Guest (public learner, student's parents, etc)

Diagram 1.4 The users of the facility
Source: Author, 2024

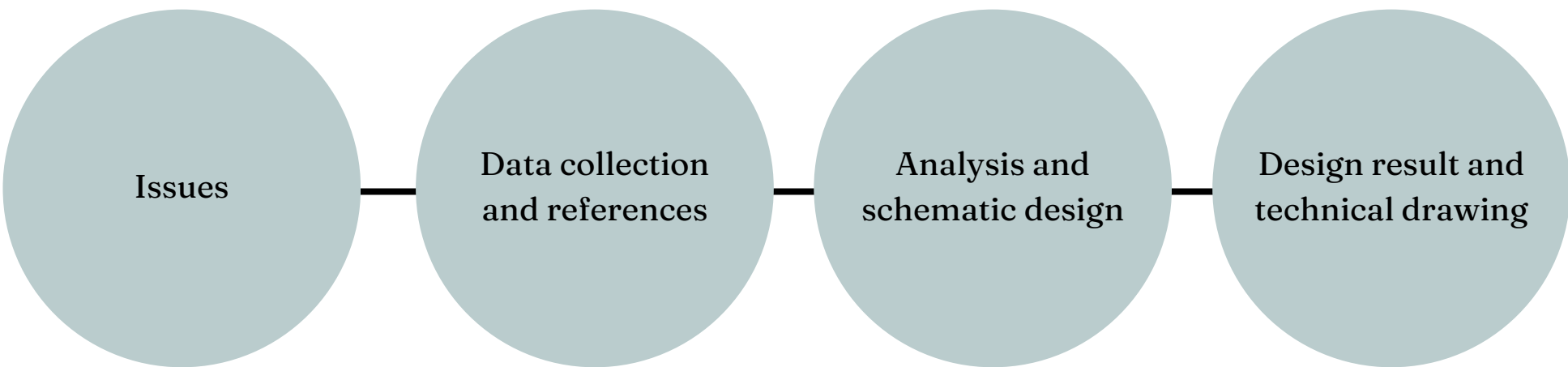


Diagram 1.5 The method
Source: Author, 2024

Issue	Data collection and reference	Analysis and schematic design	Design result and technical drawing
lack of special facility for deaf that pay attention to their character especially in education facility.	in depth research about the special need of deaf students, how to improve their sensory skill, and bioclimatic architecture. Data and studies were obtained through literature studies as well as interviews and direct observation to one of the deaf special education facilities in Yogyakarta.	using velux to simulate the building performance. In addition, a cheklist table created based on the literature study was also added to check aspects that cannot be simulated by Velux.	Design results that have gone through simulation and finalized are drawn in the form of technical drawings.

1.4 FRAMEWORK OF THINKING

Background

Yogyakarta, a city of education, has many deaf people, but still has few facilities to support them. The lack of facilities that emphasize the character of the deaf makes it difficult for the deaf to access information and education. Therefore, the design of a special school needs to emphasize the character of the deaf who rely on other senses besides hearing, which is mainly on the visual sense.

Architectural

- Many visual openings were needed, but had to deal with rain and heat

Non-Architectural

- deaf students' abilities

Method

Software simulation using Velux and checklist table

Approach

Architecture Bioclimatic

General Problem Formulation

design a special needs school for deaf students with a bioclimatic architectural approach in order to meet the needs of the students and respond to the challenges of the tropical climate.

Specific Problem Formulation

How to apply a bioclimatic architectural approach to buildings to maximize the sensory quality of deaf students.

Site Context

Special Needs School

Typology

Special Needs School

Precedent

- Lovell International School
- Deyang School for Deaf & Intellectually Disabled Children

Lighting Thermal comfort Building Orientation & layout Material Landscape Building performance Sensory Quality

Design Concept

Schematic Design

Design Test

Final Design

Diagram 1.1 The framework of thinking
Source: Author, 2024

1.5 EXCELLENCY, ORIGINALITY, AND NOVELTY

Author, year	Title	Approach	Location	Differentiate
Partina Ayu Damayanti, 2015	Sekolah Dasar Luar Biasa (SDLB) di Kota Semarang dengan Penekanan Desain Universal	Desain Universal	Semarang	Using approach that focuses on the influence of spatial forms that can be accessed by deaf or non-deaf students
Yumna Rana Naurah, 2023	Perancangan Sekolah Kebutuhan Khusus Penyandang Tunaganda Yayasan Sayap Ibu dengan Pendekatan Arsitektur Bioklimatik di Tangerang Selatan, Banten	Arsitektur bioklimatik	Tangerang Selatan, Banten	• Special Needs School for multi-disabled • Focuses on reducing energy loading
Yushinta Latifa Aureliana, 2024	Design of Special Needs School with Bioclimatic Architecture Approaches in Yogyakarta to Optimize Sensory Quality for the Deaf Student	Bioclimatic architecture	Sleman, Yogyakarta	• Special Needs Schhol only for deaf • Focus on improving the sensory quality of the deaf student using bioclimatic architecture principles

Table 1.1 The originality and novelty of the design
Source: Author, 2024

Similar design has previously been carried out by Damayanti in 2015. This design also focuses on designing a special school by considering the character of deaf children. However, the approach used is a universal design approach that focuses on the influence of spatial forms that can be accessed by deaf or non-deaf students. While the approach used in this design is a bioclimatic architecture approach that focuses on the performance of buildings that use a bioclimatic architecture approach in improving the sensory quality of deaf children.

Another research and design was conducted by Naurah (2023) who designed a school for the multi disabled student with a bioclimatic approach. Because what is designed is a school building for students with multiple disabilities, the specifications and building standards are more, while this design only focuses on designing schools for deaf children. Although both use a bioclimatic architecture approach, Naurah focuses on reducing energy loading, while this design focuses on improving the sensory quality of children.

From the previous designs, there is a gap that this design emphasizes on optimizing the sensory quality of deaf children by applying a bioclimatic architectural approach that encourages the sensory supporting aspects of deaf children.



02

Design Study &
Site Analysis

2.1 BUILDING QUANTITY AND QUALITY

2.1.1 Building Quantity

To solve the problem of the need for educational facilities for deaf children, this project aims to design special educational facilities for deaf children based on the characteristics and needs of the deaf. By paying attention to these things, it will make it easier for them to learn and communicate by optimizing their sensory abilities. Besides functioning as a special needs school for the deaf, this facility also provides a learning center for the public who want to know more about the world of deafness, especially learning about communicating with deaf people. **Thus, this educational facility has two functions in the form of special education for deaf children and also a learning center for the general public as hearing people or deaf.**

This educational facility is located in Condongcatur Sub-district, Depok District, Sleman Regency, Yogyakarta, so this facility can at least accommodate most deaf children on a **Sleman Regency scale**. Although on a regency scale, this facility is not a government-run school, but is **managed by the foundation** while still paying attention to the standards of the Ministry of Education as well as the need for school capacity in Sleman Regency. According to data from the Yogyakarta Education, Youth and Sport Affairs in 2023/2024 regarding the number of deaf students in Sleman Regency, there are 20 students at the kindergarten level and 150 students at the elementary school level. Therefore, this facility is designed to accommodate more than half of the deaf students in Sleman to prepare for an increase in the number of students in future years. As a basis of comparison to determine the amount of school capacity, one of the special needs schools in Condongcatur, SLB B Karnnamanohara, has a total enrollment of 88 students from kindergarten and elementary school levels with 24 teachers and employees. **Therefore, this project will have the same capacity as SDLB B Karnnamanohara, but with more adequate and complete facilities.**

2.1.2 Building Quality (Special Needs School Building Classification in Indonesia)

Special needs schools (SLB) are formal education institutions that provide education for children with special needs. Therefore, SLB has its own types based on the special needs of its students. According to Pratiwi and Murtiningsih (2016), there are several types of special schools as follows:

- **Group A (For visual impairments)** -> Visually impaired are individuals who have low vision or visual accuracy of less than 6/60.
- **Group B (For deaf and hard of hearing)** -> Deaf and hard of hearing are those with hearing and speech difficulties with varying degrees of hearing loss.
- **Group C (For Intellectual disabled)** -> Individuals who have below average intelligence (usually IQ scores below 70), have problems in adaptive behavior, so have difficulty in completing tasks in daily life.
- **Group D (For physical/mobility impairments)** -> Individuals who experience body defects, incomplete limbs, abnormal limb and spine shapes, limited joint movement abilities, and obstacles in carrying out daily life activities.
- **Group E (For emotional and behavioral disorders)** -> Individuals who experience obstacles in controlling emotions and social control.
- **Group F (For speech impairments)** -> Individual who has difficulty speaking due to the malfunction of organs such as the oral cavity, tongue, palate and vocal cords.
- **Group G (For multiple Disabilities)** -> Individuals who have a combination of disabilities (either two or more types of disabilities) that cause serious educational problems, so they cannot only be treated with a special education program for one disorder.
- **Group H (for who stay with HIV & AIDS)** -> Individuals who stay with HIV & AIDS are not due to promiscuity alone, but it could be because their parents stayed with this disease first.
- **Group I (For gifted individuals)** -> Individuals who are classified as potentially having intelligence above the average child in general, have intelligence above (IQ more than 125).
- **Group J (For talented individuals)** -> Individuals who potentially have special talents, usually only have one special talent such as Multiple Intelligences Language, Logicomathematic, Visuo-spatial, Bodily-kinesthetic, Musical, Interpersonal, Natural Spiritual.
- **Group K (For learning difficulty)** -> Individuals who are classified as Hyperactive, ADD/ADHD, Dyslexia (Reading difficulty), Dysgraphia (Writing difficulty), Dyscalculia (Calculating difficulty), Dysphasia (Speech difficulty), Dyspraxia (Motor difficulty), so that they have difficulty in learning at school or in a social environment.
- **Group L (For slow Learners)** -> Individuals who are classified as having IQ = 70 to 90 so that they experience a slow process in understanding or capturing lessons.
- **Group M (For autistic)** -> A disorder of nervous system development in a person experienced since birth or during toddlerhood, which affects behavior with the result of lack of communication skills, social and emotional relationships with others.
- **Group N (For victims of drug abusiveness)** -> Individuals who experience depression, personal problems or because of surrounding factors that encourage them to use drugs, so they are forced to be rehabilitated to restore mental and health conditions.
- **Group O (For indigo)** -> Indigo is a term used to describe individuals who are believed to have special, unusual and even supernatural abilities or traits.

Of the 15 types of special schools above, Indonesia already has six types of special schools, namely special schools for the blind, deaf and speech impaired, disabled, Intellectual disabled, and emotional and behavioral disabled children (Nasution et al., 2022). Although it has different types of special needs, special needs schools still have the same level of education as regular schools, starting from elementary school, junior high school and senior high school. Since the schools serve special education, each level of education has the additional word “luar biasa/special needs” to differentiate it from regular schools, thus becoming Special Needs Elementary School/Sekolah Dasar Luar Biasa (SDLB), Special Needs Junior High School/Sekolah Menengah Pertama Luar Biasa (SMPLB), and Special Needs Senior High School/Sekolah Menengah Atas Luar Biasa (SMALB). In addition to these levels of education, there are also early education programs such as pre-schools and kindergartens that provide special education.

Of all those stages of education, initial and elementary education are the most crucial for deaf children. This is because these are the stages where they build the foundations of language and communication, basic academic skills (reading, writing, and math), and social and self-regulation skills (EVERYTHING You Need to Know About Schooling For a Deaf or Hard of Hearing Child, n.d.). Because this early and basic education is equally crucial and has the same needs and focus, which is to develop the communication and learning skills of deaf children, these two levels of education are often brought together in one school. In contrast, SMPLB and SMALB focus on deepening certain knowledge and have more complex spatial needs such as computer and science laboratories, so they are sometimes separated from the initial education and SDLB. **Therefore, this project will focus on creating a school environment that includes initial education and SDLB for deaf children (type B).**

2.1.3 Building Quality (Elementary Special Needs School Type B Typology)

Based on the Regulation of the Minister of National Education of the Republic of Indonesia (PERMENDIKNAS) Number 33 of 2008, there are several rules that must be adhered to regarding special needs schools.

No	Banyak rombongan belajar	Jenis ketunaan	Luas lahan minimum (m ²)	
			Bangunan satu lantai	Bangunan dua lantai
1	6	1	1170	640
2	12	1 - 2	1700	900
3	18	1 - 3	2200	1150
4	24	1 - 4	2670	1390

Table 2.1 Minimum site area
Source: PERMENDIKNAS, 2008

As shown in Figure 2.13, which explains the minimum land area for SDLB, the land area for this project is 1,500 sqm, which can accommodate up to 12 study groups with 1-2 disabilities using a two-story building. The land area in the table above is the effective land area that can be used to construct buildings and playgrounds. The land should be located in a location that allows easy access to health facilities; should be free from water, air and noise pollution; and be accessible for emergency rescue by four-wheel drive.

No	Banyak rombongan belajar	Jenis ketunaan	Luas lantai bangunan minimum (m ²)	
			Bangunan satu lantai	Bangunan dua lantai
1	6	1	350	380
2	12	1 - 2	510	540
3	18	1 - 3	660	690
4	24	1 - 4	800	830

Table 2.2 Minimum building area
Source: PERMENDIKNAS, 2008

Besides the minimum land area, there is also a regulation regarding the minimum building area as shown in figure 2.14 For 12 study groups, with 1-2 disabilities, the minimum building area is 510 sqm for a one-storey building, and 540 sqm for a 2-storey building. Buildings must provide facilities and accessibility that are easy, safe and comfortable for people with disabilities who have mobility difficulties including wheelchair users as well as the provision of guiding blocks.

Tabel 9 Kelengkapan Sarana dan Prasarana SDLB, SMPLB dan SMALB

	Komponen Sarana dan Prasarana	SDLB					SMPLB					SMALB				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1	Ruang pembelajaran umum															
1.1	Ruang kelas	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
1.2	Ruang perpustakaan*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	Ruang pembelajaran khusus															
2.1	Ruang OM**	√					√									
2.2	Ruang BKPBI:															
2.2.1	Ruang Bina Wicara**		√					√								
2.2.2	Ruang Bina Persepsi Bunyi dan Irama**		√					√								
2.3	Ruang Bina Diri**			√					√							
2.4	Ruang Bina Diri dan Bina Gerak**				√					√						
2.5	Ruang Bina Pribadi dan Sosial**					√					√					
2.6	Ruang keterampilan*						√	√	√	√	√	√	√	√	√	√
3	Ruang penunjang															
3.1	Ruang pimpinan*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.2	Ruang guru*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.3	Ruang tata usaha*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.4	Tempat beribadah*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.5	Ruang UKS*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.6	Ruang konseling/ asesmen*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.7	Ruang organisasi kesiswaan*						√	√	√	√	√	√	√	√	√	√
3.8	Jamban*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.9	Gudang*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.10	Ruang sirkulasi*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.11	Tempat bermain/ berolahraga*	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Table 2.3 Special room needed
Source: PERMENDIKNAS, 2008

The facilities required by type B SDLB according to the table above and their functions are:

- **General learning room specs**
 - **Classroom:** The function of the classroom is a place for theoretical and practical learning activities with simple tools that are easy to present.

- **Library:** functions as a place for students, teachers and parents to obtain information from various types of library materials by reading, observing and listening, as well as a place for officers to manage the library.
- **Special learning room**
 - **Special learning room (Sound and Rhythm Perception Development Room (BKPBI)):** a room for training to develop the ability to utilize residual hearing and/or vibrational feelings to appreciate the surrounding sound and vibration stimuli, and develop language skills, especially rhythm language for deaf learners.
 - **Special learning room (Speech Development Room):** serves for individual speech training for deaf learners.
- **Supporting room**
 - **Headmaster's room:** serves as a place to conduct SDLB management activities, meetings with a small number of teachers, parents, school committee members, education office staff, or other guests.
 - **Teacher's room:** serves as a place where teachers work and rest and receive guests, both learners and other guests.
 - **Administration room:** serves as a place for staff to work on SDLB administration.
 - **Prayer Room:** serves as a place for SDLB residents to worship as required by their respective religions during school hours.
 - **School Health Unit Room (UKS):** serves as a place for early treatment of students who experience health problems at SDLB.
 - **Counseling/assessment room:** serves as a place for students to get counseling services from counselors related to personal, social, learning, and career development, and serves as a place for activities in exploring data on the initial abilities of students as the basis for further educational services.
- **Toilet:** serves as a place to defecate and/or urinate.
- **Warehouse:** serves as a place to store learning equipment outside the classroom, a place to temporarily store SDLB equipment that is not yet functioning, and a place to store archives that are more than 5 years old.
- **Circulation area:** serves as a place to connect between rooms in the SDLB building and as a place for play activities and social interaction of students outside of class hours, especially during rainy days when it is not possible for these activities to take place in the SDLB courtyard.
- **Playground/sports area:** serves as an area for playing, exercising, physical education, ceremonies, extracurricular activities, as well as a place to train the sensoria of deaf children.
- **Additional room**
 - **Learning room for public:** A room used for the public to learn more about the world of deafness, such as sign language learning. The audience can be either deaf or hearing individuals.
 - **Indoor exercise area:** A large room that can accommodate the most of school population. This large room can be used for indoor physical training so it requires a lot of mirrors, so deaf students can follow the physical movements easily. It can also be used as a multi-purpose room, such as when there are school events.
 - **Sensory room:** A room to stimulate the senses of deaf children. This room is filled with fun stimuli, so the child will learn as well as play.
 - **Sensory garden:** A garden that stimulates all five senses, thus increasing deaf students' sensitivity to their surroundings.

The following table is the specification of each room needed and its application based on the needs of the school.

Room	Component	Specification	Application
Classroom	Size	• The minimum number of classes is equal to the number of study groups (PERMENDIKNAS, 2008).	• As the school is a combination of kindergarten and elementary school, it has a total of 9 grades (3 grades for kindergarten and 6 grades for elementary school) and each grade is considered to be one study group. However, due to the demands of the number of students, 3 additional classes will be added to the elementary school level, resulting in a total of 12 classes.
		• The minimum ratio of classroom area for one student is 3 m2/student (PERMENDIKNAS, 2008).	• If this ratio is followed, the classroom area will be 24 m2-30 m2 for a capacity of 8-10 children.
		• Minimum width of a classroom is 3 m (PERMENDIKNAS, 2008).	
	Capacity	• The maximum capacity of students in one special needs elementary school class is 5 students (PERMENDIKNAS, 2008).	• If we look at the number of students in SLB B Karnnamanohara which is 84 students, if we follow this standard then 16 classes will be needed which will be too many classes. Furthermore, the school to be designed will have a capacity of 100 people, so 20 classes will be needed, which will be too many and the number of teachers will be insufficient. Therefore, for this school, one class will have a capacity of 8-10 students, so only 12 classes can be used.
	Acoustics	• Maximum noise of 40dB (Martinz & Gaudiot, 2012)	• Use of floor finishes such as vinyl or wood to allow for reverberation and to help with the acoustics (Martinz & Gaudiot, 2012). • The use of acoustic ceiling materials (Martinz & Gaudiot, 2012). • Use acoustic wall panels to avoid sound reflecting back to deaf students (Marzouk et al., 2024). • Flat walls and ceiling to avoid echoing and noise reflections on deaf students (Marzouk et al., 2024).

Room	Component	Specification	Application
	Lighting	• A light intensity of 300–500 lux (Marzouk et al., 2024). • The light must not cause distraction in the form of glare, backlight, direct sunlight, and so on (Hansel Bauman, 2010).	• Windows covering 30% of the total room area with external sunscreen as slat or roller sunscreen (Marzouk et al., 2024). • Avoid sun glare on whiteboards and classrooms with curtains or brise soleil outside (Martinz & Gaudiot, 2012).
	Material	• Anti slippery materials for floor (Marzouk et al., 2024). • Use of light colors on the walls (Martinz & Gaudiot, 2012).	• Such as rugs, vinyl, carpets, foam mats that must strike a balance between having some patterning and not being overly light in color (simple cleaning and a reduction in markings showing), as well as in relaxing colors and patterns for kids with severe sensory difficulties (Marzouk et al., 2024). • Avoid warm colors rather use cool colors for furniture and walls, because that gives a sense of eye comfort, stimulate their wish to learn and engage in the room activities, reducing visual strain and improving focus. Use matte rather than gloss paint on walls to reduce glare (Marzouk et al., 2024).
	Door, Window, and ventilation	• Access door with a minimum width of 36 inches (91.44 cm) (Martinz & Gaudiot, 2012). • Classrooms are naturally ventilated	• The doors use vision lights to see who is coming or going to class and are made of acoustic materials to avoid corridor noise (Martinz & Gaudiot, 2012). • Offering openable windows or openings each with width of 1.0 m–1.5 m. Windows openable surface is approximately 10 % of the gross surface.
	Layout & Furniture	• Placement of furnitures (Martinz & Gaudiot, 2012)	• The placement of furniture such as tables and chairs are separated to prevent the fall of materials during sign language use (Martinz & Gaudiot, 2012).

Room	Component	Specification	Application
		Sitting layout	- The layout in u-shape therefore makes it easy to capture information and is very visibility, comfortable, independent for deaf students (Harahap et al., 2020). - Raked seating for larger numbers of students (Martinz & Gaudiot, 2012).
		Furnitures	- Implement a color signal system above the whiteboard with buttons located near the teacher's desk to indicate attention, danger, break, end of class, and more (Martinz & Gaudiot, 2012). - Ensure that the whiteboard is sufficiently large to maintain readability and writability for deaf students (Martinz & Gaudiot, 2012).
Library	Size	- The minimum area of a library is 30 m² - The minimum width is 5 m (Martinz & Gaudiot, 2012).	The minimum space requirement is 9m² + 0.05m² for each primary school student. 10% of the school population or the entire class, whichever is greater, should be able to sit in the library at any one time (Millar, 2021).
	Lighting	Minimum light of 350 lux (Badan Standarisasi Nasional, 2020)	- It is equipped with windows to provide adequate lighting for reading books (Martinz & Gaudiot, 2012). 20% to 50% of the wall space should be kept clear to stimulate students' attention without becoming chaotic (Millar, 2021).
	Access	The library is located in an easily accessible area of the school (Martinz & Gaudiot, 2012).	
Sound and Rhythm Perception Development Room (BKPBI)	Size	Have a minimum of one BKPBI room with a minimum area of 30 m² (PERMENDIKNAS, 2008).	As there are two stages of the educational program in this project, thus there will be two BKPBI rooms.

Room	Component	Specification	Application
	Material	• Noise control	• Use of floor finishes such as vinyl or wood to allow for reverberation and to help with the acoustics (Martinz & Gaudiot, 2012). • Use acoustic panel for wall and ceiling.
	Furnitures	• There are special equipments that help to enhance the sense of hearing (PERMENDIKNAS, 2008).	• Special equipment includes: Mirror, sound system, sound level meter, keyboard, hit instruments, wind instruments, vibrating stage (4 m2 stage with a height of 30 cm, strong and supportive of learners' movements), and hearing aids (PERMENDIKNAS, 2008).
Speech Development Room	Size	• At least one Speech Development Room with a minimum area of 4 m2 (PERMENDIKNAS, 2008).	• As there are two stages of the educational program in this project, thus there will be two speech development rooms.
	Furnitures	• There are special equipments that help to enhance the communication skill (PERMENDIKNAS, 2008).	• Special equipment includes: Speech trainer, Recorder, mirror, nasalizer, vibrating brush, breathing exercises, speech organ exercises, spatulas, tuning forks, pictures of articulation organs, consonant and vowel charts, identification cards, training program book. (PERMENDIKNAS, 2008).
Headmaster's Room	Size	• The minimum area of the leader room is 12 m2 and the minimum width is 3 m (PERMENDIKNAS, 2008).	
	Access	• Easily accessible to teachers and school guests (PERMENDIKNAS, 2008) .	

Room	Component	Specification	Application
Teacher's Room	Size	The ratio of teacher's room is 4m²/teacher with a minimum area of 32 m² (PERMENDIKNAS, 2008).	
	Access	Easily accessible from the school yard or from outside of the school environment, and close to the headmaster's room. (PERMENDIKNAS, 2008).	
Administration room	Size and access	The minimum ratio of area per staff is 4m² with a minimum room area of 16 m² and the room should easily accessible (PERMENDIKNAS, 2008).	
Prayer Room	Type of prayer room and size	The number of places of worship depends on the needs of each school (PERMENDIKNAS, 2008).	The school is a public school, so it needs to provide a worship space for students of all six recognized religions in Indonesia. However, since the school operating hours are only until the afternoon, the worship space provided is for religions that perform religious rituals between school operating hours. Such as for Muslims who need to perform dhuhur and asr prayers; Hindus who have madyana savanam worship at midday; Christians and Catholics who have Tertia worship, worship before midday and Sextia, the midday worship. As for the Confucianists who have morning and night worship, and the Buddhist that there is no fixed time for meditation or prayer, it does not need to be added.
	Size	The minimum area is 12 m² (PERMENDIKNAS, 2008).	

Room	Component	Specification	Application
School Health Unit Room (UKS)	Size	The minimum area is 12 m2 (PERMENDIKNAS, 2008).	
Counseling/assessment room	Size	The minimum area is 9 m2 (PERMENDIKNAS, 2008).	
	Comfort	Can provide a comfortable atmosphere and ensure student privacy (PERMENDIKNAS, 2008).	To provide comfort and privacy for deaf students, it can be achieved by the application of wall colors, lighting, and acoustic controls, such as those that will be applied in the classroom.
Toilet	Size	Minimum of 2 toilets with the minimum size per unit is 2 m2 (PERMENDIKNAS, 2008).	
	Equipment	Equipped with equipments that makes it easier for students with special needs to use the toilet (PERMENDIKNAS, 2008).	
Werehouse	Size	The minmum size is 18 m2 (PERMENDIKNAS, 2008).	
Circulation area	Detail specs	Corridor	- Connecting each room in the school with a minimum area of 30% of the total building area. - The minimum width is 1.8 m and the minimum height is 2.5 m. - Corridors without walls on upper floors should have safety railings with a height of 90-110 cm.

Room	Component	Specification	Application
		Stairs and ramp	- The farthest distance to reach the stairs in a multi-storey building is 25 m. - The minimum width of the stairs is 1.5 m, the maximum height of the steps is 17 cm, the width of the steps is 25-30 cm and it is equipped with a sturdy handrail with a height of 85-90 cm. - Stairs that have more than 16 steps must be equipped with borders with a minimum width equal to the width of the stairs. - Multi-storey buildings with a length of more than 30 m have a minimum of 2 stairs. - The slope of the ramp is no steeper than 1:12.
		Equipped with good lighting and air circulation	
Playground /sports area	Size	Minimum size of 20 m x 10 m (PERMENDIKNAS, 2008).	- Has a flat surface, good drainage, and no trees, drains, and other objects that interfere with exercise activities. - Some area of land outside the playground is planted with trees that serve as shade. - The playground does not interfere with the learning process in the classroom. - It is not used as a parking lot.
Learning room for public	Capacity	The maximum capacity is 20 people, including deaf and hearing individuals.	Because the users of this room are for the general public, the users can be both deaf and hearing individuals. Therefore, this room is still designed with consideration of the needs of the deaf, just like the specifications of the classroom. However, because the capacity of the room is 20 people, the layout of this class will have raked seating.

Table 2.4 Specification of each room needed
Source: *Author, 2024*

2.1.4 Building Quality (Special Needs School User Activites)

From the above facilities, the space requirements and user activities can be seen. The main users of this school are the deaf students and the teachers. In addition, there are also general users who are student parents, visitors who want to learn directly about the deaf world, and also other guests. Then these things can be classified as follows:

User	User Activities	Room Needed
Deaf Student	1.Practicing sensitivity to rhythm and sound 2.Practicing communication skill 3.Physical activity: ◦ physical exercise ◦ playing 4. Outdoor learning 5. Indoor learning	1.Sound and rhythm perception room 2.Speech development room 3.- Hall - Playground 4. Sensory garden 5.- Classroom - Library
Teacher and staff	1. Teaching 2. Managing school activities 3. School administration 4. Counseling 5. Cooking 6. Cleaning 7. Taking care of sick students 8. Storing learning items	1. Classroom 2.- Headmaster room - Teacher's room 3. Administration room 4. Counseling room 5. Kitchen 6. Janitor 7. School Health Unit Room 8. Warehouse
Public	1.Parking 2. Praying 3. Lunch 4. Learning (for public) 5. Urinate	1. Parking area 2.- Musholla - Christian & Chatolic chapel - Hindu holy room 3. Canteen 4. Learning room for public 5. Toilet

Table 2.5 User activities
Source: Author, 2024

2.2 BIOCLIMATIC ARCHITECTURE (PRINCIPLES)

The rooms in a special needs school for the deaf aim to improve the sensory quality of deaf students in order to optimize their learning and in communication ability. To achieve this goal and in accordance with the needs of deaf children, in this case the architectural approach of bioclimatic architecture can be a solution. Bioclimatic architecture refers to a method that emphasizes the influence of climate or the understanding of climate as the main element that influences design with the aim of optimizing the use of as little energy as possible to create thermal comfort indoors. The approach not only creates thermal comfort, but also maximizes natural energy that can improve sensory quality, especially visual quality by maximizing natural lighting. Buildings with bioclimatic architecture are produced through adaptation to climatic conditions and the surrounding environment. (Almusaed, 2011). This approach is a flexible approach because it can be applied in various locations and climates, as its principles are designed to take advantage of local climatic conditions. The principles of bioclimatic architecture according to Ken Yeang (Taken from Pawitro et al., 2014) are as follows:

- **Opening** -> Using components on the facade of the building to provide natural ventilation and lighting.
- **Orientation & Zone** -> Orienting buildings or openings to get natural light as much as possible and avoid receiving solar heat radiation.
- **Shade & Filter** -> Application of shades and filters on the building skin to provide shading on the facade, especially on openings (shade) and also to reflect or absorb some of the sun radiation (filter).
- **Insulate** -> Restraining the reception of solar radiation through wall insulation or roof insulation.
- **Green** -> Using vegetation that can help the cooling effect of air on the building and its environment.
- **Cooling Effect** -> A passive technique to cooling buildings and the environment by using water.

The above principles can be applied according to the needs of special schools for the deaf and with consideration of Indonesia's tropical climate. The need for sensory quality in deaf special needs school can be achieved by utilizing the important aspects of each of the above principles, which can be broken down as follows:

- From the **opening principle**, it can generate **natural lighting** that can improve visual quality **and also thermal comfort** for students' comfort in learning. These two aspects, which are natural lighting and thermal comfort, can be achieved by adapting the principle of opening to the building envelope and building form.
- The principle of **orientation & zone can be used to achieve natural lighting as well as a building layout** that facilitates the visual navigation of deaf students. The zoning and orientation of the school building can also expand their visual range, but must still be aware of the challenges of the tropical climate such as rain and solar heat.
- From the principles of **shade & filter and insulate, referring to the use of building materials** to create comfort in buildings, so it can be applied to the building skin. In addition, the selection of materials for the exterior and interior also needs to be considered in order to improve the sensory quality of deaf students.
- From the principle of **green and cooling effect**, it can be combined to **create a school landscape** with a variety of vegetation that can improve sensory capabilities and also cooling in the school environment.

From the above breakdown of the principles of bioclimatic architecture, it can be cleared up with the diagram below:

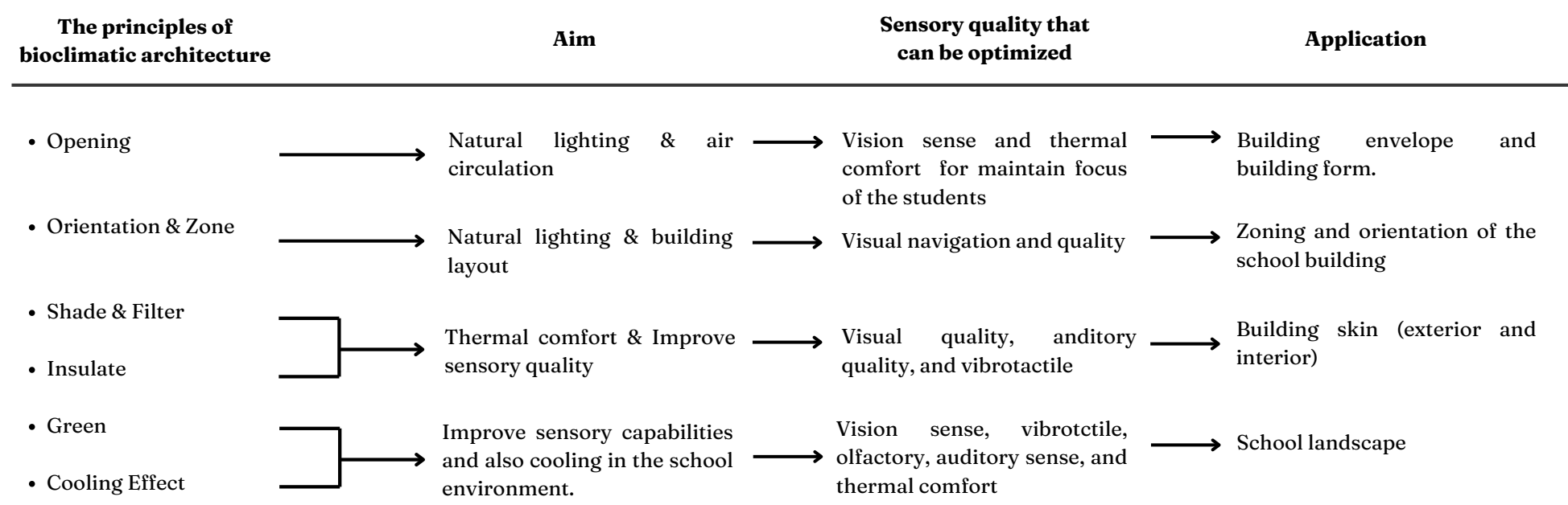


Diagram 2.1 Bioclimatic architecture principle breakdown
Source: Author, 2024

From the diagram above, it can be seen that there are several aims of each bioclimatic architecture principle. These aims if used in a special needs school for the deaf can help improve the sensory quality of the students. These aims can be summarized into several prominent aspects as follows:

- 1. Lighting for visual quality
- 2. Thermal comfort for maintaining focus
- 3. Building layout for visual navigation
- 4. Sensory quality through building material
- 5. Sensory quality through landscape and plants

2.3 PROMINENT ASPECTS TO IMPROVE SENSORY QUALITY

Prominent Aspects of Bioclimatic Architecture to Improve Sensory Quality

In the background, the Bioclimatic Architecture approach and its principles were discussed in a short way. It has also explained the aspects generated from the principles and its influence on optimizing the sensory qualities of deaf students. Therefore, this chapter will discuss in more detail how each aspect affects children's sensory and how it can be applied in the building.

2.3.1 Lighting for visual quality

Maximizing the use of natural light is highly recommended to meet the needs of deaf students rather than using artificial lighting. **Apart from being more energy-efficient, the use of natural light can create a stronger connection with the surrounding environment, such as knowing changes in time or environmental conditions that enhance spatial awareness and well-being.** However, this does not mean not using artificial lighting at all, but reducing its use. Artificial lighting can be used under certain conditions if natural lighting is not maximized, such as when the weather is cloudy. Both natural and artificial lighting must meet lighting standards so that they are more on-target to meet the needs of deaf students. In Indonesia, classrooms in a school building require minimum light of 350 lux (Badan Standarisasi Nasional, 2020). This is different from the Australian Standard which sets out in more detail the minimum lighting for deaf people, which is at a minimum level of 150 lux without glare to be maintained, a minimum lighting of 240 lux for signage, and 160 lux in general to enable lip reading and sign language communication (NATSPEC, 2022). Thus, from these standards, it can be concluded that the minimum lighting for deaf is 150 lux, 160 lux to be able to communicate, 240 lux for light reading activities, and 350 lux for deep reading activities.

For deaf individuals, it is not enough just to meet the lux standard, but there are several specifications that must be considered. These specifications must be paid attention in detail to make them easier to communicate and do activities that rely heavily on their visual senses. Thus, these following specifications aim to improve visual quality. These specifications are as follows:

- Besides the lux lighting that meets the standard, **the light must also not cause distraction in the form of glare, backlight, direct sunlight**, and so on as shown in the picture 2.1 (Hansel Bauman, 2010).
- Good lighting and color selection can create **background contrast** that can help deaf people communicate (Hansel Bauman, 2010).

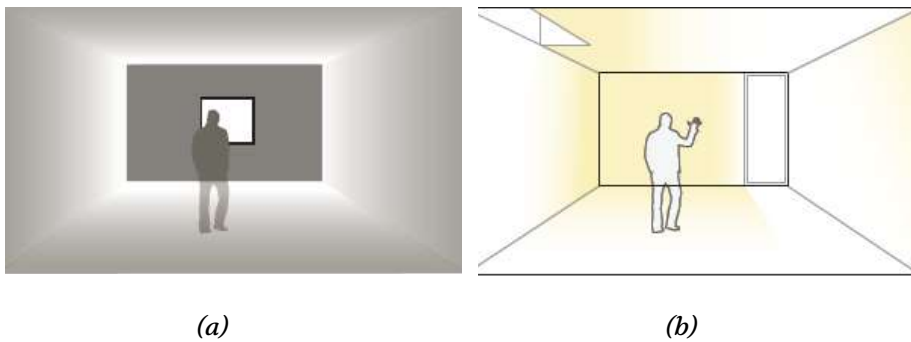


Figure 2.1 Bad lighting due to backlight (a) and good lighting (b)
Source: Hansel Bauman, 2010

- Good lighting not only helps deaf students to communicate, but it can also improve their sensory abilities, especially in the senses of sight and touch. This is because **light, color, and texture** are inseparable in shaping deafspace. Color and texture are not just aesthetics in deaf culture, they **are a way to shape space and help with orientation and wayfinding** (Hansel Bauman, 2010).

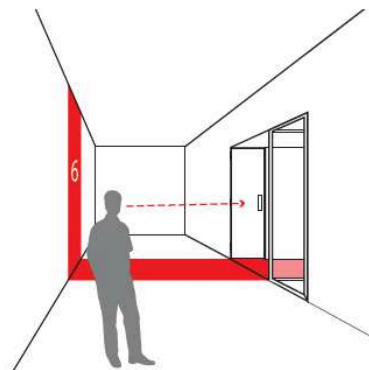


Figure 2.2 Color as wayfinding
Source: Hansel Bauman, 2010

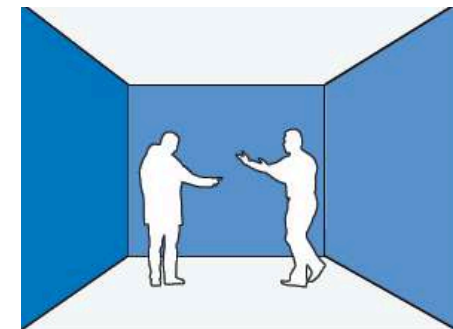


Figure 2.3 Contrast background
Source: Hansel Bauman, 2010

Besides good lighting, color selection is also important, so that the colors used can help the deaf to communicate when supported by good lighting. There are several things to consider in color selection as follows:

- Choosing colors that contrast with human skin, such as green and blue.
- Light colors tend to reflect light which can create glare, thus we must be careful in using it. In contrast, dark colors can absorb this strong reflective light.
- Avoid warm colors rather use cool colors for furniture and walls for eye comfort and to give joy and pleasure for the children (Marzouk et al., 2024).
- Use matte rather than gloss color and surface to avoid glare.

From the specifications above, we can see that creating good lighting for deaf is quite complex. But, we can **achieve good daylighting by applying several ways below:**

- A light shelf functions as a horizontal surface placed near a window or inside a building, with the purpose of reflecting daylight onto the ceiling of the room. In this way, natural light can go deeper into the room, spread more evenly, and reduce the need for artificial lighting. it can avoid avoiding light that is overly concentrated and which negatively impacts deaf individuals' ability to communicate and comfortably navigate their environment (Hansel Bauman, 2010).

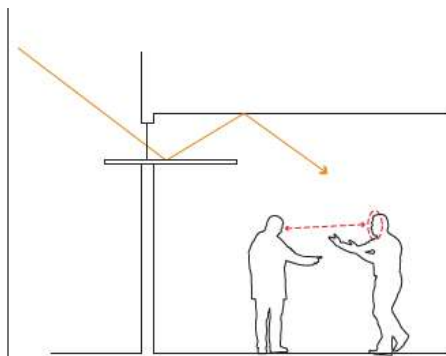


Figure 2.4 Light shelf
Source: Hansel Bauman, 2010

- Window height, the higher the window, the deeper the range of light entering the room. The depth of light entering the building can range from 1.5 to 2 times the window height (Ruck et al., 2000). Because the deaf students need more light, we can **use higher window to maximize daylight entering the rooms**. But, we have to pay attention to not causing glare, backlight and direct sunlight

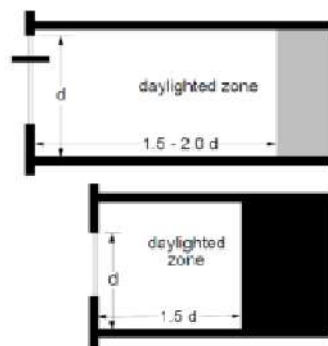


Figure 2.5 The influence of window height
Source: Ruck et al., 2000

- Building shape, according to Lechner (2015), within the same area, buildings can be divided into two main shapes: square and rectangular. The square plan (see figure 2.6) has 16% of the area without natural light, 33% gets some light, and 51% gets maximum light. In contrast, a rectangular plan has the center area without light, while a square plan with an atrium receives even light with top lighting above the atrium. From this theory, **we can apply square plan for the rooms that need more light and add atrium to maximize daylighting**.

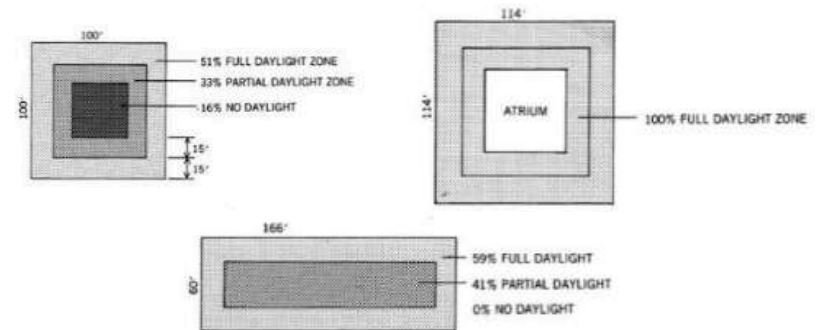


Figure 2.6 The influence of building form
Source: Lechner, 2015

- **Daylight should be balanced** in a space through multiple sources. A single window on an exterior wall can create glare or backlighting issues. Then, we can add second light source from a window above a door or skylight, for example, can balance light levels, reduce eye strain and improve visual communication.

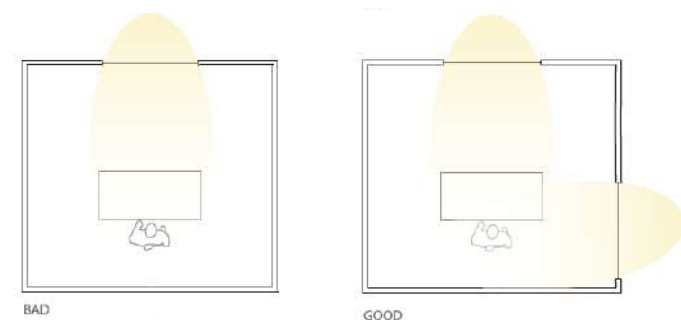


Figure 2.7 Balancing the daylight
Source: Hansel Bauman, 2010

Lighting Specifications Table

The following table is the specification of lighting and some ways of application based on the needs of the school.

Aspect	Specification	Application
Lighting	Minimum lighting for rooms with intense communication and reading activities is 350 lux	- Using square plan with atrium to maximize the daylighting. - Using higher windows with external sunscreen as slat or roller sunscreen to reduce glare and direct sunlight.
	Not cause distraction in the form of glare, backlight, direct sunlight	- The use of external sunscreen as slat or roller sunscreen, shading, or etc. - Balancing the daylight using multiple light sources. - Avoid glossy surface or color. - Use dark color next to light color to absorb the reflective light. - Use light shelf to avoid or reduce the direct sunlight
	Contrast background and make the color as a wayfinding	- Use contrast colors with human skin, such as green and blue. - Do not use too much color

Table 2.6 Lighting Specifications Table
Source: *Author, 2024*

2.3.2 Thermal Comfort for maintaining focus

The relation between thermal comfort and learning has a significant impact, especially when focusing on deaf students. Optimal thermal comfort can affect students' well-being and concentration in the learning process. If the classroom temperature is uncomfortable, students with special needs feel hot and uncomfortable, so they do not focus on absorbing the lesson and make the teacher have to repeat the explanation (Syafriyani et al., 2013). By creating good thermal conditions, such as appropriate temperature and adequate ventilation, can help deaf students feel more focused and comfortable in learning. In addition, classroom design that considers bioclimatic aspects can help create an environment that supports thermal sustainability, making classrooms more inclusive and providing a more positive learning experience for deaf students. By understanding these specific needs, a design approach that focuses on thermal comfort can increase deaf students' participation, understanding and engagement in the educational process.

According to Sudiarta (2016), thermal comfort can be achieved in various ways, such as:

According to Sudiarta (2016), thermal comfort can be achieved in various ways, such as:

- Cross ventilation, This system places openings in opposite directions, allowing air exchange from inside to outside the building. The effectiveness of this system depends on the dimensions of the opening (inlet-outlet), which results in an increase in air velocity and a decrease in temperature in the room.

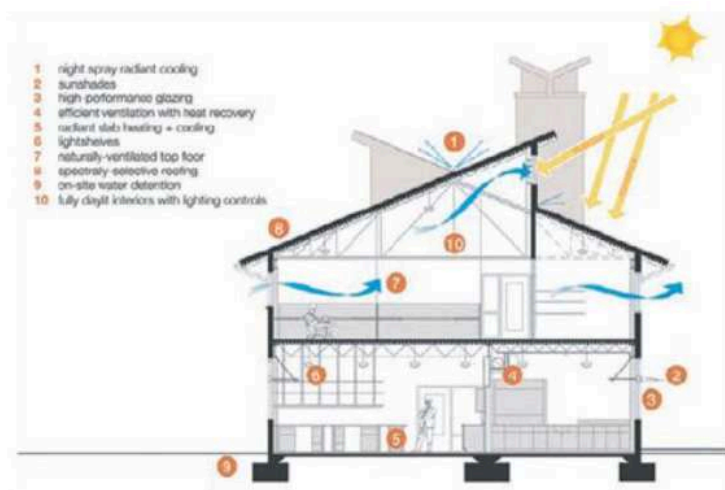


Figure 2.8 Cross ventilation
Source: Sudiarta, 2016

- Stack ventilation, Stack ventilation occurs due to the temperature difference between the air inside the building and the air outside, creating a drag force that allows vertical airflow. This system can be seen in the application of buildings with high roofs, as hot air tends to rise upwards and exit the building through vents in the roof. At the same time, fresh air from outside will enter the building through the lower vents, creating a natural airflow.

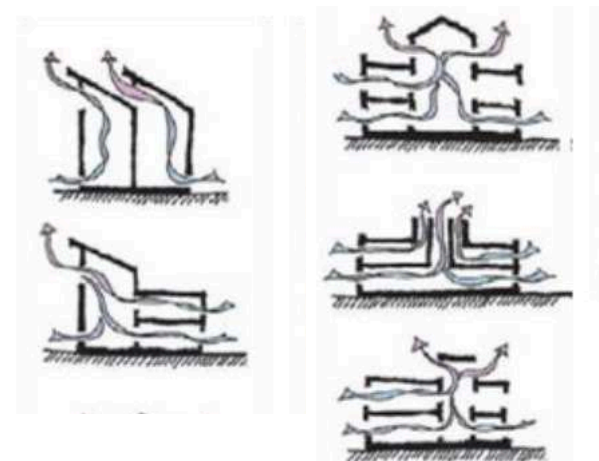
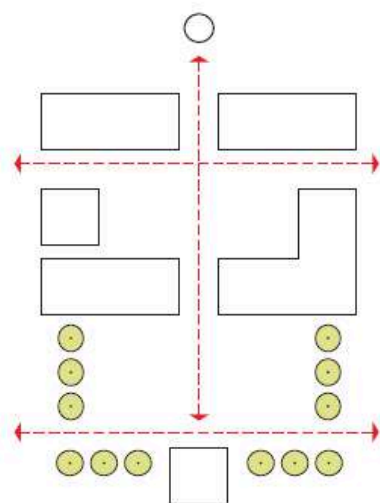


Figure 2.9 Stack ventilation
Source: Sudiarta, 2016

2.3.3 Building layout for visual navigation

Building orientation is a crucial aspect of the bioclimatic architecture approach that affects the quality and quantity of sunlight and wind that will be obtained by the building. In addition to affecting building performance, the placement of orientation and layout arrangement between building masses also affects the visual connection for deaf students. This is because they rely heavily on their eyesight to navigate their surroundings. Key buildings should be immediately visible as one enters the public outdoor area, which serves to assist deaf individuals in navigating the overall building layout (Hansel Bauman, 2010).



View corridors through buildings serve to visually connect building districts, important landmarks, destinations, and adjacent neighborhoods. View corridors play an important role in wayfinding and should serve as key building circulation routes.

Figure 2.10 View corridors
Source: Hansel Bauman, 2010

Important destinations and building landmarks should be immediately visible when entering shared exterior spaces to help deaf people orient themselves within the larger building plan.

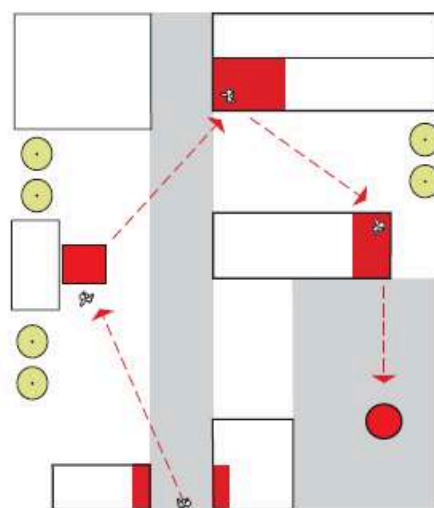
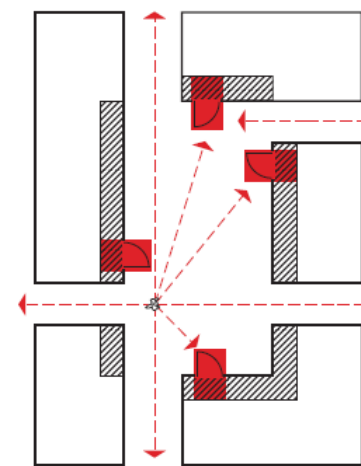


Figure 2.11 Visible destinations in sequence
Source: Hansel Bauman, 2010



The main building entrance should be clearly visible from key points along the main circulation of the building and from open spaces.

Figure 2.12 Location of building entrances
Source: Hansel Bauman, 2010

Key destination points should be visible from various places in the building and should be immediately visible and unobstructed access. Circulation routes and layouts should be clear and intuitive.

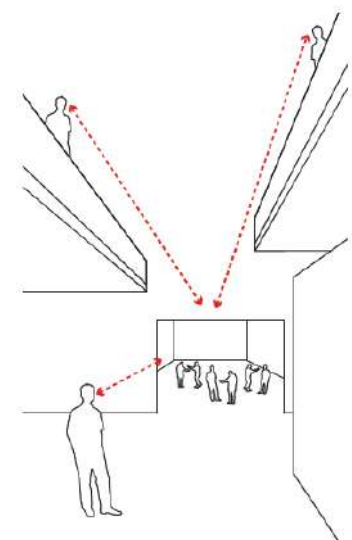


Figure 2.13 Visible destinations within buildings
Source: Hansel Bauman, 2010

2.3.4 Sensory quality through building material

The selection of building materials for schools for deaf students is not only based on the material's ability to provide thermal and sustainable comfort, but should also support the enhancement of their sensory abilities. The selection of materials with texture transitions for different areas, for example, can provide subtle clues about the presence of thresholds, entrances, and decision points (Hansel Bauman, 2010). In addition, the selection of materials that can conduct vibrations can enhance their ability to recognize the perception of sound and rhythm such as wood plank as flooring material.



Figure 2.14 Different texture of materials
Source: Pinterest



Figure 2.15 Wood platform
Source: Pinterest

2.3.5 Sensory quality through landscape and Plants

The arrangement and selection of plants can not only help provide thermal comfort for school environments, but can also enhance their sensory qualities. In terms of enhancing visual quality, landscape elements and vegetation should be used along main pathways to provide easily recognizable and continuous visual references as landmarks (Hansel Bauman, 2010). The presence of plants and other natural elements in the landscape can provide rich sensory stimulation for children, including the deaf. They can experience the textures, scents, colors, and sounds of the landscape environment. The landscape can use plants with bright colors to stimulate the sense of sight; using plants that have a unique texture to stimulate the sense of touch; using plants that can produce soft sounds when blown by the wind to stimulate the remaining hearing of deaf students; using plants that can be eaten directly; and using plants that have a fragrant and distinctive fragrance to stimulate the sense of smell.



Figure 2.18 Plant that can giving natural noise
Source: Pinterest



Figure 2.16 Plants that have striking color
Source: Pinterest



Figure 2.17 Plants that have unique texture
Source: Pinterest



Figure 2.19 Edible plant
Source: Pinterest



Figure 2.20 Plants that have pleasant fragrance
Source: Pinterest

2.4 BIOCLIMATIC ARCHITECTURE IN TROPICAL CLIMATE

Indonesia belongs to the wet tropical climate region. According to Lippsmeier (in Handoko & Ikaputra, 2019), this wet tropical climate area is characterized by high humidity conditions (>90%), high rainfall, and annual average temperatures above 18°C. Seasonal differences are almost non-existent and annual temperature fluctuations are very small. Therefore, the application of the concept of bioclimatic architecture must heed these conditions.

According to Givoni (1998) (in Handoko & Ikaputra, 2019) there are several bioclimatic architectural design principles for wet tropical climates. These principles are:

- Minimizing solar heating of the buildings. The building's arrangement with the opening facing north and south provides an advantage in reducing heat insulation (Savero et al., 2020). According to Sayigh (2017), sun shading is needed on the east, west, south of the building. Because it has a long radiation exposure period, Light shelves can reduce glare and support sunlight entering deeper room buildings. Fixed shading devices are more effective and no cost for operable. Portable shading devices are more expensive but flexible in control related to outside conditions. While the intelligence façade is a sunshade that operate automatically following solar radiation or outdoor temperature (Savero et al., 2020).



Figure 2.21 Building orientation and shape in tropical climate
Source: Savero et al., 2020

- Maximizing the rate of cooling in the evenings.
- Providing effective natural ventilation, even during rain. According to Gonzalo (2006)[6], at least two sides have ventilation in each zone of the room (Savero et al., 2020). overhanging roofs can assist in protecting the openings and walls from the sun, which decreases the surface temperature of the internal space and increases shading (Goyal, 2023).

Install higher windows as vents and ensure all openings are located on the outside walls for cross ventilation. Small openings are recommended to avoid heat accumulation within the building, and west-facing glazing is recommended. Instead, south-facing glazing with horizontal louvers should be installed to control the amount of solar light coming into the building. It is recommended to include window openings on the north side to obtain diffuse daylight and reduce radiation. Window sizes should be carefully designed for the intended use, orientation, and shading required. Vertically positioned operable shutters are an appropriate solution for maintaining the desired internal temperature throughout the day (Goyal, 2023). Compact constructions and inward-facing buildings with interior courtyards contribute to lowering heat absorption. Combining these two methods can lead to a volumetric cooling effect for large-scale urban structures in tropical areas (Goyal, 2023)

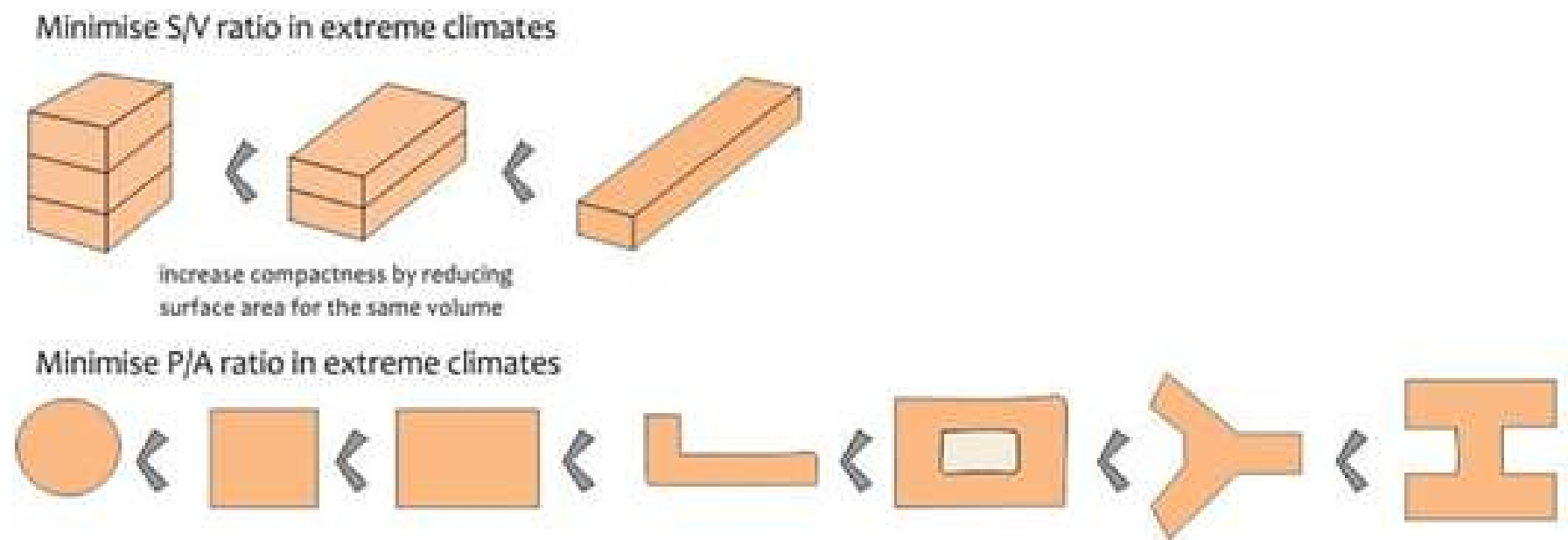


Figure 2.22 Building compactness in tropical climate
Source: Goyal, 2023

- Preventing rain penetration, even during rain
- Preventing entry of insects while the windows are open for ventilation.
- Providing spaces for semi outdoor activities as integral part of the living space.
- Minimize the risks from tropical storms. (in region subjected to hurricanes or typhoons)

2.5 PRECEDENTS

2.5.1 Precedent of the concept (Lovell International School, Pattaya, Thailand)

The design concept to be used is the bioclimatic concept. This concept makes the building adapt to the local climate and also maximizes natural lighting, thermal comfort, and also energy efficiency.

One building that uses the bioclimatic concept is Lovell International School in Pattaya, Thailand. This school has separate building masses, but is still connected by an open hallway, which aims to preserve existing trees and increase open areas.



Figure 2.23 Lovell International School
Source: Archdaily, 2023



There are several aspects of bioclimatic architecture applied by this building, including:

- The semi-open hallway makes this hallway does not need artificial light during the day and also artificial cooling at the same time to make this building closer to nature.
- There are many rooms with large glass windows to maximize daylight.
- The use of a high tapered roof is very suitable for the tropical climate. This is because the heat inside the building will move up and fresh air can enter through vents or windows in the lower areas.
- Separate building masses allow air to move between the building masses.
- The orientation of the building masses is different in order to maximize sunlight without being blocked by other building masses and minimize solar heat radiation.

Although applying bioclimatic principles, some areas still require artificial lighting and cooling, some areas get enough sunlight, but there are also areas that are not maximized by sunlight so they require artificial lighting.

2.5.2 Precedent of the function (Deyang School for Deaf & Intellectually Disabled Children, Deyang, China)



Figure 2.24 Deyang School
Source: Archdaily, 2012

The main function of this design is provide educational facilities that meet the needs of deaf students. This function is carried by the building named Deyang School for Deaf & Intellectually Disabled Children in Deyang, China. This school is recruiting children with talking and hearing disabilities or mentally retarded pupils. The school includes teaching, sports and accommodation facilities. There are several aspects that are highlighted in this building, which are:

- The rooms in each building are oriented towards the atrium that follows the relationship of 'Rooms'-'atrium'-'courtyard' to create multi-level interactions between private and public spaces.
- The atriums, courtyards, as well as the different-sized windows provide various opportunities for those special children to

explore the world from different heights, inspiring them to enhance the interactions with each other and discover the surrounding world together, which helps develop intelligence better.

- Simple circulation, making it easier for children to access each area.
- Using many openings and skylights to optimize natural lighting
- Not using too many colors, so as to make children more focused.

According to Hansel Bauman (2010), buildings for the deaf should use colors that contrast with human skin, such as blue and green rather than white. However, this is understandable because it is not only deaf children who attend this school, who may find it difficult to use too many colors.

2.6 SITE ANALYSIS

Location: Jl. Pandean II No.8, Candok, Condongcatur, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55283

This total area of this site is 2.600 sqm with several existing trees that are quite lush. In the eastern area of the land, there is a green area in the form of a forest with a small river flowing near the site. While the north, south and west areas are residential areas, where the buildings around the site are at most only 2 stories high.



Figure 2.25 Area of the site
Source: Google Earth, 2024

2.6.1 Regulations

In Sleman Regency Regional Regulation No. 12/2012 related to location:

1. Basic Building Coefficient (KDB) 40-60% for buildings in residential areas.
2. Building Floor Coefficient (KLB) 1.2-2.0.
3. KDH is at least 20% (twenty percent) of the land area for KDB value of 31% (thirty one percent) to 70% (seventy percent).
4. Maximum building height of 33 m based on radar for airplanes.

From the above regulations, the conditions for this project are as follows:

KDB 60% -> $2.600 \text{ m}^2 \times 60\% = 1.560 \text{ m}^2$

KLB 1,2 -> $2.600 \text{ m}^2 \times 1,2 = 3.120 \text{ m}^2$

KDH 20% -> $2.600 \text{ m}^2 \times 20\% = 520 \text{ m}^2$

Maximum building height -> 33 m

Sleman Regency Regional Regulation No. 2 of 2015 concerning Building Setback Lines (GSB):

“Village/rural road, building distance from the road is 3.5 meters. The road area around the site is 3 meters, so the outermost building wall allowed is at least 2 meters from the roadside. For multi-storey buildings up to 3 (three) floors, the outer building walls, structures and foundations can coincide with the parcel boundary, if not coinciding then the distance is at least 1 (one) meter inward from the parcel boundary.”

2.6.2 Accessibility

This area is close to the city center, but located in the middle of a residential area (see picture). Access to the site is through the main highway (blue line), then into the main residential street (green line) which can be passed by two cars. From the main residential road, then into the alley (red line) where the width of the road can only be passed by one car. Because of its location in the middle of a residential area, it is far from the noise of motorized vehicles, making the learning process more comfortable.



Figure 2.26 Access to the site

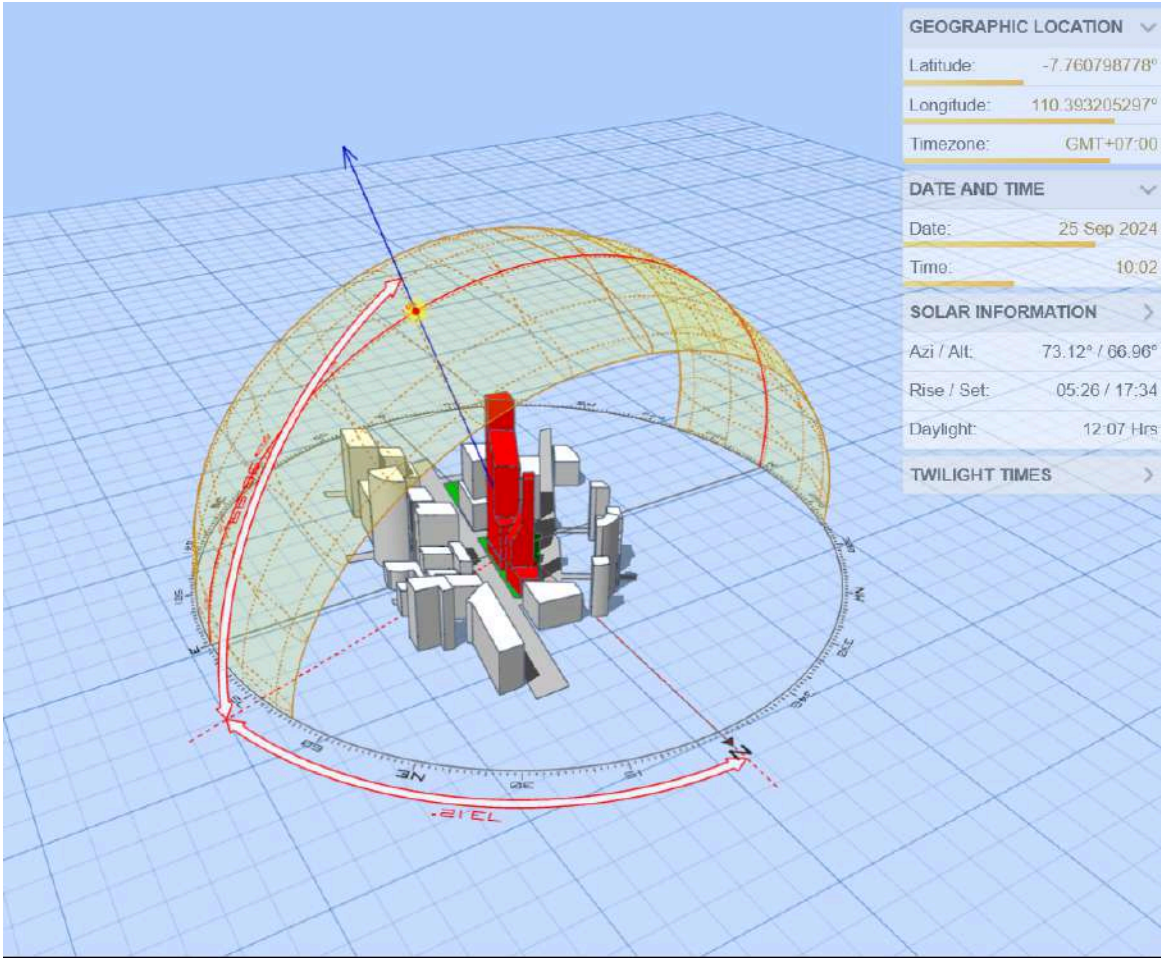
Source: Google Map, 2024

2.6.3 Climate

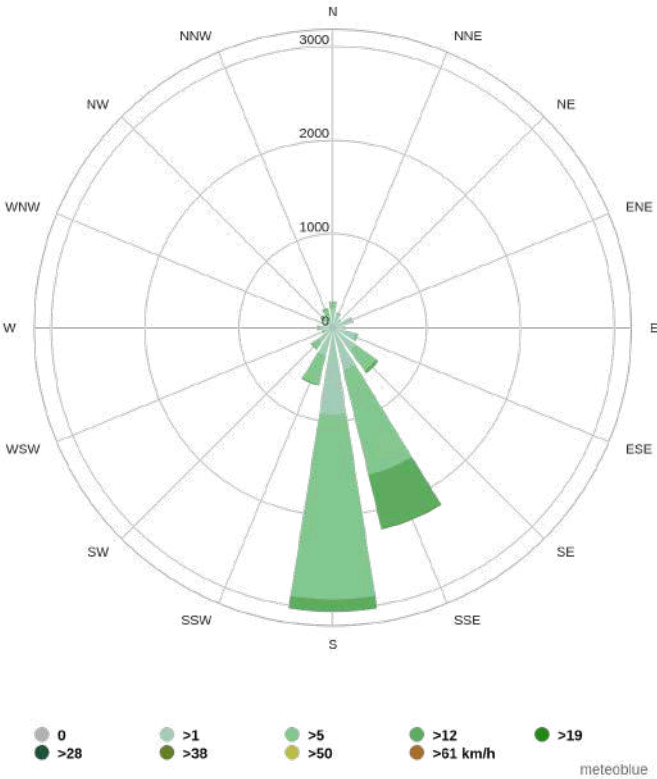
Sun Path

The sun path tends to have a relatively consistent pattern throughout the year, with the sun rising from the east, reaching its highest point in the sky around midday, and descending towards the west towards dusk. Due to Jogja's relatively low southern latitude, the sun tends to be in the sky most of the year, providing abundant daylight. This influences building design and space layout to maximize natural lighting and reduce overheating from sunlight.

Figure 2.27 Sun path
Source: Andrewmarsh.com, 2024



GEOGRAPHIC LOCATION	
Latitude:	-7.760798778°
Longitude:	110.393205297°
Timezone:	GMT+07:00
DATE AND TIME	
Date:	25 Sep 2024
Time:	10:02
SOLAR INFORMATION	
Azi / Alt:	73.12° / 66.96°
Rise / Set:	05:26 / 17:34
Daylight:	12:07 Hrs
TWILIGHT TIMES	



Wind rose

From this wind rose, it can be seen that most of the wind in the Sleman area blows from the south. Knowing the direction of the wind can help in the arrangement of building masses and building openings, so that they can fulfill thermal comfort.

Figure 2.28 Wind rose
Source: meteoblue.com, 2024

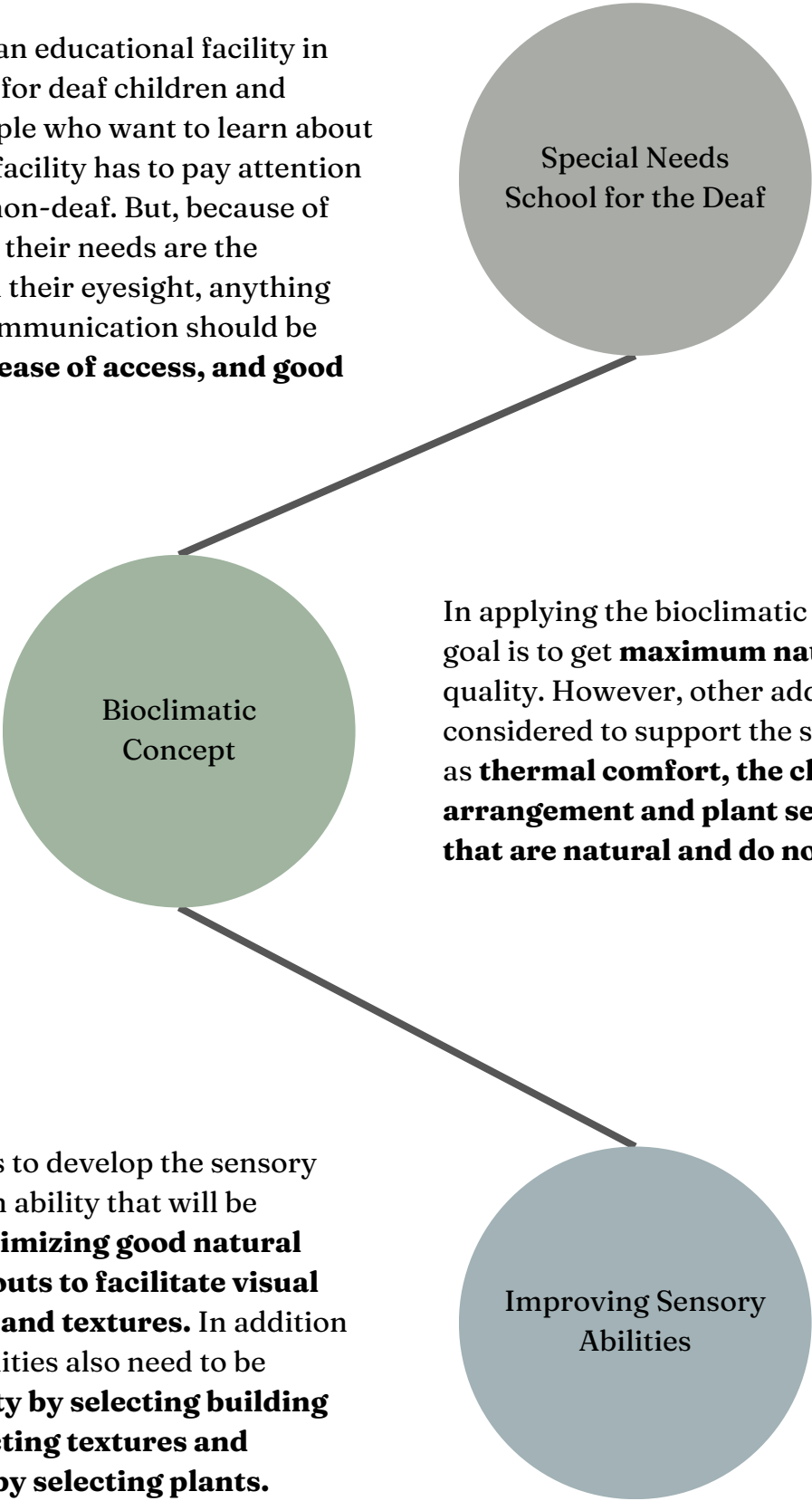


03

Design Concept

FOCUS OF THE DESIGN CONCEPT

The function of this building is as an educational facility in the form of a special needs school for deaf children and provides a learning center for people who want to learn about deaf culture. Because of that, this facility has to pay attention to the needs of deaf children and non-deaf. But, because of the main user is the deaf students, their needs are the priority. Since they rely heavily on their eyesight, anything that supports easy viewing and communication should be used. This includes **room clarity, ease of access, and good lighting without glare.**



In applying the bioclimatic concept in this building, the main goal is to get **maximum natural lighting** to improve visual quality. However, other additional things also need to be considered to support the sensory skills of deaf students, such as **thermal comfort, the choice of materials, landscape arrangement and plant selection, to the selection of colors that are natural and do not distract vision.**

The main purpose of this facility is to develop the sensory abilities of deaf children. The main ability that will be improved is **visual ability by maximizing good natural lighting, arranging building layouts to facilitate visual navigation, and selecting colors and textures.** In addition to visual ability, other sensory abilities also need to be developed, such as **auditory ability by selecting building materials; tactile ability by selecting textures and materials; and olfactory ability by selecting plants.**

Diagram 3.1 Focus of the design concept
Source: Author, 2024

3.1 PROPERTY SIZE TO DETERMINE THE SIZE OF BUILDING MASSES

State of the rooms function		Room function	Room type		Capacity	Circulation	
	Primary room		Learning rooms		Private	Qty + Qty ↓ Max quantity of main user (student, teacher, etc) ↘ Additional user (teacher, guest, etc)	
	Secondary room		Supporting rooms		Semi private		
			Service rooms		Public		
						30% + 20% ↓ Circulation for deaf ↘ Circulation for non-deaf	
State	Function	Room	Standard	Capacity	Area/unit + circulation (+ 30%/20%)	The number of room	Total area
Primary rooms	Learning rooms (indoor)	Classroom (Elementary School)	3 m2/students	8 + 1 10 + 1	27 m2 + 8,1 m = 35,1 m2 33 m2 + 9,9 m = 42,9 m2	6 2	210,6 m2 85,8 m2
		Classroom (Kindergarten)	3 m2/students	5+1 8+1	18 m2 + 5,4 m = 23,4 m2 27 m2 + 8,1 m = 35,1 m2	2 1	46,8 m2 35,1 m2
		Library	9m2 + 0.05m2/ students	25	226,25 m2	1	226,25 m2
		Speech development room	3 m2 / students	3+1	12 m2 + 3,6 m = 15,6 m2	1	15,6 m2
		Sound and rhythm perception room	3 m2 / students	10+1	33 m2 + 9,9 m = 42,9 m2	1	42,9 m2
		Learning room for public/hall	3 m2 / students	20+1	63 m2 + 18,9 m = 81,9 m2	1	81,9 m2
		Counseling room	3 m2 / students	2+1	9 m2 + 2,7 m = 11,7 m2	1	11,7 m2
		Indoor sensory room	3 m2 / students	8+1	27 m2 + 8,1 m = 35,1 m2	1	35,1 m2
Secondary rooms	Supporting rooms	Teacher room	4 m2/person	18	72 m2 + 14,4 m = 86,4 m2	1	86,4 m2
		Headmaster room	12 m2/unit	1+2	12 m2	1	12 m2
		Administration room	16 m2/unit	1+1	16 m2	1	16 m2
		School Health Unit	12 m2/unit	1+1	12 m2 + 3,6 m = 15,6 m2	1	15,6 m2

State	Function	Room	Standard	Capacity	Area/unit + circulation (+ 30%/20%)	The number of room	Total area
Secondary rooms	Supporting rooms	Warehouse	18 m2/unit	-	18 m2	1	18 m2
		Canteen	3 m2/ student	58	174 m2 + 34,8 m= 208,8 m2	1	208,8 m2
		Musholla • Praying area • Toilet • Wudhu area	• 0,66 m2/pers on • 2 m2/unit • 1,2 m2/pers on	• 58 • 1 • 5	• 38,28 m2 + 7,66 m= 45,94 m2 • 2 m2 • 6 m2 + 1,2 m= 7,2 m2	• 1 • 2 • 2	• 45,94 m2 • 4 m2 • 14,4 m2
		Christian & Catholic chapel	12 ^{on} m2/unit	8	12 m2	1	12 m2
		Hindu holy room	12 m2/unit	5	12 m2	1	12 m2
	Service rooms	Kitchen	12 m2/unit	2	12 m2	1	12 m2
		Janitor	4 m2/unit	2	4 m2	1	4 m2
		Toilet • Elementary school’s toilet • Kindergarten’s toilet • Canteen • Teacher’s toilet	2 m2/unit	1	• 2 m2 + 0,6 m= 2,6 m2 • 2 m2 + 0,6 m= 2,6 m2 • 2 m2 + 0,6 m= 2,6 m2 • 2 m2 + 0,4 m= 2,4 m2	• 2 • 2 • 2 • 2	• 5,2 m2 • 5,2 m2 • 5,2 m2 • 4,8 m2
	TOTAL						1.252,89 m2

Table 3.1 Property size
Source: *Author, 2024*

The total of all room requirements is 1,253.89 m2 which does not exceed the Floor Area Coefficient (KLB) which is 3.120 m2. From this total floor, it will be divided into several masses and floors so as not to exceed the Basic Building Coefficient (KDB) of 1.560 m2. Although the total floor is still below the KDB, several masses will still be made and there will be hallways connecting each mass so as not to exceed the predetermined KDB.

Other than estimating the room area requirement, it is also important to calculate the landscape space requirement. This is to ensure that the capacity of the landscape area does not exceed the remaining site area and can fulfill the Green Basic Coefficient (KDH).

State	Function	Landscape	Standard	Capacity	Area/unit + circulation (+ 30%/60%)	The number of area	Total area
		Sensory Garden	3 m2 / students	15	45 m2+ 13,5 m= 58,5 m2	1	58,5 m2
		School yard & Playground	200 m2/unit	-	200 m2 + 60 m= 260 m2	• 1 • 1	260 m2
		Parking area	• 16,2 m2/car • 1,2 m2/bike	• 10 (car) • 35 (bike)	• 162 m2 + 97,2 m= 259,2 m2 • 42 m2 + 25,2 m= 67,2 m2	• 1 • 1	326,4 m2
TOTAL							644,9 m2

Table 3.2 Property size for landscape
Source: Author, 2024

The Basic Green Coefficient (KDH) for this site is 520 m2, while the KDB is 1.560 m2. This means that of the total site area, only 440 m2 is left for hardscape. As seen from the table above, the areas that might use hardscape are the parking area as well as the school yard and playground. However, the amount of both areas exceeds 440 m2, so both areas will partially use grass blocks to increase the amount of green area.

For the sensory garden area itself can be an area that contributes the largest percentage for KDH. The remaining area to increase the percentage of KDH can be taken from some areas that use grass blocks, border areas, and also some areas between building masses.

By considering the amount of space requirements, it can be an initial guide to determine the size of each building mass and how many floors are needed. In addition to determining the size of the building mass, it can also be used to determine the parking area, as well as other landscape areas.

3.2 ZONING AND ROOM CONNECTIVITY

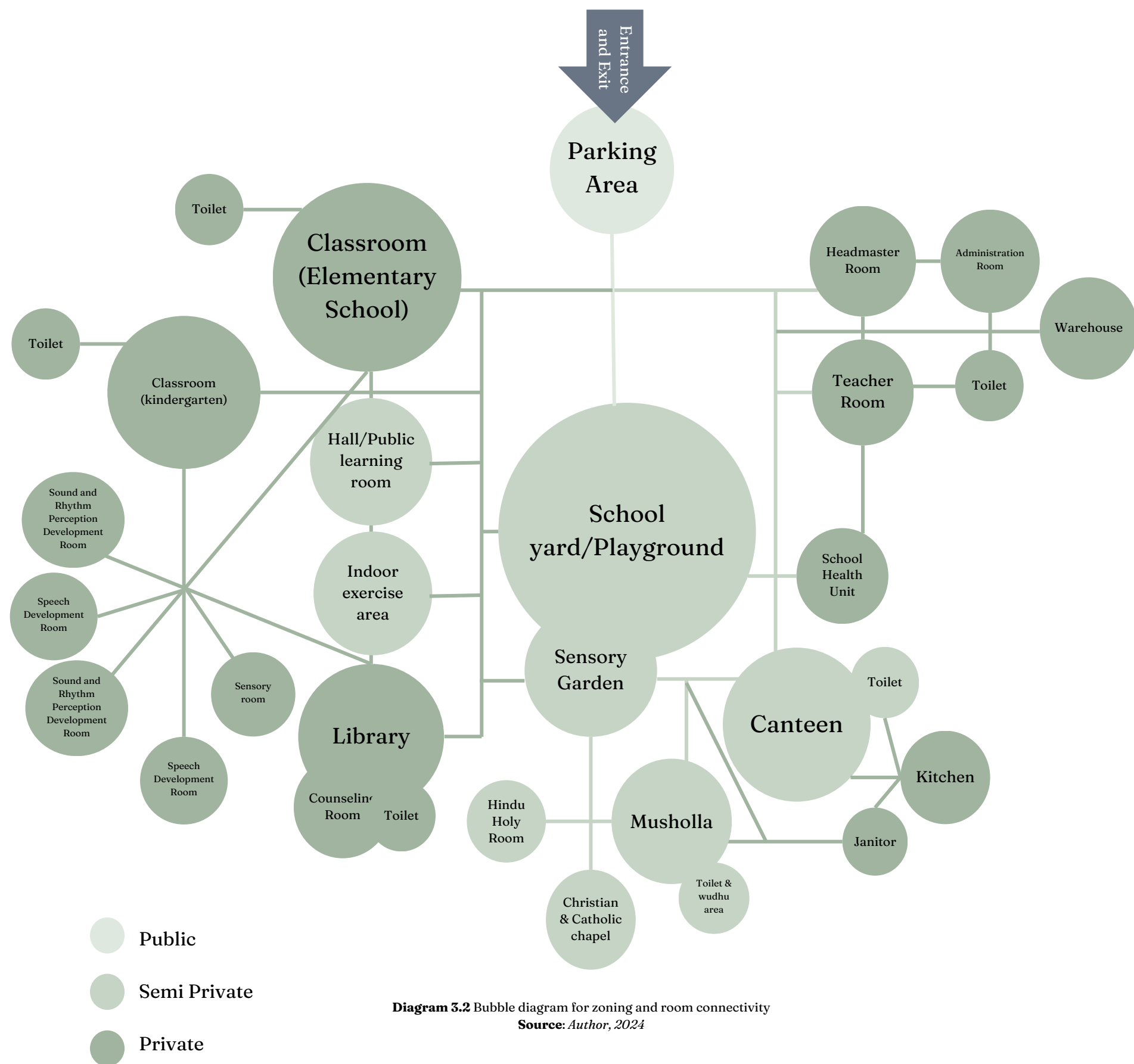


Diagram 3.2 Bubble diagram for zoning and room connectivity
Source: Author, 2024

3.3 SITE PLAN CONCEPT TO OPTIMIZE ROOMS FUNCTION (macro concept)

The division of zoning areas is **divided based on the function of space and also the type of space**. The division of rooms based on function is as follows:

- **Learning function:** this function is filled by primary rooms for learning both indoor and outdoor learning. These rooms are **mostly private spaces** such as classrooms, but there are also semi-private rooms that include outdoor learning spaces such as playgrounds and sensory gardens, as well as learning spaces for the public. As these rooms function as learning areas, it should be away from noise, but be easily accessible to students. Also, only learners and teachers can reach these areas.
- **Supporting function:** rooms included in this function are rooms that support the main function as a learning space, including rooms for school administrators, canteens, prayer rooms, etc. **These rooms are semi-private**. Since this room supports the main function and also semi-private, the rooms included in this function must be easily accessible to both the public and users from private areas.
- **Service function:** Rooms that are included in this category are rooms such as toilets, janitor, kitchen, and parking area. All rooms other than the parking area are **private and semi-private**. Rooms that are private and semi-private can be placed close to related rooms. Meanwhile, the parking area, which is a **public** area, must be close to the entrance and can reach other areas easily.

Based on these divisions, there are two alternatives for the zoning division of the area which will be the forerunner of the determination of further concepts.

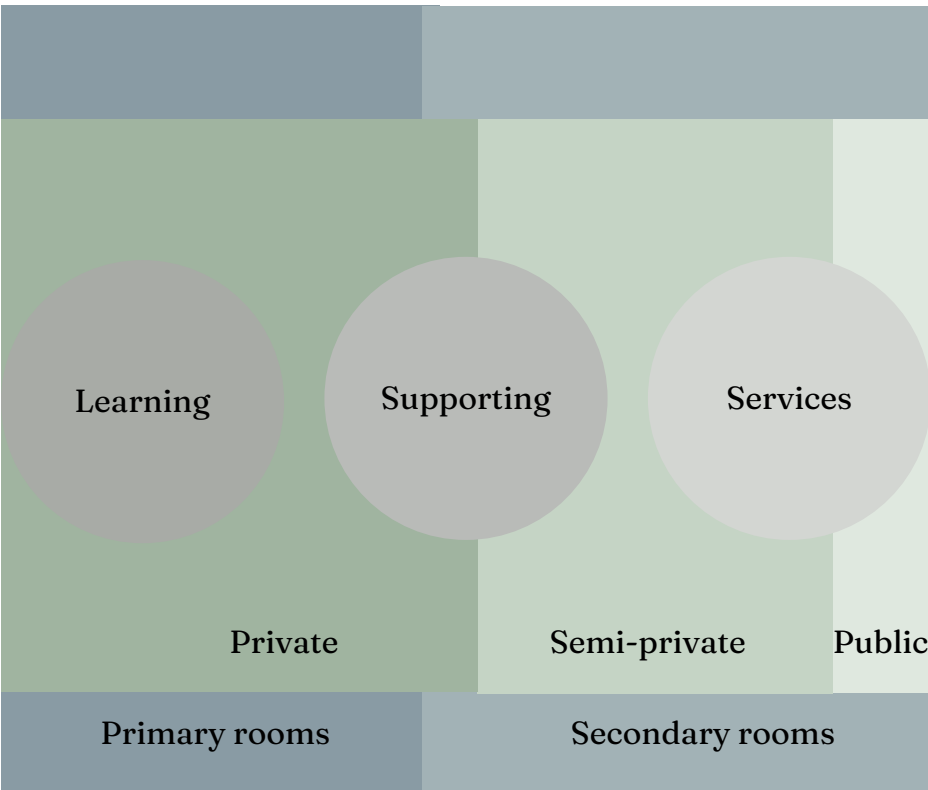


Diagram 3.3 Zoning and rooms function within
Source: Author, 2024

Alternative 1

In this first alternative, the public zone is located in the north area to the west, because this area is close to the road, making circulation easier, due to its function as parking area. The semi-private zone which contains the school offices and the yard is between the public and private zones. The private zone itself, which functions as a learning area, is in the southern area and far from the public zone.

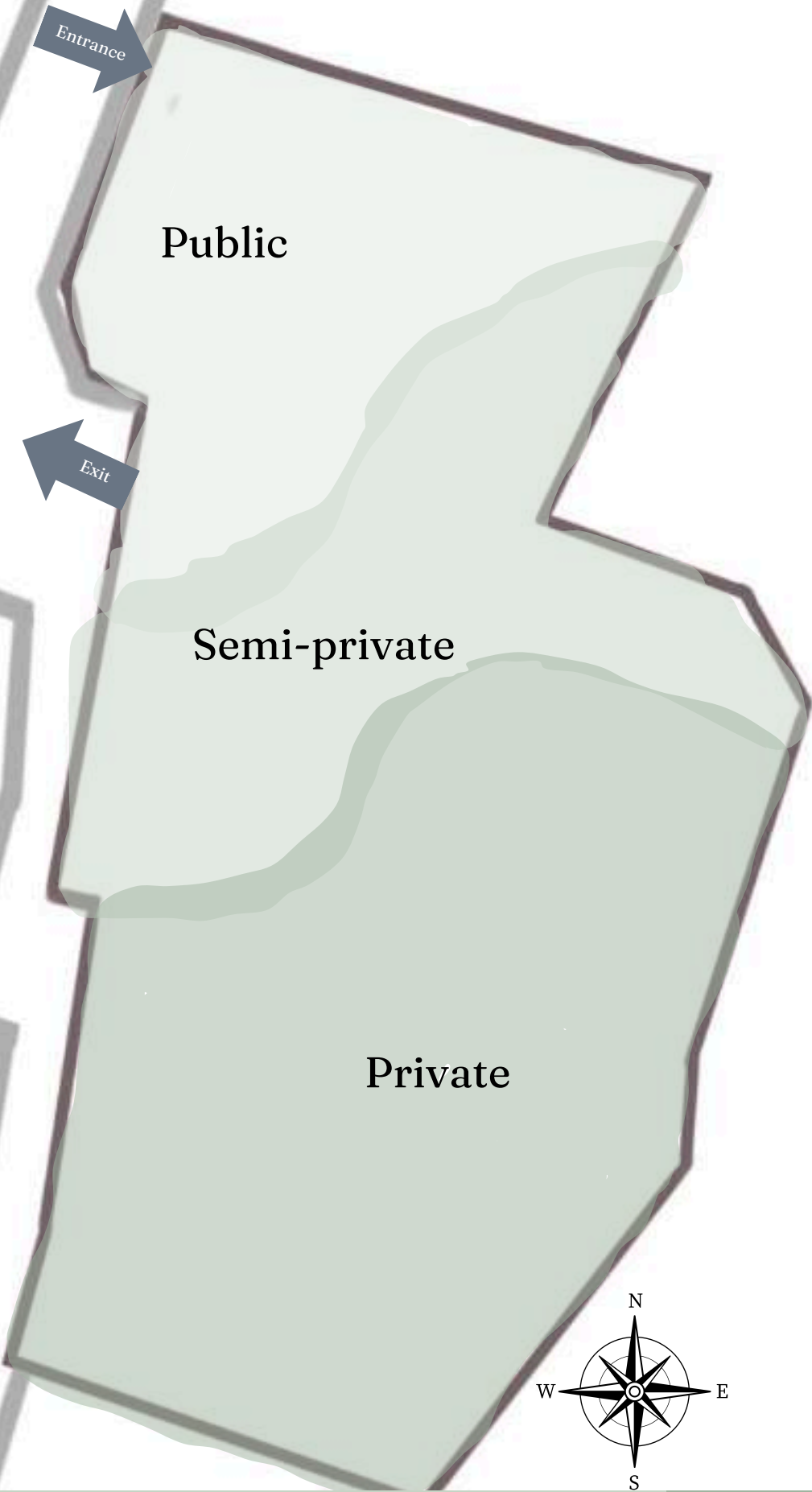
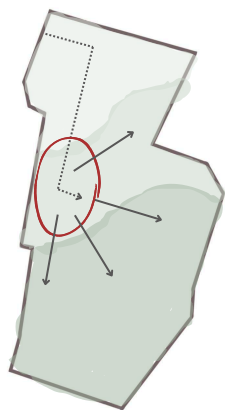
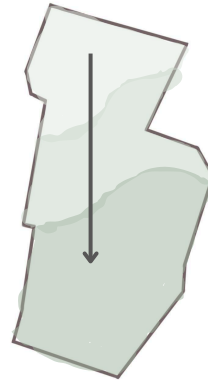


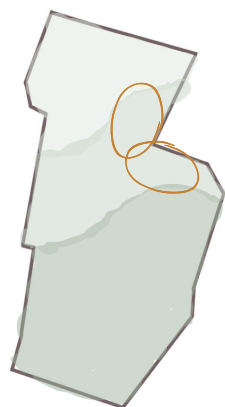
Figure 3.1 Alternative 1 for zoning
Source: Author, 2024

Pros

- The hierarchy of room types is clearly visible. The further south it goes, the more private it becomes, which gives the learning area the advantage of being quieter and not disturbed by the sound of parked vehicles or guests coming to the school.

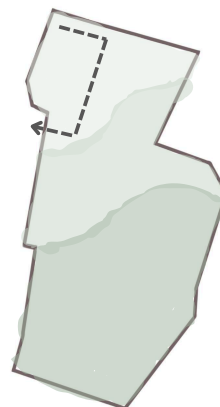


- The area circled in red can become the school yard, so this area can make visual navigation easier.



- The area circled in yellow can become the school offices, making it easier for teachers and staff to go to private and public zones.

- Easy vehicle accessibility as it is close to bigger area of the road.



Cons

- The learning spaces are too far from the parking lot, making it quiet difficult for students.

- The parking area will be quite small, which means that it will only accommodate less vehicles.

Table 3.3 Pro and cons for alternative 1
Source: Author, 2024

Alternative 2

In this second alternative, the public zone is fully located in the north area while still using different entrance and exit gates. The public and private zones both have a larger area than the first alternative. This causes the semi-private zone located between them to be smaller.

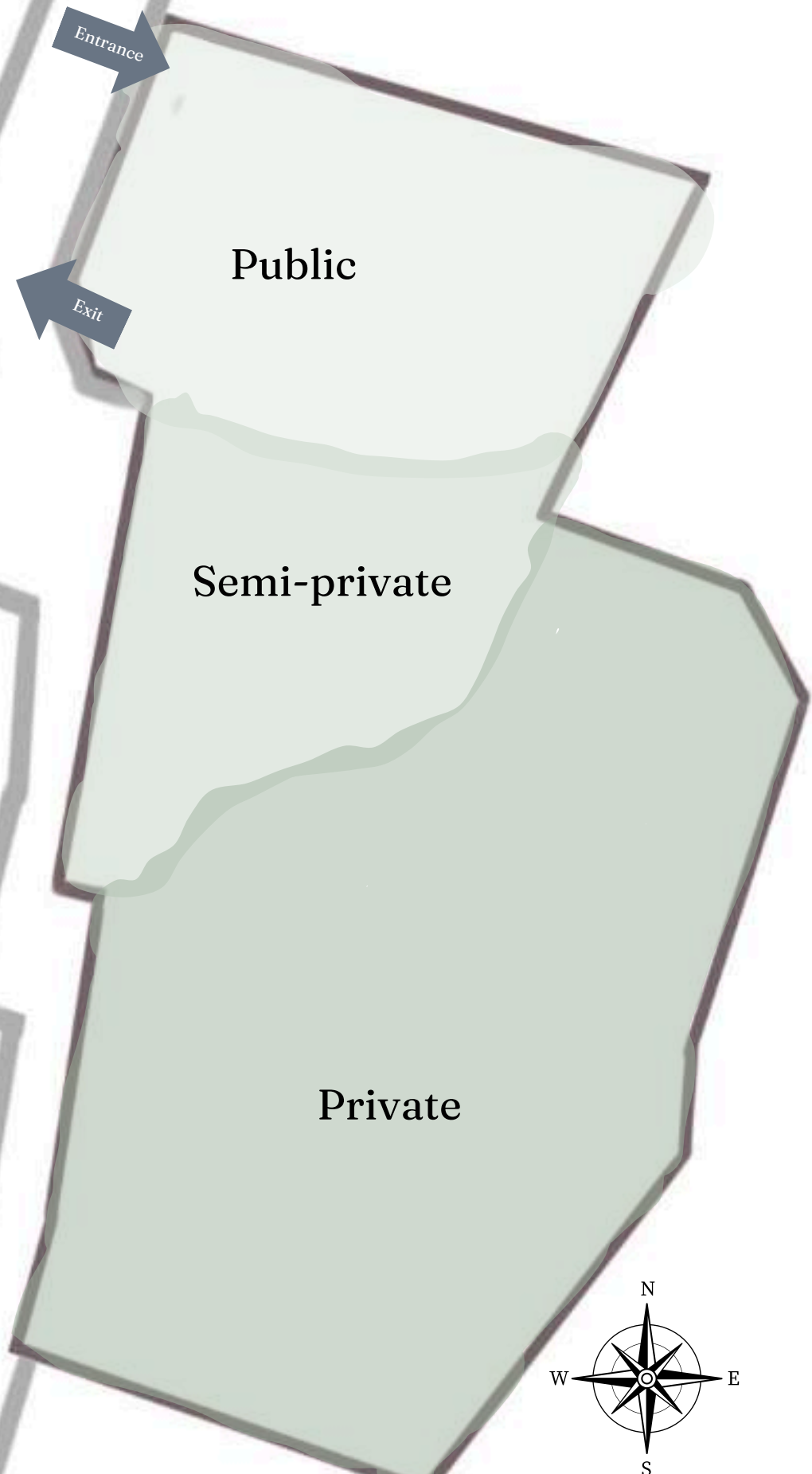
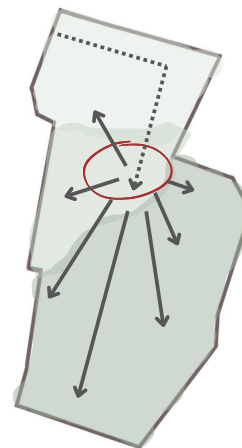
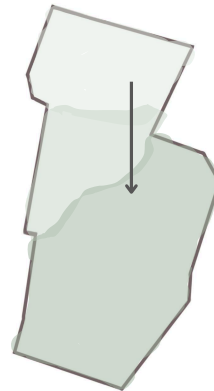


Figure 3.2 Alternative 2 for zoning
Source: Author, 2024

Pros

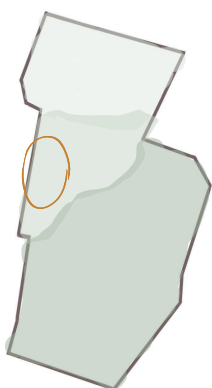
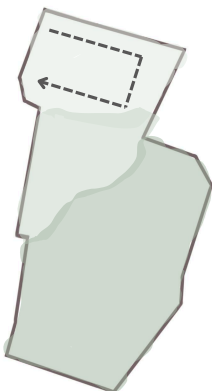
- The learning area is not too far from public zone.
- Larger learning area.

- The area circled in red can become the school yard, allowing easier visual navigation and larger visual range.



- Easy access for the vehicles.
- Can accommodate more vehicles.

- The area circled in yellow can become the school offices, it will make the teacher and staff easier to go to both of other zones.



Cons

- Because it is not too far from the public zone, it is necessary to ensure that the privacy of this zone is maintained.

- The area is quite small for school yard.

Table 3.4 Pro and cons for alternative 2
Source: Author, 2024

From the advantages and disadvantages of each alternative above, **alternative two has more advantages** in terms of visual navigation, accessibility, fulfilling the need for a larger learning area, and can accommodate more vehicles. However, **in terms of privacy, it is a bit lacking**, but this can be handled with building mass configuration or spatial layout.

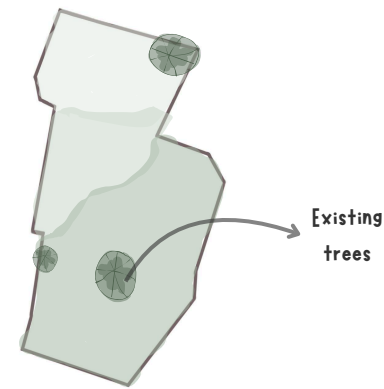


Figure 3.3 Selected zoning alternative
Source: Author, 2024

Controlling privacy through building configuration and form can be done by placing a transition area that is semi-private between public and private areas.

- **The placement of semi-private areas in the form of hallways, waiting area, school yards, and gardens between the public areas (parking area) and private areas (building mass for learning areas).** With this transition area, private areas used for learning will not be easily disturbed by vehicles or guests.
- Transition areas can not only be positioned horizontally, but **can also be positioned vertically such as putting the hall and indoor physical exercise area on the ground floor, while the learning rooms are on the upper floor.** Therefore, privacy in the study rooms can be maintained.

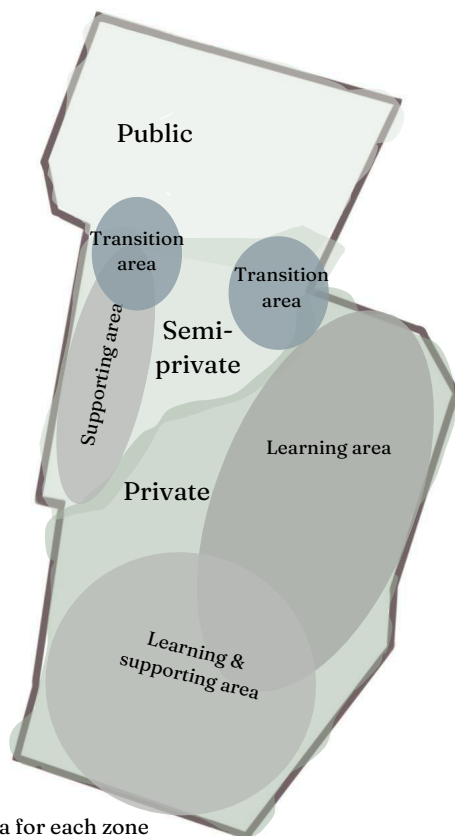


Figure 3.4 Transition area for each zone
Source: Author, 2024

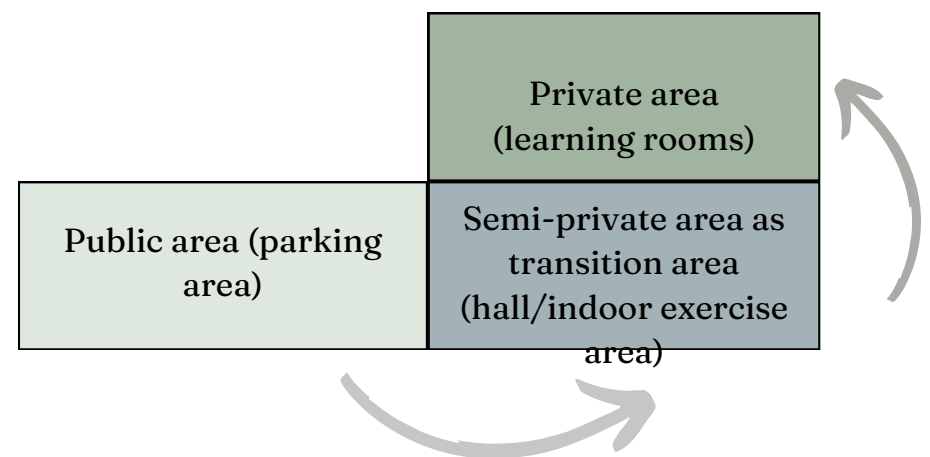
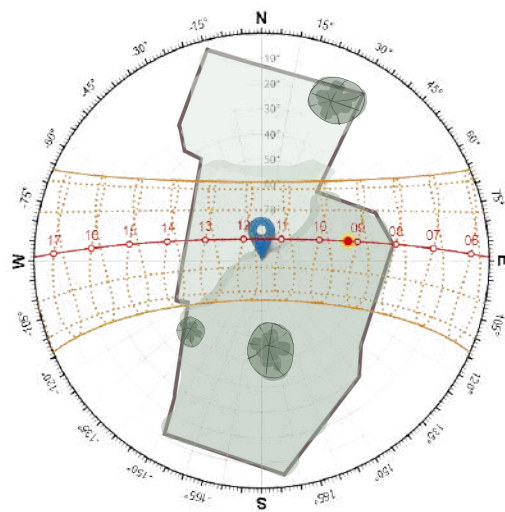


Diagram 3.4 Transition area horizontally
Source: Author, 2024

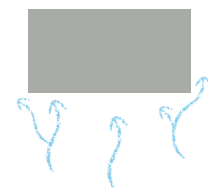
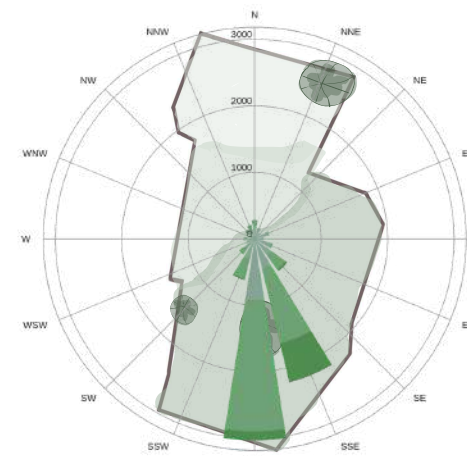
3.4 BUILDING CONFIGURATION CONCEPT TO RESPOND LOCAL CLIMATE (macro-mezzo concept)



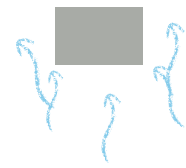
✗ If it is too precisely facing east and west, there will be a lot of surfaces exposed to the sun's heat.



✓ The mass should be slightly angled, to minimize the surface exposed to the sun heat.

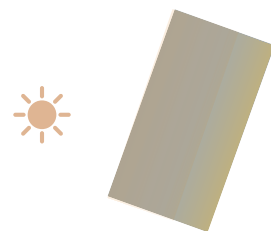


✗ Large multistory building mass on the southern part will block the wind flow.



✓ Small or single story mass on the southern part.

To get optimal daylighting, the direction of sunlight should be considered. In tropical climates, **buildings should have the widest sides facing north and south, while those facing east and west should be narrower.** This is intended to reduce heat gain in the building. In addition, openings on the east and west sides must be conditioned so as not to cause direct sunlight and glare by using light shelves, shading, or the form of the building mass itself.

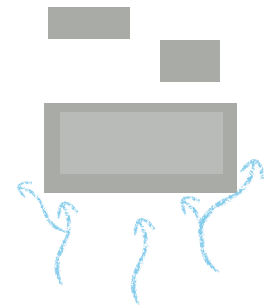


✗ If the wider side face east and west, more surfaces will receive solar heat.

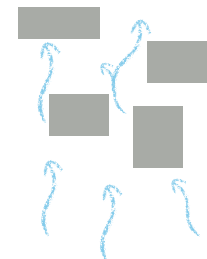


✓ The wider side should facing north and south to minimize solar hear gain.

Determining the building configuration should also take into account the direction of the wind. From the windrose above, it can be seen that the wind mostly blows from the south and south-southeast. Therefore, **the arrangement of building masses should not block the southern area so that the wind can blow to all areas and other building masses without being blocked.**



✗ Massive and solid building mass will make it difficult for air to circulate throughout the site and inside the building.



✓ Create some masses to allow the air to circulate throughout the site and each mass.

Figure 3.5 How dealing with the sunlight on the site
Source: Author, 2024

Figure 3.6 How dealing with the wind on the site
Source: Author, 2024

Based on this climatic consideration, there are three alternatives of building configuration

Alternative 1

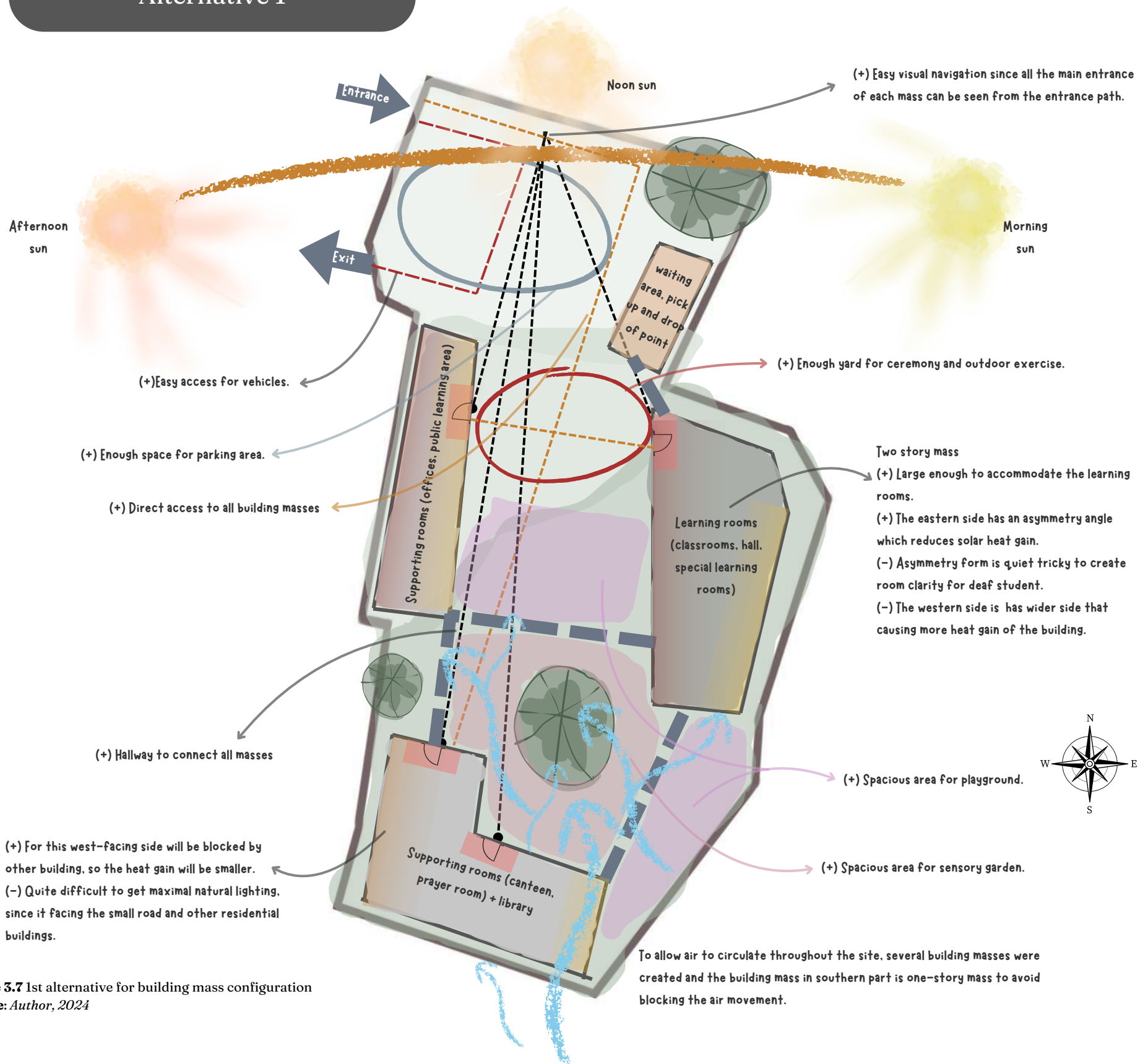


Figure 3.7 1st alternative for building mass configuration
Source: Author, 2024

The first alternative has three building masses with the largest mass that accommodates learning rooms having two stories, while the others are single story. The configuration and shape of these masses are influenced by the ease of visual navigation so that each mass's main door can be seen from around the entrance gate.

Alternative 2

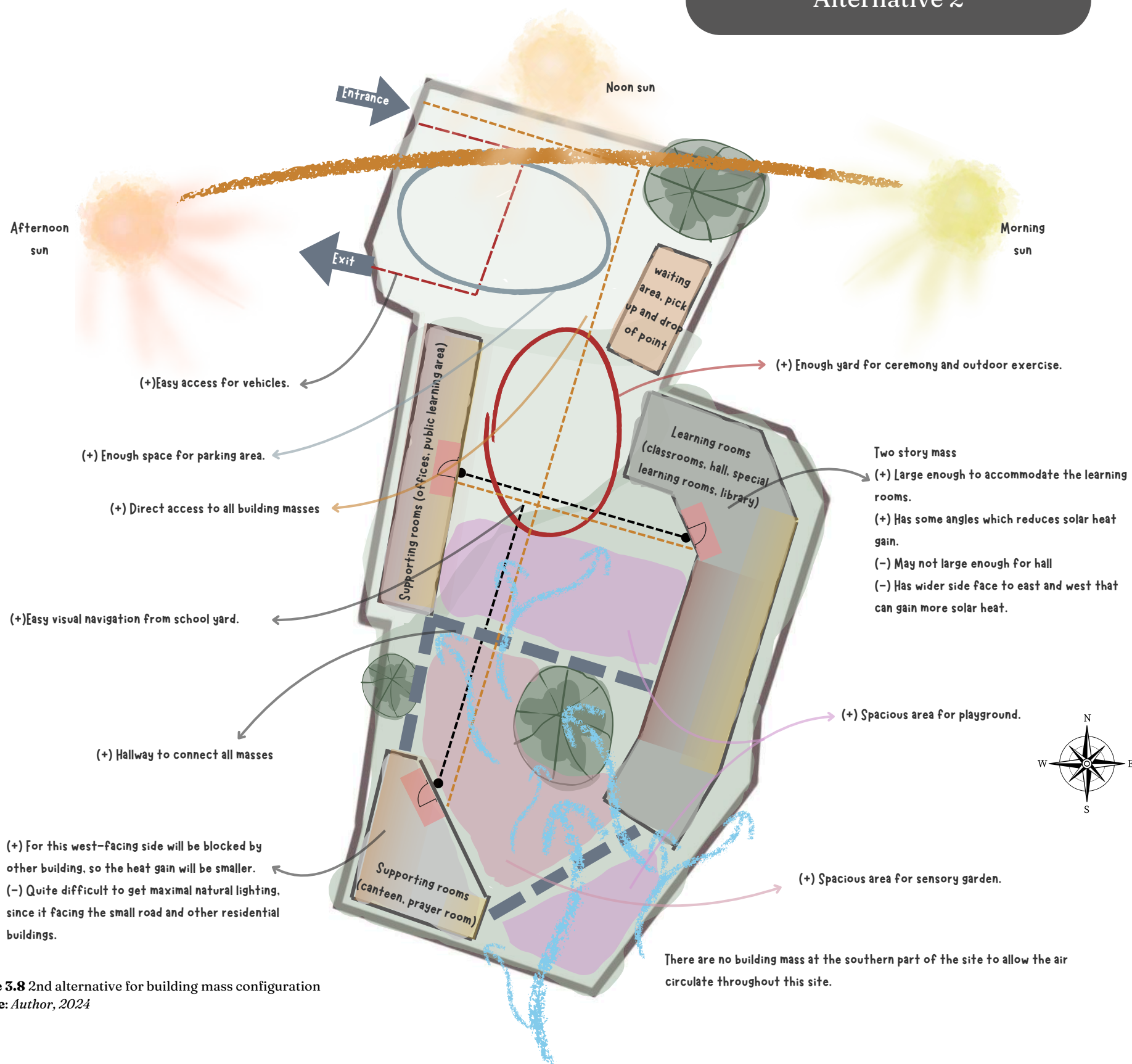
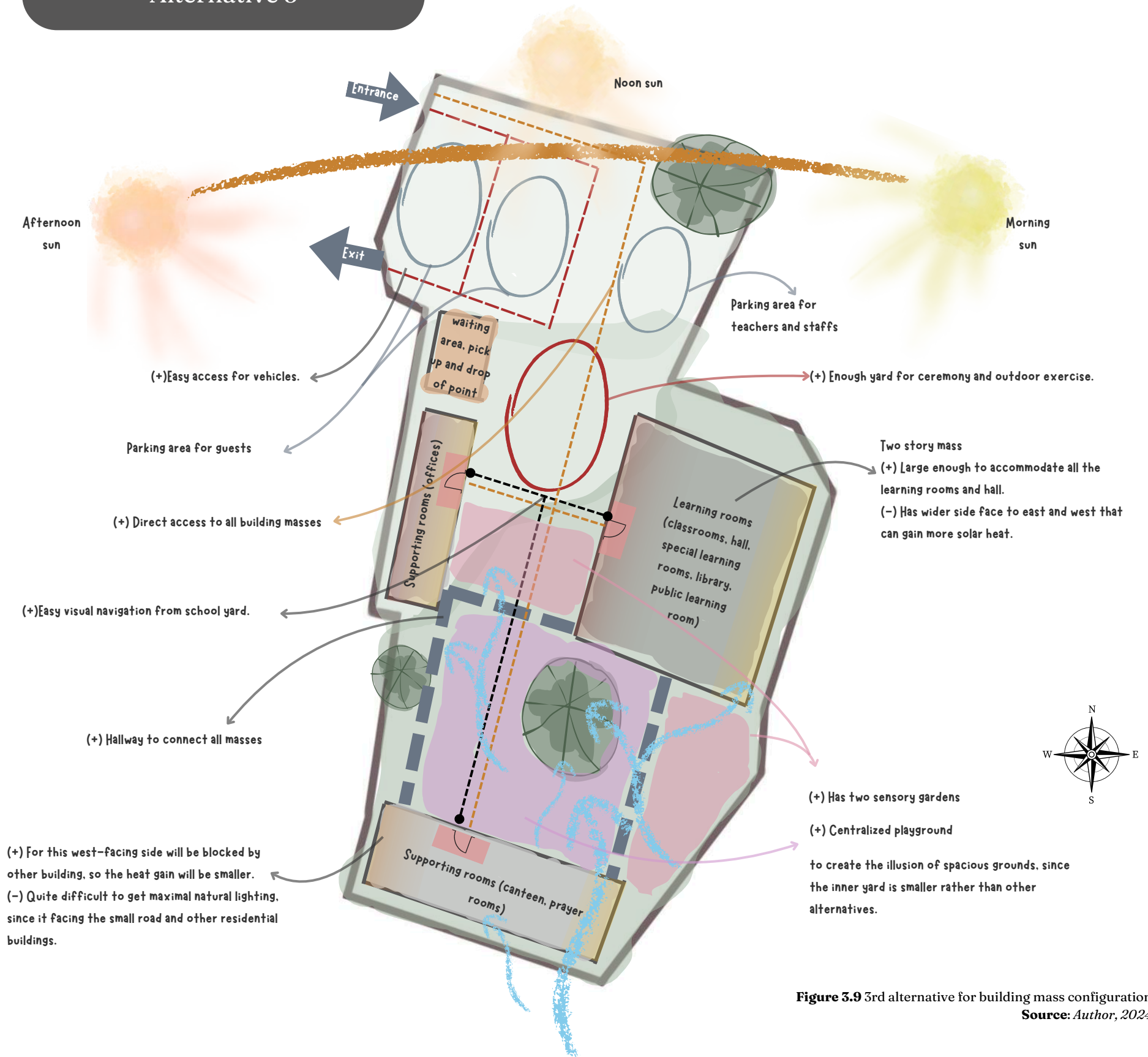


Figure 3.8 2nd alternative for building mass configuration
Source: Author, 2024

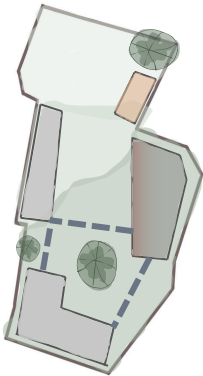
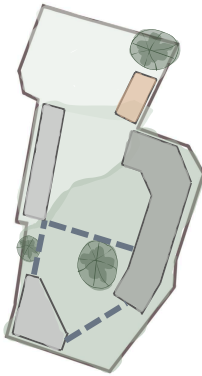
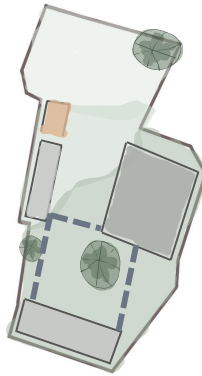
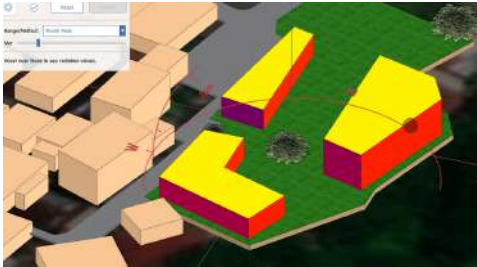
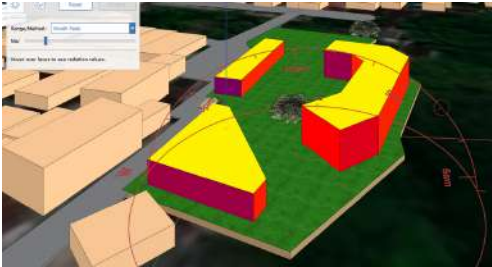
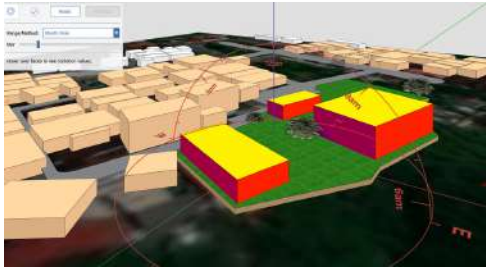
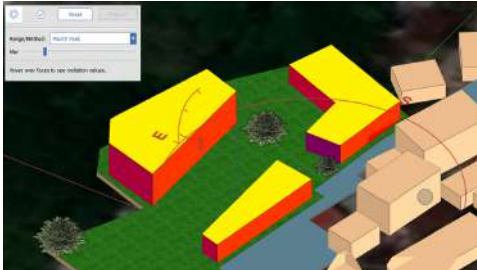
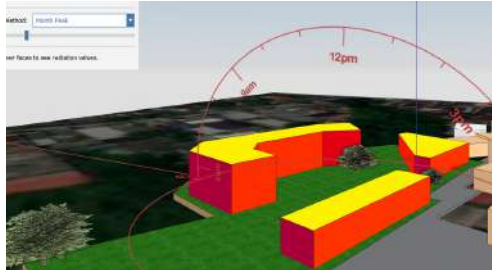
The second alternative has three masses with a centered configuration facing to the school yard, sensory garden and playground. The largest mass is the one that functions as a learning area with two stories.

Alternative 3



This third alternative has three masses with a simpler mass arrangement that facilitates access and visual navigation. The largest mass has two stories that can accommodate all the learning areas. In addition, in this configuration, the playground is in the center of the three masses and has two sensory gardens.

Table 3.5 Pro and cons for each building mass configuration alternatives and its simulation
Source: Author, 2024

	Alternative 1	Alternative 2	Alternative 3
			
Pros	• Simple and direct access • Has spacious school yard and playgrounds • Quiet easy for visual navigation • Has some angles to reduce solar heat gain	• Simple and direct access • Has spacious school yard and playgrounds • Easy for visual navigation • Unique and clear mass configuration • Smoother air circulation because there is no building mass in the direction of the incoming wind	• Simple and direct access • The playground area is centralized and two sensory gardens • Can accommodate all learning rooms in one building mass • Has separated parking area • Easy for visual navigation • Easy to achieve room clarity
Cons	• Asymmetric form is tricky to achieve room clarity • Has direct access and visual navigation, but it is still quiet complex	• Not enough space for hall and all learning rooms in one building mass • Has the wider side on the eastern and western side	• Has the wider side on the eastern and western side
Simulation			
			

Final Mass Configuration

From the comparison table above, the three alternatives have different advantages and disadvantages. The simulation results also show that there is not much difference between the three mass configurations. **Therefore, the best mass configuration that can be achieved is by combining the advantages of the three alternatives.** The third alternative has the most simple visual navigation, direct access, and functional massing arrangement, therefore this third alternative becomes the base mass configuration. The second alternative has a mass configuration that can facilitate wind circulation, so this concept can be applied. While the first alternative has advantages in its building mass that has many angles, which reduces solar heat gain. From the advantages of each alternative, it can be combined into a new mass configuration as shown on the picture on the side.

In this mass configuration, all masses are interconnected with hallways for easy access and centralized facing the school yard area. **This kind of mass configuration is a spatial concept of seamless mass configuration** which is intended so that all building masses are visible from the school field. For the concept of the building mass form itself - especially the main mass for the learning area - uses an octagonal shape besides to reduce heat gain as well as to provide visual smoothness with less corners. In the element concept, these masses will have a consistent color so that there are not too many color differences that can distract visually.

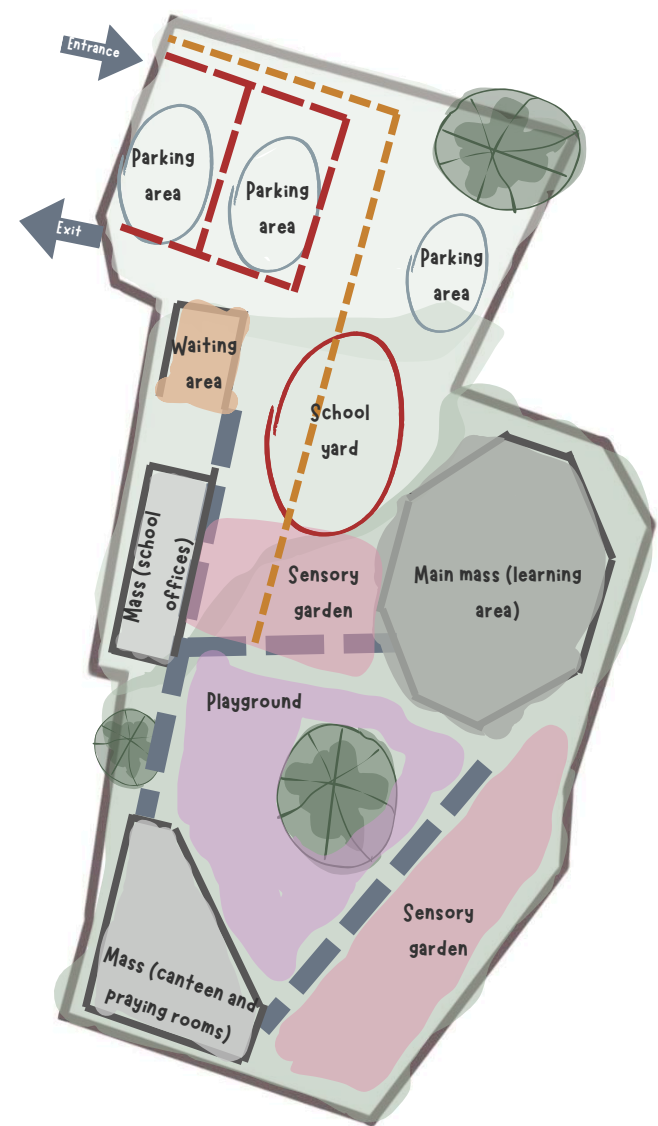


Figure 3.10 Final mass configuration
Source: Author, 2024

- Despite applying the three outstanding concepts from each alternative, this **mass configuration still has problems on the wider surface that need to be handled through the form of the building mass. In this project we will using form with multi angles like octagonal** in order to reduce the surface of the building facing east and west.

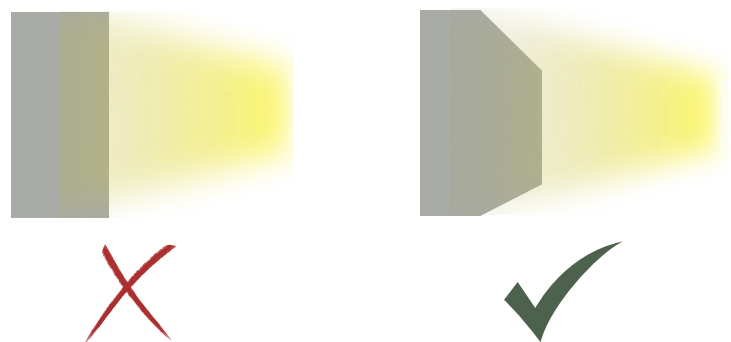


Figure 3.11 How to reduce sun exposure on building surface
Source: Author, 2024

3.5 BUILDING MASS TO ITS DETAILS TO OPTIMIZE NATURAL LIGHTING, FUNCTIONS, AND ACCESSIBILITY (*mezzo-micro concept*)

The building masses are connected to each other with hallways. There are two types of hallways, one that connects the mass of buildings on the ground floor and also a hallway that connects the mass with two floors. The three building masses all have two floors. **All the masses have the same basic shape, which is an octagonal shape. The octagonal shape was chosen to reduce solar heat gain and providing clear and smooth visual navigation.** Although the shape is different for each mass, the same basic form will still be able to give a harmony. **The main mass uses the full octagonal shape, while the other two masses use the shape of the octagon which is adjusted to the function of each mass which is on the small scale and also the shape of the mass area.** In addition, the form of these masses provides ease of visual navigation from the school field and playground area because of its smooth and centralized shape facing the center of the site.

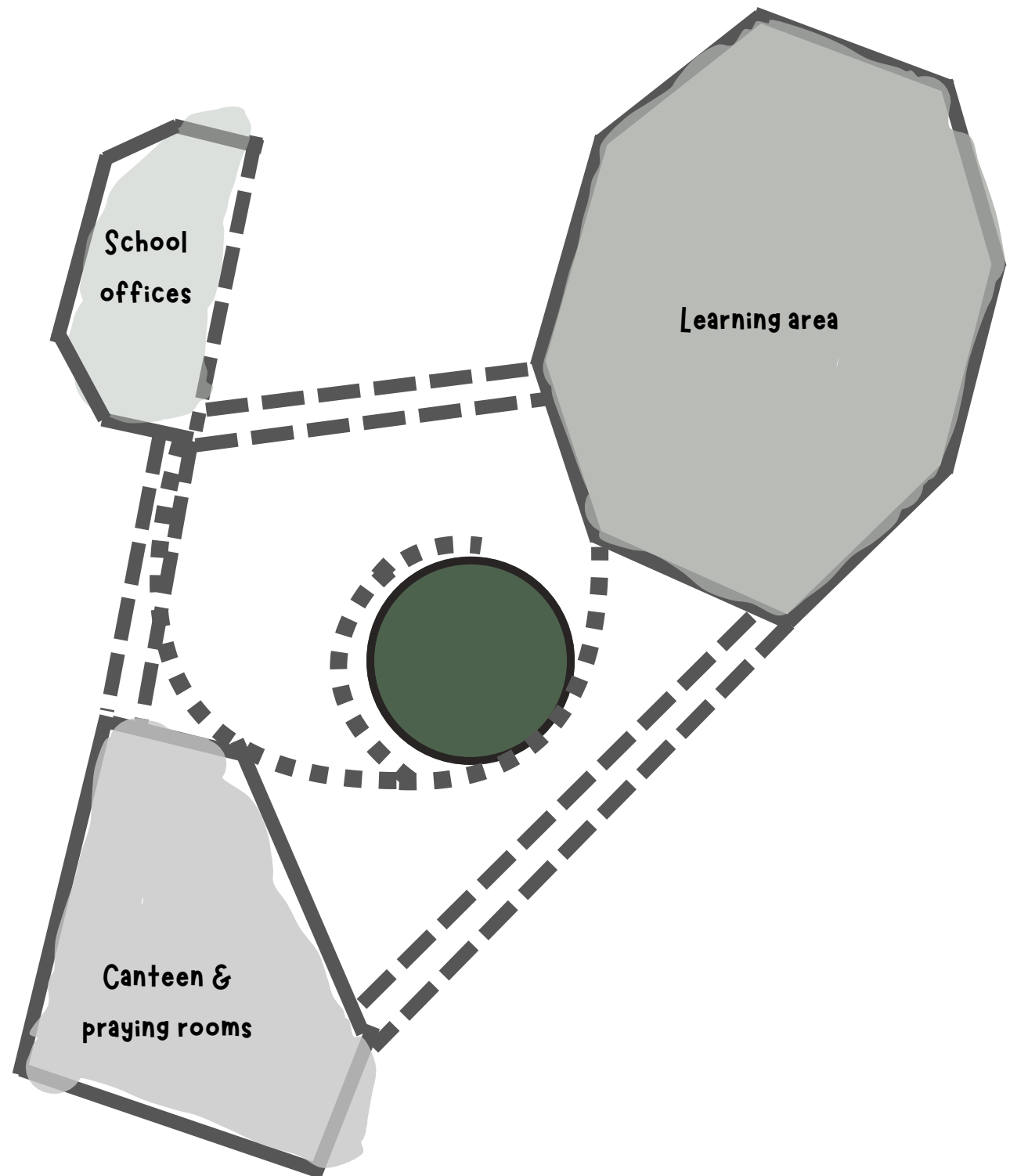


Figure 3.12 Final building masses
Source: Author, 2024

3.5.1 Mass 1 (Learning rooms)

This main mass is the largest mass since it accommodates all learning spaces.
Here is the zone concept for each space in this main mass.

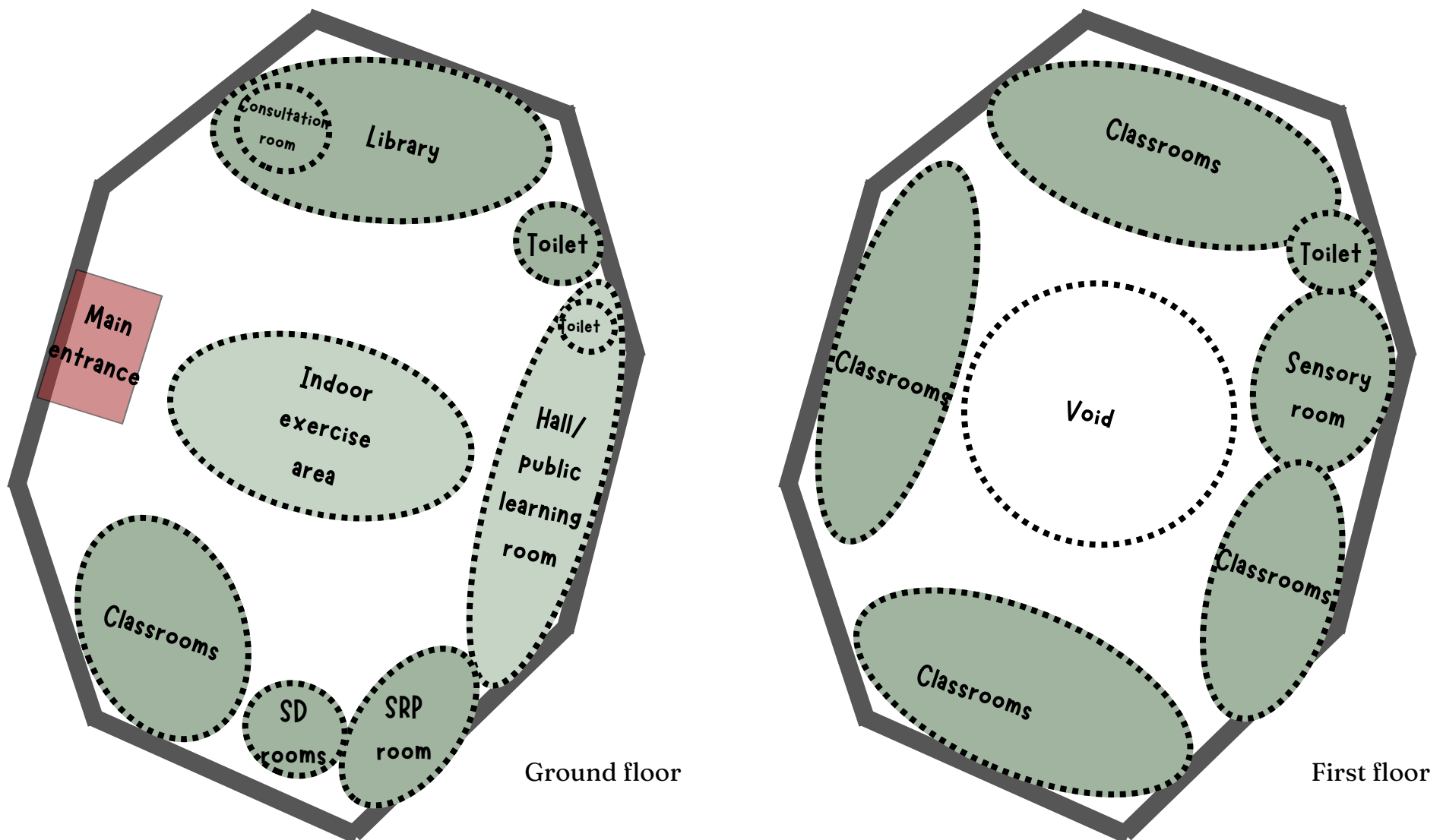


Figure 3.13 Rooms configuration in mass 1
Source: Author, 2024

This concept is mainly to put the indoor exercise area in the center of the mass because basically this area is actually a multifunctional area, which makes it easier for students from all over this mass area to go to this area. This area is also designed with voids, so that the sun can maximally illuminate this area, as well as spreading natural light to other rooms. Meanwhile, the other rooms are made around the void area in order to get natural light distributed from the void, facilitate easy visual navigation and accessibility.

The hall space is merged with the public learning room because if it is not used for learning, it can also be used as a meeting room. **The indoor exercise area and hall are placed on the ground floor to be a transition area to the more private rooms on the first floor.** The first floor is mostly a classroom area, but there are also classes on the ground floor for kindergarten, to make it easier for kindergarten students to get to class.

Plan and mass form

From the zoning concept above, the plan and mass form of the main mass is shown below.

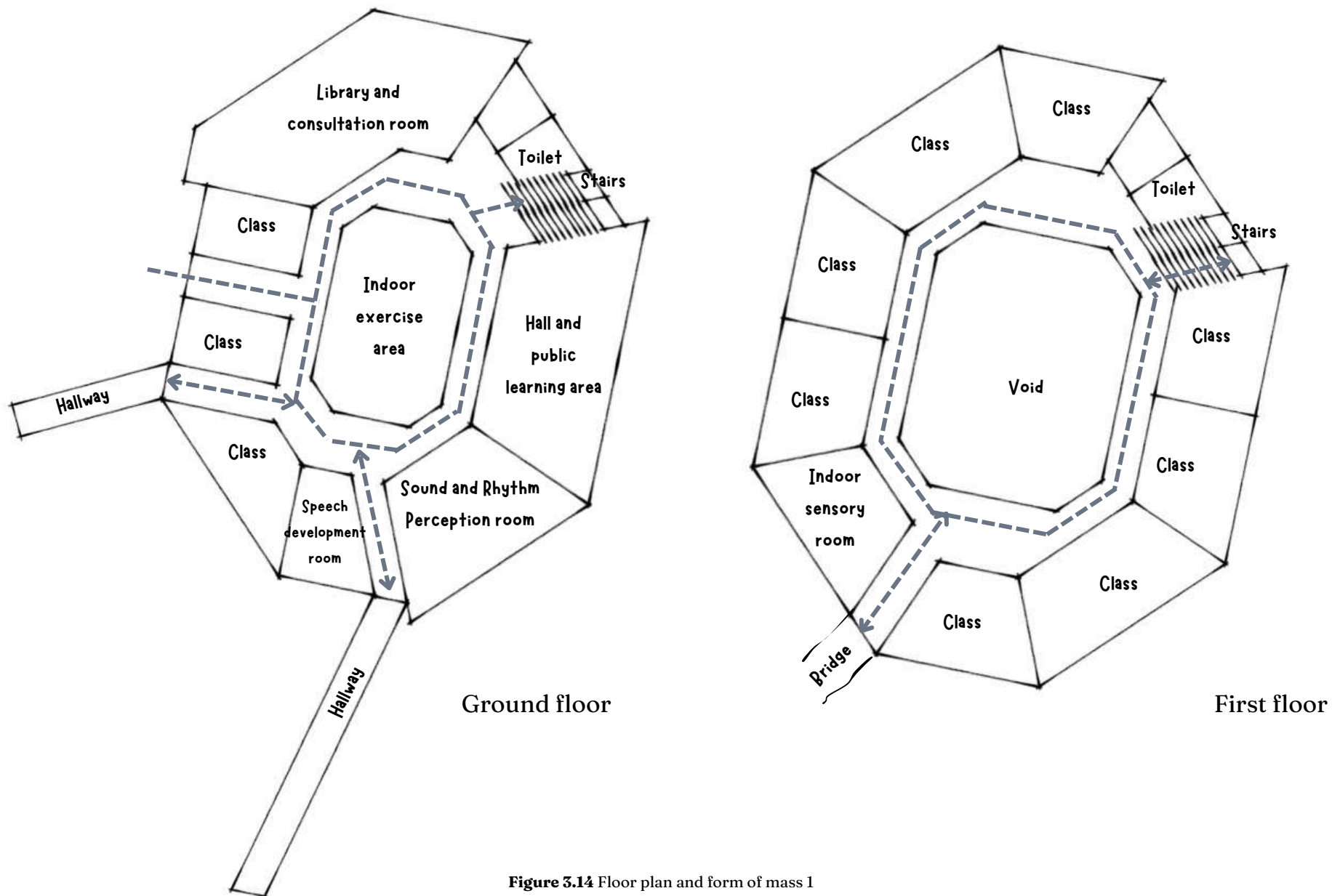


Figure 3.14 Floor plan and form of mass 1
Source: Author, 2024

The rooms in this main mass tend to follow the concept of octagonal form to harmonize with the form of this mass itself. On the first floor, the void is wider than the ground floor because the sunlight coming in from the roof can spread to the ground floor without being blocked by the corridor on the second floor. Besides, the wider second floor void makes it easier for deaf students to see and communicate with their colleagues on the ground floor.

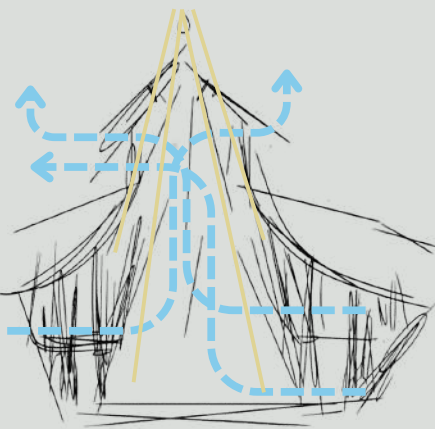
There are eleven classrooms with three classes on the ground floor for kindergarten, six classes for elementary school on the second floor, and two additional classroom that can be used for mixed classes on the first floor. Other learning support rooms are located on both the ground floor and first floor.

Circulation in this mass is circular, but still direct to the rooms and clear because there are no barriers in the voids. In addition, on the ground floor, there are two accesses to the hallway that leads to the two other building masses. On the first floor, there is also access to the bridge that connects this mass with the other masses.

Roof shape

The main concept of the roof for this main mass is to provide maximum natural light into the building both void areas, as well as to other rooms. In addition, the roof is also made high so that hot air inside the building can escape through the roof and be replaced with cooler air from the windows and vents below the roof. There are four alternative roof shapes described in the section drawings below:

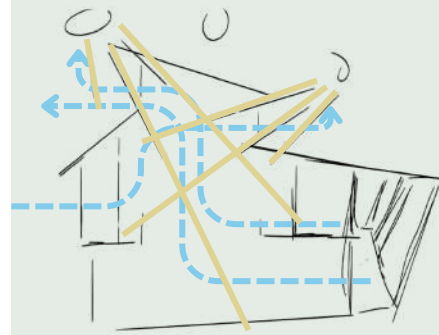
Alternative 1



Alternative 1 uses a stacked roof with glass on the topmost roof. The glass is located on either side of the top roof. This glass placement can capture natural light throughout the day. The distance between the topmost roof and the bottom becomes openings to remove hot air from the building.

Figure 3.15 1st alternative for roof shape
Source: Author, 2024

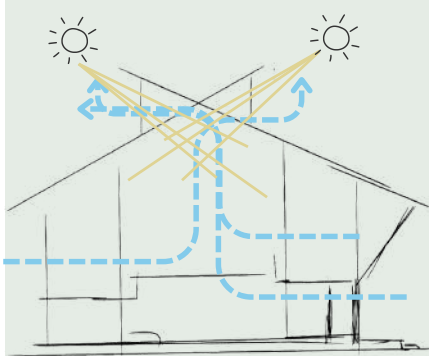
Alternative 3



Alternative 3 has stacked sloping roofs. The glass segments are located on the north and south sides of the building at different heights. This avoids glare and heat, but the sun is not in the north and south all year round. There are also vents in between the glass to release hot air.

Figure 3.17 3rd alternative for roof shape
Source: Author, 2024

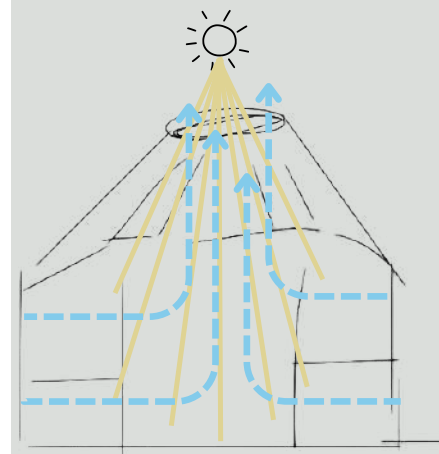
Alternative 2



Alternative 3 has a crossing roof structure, forming a butterfly roof at the top. Glass is located on the north and south sides at the same height. There are vents between the glass to release hot air.

Figure 3.16 2nd alternative for roof shape
Source: Author, 2024

Alternative 4



If the other three alternatives have the roof formed by dividing the building mass to form a rectangle, this last alternative follows the original shape of the building mass, which is an octagonal roof. It is a high conical roof, with the tops replaced with glass. Its high shape allows hot air to move up.

Figure 3.18 4th alternative for roof shape
Source: Author, 2024

Simulation result of the roof alternatives

This simulation uses the velux application with all surfaces of the four alternatives being the same. Additionally, the glass used has a transmittance of 16%, so it can reduce the intensity of incoming sunlight.

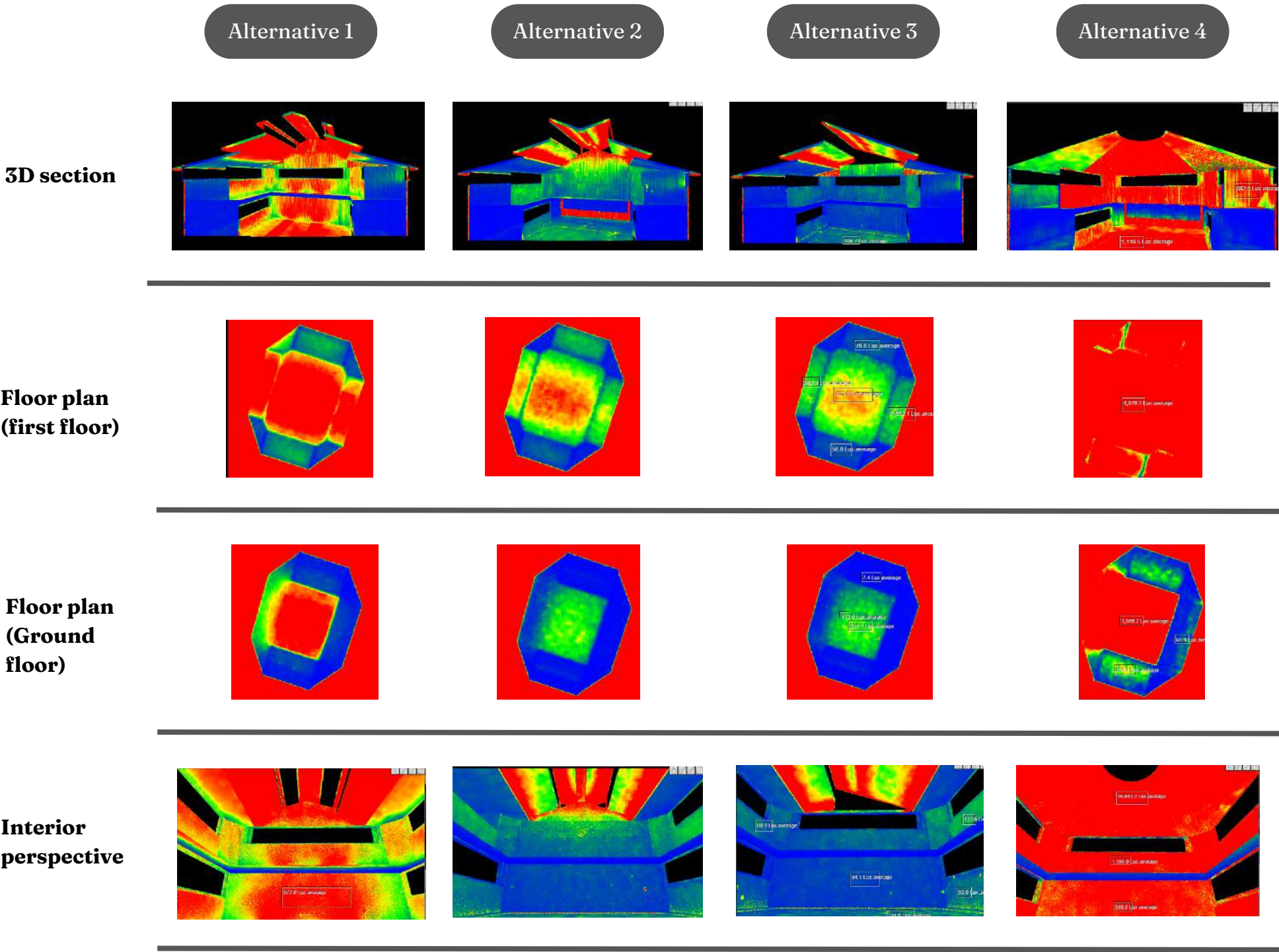
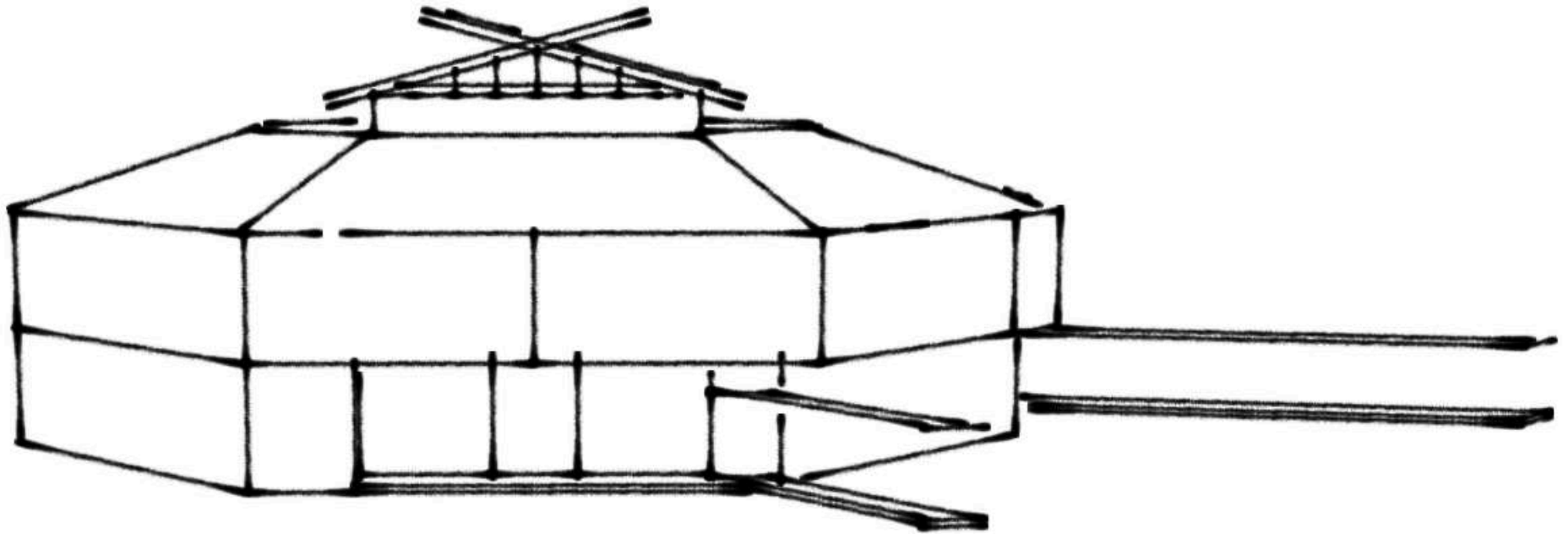


Table 3.6 Simulation for each roof shape
Source: Author, 2024

From the simulation above, **alternative 2 can provide very sufficient natural lighting and can spread widely** to almost all parts of the main room both on the ground floor and the upper floor.

Final building mass + roof



The use of alternative roof two is adapted to the octagon-shaped mass of the building, therefore only the middle part uses a butterfly roof with glass on the right-left side and also additionally on the front and back. The gap between the butterfly roof and the octagon roof becomes a ventilation to remove hot air from the building. This mass also has two hallways that lead to the other two masses.

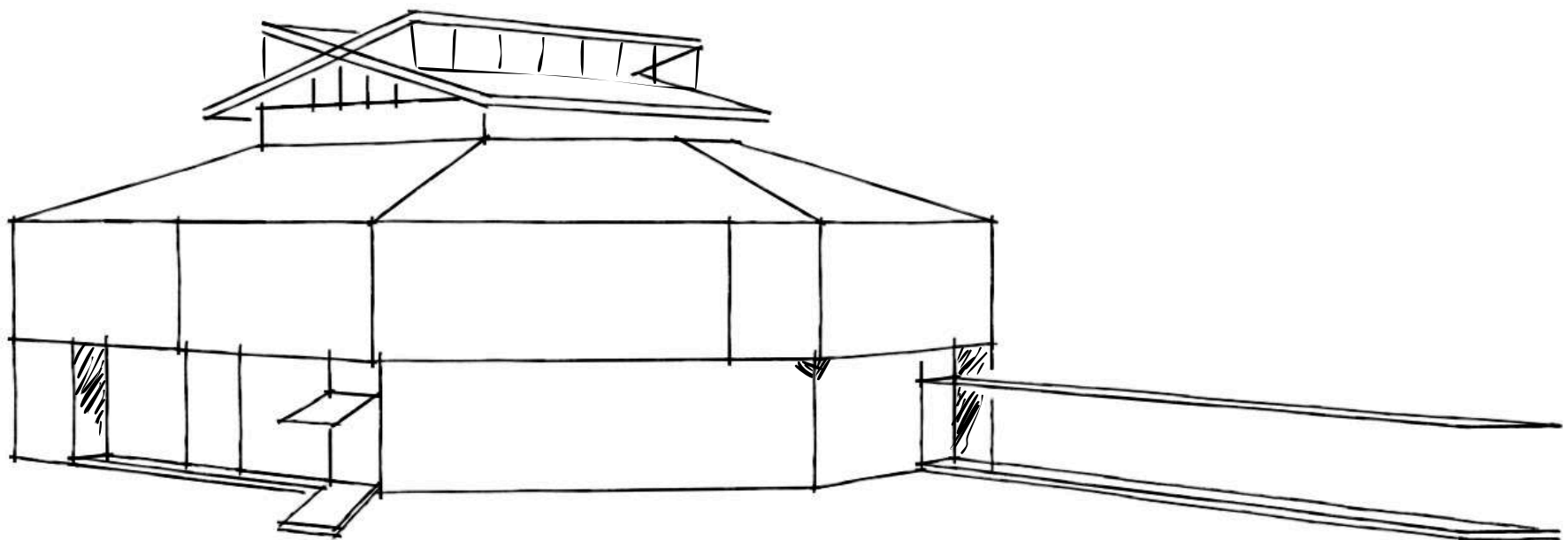


Figure 3.19 Mass 1 final form + roof

Source: Author, 2024

Rooms concept

Void

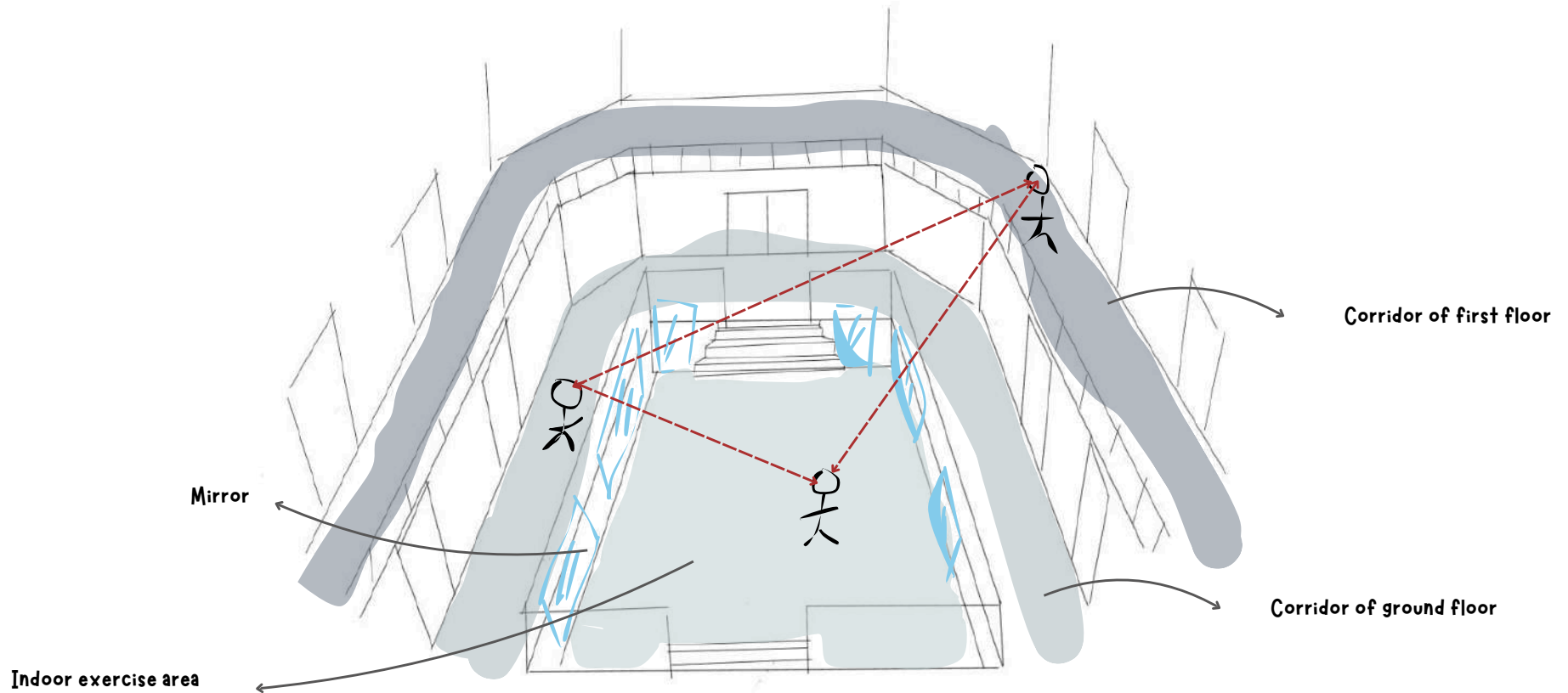


Figure 3.20 Concept of the void
Source: Author, 2024

In this void area, the location of the ground and upper floor corridors are not parallel, but the void on the second floor is wider, so that people from the second floor can see people walking in the first floor corridor and also in the indoor exercise area. The indoor exercise area is lower than the first floor so as to facilitate visual navigation to all floors, and also so that mirrors can be installed for indoor physical exercise without blocking the view of people walking in the corridor.

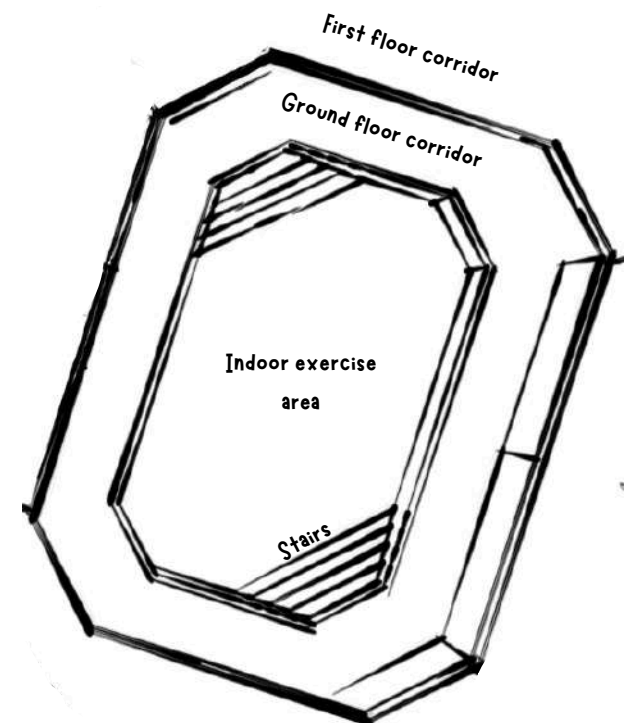


Figure 3.21 Concept of the void (floor plan)
Source: Author, 2024

Rooms concept

Classroom

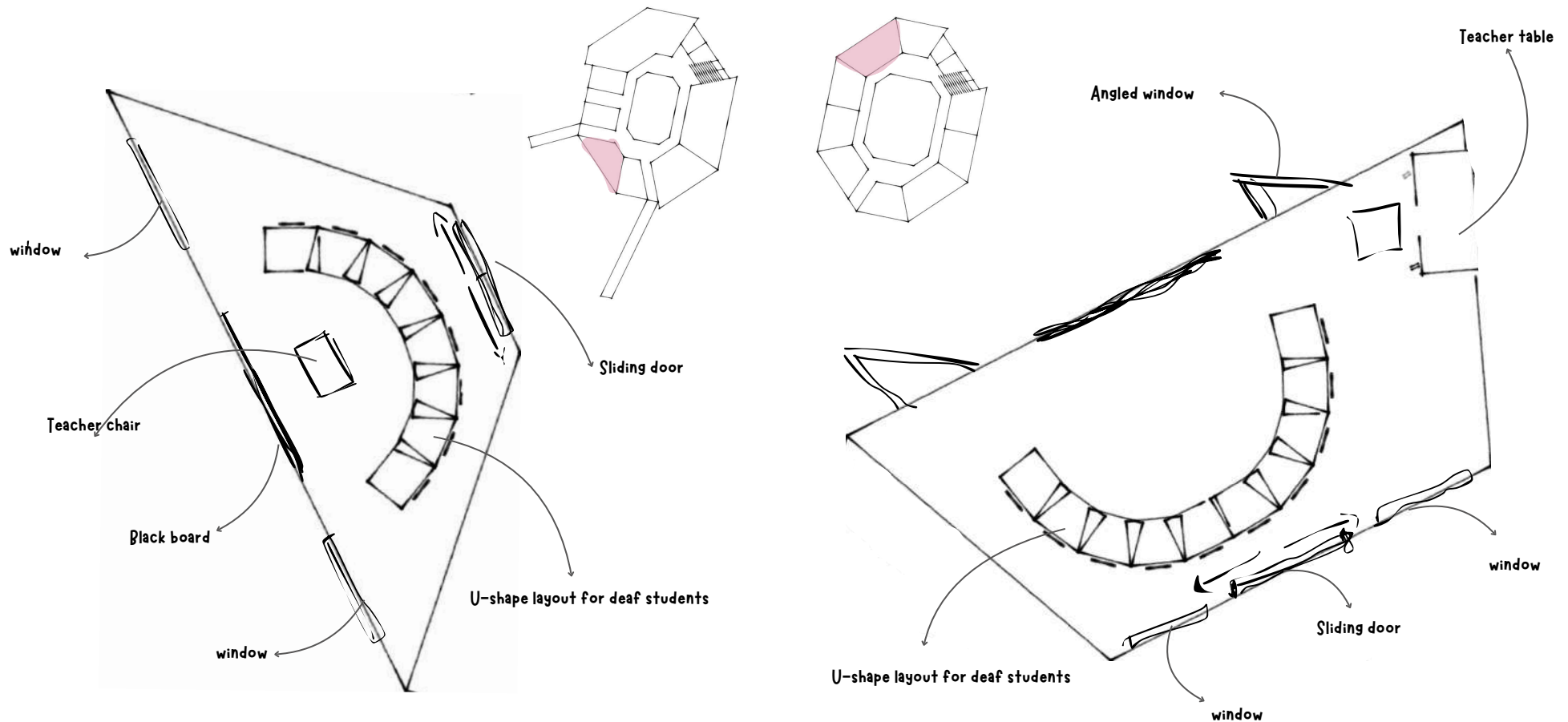


Figure 3.22 Concept of classroom
Source: Author, 2024

Kindergarten classes

There are three classes for kindergarten on the first floor. Two classes have a capacity of 6 people and the other class has a capacity of 8 people. Because they are located on the first floor, the sunlight is not as intense as the classes on the upper floors, so they only use ordinary windows. However, **there is an additional system of sun tubes to increase the lighting in the classroom.** For the kindergarten class, the teacher's chair is in the center of the circle of students to make it easier to focus on each individual.

Elementary school classes

There are 6 classes for elementary school with a capacity of 8 people and there are also two additional classes with a capacity of ten students in each class. For the seating layout, it is no different from the kindergarten class, which still uses a U-shape layout. However, the teacher's seat is not in the middle of the students, so as not to block the students' view. For the elementary class because **it is located on the second floor, the sunlight obtained is quite intense, so to avoid glare and excessive backlight, an angled window is used to deflect light and spread it into the room.**

Structure

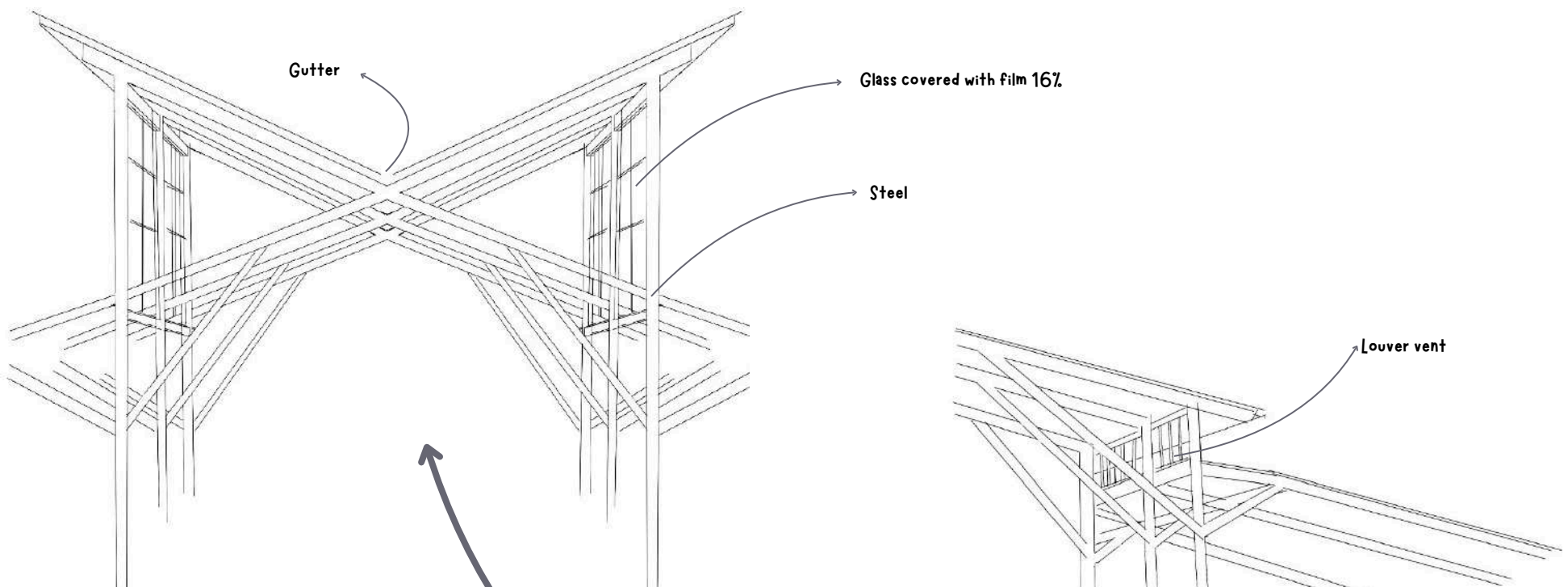


Figure 3.23 Concept of roof structure
Source: Author, 2024

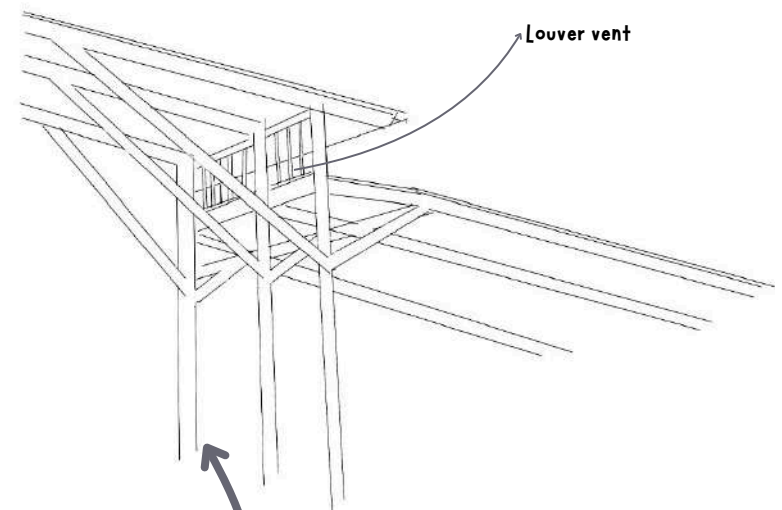


Figure 3.24 Concept of roof vents
Source: Author, 2024

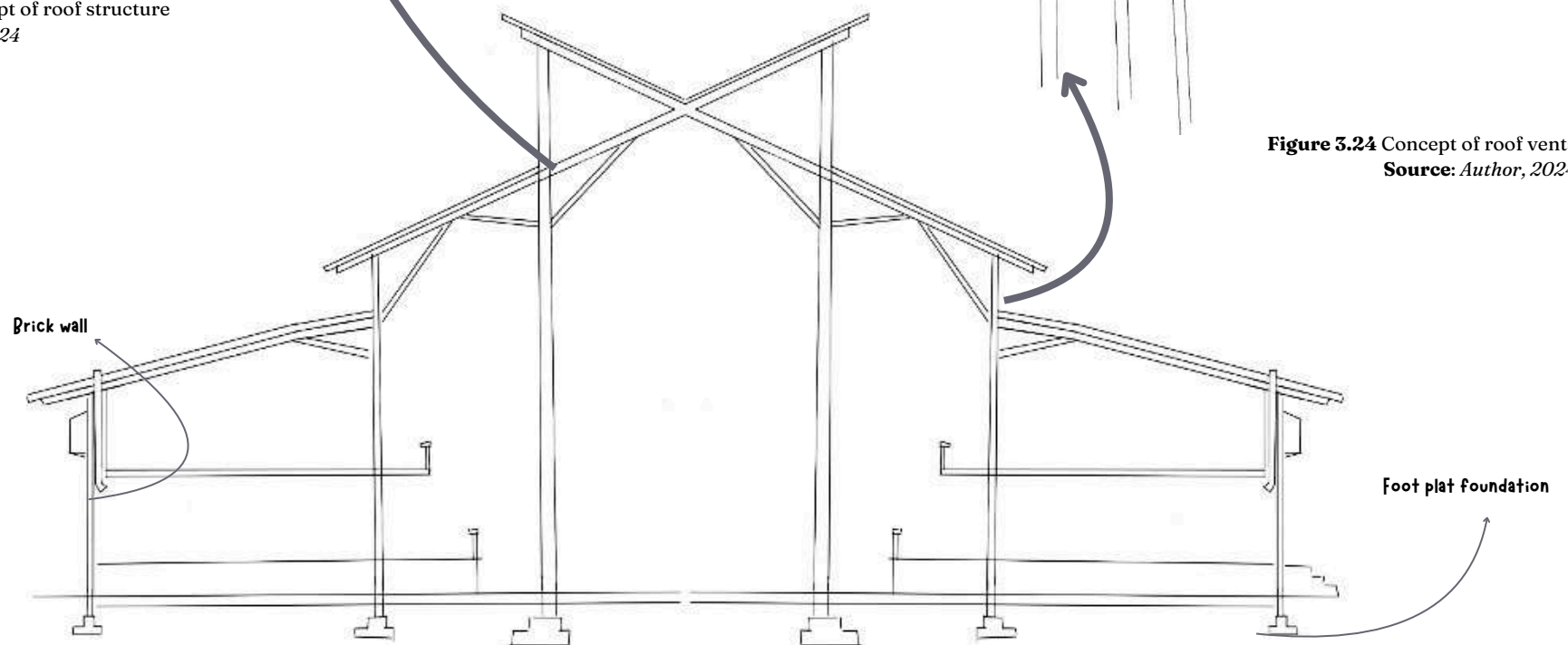


Figure 3.25 Concept of building structure
Source: Author, 2024

The building uses a **wide-span steel structure**, as it considers areas that require large areas without columns such as the indoor training area and hall. This steel structure is combined with brick walls that can keep the building from getting too hot. In order to keep the brick wall from being exposed to the sun too much, the overhanging roof and many openings help to reduce the heat in the building.

Building envelope (window)

On the second floor there is an angled windows that functions to direct sunlight into the classroom without creating glare, because this window will direct and reflect light onto the wall, so that the class remains bright without glare. The type of window used is a sliding door so that it can be adjusted how large the opening is needed.

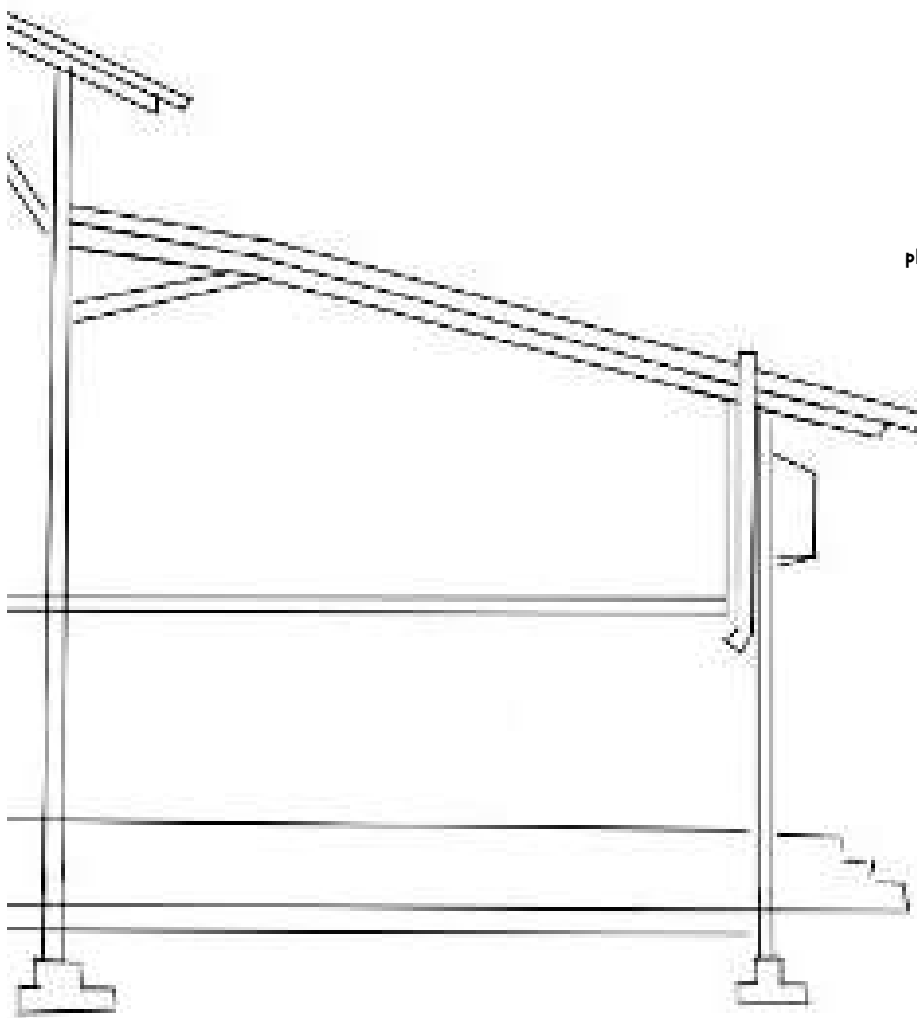


Figure 3.26 Concept of angled window
Source: Author, 2024

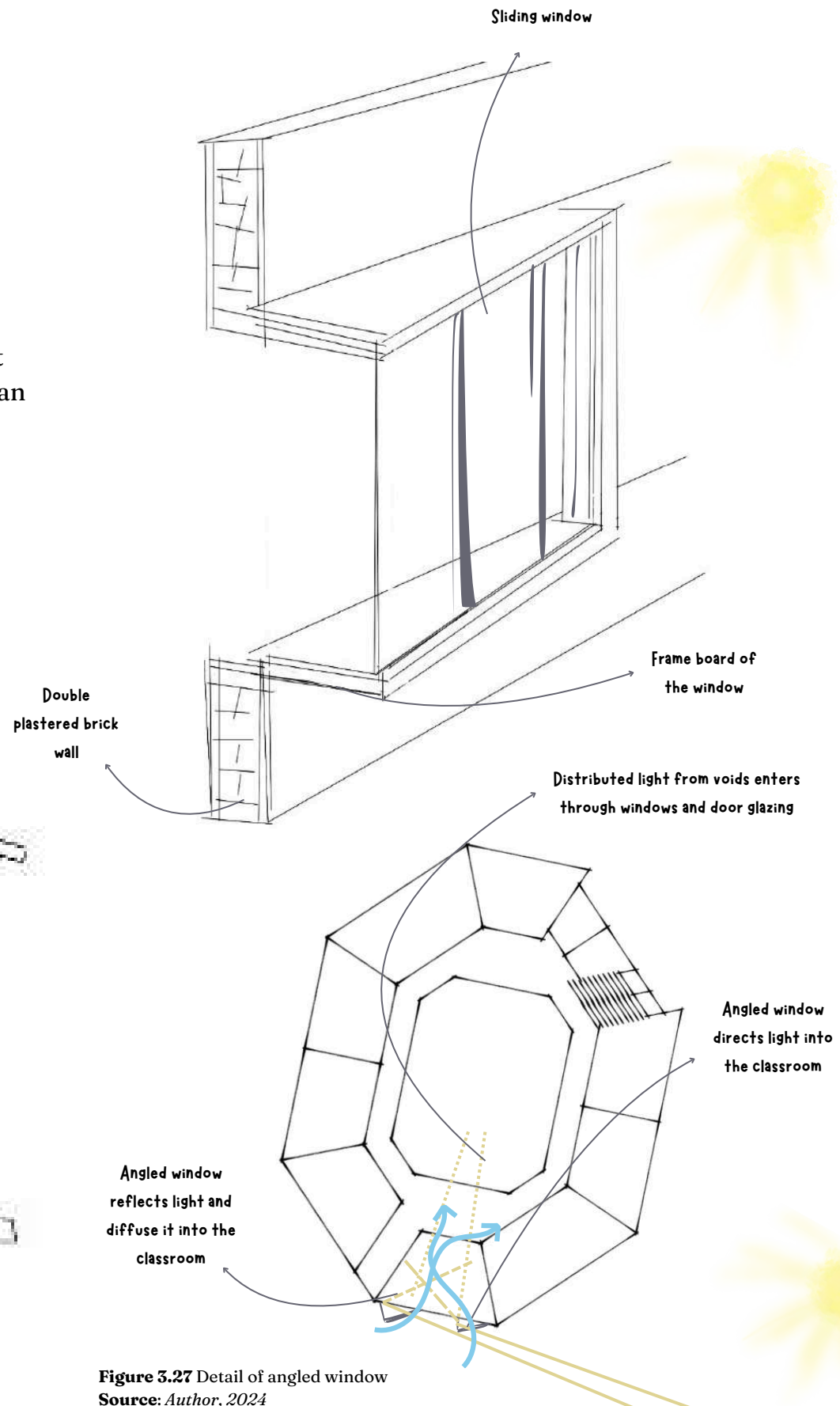


Figure 3.27 Detail of angled window
Source: Author, 2024

3.5.2 Mass 2 (School offices)

This mass is the first mass to be entered by guests, as it accommodates school offices. Here is the zone concept for each space in this second mass.

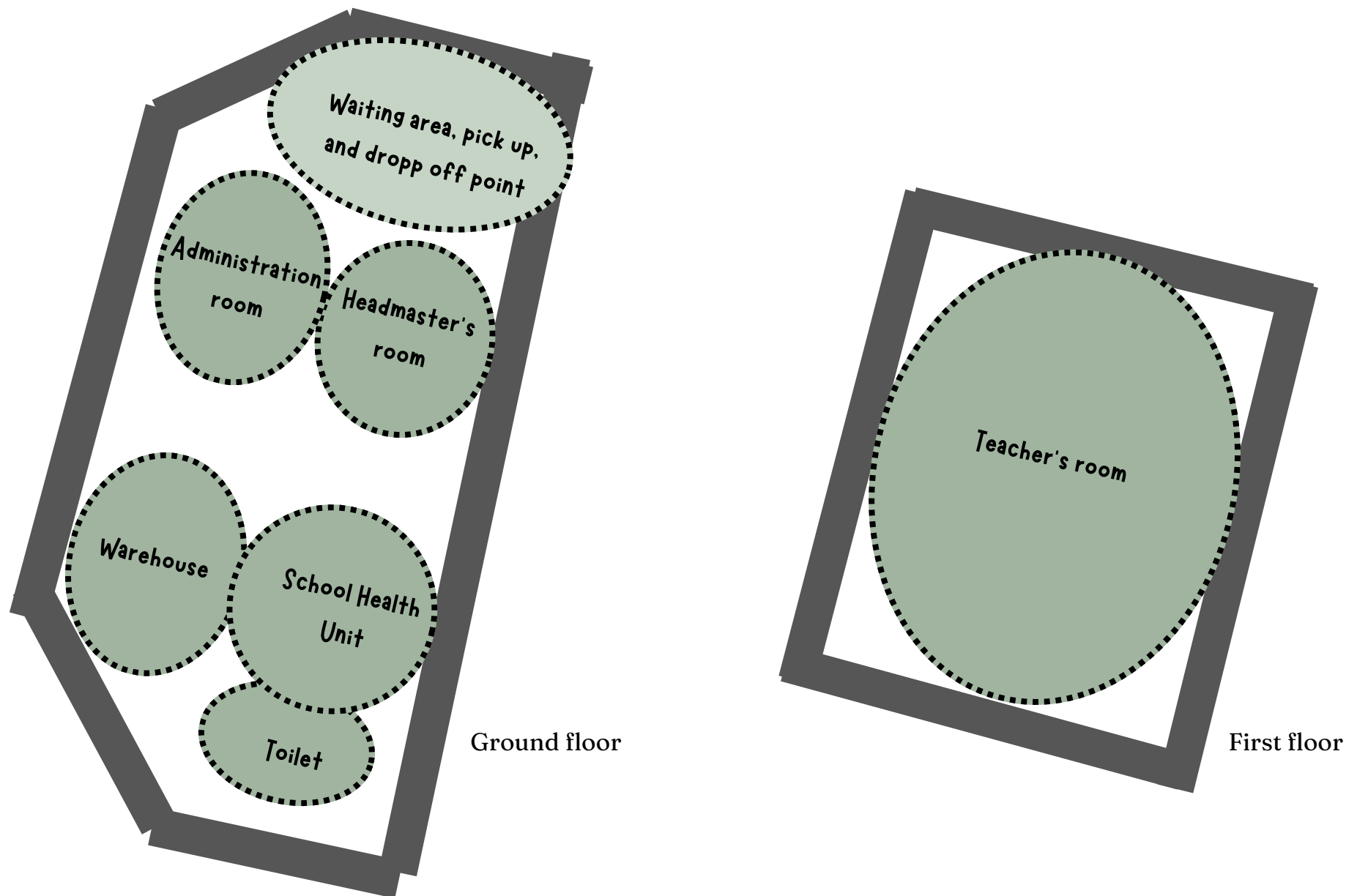
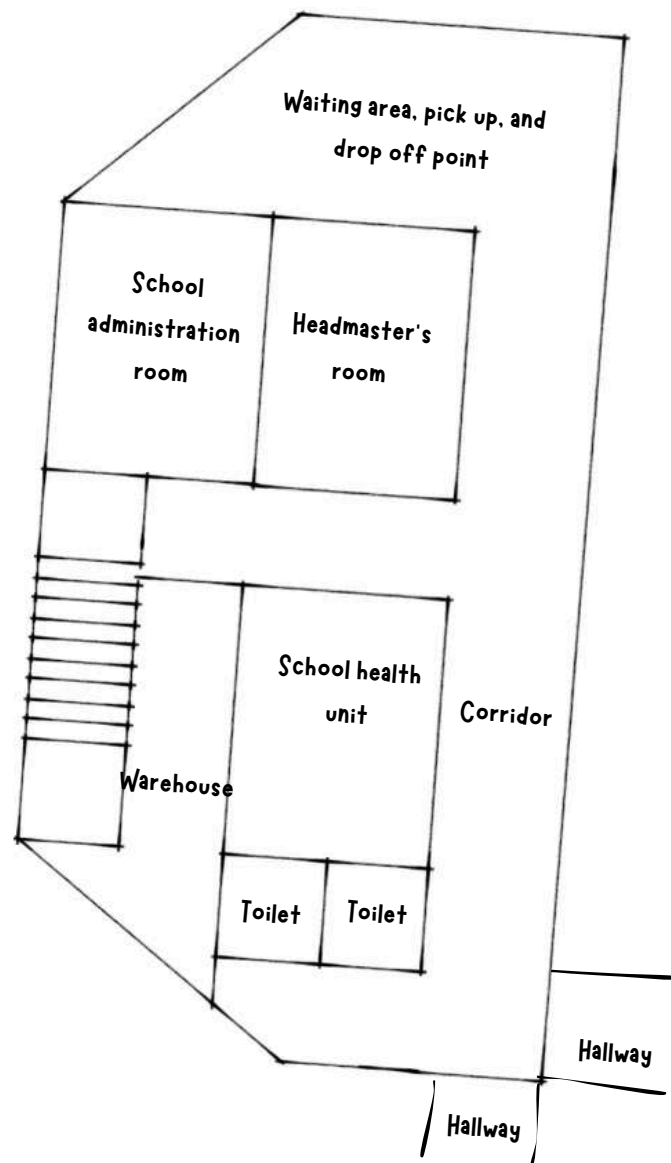


Figure 3.28 Room configuration of mass 2
Source: Author, 2024

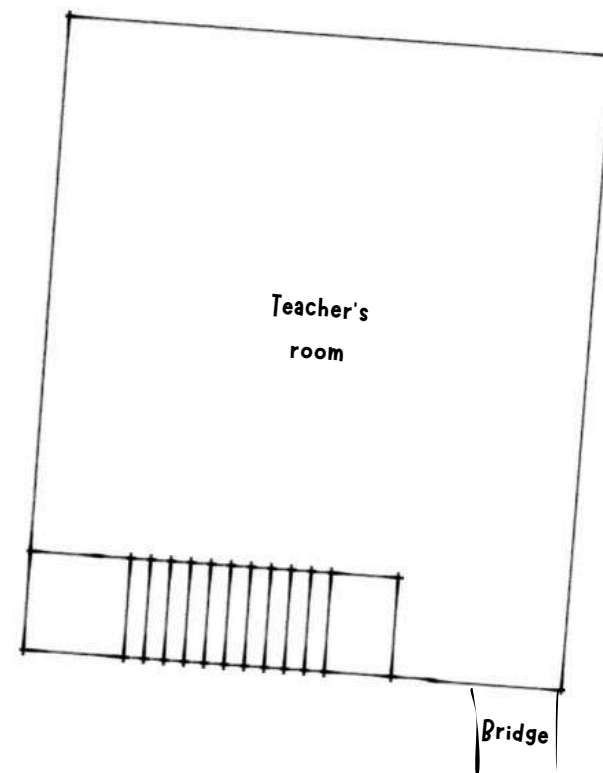
This mass is specifically for rooms related to school administration and management. The headmaster and administration rooms are on the ground floor to make it easier for guests who come to meet with school administrator. In this mass there is also a School Health Unit on the ground floor, so that if there are students who are sick, the teacher is easier to supervise, and close to the parking lot so that it is easier if there are students who need to be taken to the clinic or picked up by student guardians. In this building mass there is also a waiting area which also functions as a pick-up and drop-off area.

Plan and mass form

From the zoning concept above, the plan and mass form of the second mass is shown below.



Ground floor



First floor

Figure 3.29 Floor plan and form of mass 2

Source: Author, 2024

Although the basic shape of this mass is a subset of the octagon geometry, **the rooms tend to be square. This is intended to maximize the function of the limited space.** Even the warehouse uses the area under the stairs, which is quite spacious. **The teacher's room is on the upper floor with two doors leading to the stairs to the first floor and also to the bridge to go to the other two building masses.** The bridge access is intended to facilitate teacher access, especially access to the learning spaces on the second floor.

3d building mass

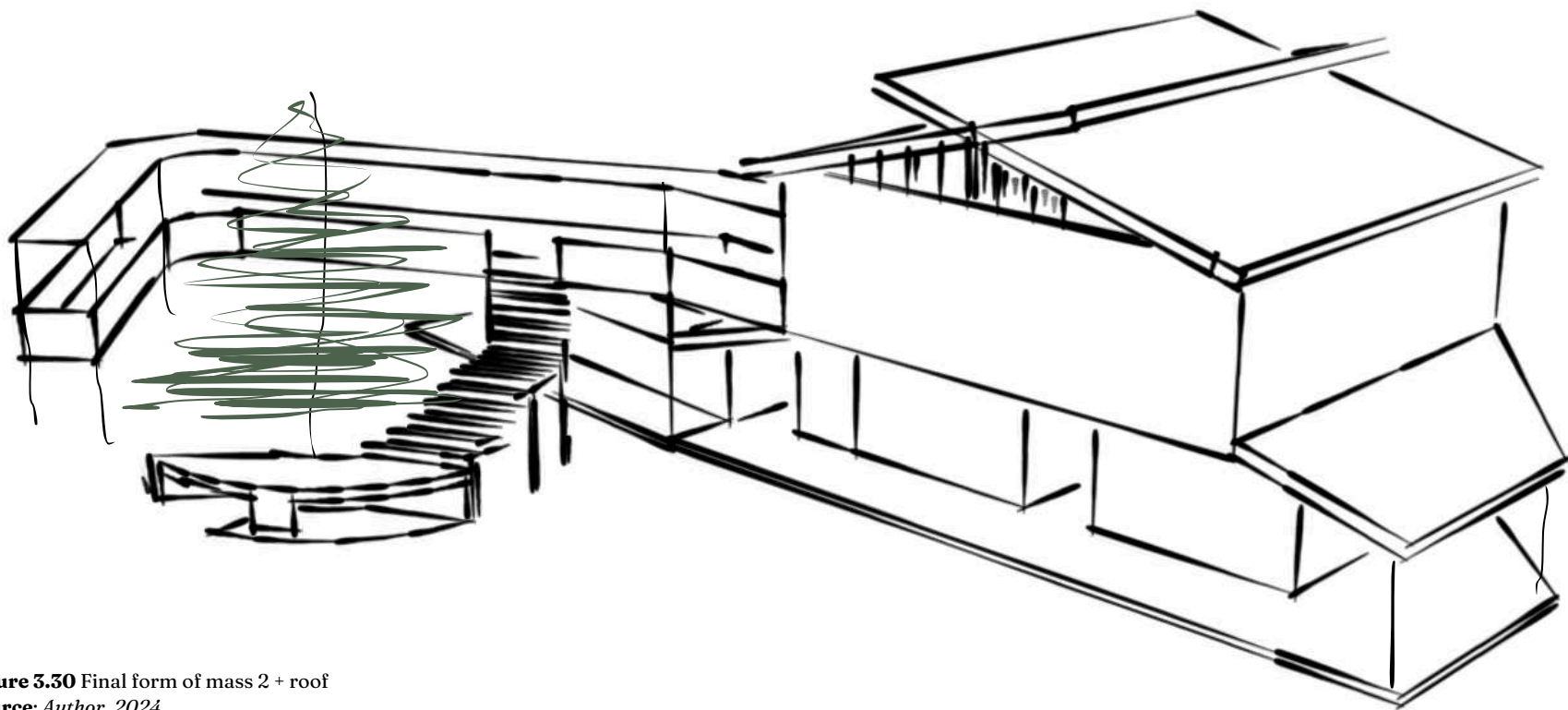
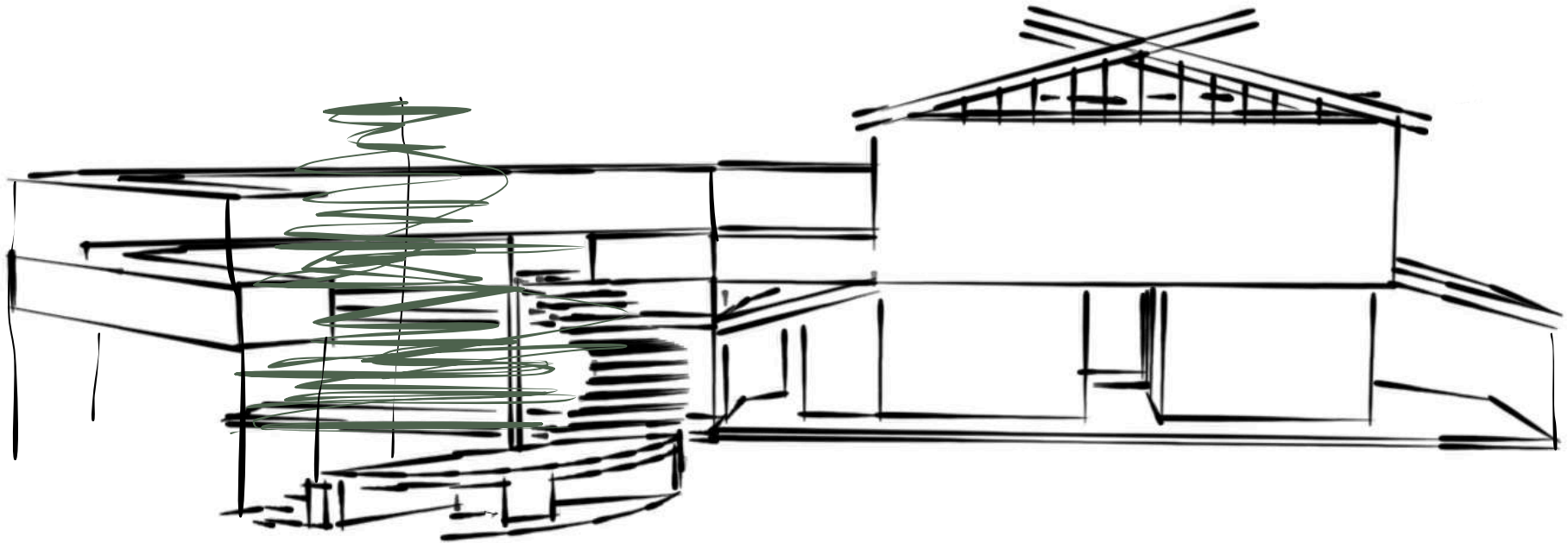


Figure 3.30 Final form of mass 2 + roof
Source: Author, 2024

3.5.3 Mass 3 (Canteen and praying rooms)

This mass is accommodating the supporting rooms such as praying rooms and canteen. Here is the zone concept for each space in this second mass.

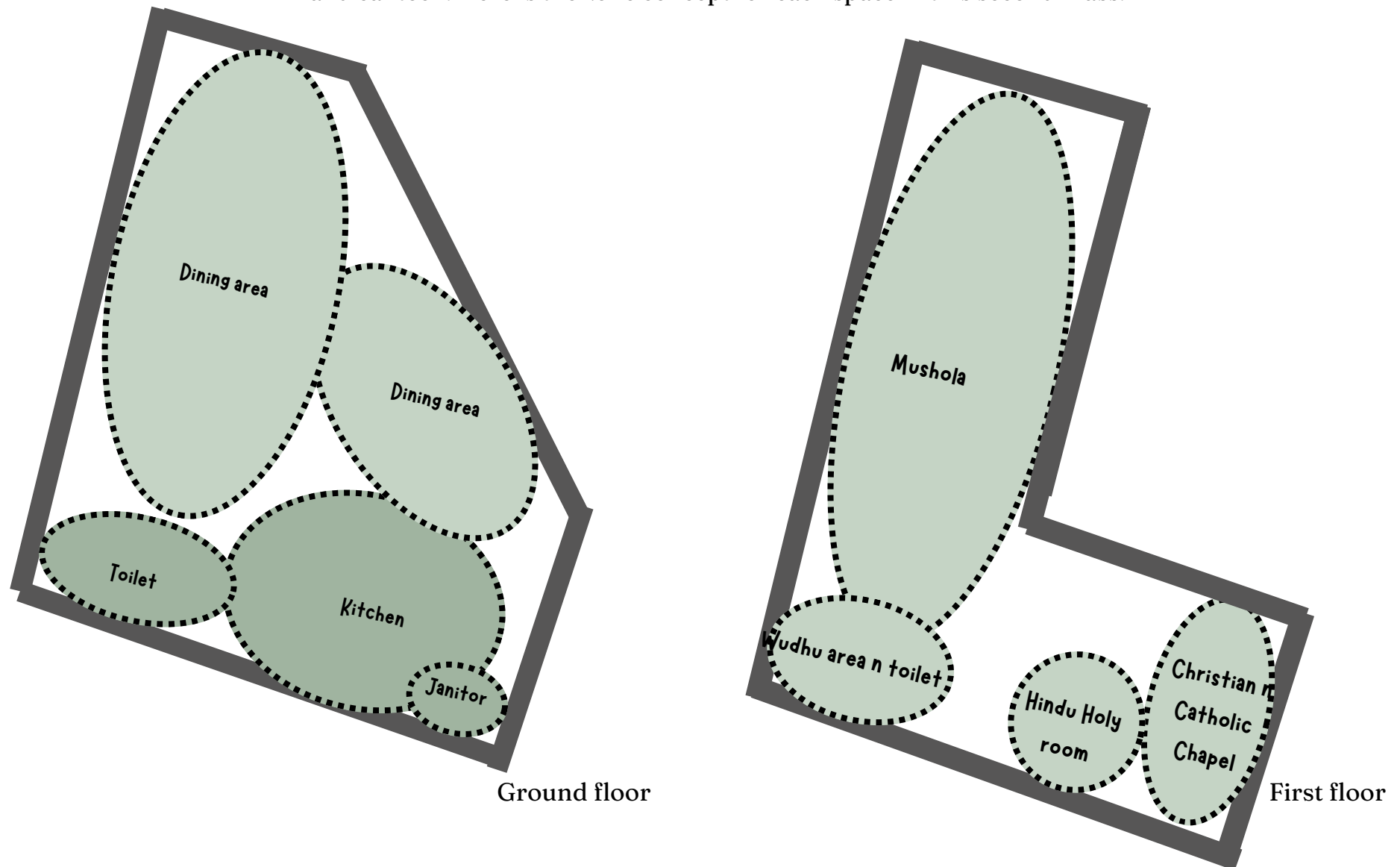


Figure 3.31 Room configuration of mass 3
Source: Author, 2024

The mass has two floors, the ground floor is used for the canteen and the upper floor for praying rooms. The service areas in the canteen such as toilets, kitchen, and also janitor are in the back area of this mass, so the **dining area has semi-open space to enjoy the view of the nearby sensory garden. While the upper floor is a bit more closed to maintain the solemnity of worship.** There are three prayer rooms, which are a musholla, a chapel, and also a Hindu holy room. The musholla area is the most spacious worship area, followed by the Christian and Catholic chapels, and the smallest is the Hindu Holy room.

Plan and mass form

From the zoning concept above, the plan and mass form of the third mass is shown below.

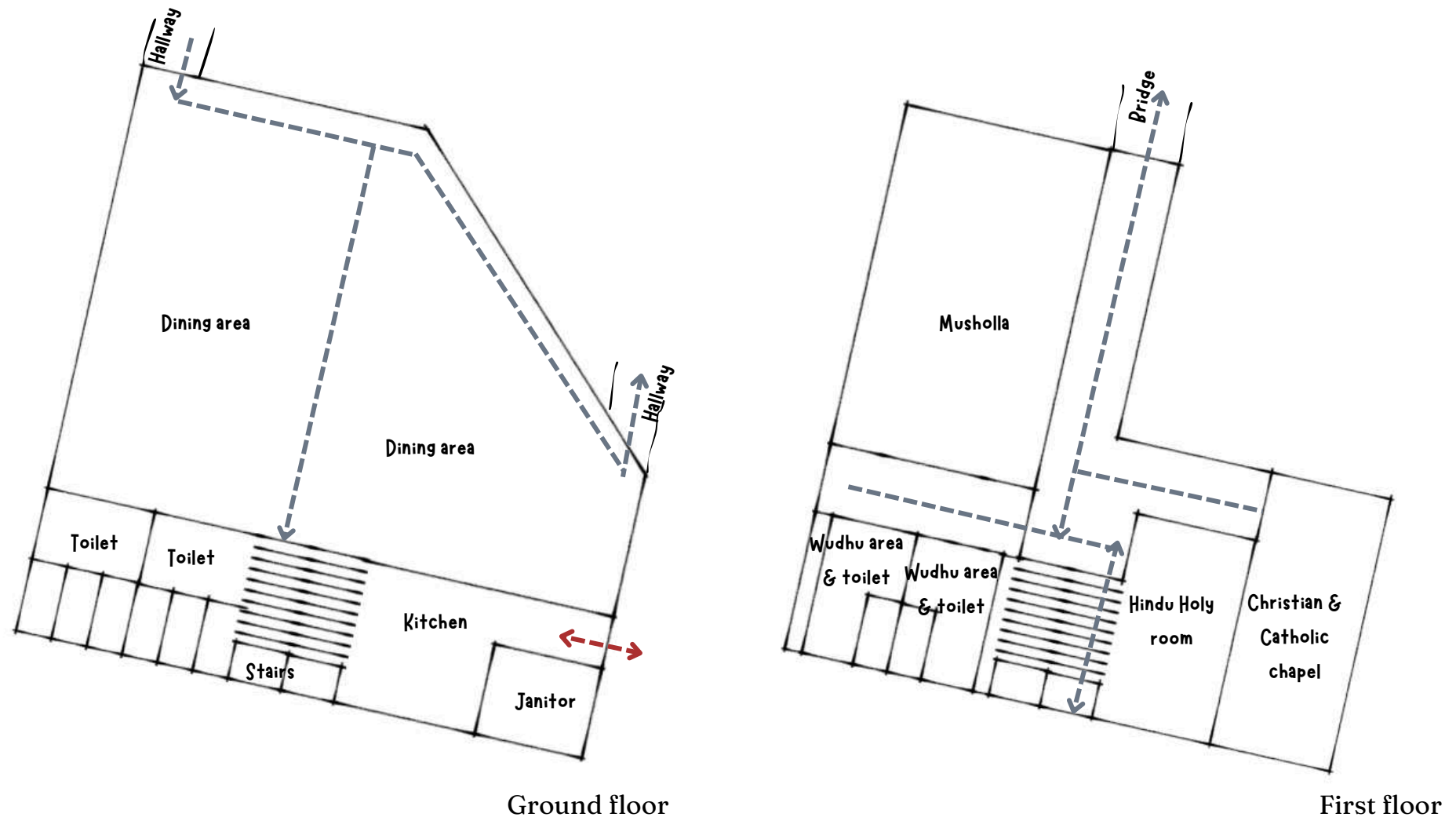


Figure 3.32 Floor plan and form of mass 3
Source: Author, 2024

The first floor as the **canteen area has a semi-open concept, which facilitates easy circulation and also makes the room feel more spacious. In addition, with this semi-open space concept, students can communicate with their friends who are on the playground or in the sensory garden.** For staff, there is a separate access from outside the building mass to the kitchen and janitor without having to pass through the dining area (red arrow). While access to the upper floors can go by two ways, by using stairs and also using a bridge that connects the upper floors of the three masses on this site. This upper floor area tends to be more closed to maintain the solemnity of worship.

3d building mass

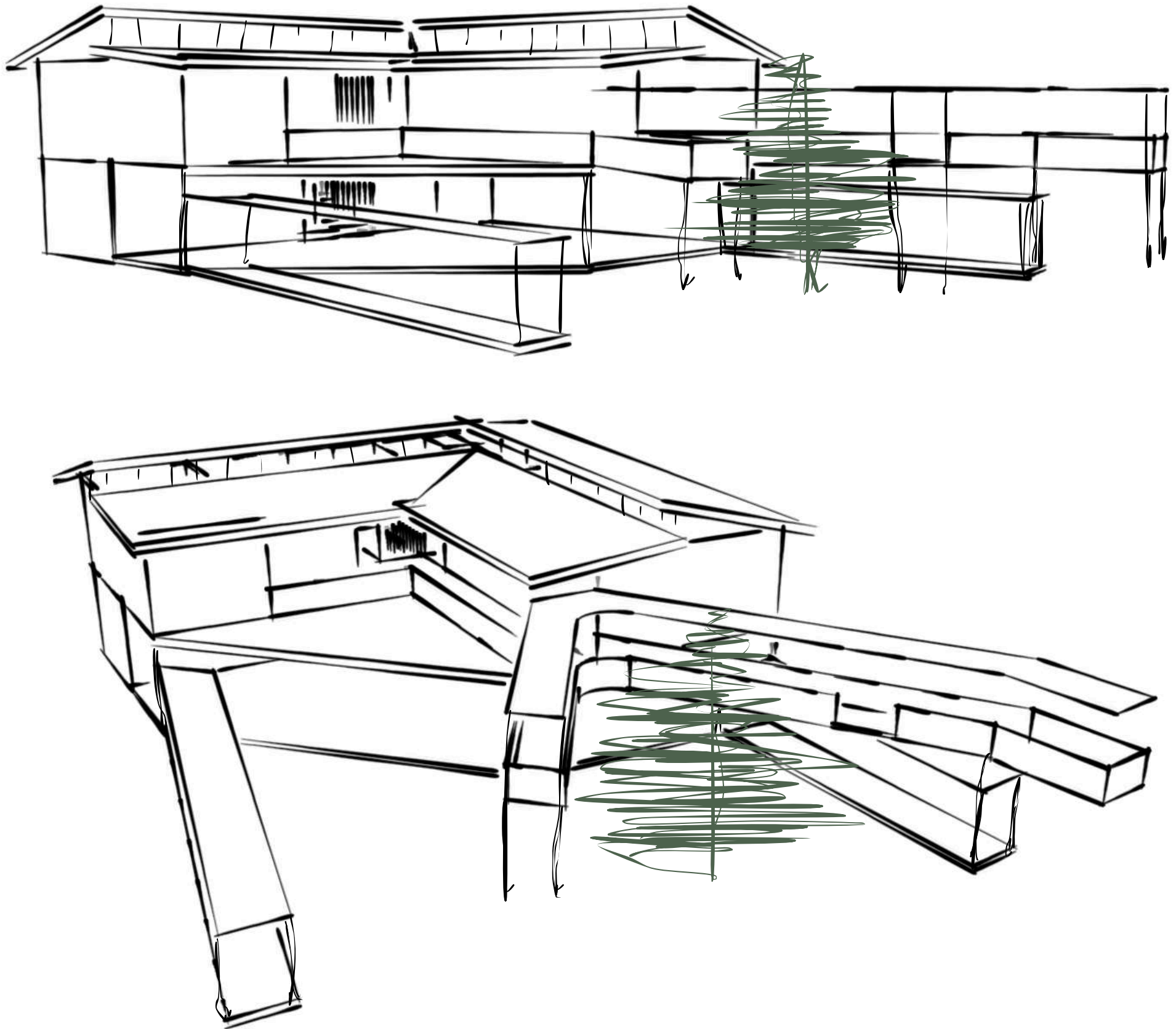


Figure 3.33 Final form of mass 3 + roof
Source: Author, 2024

3.5.4 Hallway



Figure 3.34 Concept of the hallway
Source: Author, 2024

The hallway is made open to better integrate with the surrounding environment, allowing natural light and air circulation, as well as to make the site feel wider and facilitate visual navigation. This hallway connects each building mass, making it easier to access each building and remain protected from heat and rain. The hallway floor is made higher than the ground so that it is not flooded with rainwater.

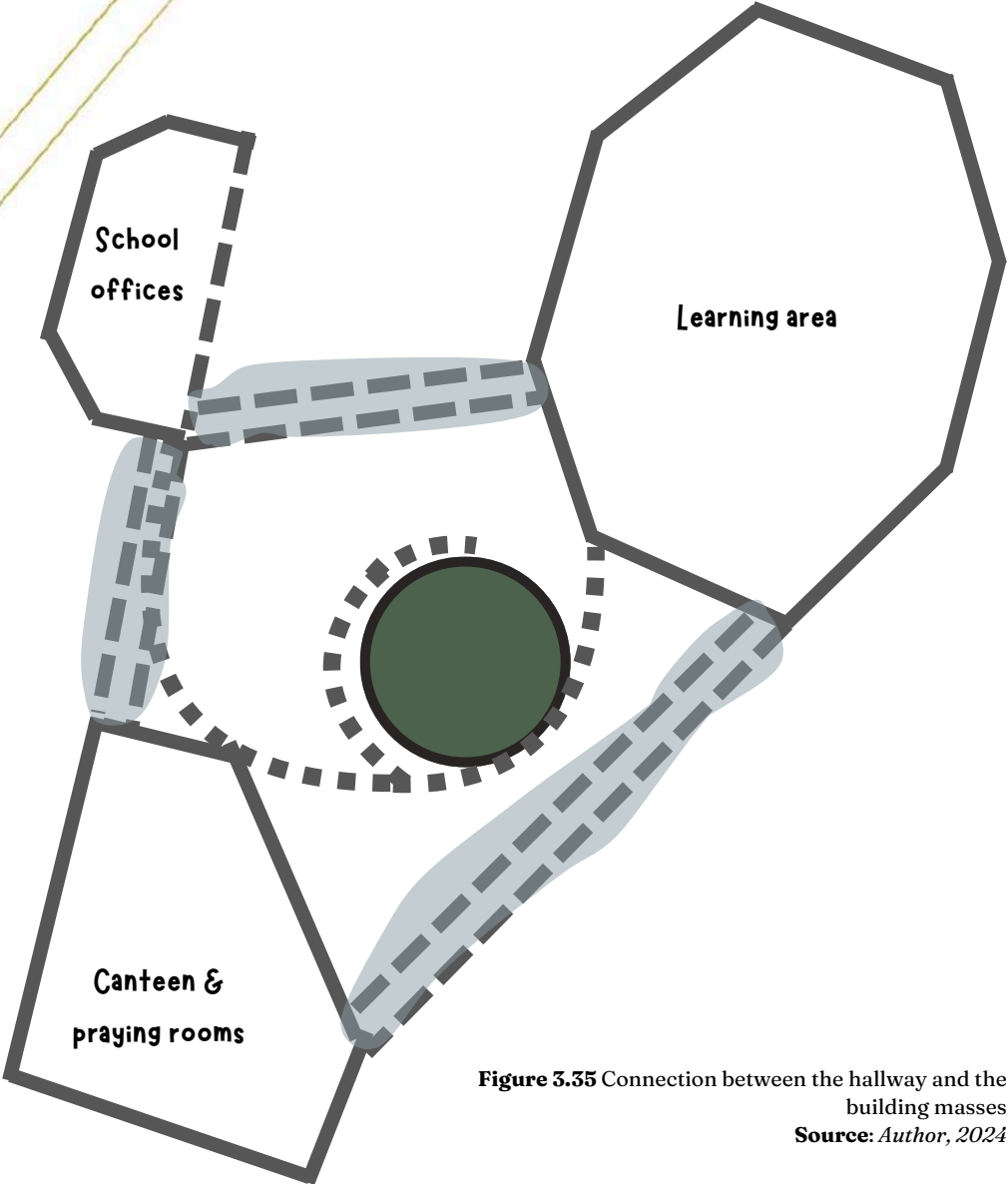


Figure 3.35 Connection between the hallway and the building masses
Source: Author, 2024

There is a hallway that connects the second floor of the mass learning area with the second floor of the mass which functions as a canteen and praying area. The existence of this hallway makes it easier for students and teachers to go to the praying area or to the canteen. This hallway is also equipped with a roof to avoid heat and rain. This hallway is made slightly curved, in contrast to other hallways that are straight, because there is a large tree between the two masses.

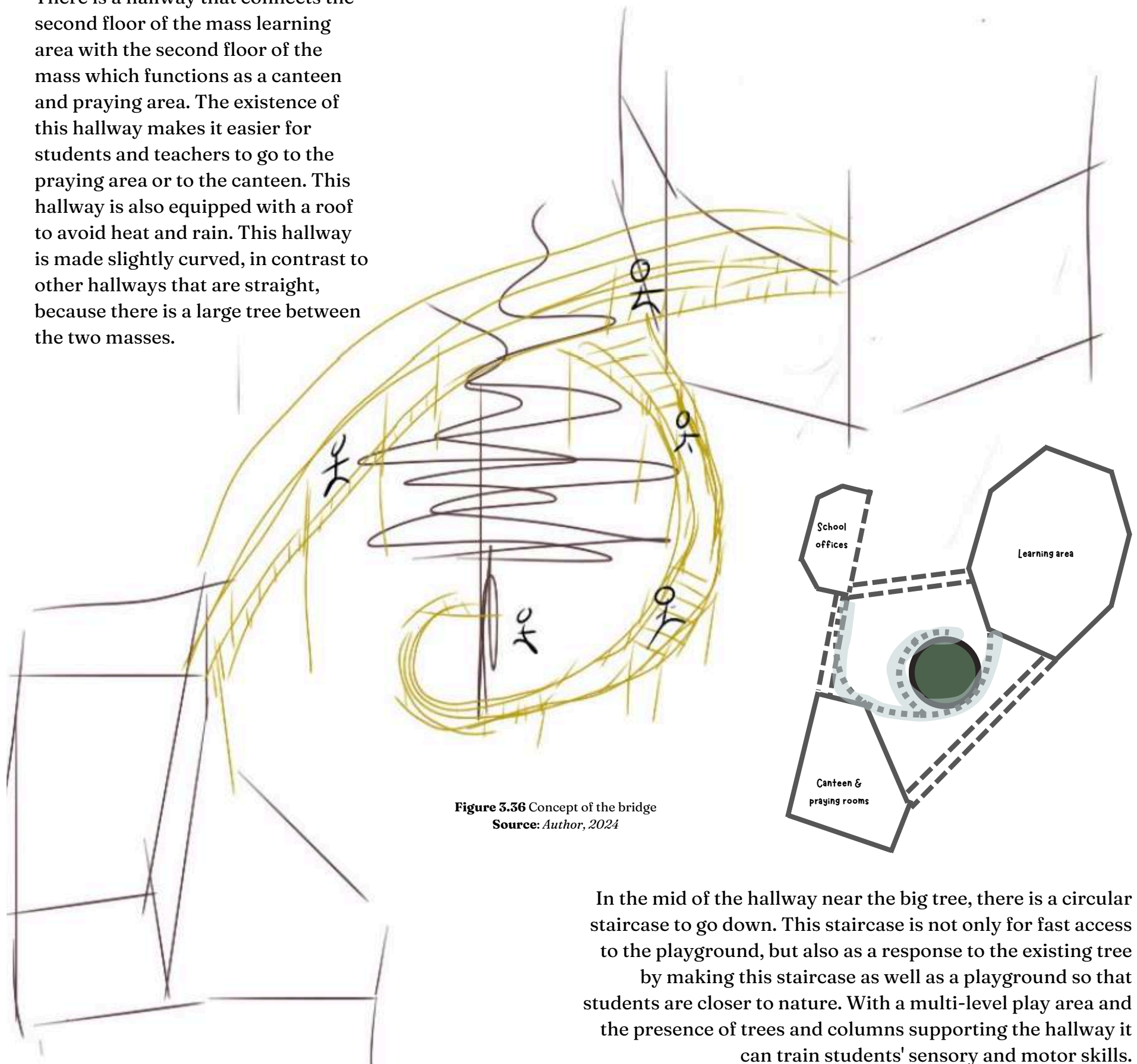
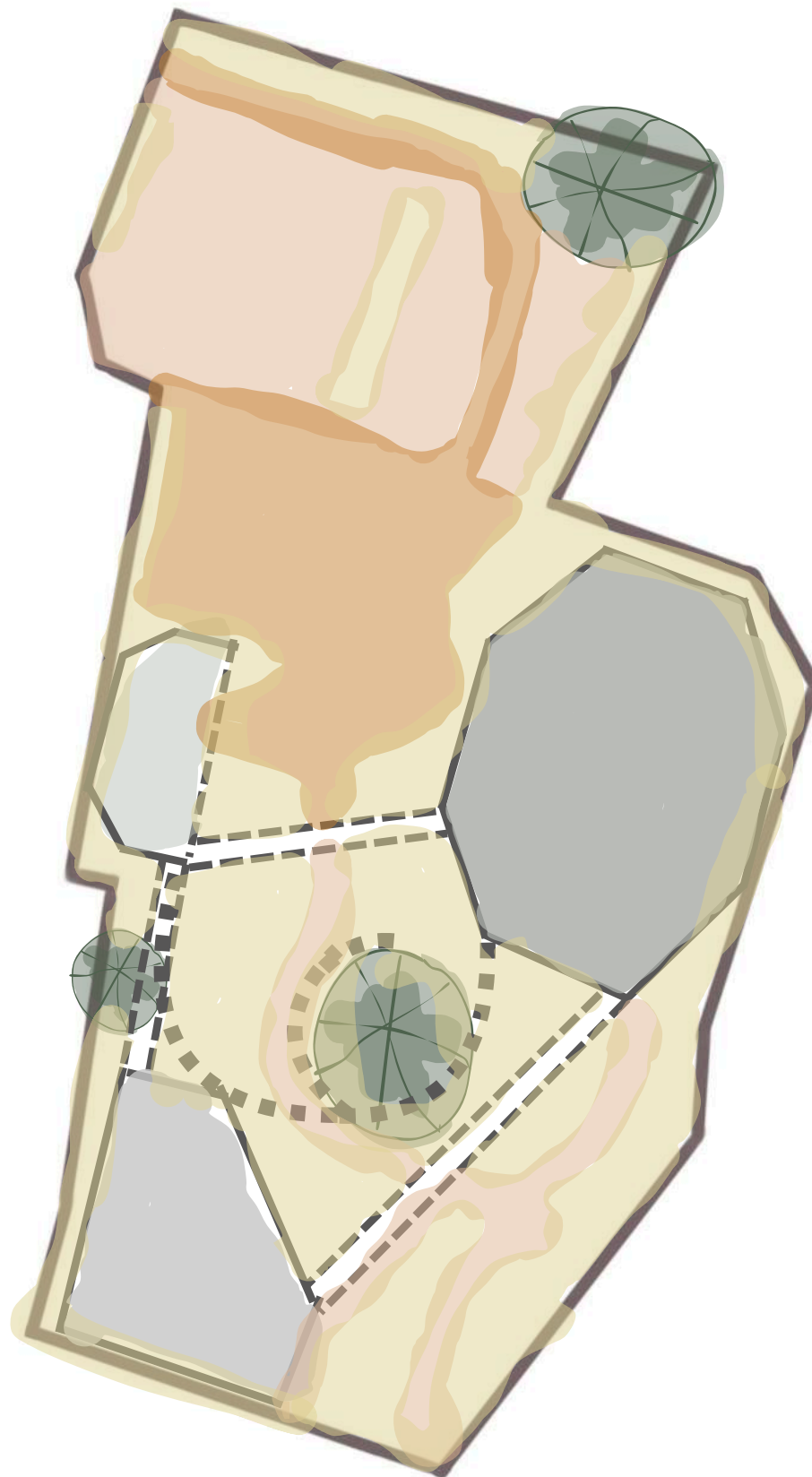


Figure 3.36 Concept of the bridge
Source: Author, 2024

In the mid of the hallway near the big tree, there is a circular staircase to go down. This staircase is not only for fast access to the playground, but also as a response to the existing tree by making this staircase as well as a playground so that students are closer to nature. With a multi-level play area and the presence of trees and columns supporting the hallway it can train students' sensory and motor skills.

3.6 LANDSCAPE CONCEPT (mezzo-micro concept)

3.6.1 Hardscape and softscape



On this site there are three types of landscapes, which are hardscape, semi-softscape, and softscape. These three types are used based on function and also divide an area. The difference in landscape is also a navigation tool for deaf students to determine direction and destination.

The use of hardscape starts from the entrance as a pedestrian path, school yard, until it ends at the two forefront masses and also the hallway that connects both masses. The hardscape used is solid paving to make it easier for deaf students to walk without tripping and provide clear visuals.

For the use of semi-softscape is in two areas, which are the parking area and also the playground and sensory garden area. In the parking area, the type of hardscape used is paving grass block. While in the playground and sensory garden area used is a type of cobblestone path. In these two areas, the landscape is made softer than the front area because this is an area that stimulates children's sensory, so it must blend more with the surrounding nature.

Lastly, the softscape is mostly used in the playground and sensory garden areas. In these two areas, the softscape is covered by grass and natural soil. Apart from these two areas, softscape is used around the site in the border area and also a few in the parking area to add freshness.

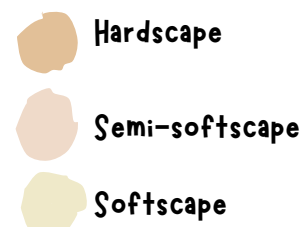


Figure 3.37 Concept of the hardscape and softscape
Source: Author, 2024

3.6.2 Parking area

The parking area is located in the northernmost area of the site with different entrances and exits. This is intended to facilitate easy circulation of vehicles, because the village road is not too wide, which will make it difficult if there are two cars to get in and out. Therefore, **a different exit is provided that leads to another alternative road** to out onto the main village road. **The parking area can accommodate 10 cars for guests.** This parking area also has two parking areas for motorcycles, **the western one can accommodate a maximum of 30 motorcycles, while the eastern one can accommodate 10 motorcycles.** The western parking area is specifically for teachers and staff, while the eastern area is for guests. **There is a pedestrian path that has a different motif and pavement color from the vehicle path.** This makes it easier for deaf students to navigate their way to the school building.

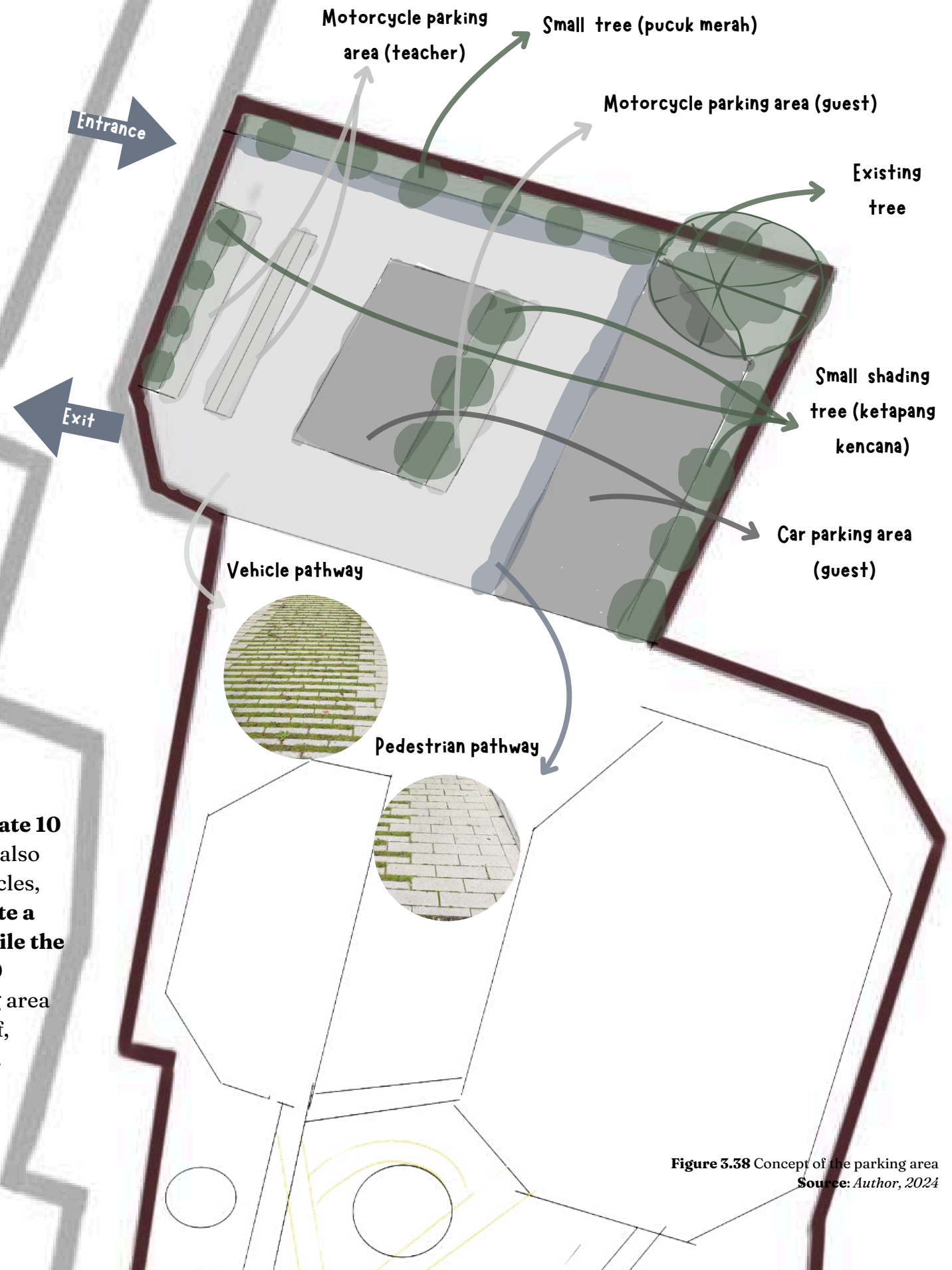


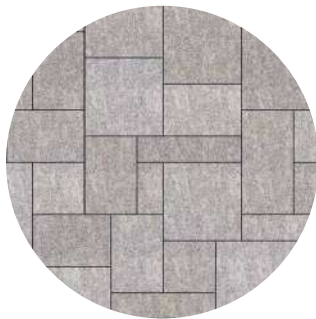
Figure 3.38 Concept of the parking area
Source: Author, 2024

3.6.3 School yard

The school yard area has the main function as a weekly flag ceremony area and also an outdoor sports area. Therefore, **the landscape is made flat so that students do not trip when they are running or exercising.** In addition, the **flagpole is placed in the west, so that during the flag ceremony, students face west to avoid direct sunlight and the backlight of the ceremony leader.**



In the school yard area, there is a slight difference in pavement. This is intended to **provide navigation guidance to go to the destination building mass.** Pavement that is used as a pedestrian smoothly provides guidance from the entrance gate to the main mass as well as the mass for school offices.



In the area outside the pedestrian pathway, using slightly different motifs and colors. **The difference in motifs and colors is not striking in order not to disturb the visual but can still highlight the way-finding pavement.**

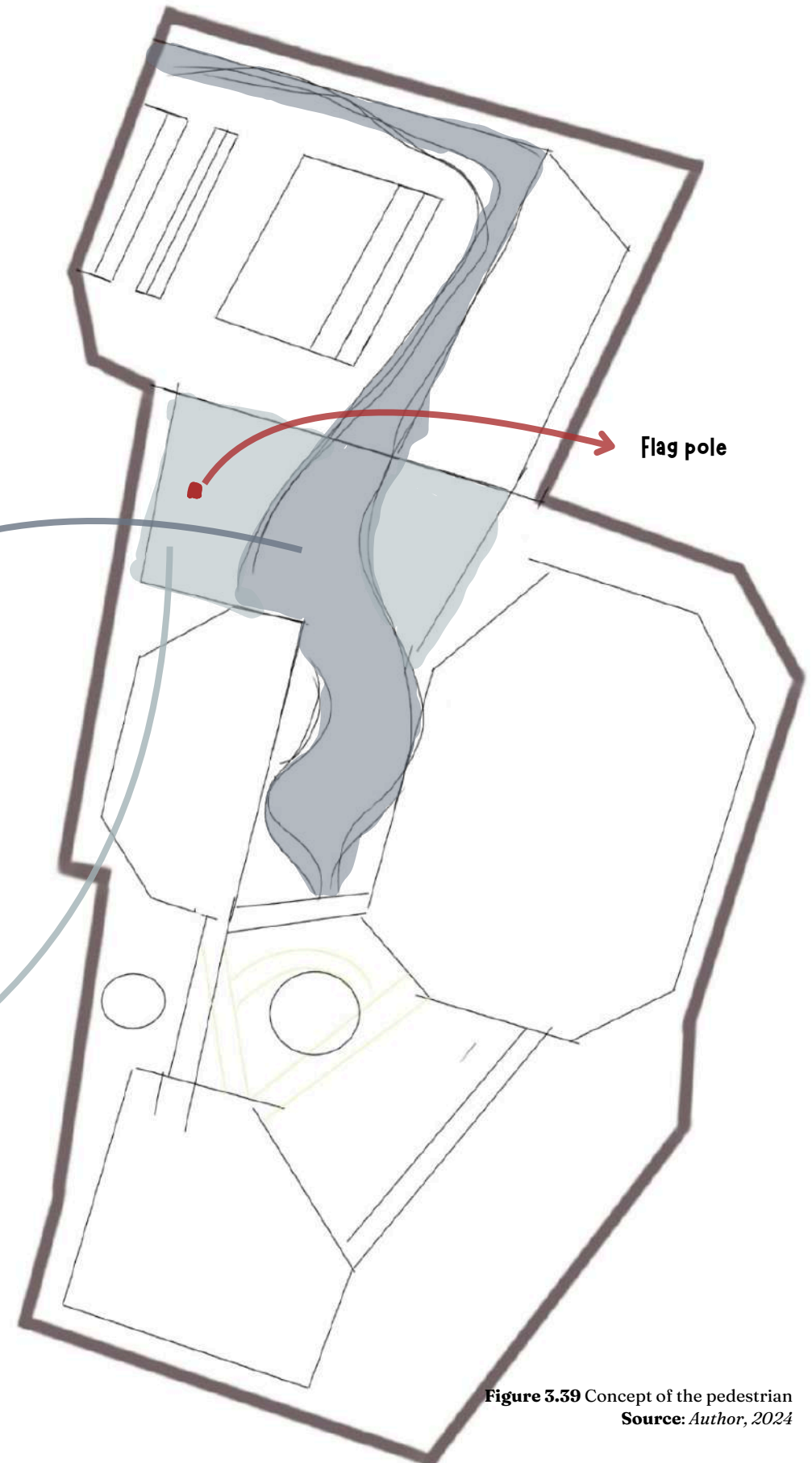
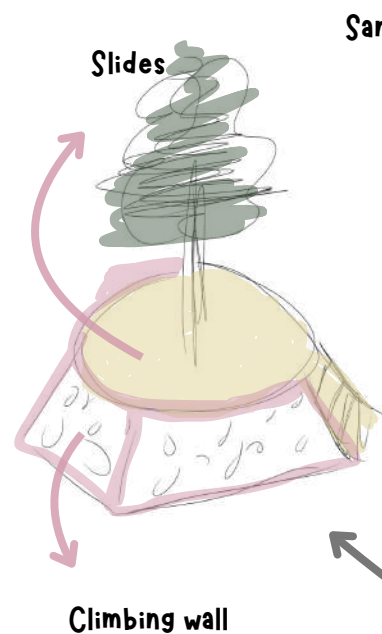


Figure 3.39 Concept of the pedestrian
Source: Author, 2024

3.6.4 Playground

The playground is located in the center of the three building masses to make it easier for students to go to the playground from all directions and make it easier for teachers to supervise and play with students. **This area tends to be for gentle physical games**, while heavy games that require more intense physical activities such as sports can be held in the school yard.

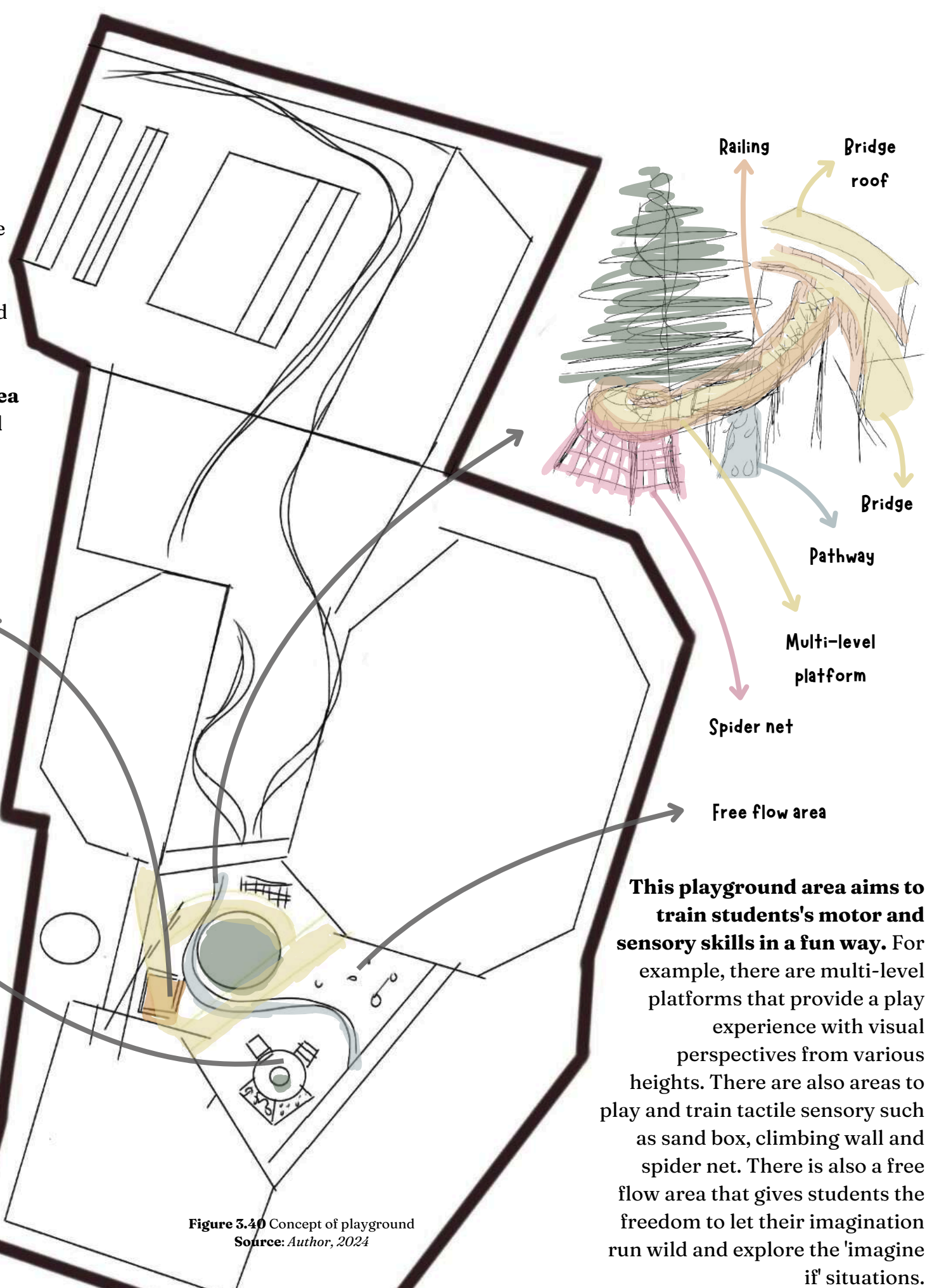


This playground area uses semi-softscape and softscape. **The use of cobblestone pathway as the main pathway in this playground provides ease of navigation** to explore this playground and also leads to other areas such as hallways and sensory garden.

Sand box

Slides

Climbing wall



This playground area aims to train students's motor and sensory skills in a fun way. For example, there are multi-level platforms that provide a play experience with visual perspectives from various heights. There are also areas to play and train tactile sensory such as sand box, climbing wall and spider net. There is also a free flow area that gives students the freedom to let their imagination run wild and explore the 'imagine if' situations.

Figure 3.40 Concept of playground
Source: Author, 2024

3.6.5 Sensory garden

This school has a sensory garden which is located in the far back side corner of the site. The location in the corner is intended to keep the children focused without being distracted by guests or other students playing and can focus, and enjoy the garden. **Although the main garden is at the back, the placement of plants and other sensory stimulus can be found in many areas of the site.** This aims to improve the sensory experience of deaf students not only in the main sensory garden at the back, but throughout the school area. **The plants used for this sensory garden are mostly tropical plants and the use of water elements to add to the tropical atmosphere.**

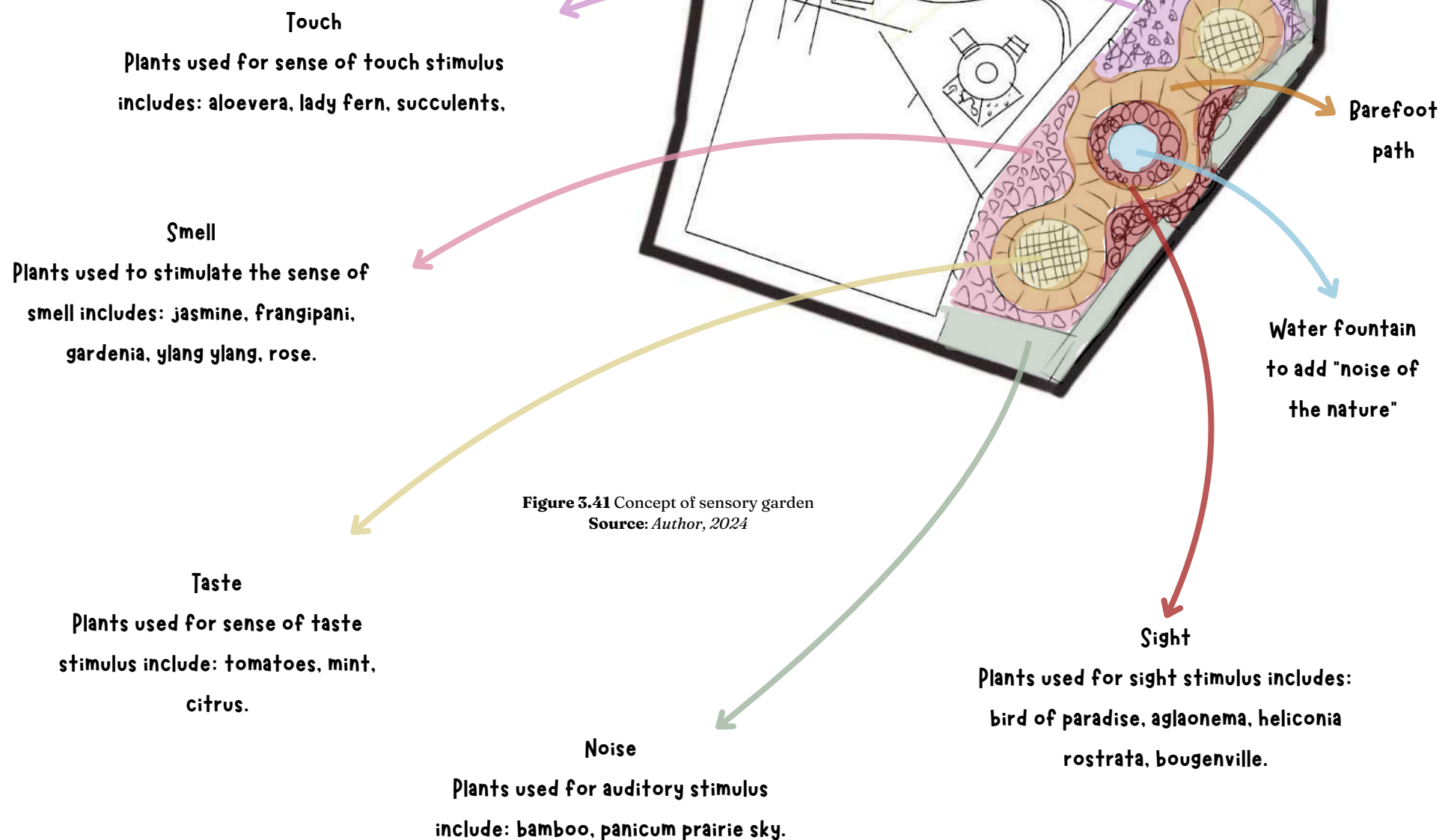


Figure 3.41 Concept of sensory garden
Source: Author, 2024

Barefoot path

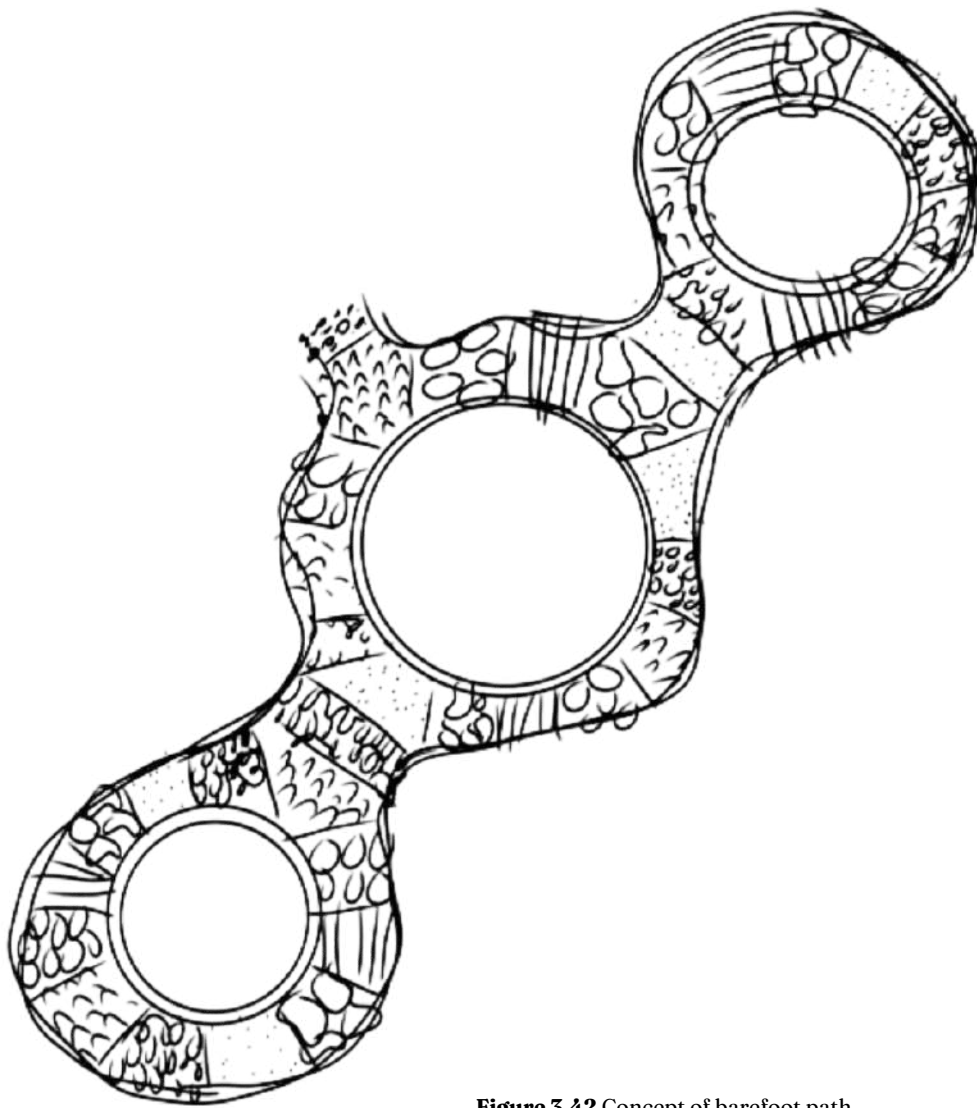


Figure 3.42 Concept of barefoot path
Source: Author, 2024

This barefoot path is **made to improve student's tactile sensory especially on the feet, so that their feet can become more sensitive to texture and vibration**, thus helping them to maximize their sense of hearing. The path consists of six different materials: gravel, grass, cobble stone, bamboo slats, cord wood cobbles, and sand. These six materials are arranged around the path in this sensory garden, so that students can learn while enjoying this garden.

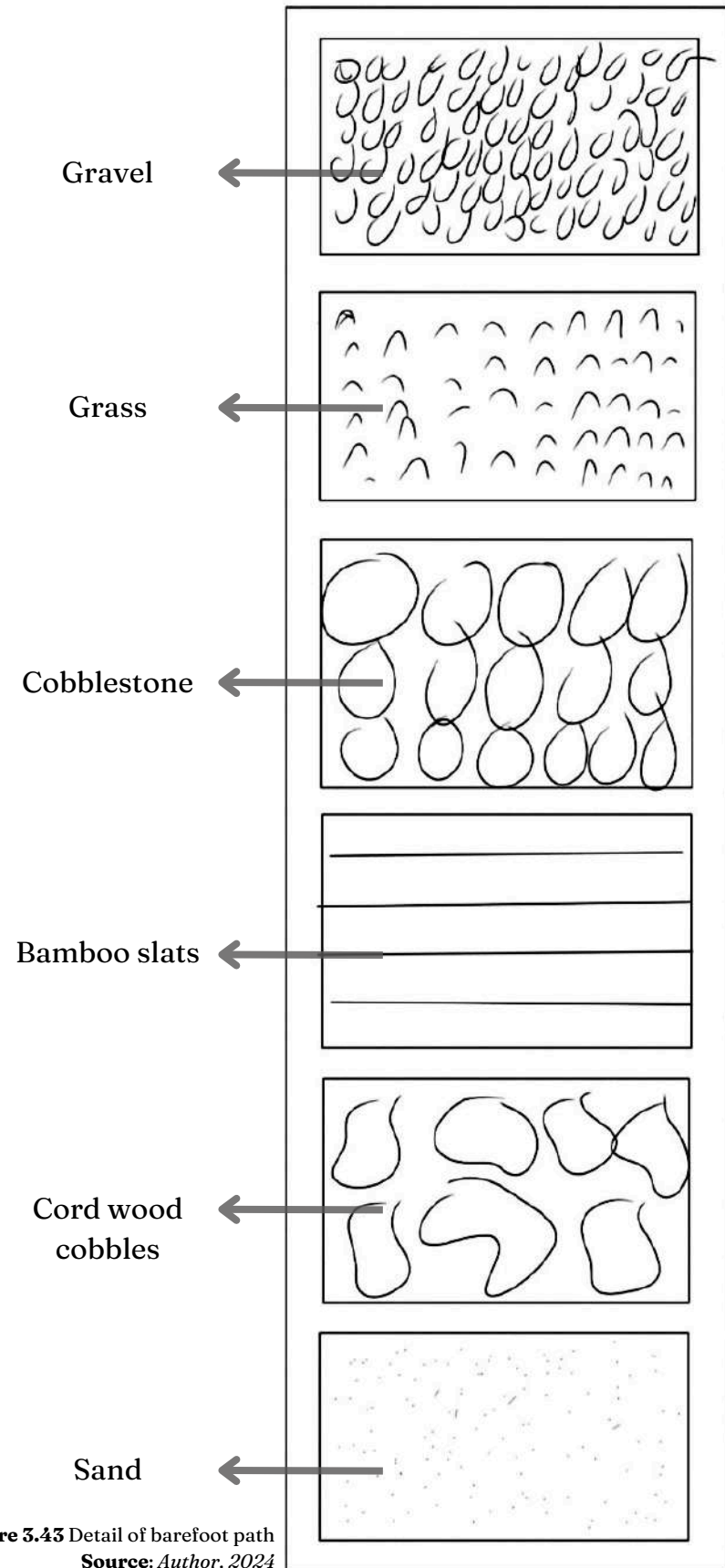


Figure 3.43 Detail of barefoot path
Source: Author, 2024

3.7 UTILITY CONCEPT (mezzo concept)

3.7.1 Clean water system

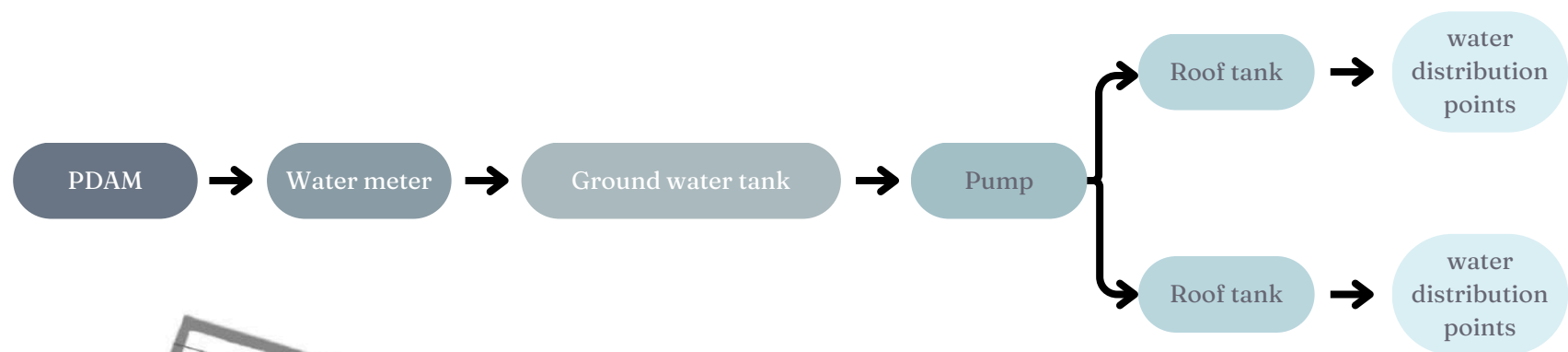
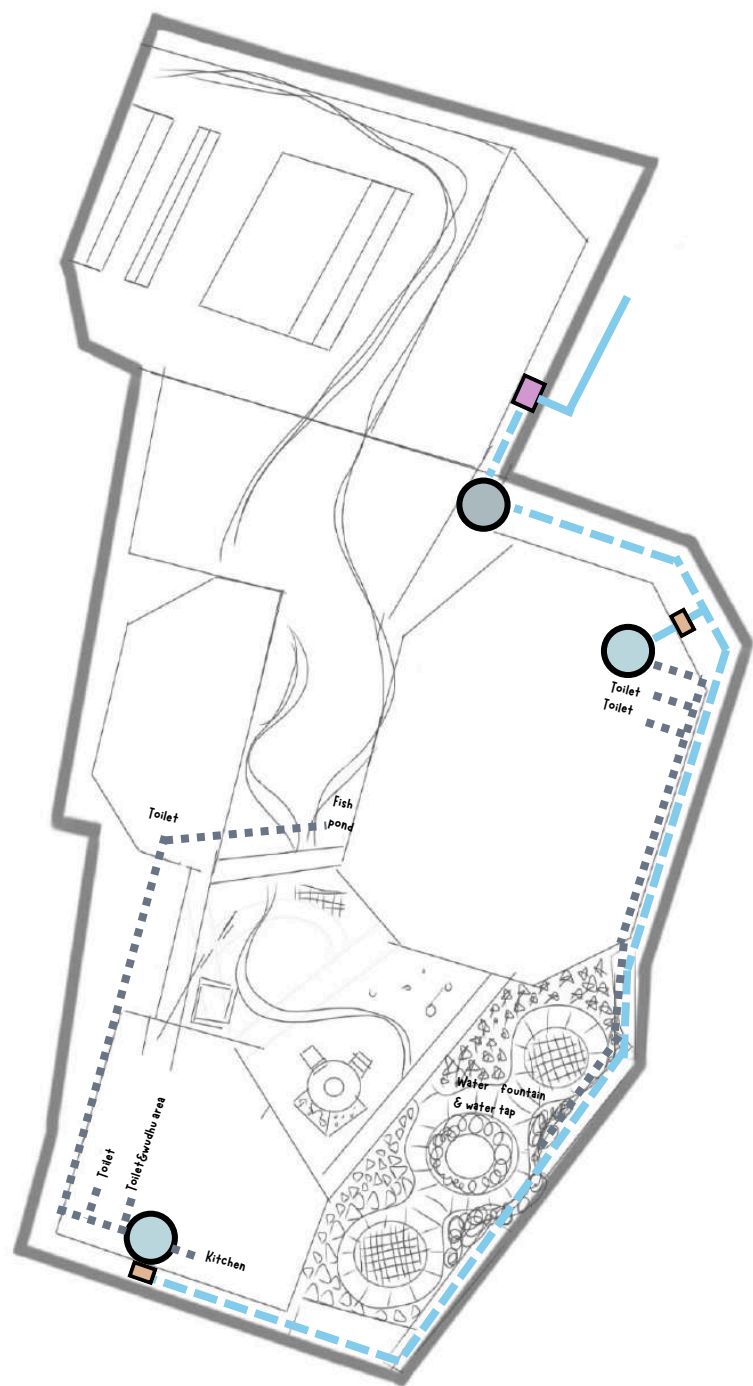


Diagram 3.5 Scheme of clean water system
Source: Author, 2024



The clean water source for the school comes from the PDAM. The PDAM channel enters from the residential areas, then enters into the site and is temporarily collected in the ground water tank. From the ground water tank, the water is distributed to two roof tanks located in the main building mass and the building mass for the canteen. From the main building mass, water from the roof tank is distributed to toilets on the 1st and 2nd floors, as well as to the sensory garden. While water from the roof tank in the building mass for the canteen, water is distributed to the toilet and ablution area on the second floor, toilet on the first floor, kitchen, teacher's toilet, and fish pond.

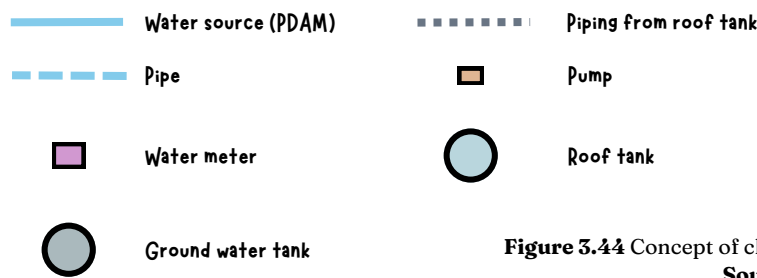


Figure 3.44 Concept of clean water system
Source: Author, 2024

3.7.2 Grey & black water system

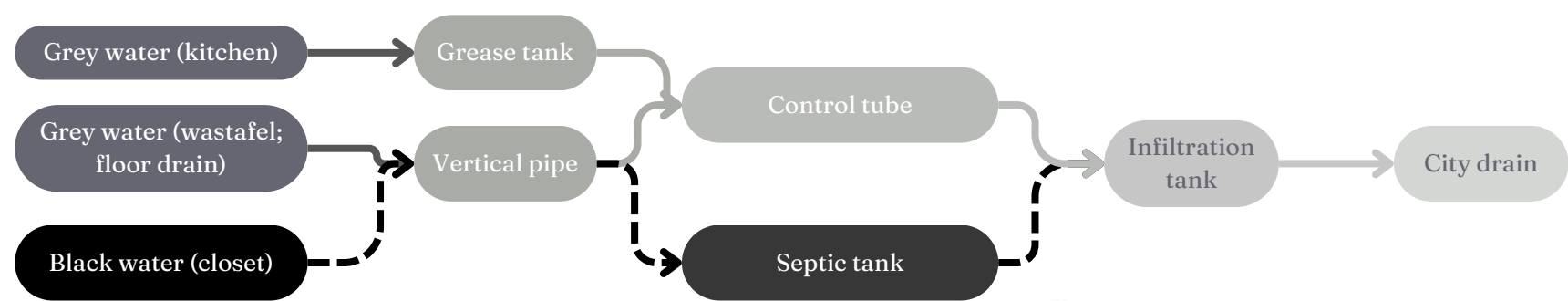


Diagram 3.6 Scheme of grey and black water system
Source: Author, 2024

Grey water from the sink, floor drain, and used water for ablution flows directly to the manhole. After the manhole, the water is filtered in the infiltration tank and then the filtered water is channeled to the city drain. For grey water coming from the kitchen, where the liquid waste is oily, the liquid waste will pass through the grease tank to filter the oil, in order that the water entering the manhole is not mixed with oil. After going through the grease tank, the liquid waste that has been freed from oil can go to the control tube, then to the infiltration tank, and ends up in the city drain. Meanwhile, black water which is solid waste from the toilet goes to the septic tank.

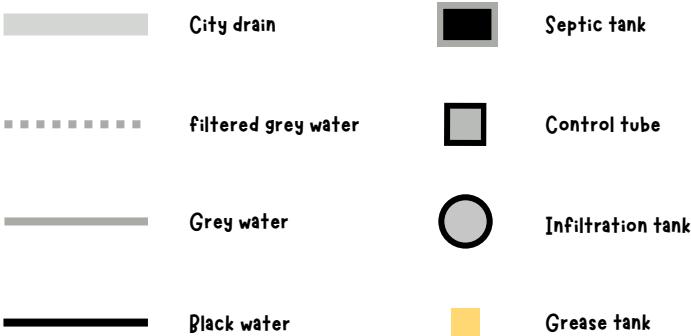
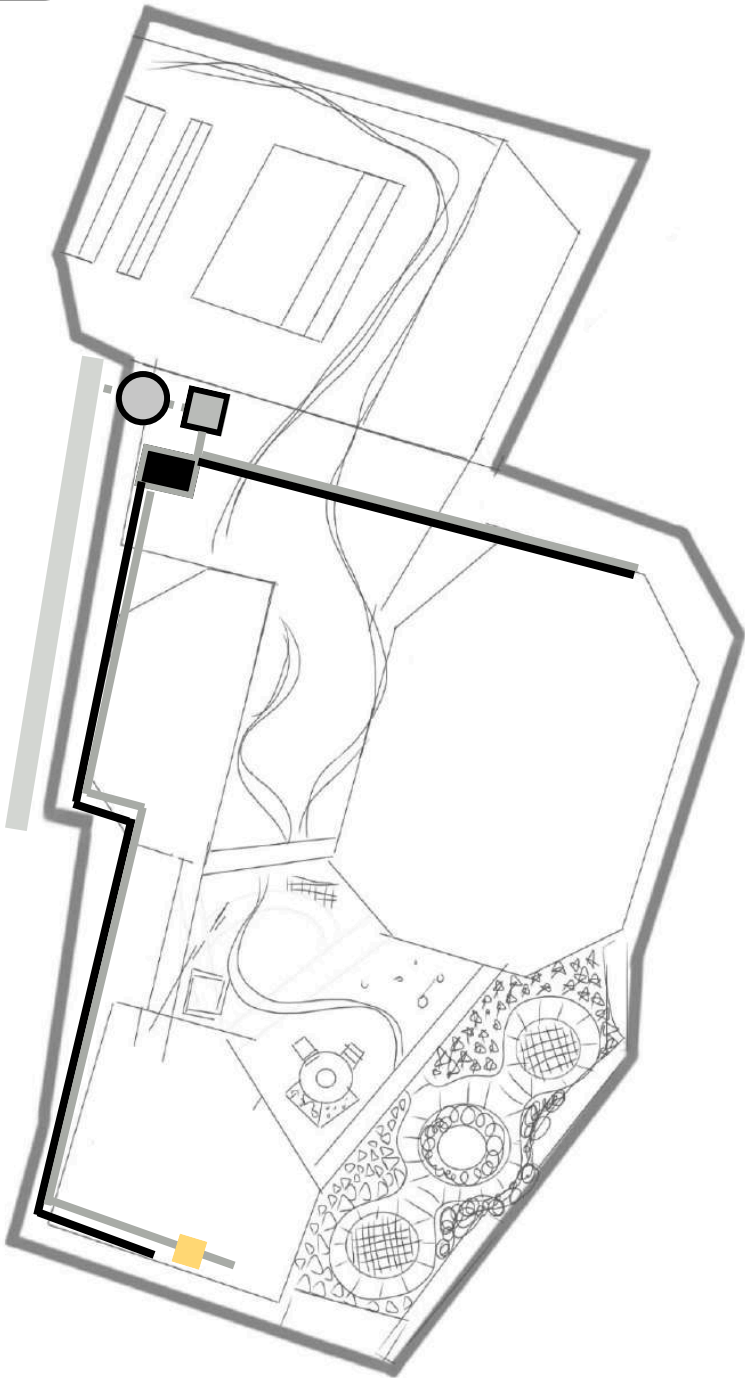


Figure 3.45 Concept of grey and black water system
Source: Author, 2024

3.7.3 Rain water system



Diagram 3.7 Scheme of rain water system
Source: Author, 2024



For the rain water system, rainwater that falls from the roof of each mass and hallway will go to the gutter and to the control tube. From this control tube, it will then flow to the infiltration tank. The remaining excess water from this infiltration tank is finally released into the city drain.

In the school yard area, which predominantly uses hardscape, it is important to have infiltration tank, so that this area does not flood. When it rains, water from the parking lot and school yard that is not absorbed by the soil will flow to the manhole, then flow to the infiltration tank, and then flow to the city drain.

Other areas such as the sensory garden and playground are green areas that can immediately absorb rainwater.

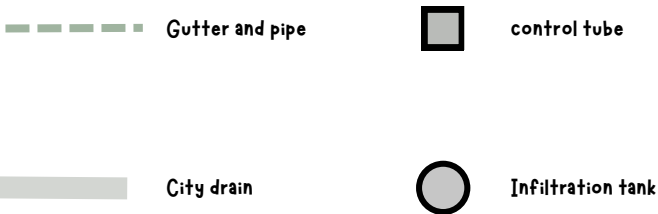


Figure 3.46 Concept of rain water system
Source: Author, 2024

3.8 3D VISUALIZATION

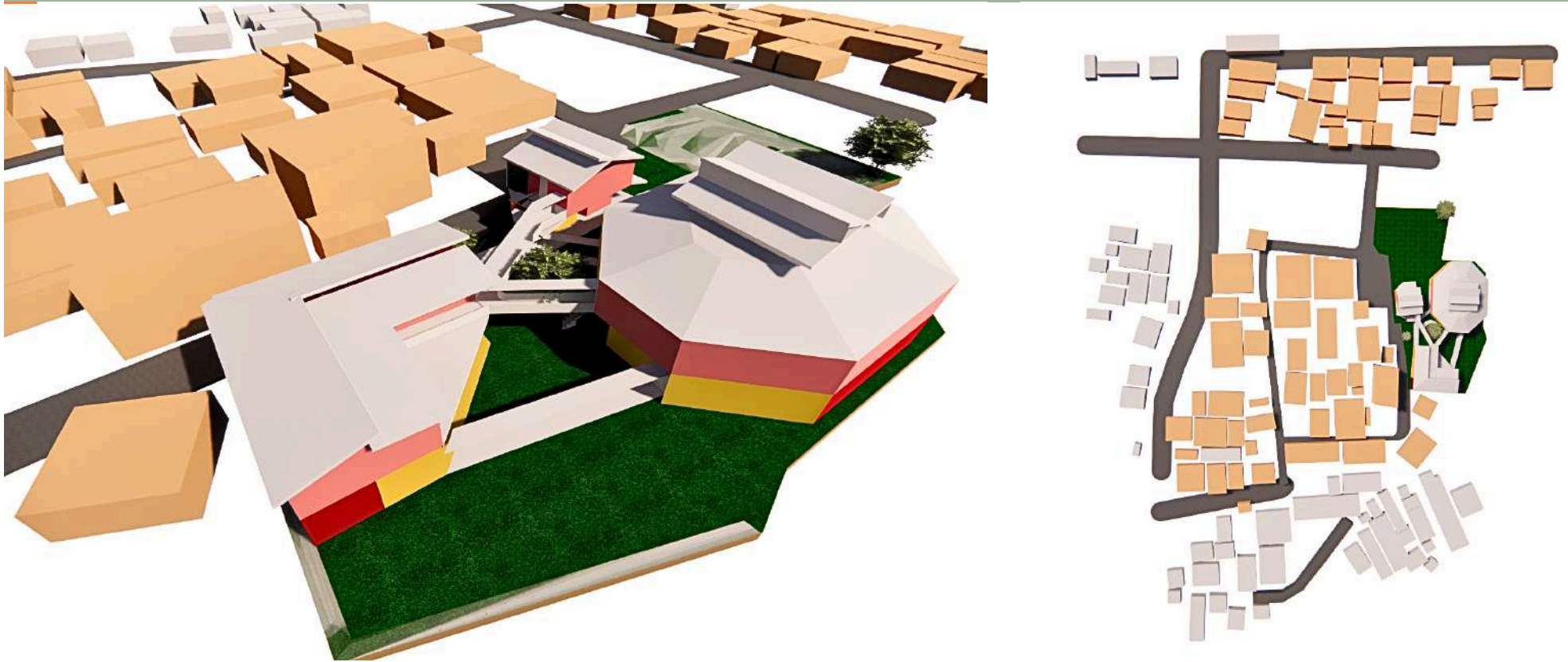
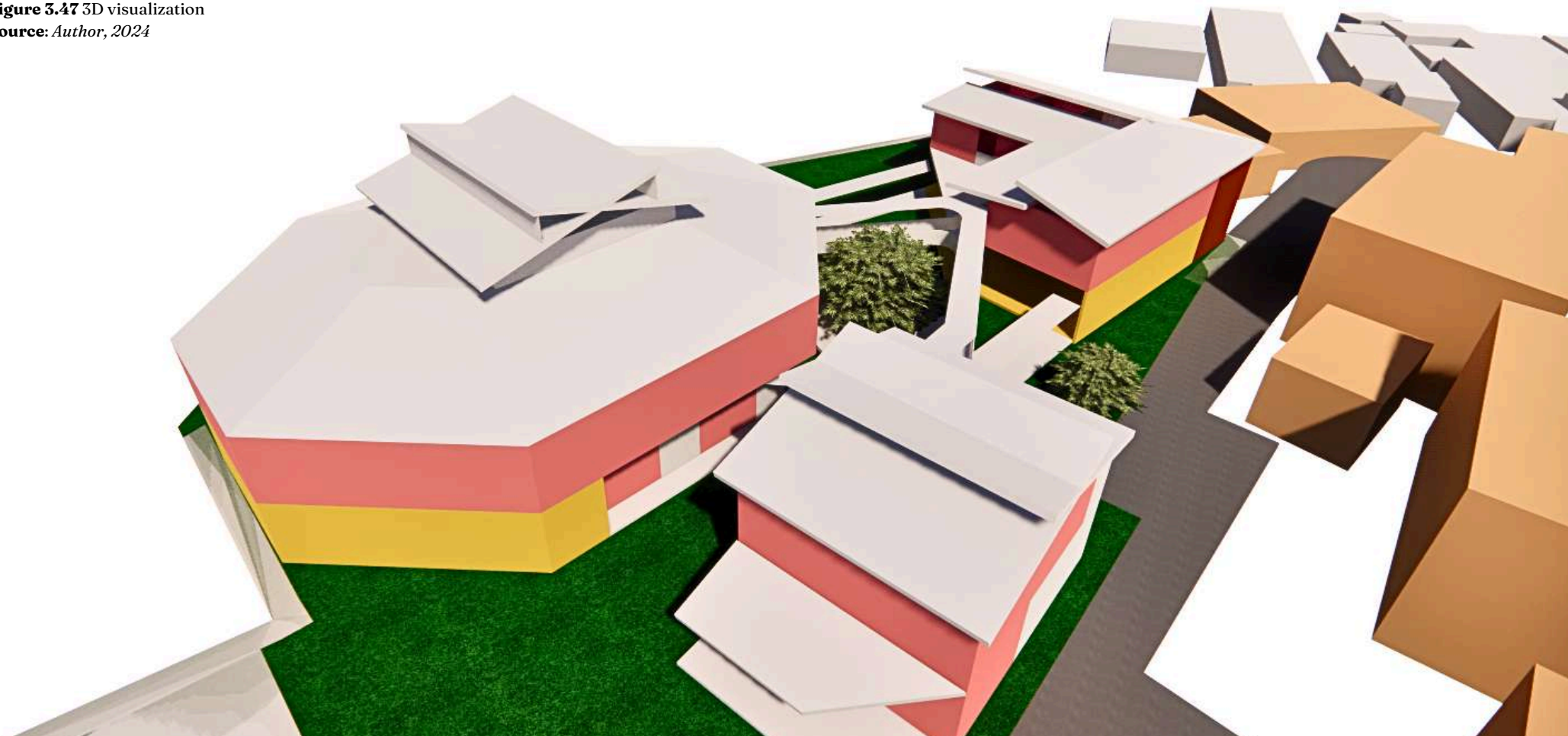


Figure 3.47 3D visualization
Source: *Author, 2024*



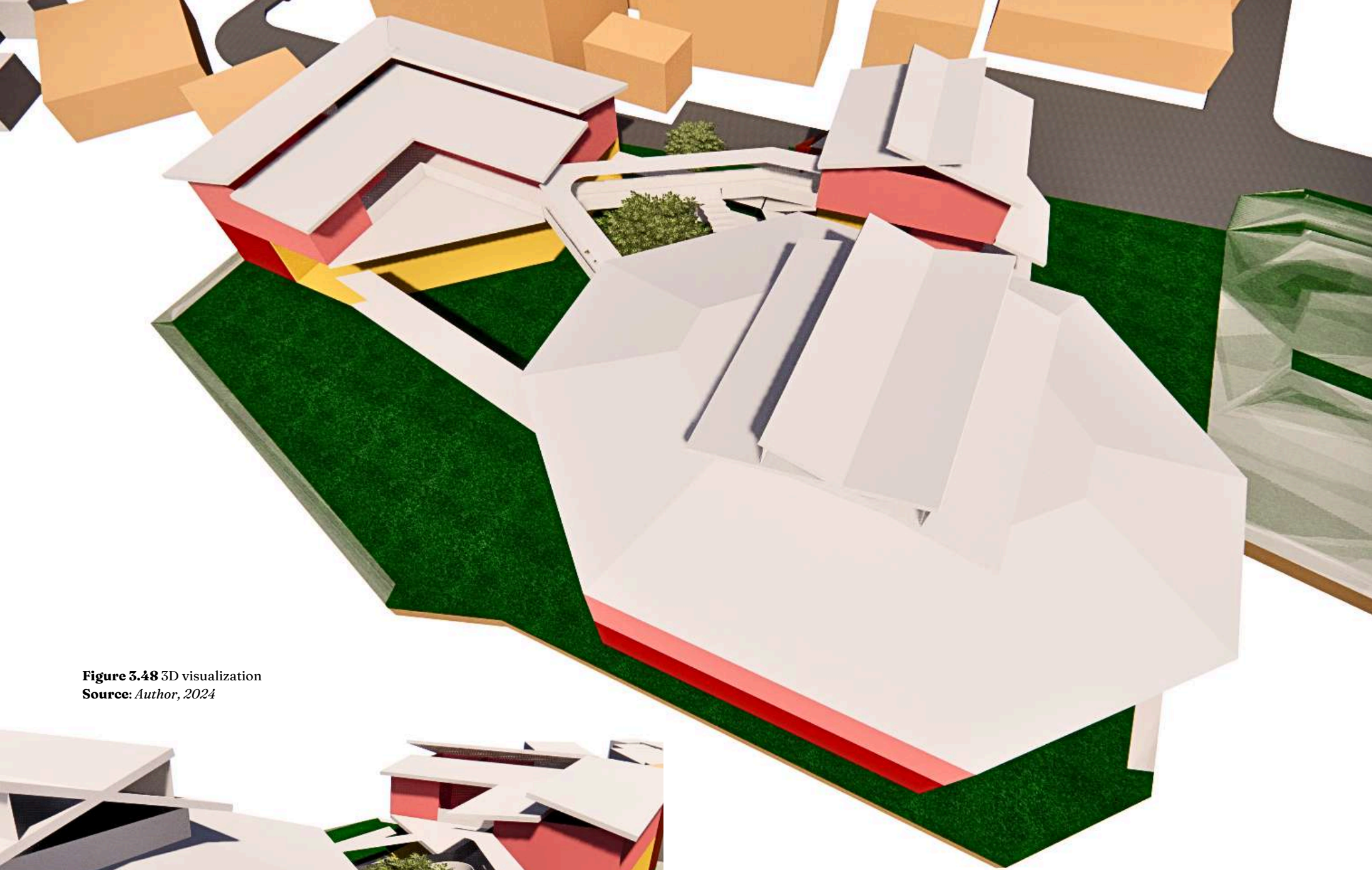


Figure 3.48 3D visualization
Source: *Author, 2024*



3.9 DESIGN DEVELOPMENT

3.9.1 The changes in the size of the site



Figure 3.49 Before and after of site size
Source: Author, 2024

The previous site was 2,200 m² in size and accommodated all the facilities as well as the parking area. This caused the three building masses to be too close together so that the outdoor and indoor spaces were too narrow. In addition, because of the need for a lot of space in a narrow area, the previous building masses were too close to the building boundaries.

Because of these problems, the site was enlarged to 2,600 m². The additional area is separated by the village road, so it will become the parking area. Because the parking area is on a different land, the main site area becomes larger so that the buildings can have a safe distance from each other and also from the building boundaries. In addition, the outdoor area for the school yard, playground, and sensory garden can be larger.

3.9.2 The changes in building masses

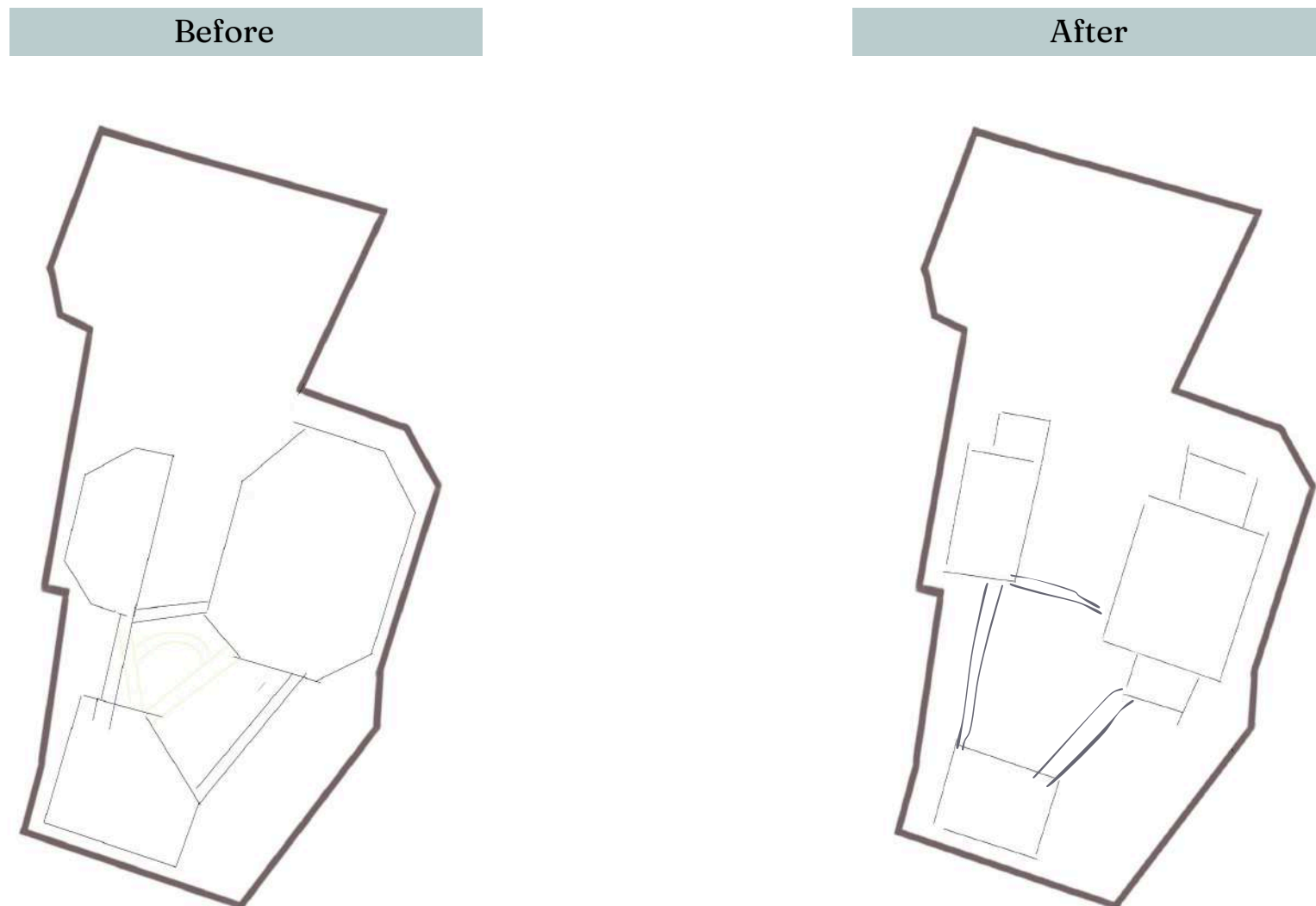


Figure 3.50 Before and after of building masses
Source: Author, 2024

The mass of the building initially used a shape that had angles to reduce the surface area of the building exposed to direct sunlight. However, this creates problems regarding the complex and non-uniform shape of the building. This makes the goal of creating "room clarity" and "easy access" difficult to achieve. In addition, the octagon-shaped main mass is too massive for the narrow site, making the outdoor area and other buildings less free.

It still uses the same original idea of reducing the surface exposed to direct sunlight, but instead of creating an octagon-shaped and asymmetrical building mass, it uses several squares that produce different surface depths. The use of squares and rectangles can be more functional and effective in this narrow space and can achieve the room clarity and easy access. In addition, the avoidance of direct sunlight is not only from the shape of the building, but can also be from the shape of the building facade and others.

3.9.2 The changes in total floor

Before

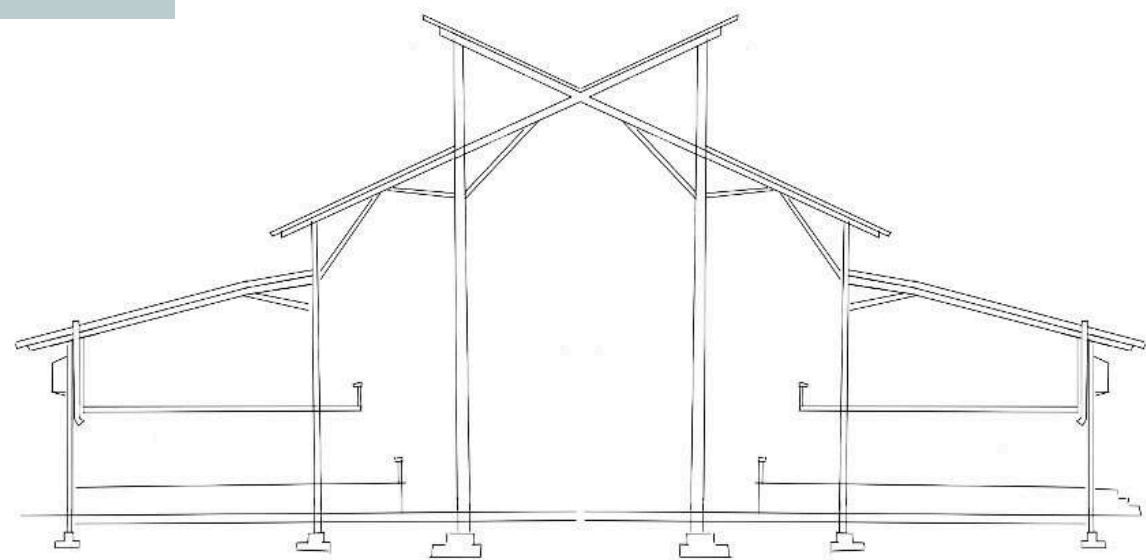
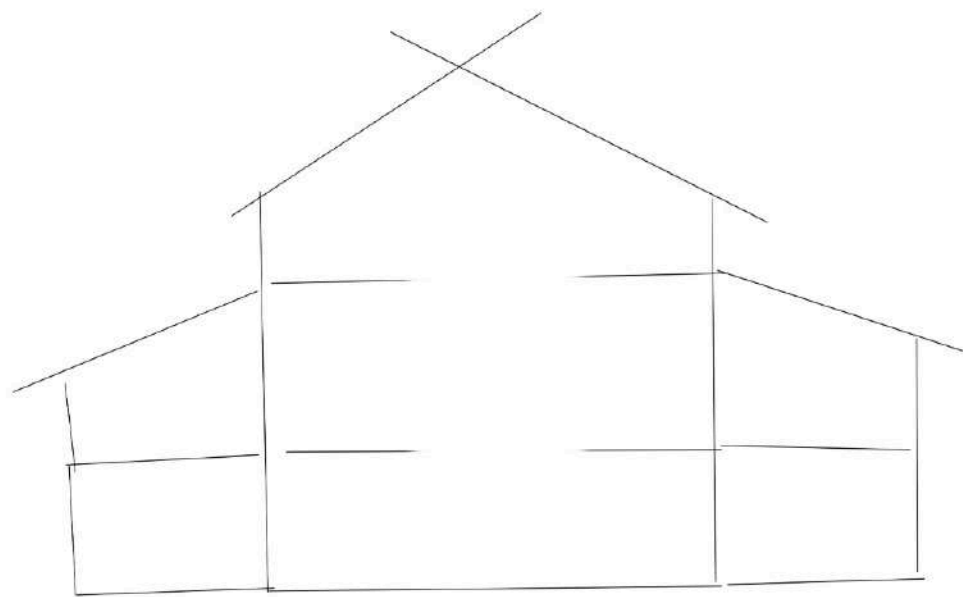


Figure 3.51 Before the change of total floor
Source: Author, 2024

Previously, all building masses had two floors to accommodate all school facilities. This caused the building mass to be quite large and take up quite a lot of land.

After

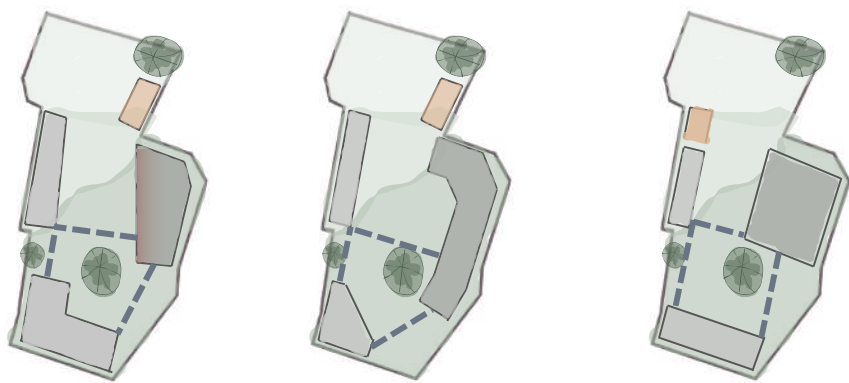


So that the building mass is not too large, the building mass will be elevated to three floors. The elevated building mass is only the main building mass, while the other building masses still have two floors. In addition, it is also necessary to reduce the area and capacity of some rooms to get an effective building mass that can accommodate all school facilities.

Figure 3.52 After the change of total floor
Source: Author, 2024

3.9.2 The changes in determining building's grid

Before



Sebelumnya, ketiga alternatif massa bangunan memiliki grid yang berbeda-beda. Ini menghasilkan massa bangunan yang terlihat tidak seragam.

Figure 3.53 Each building has different grid
Source: Author, 2024

After

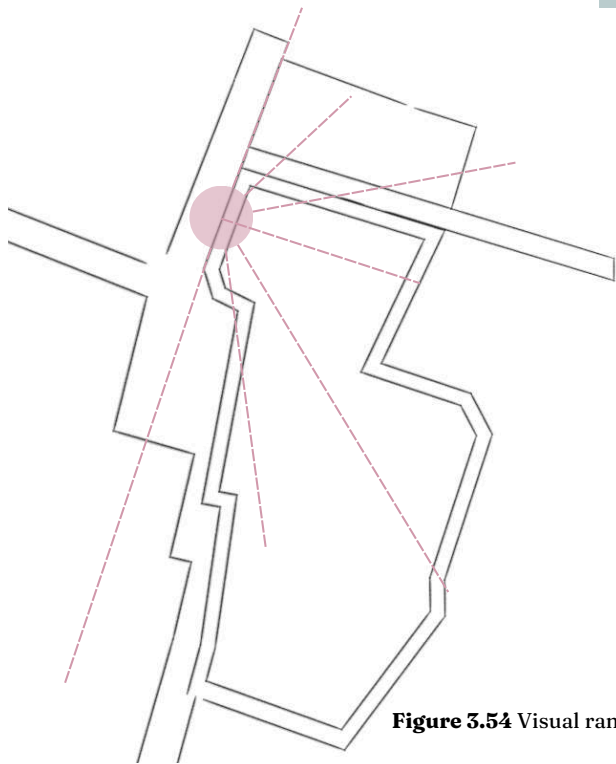


Figure 3.54 Visual range as the building grid
Source: Author, 2024

Since the users of this facility are deaf students who rely heavily on visuals, therefore the visual range becomes the grid of the building mass. The pink circle in the image shows the entry area which is the point where deaf students can start their visual navigation. From this point, the user can see the big picture of the school layout, especially the primary areas.

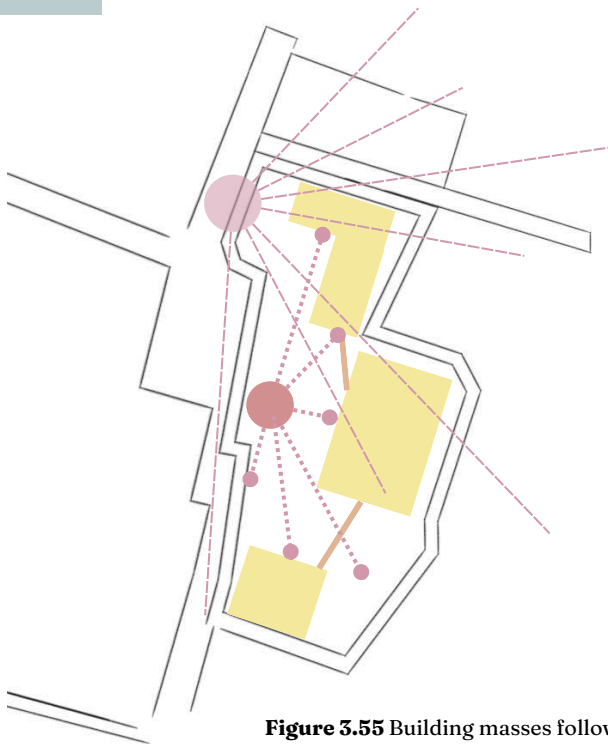


Figure 3.55 Building masses following the visual grid
Source: Author, 2024

The three building masses and their main entrances should also be visible at crucial points on the site. The crucial point is the school yard (red circle) because it is an area where all users can gather and an open area that can provide a wider visual navigation.



04

FINAL DESIGN

4.1 MASTERPLAN

LEGEND

- A: Parking area
- B: Main entrance gate
- C: Sub-entrance gate
- D: School yard
- E: Playground
- F: Sensory garden
- G: 1st mass (main building-elementary school and other learning rooms)
- H: 2nd mass (kindergarten and school offices)
- I: 3rd mass (canteen and praying rooms)
- J: Residential area
- K: Forest
- L: River

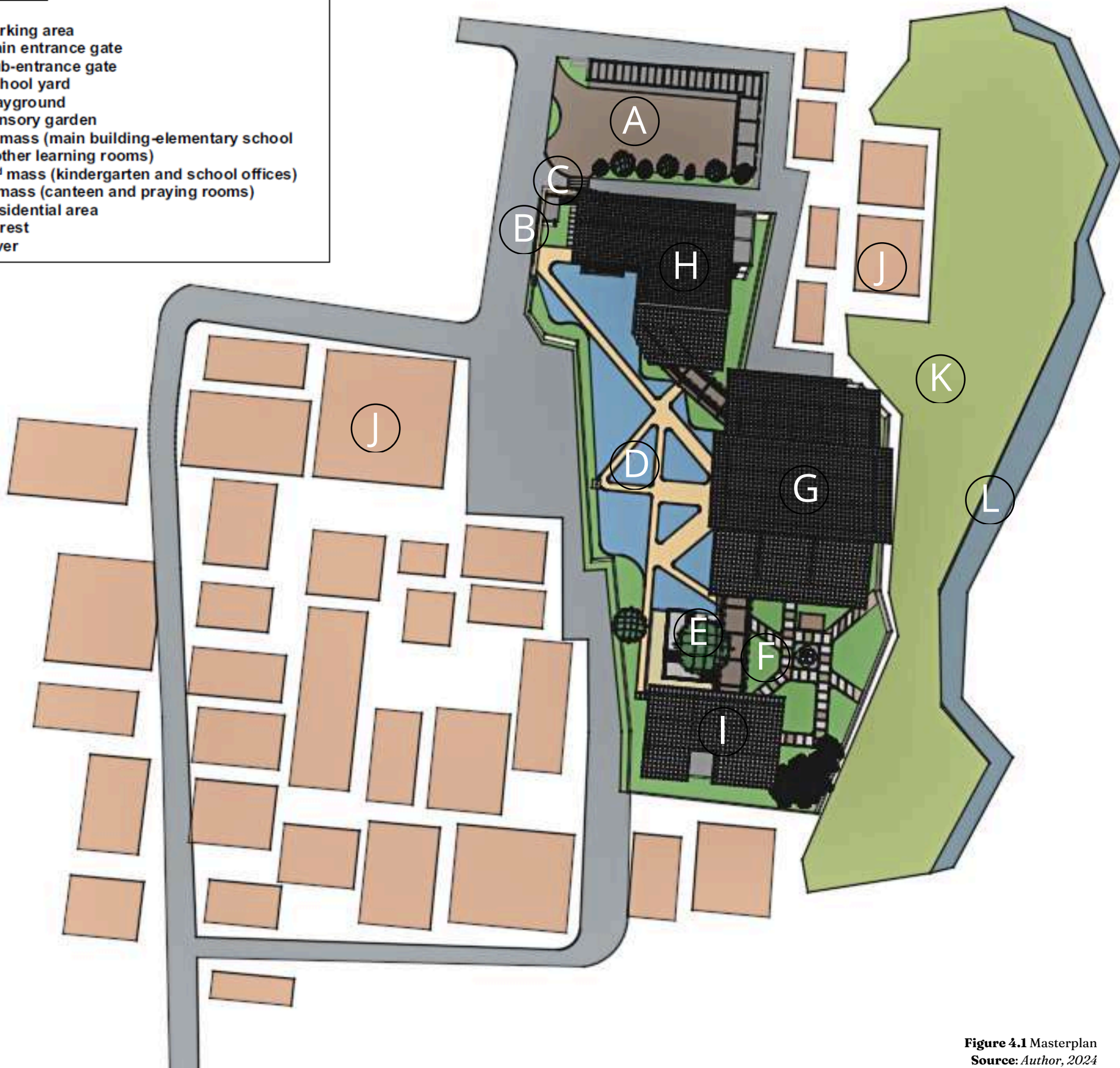
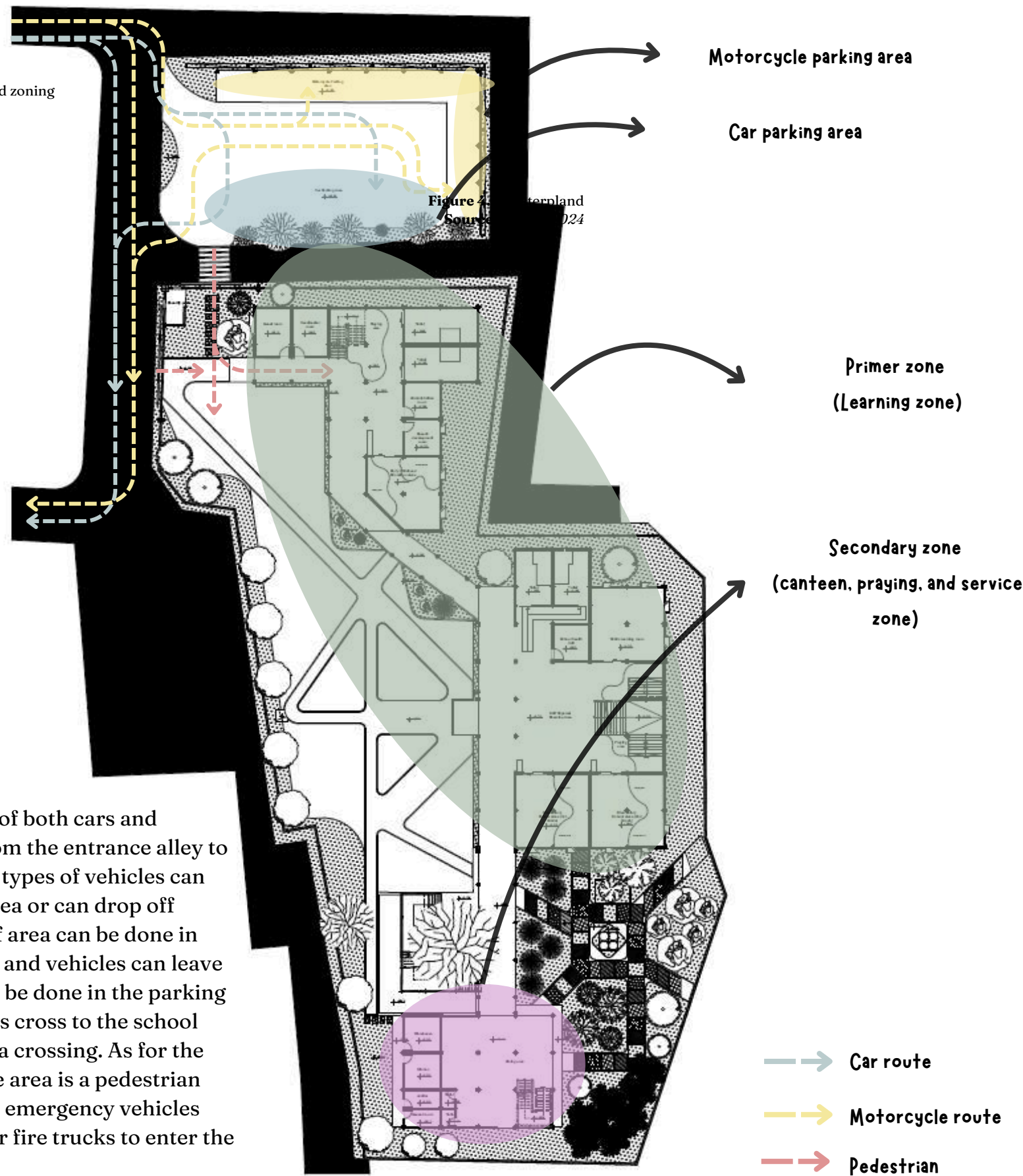


Figure 4.1 Masterplan
Source: Author, 2024

4.2 CIRCULATION AND ZONING

Figure 4.2 Circulation routes and zoning
Source: Author, 2024



Vehicular circulation of both cars and motorcycles starts from the entrance alley to the site area and both types of vehicles can park in the parking area or can drop off students. The drop off area can be done in front of the main gate and vehicles can leave immediately, or it can be done in the parking area and then students cross to the school area through the zebra crossing. As for the school area, the whole area is a pedestrian area, but it still allows emergency vehicles such as ambulances or fire trucks to enter the school area.

4.3 PROVIDING VISUAL QUALITY THROUGH SITE AND BUILDING LAYOUT

4.3.1 Siteplan

The visual quality provided in the siteplan design is in the form of ease of directional navigation starting through the landscape to the shape and location of the building mass. As explained in the "design development" sub-chapter, the ease of visual navigation starts from the main entrance and also the crucial point, the school yard.

-  The pink circle shows the visual range of the main entrance gate. From this point, the deaf students can see the rural road, so they can see if any vehicles will pass by; the parking area; the sub-primary mass in front of the entrance gate; the primary mass which is the largest in size; and the school yard.
-  The red circle shows the visual navigation of the school yard as a crucial point because in this area students can determine the destination they will go to. From this point, deaf students can determine whether to go to the primary mass; sub-primary mass; secondary mass; hallway; playground; or sensory garden. In the school yard landscape, there is clear yellow outline that helps direct deaf students to other places.

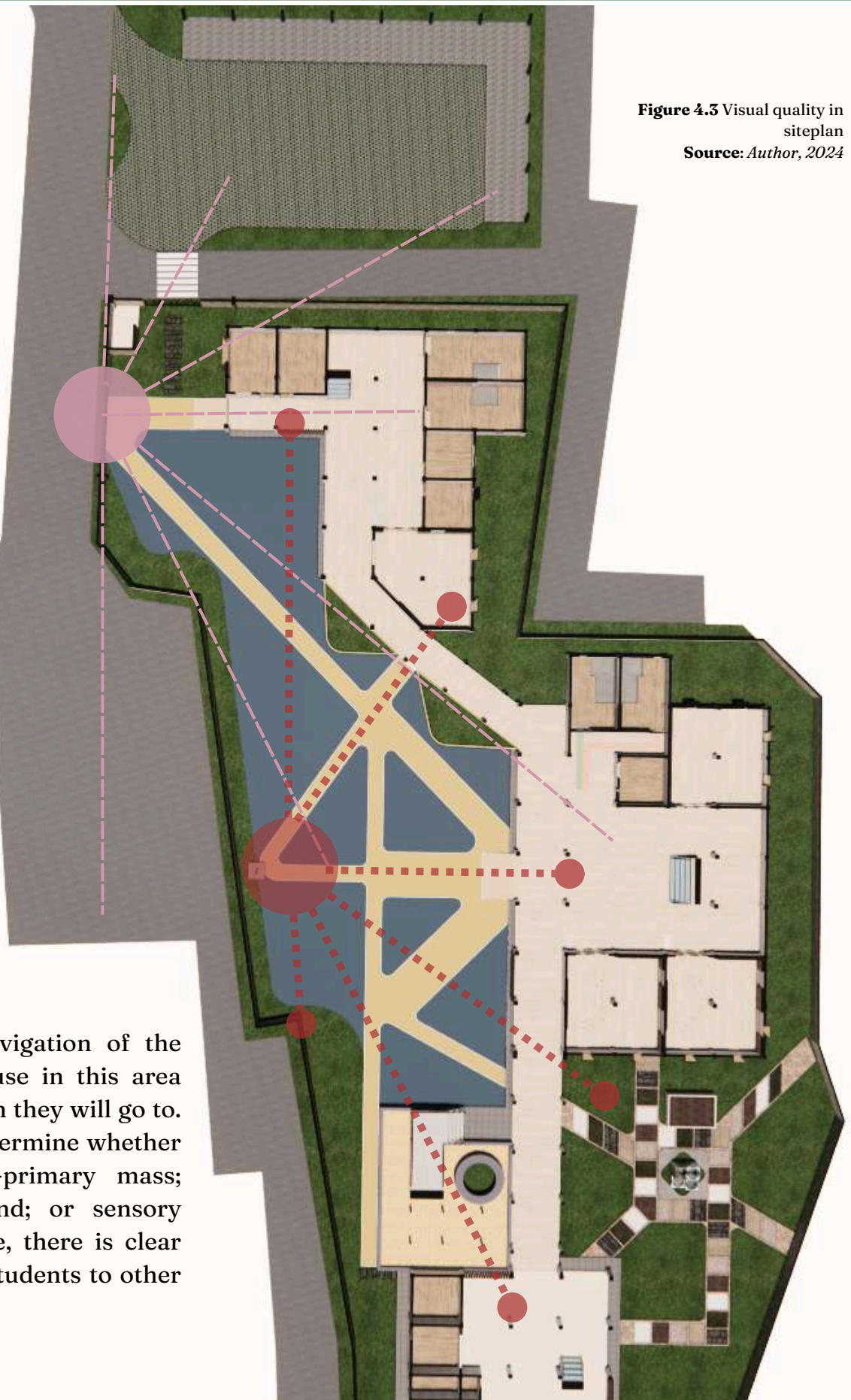


Figure 4.3 Visual quality in siteplan
Source: Author, 2024

4.3.2 Building layout

The design of mass and room layout greatly affects the visual quality inside the building.



The sub-primary building mass has an angle as circled in orange so as not to obstruct the view from the main entrance to the primary building mass. The angle used is more than 90 degrees, so that it remains functional and still allows the deaf students to see across the corridor.



The dominant semi-open layout of the room makes the range of views wider and makes it easier for deaf students to determine the destination of the room. In addition, a square or rectangular floor plan can make the room more functional, not to be complicated and get enough natural sunlight.

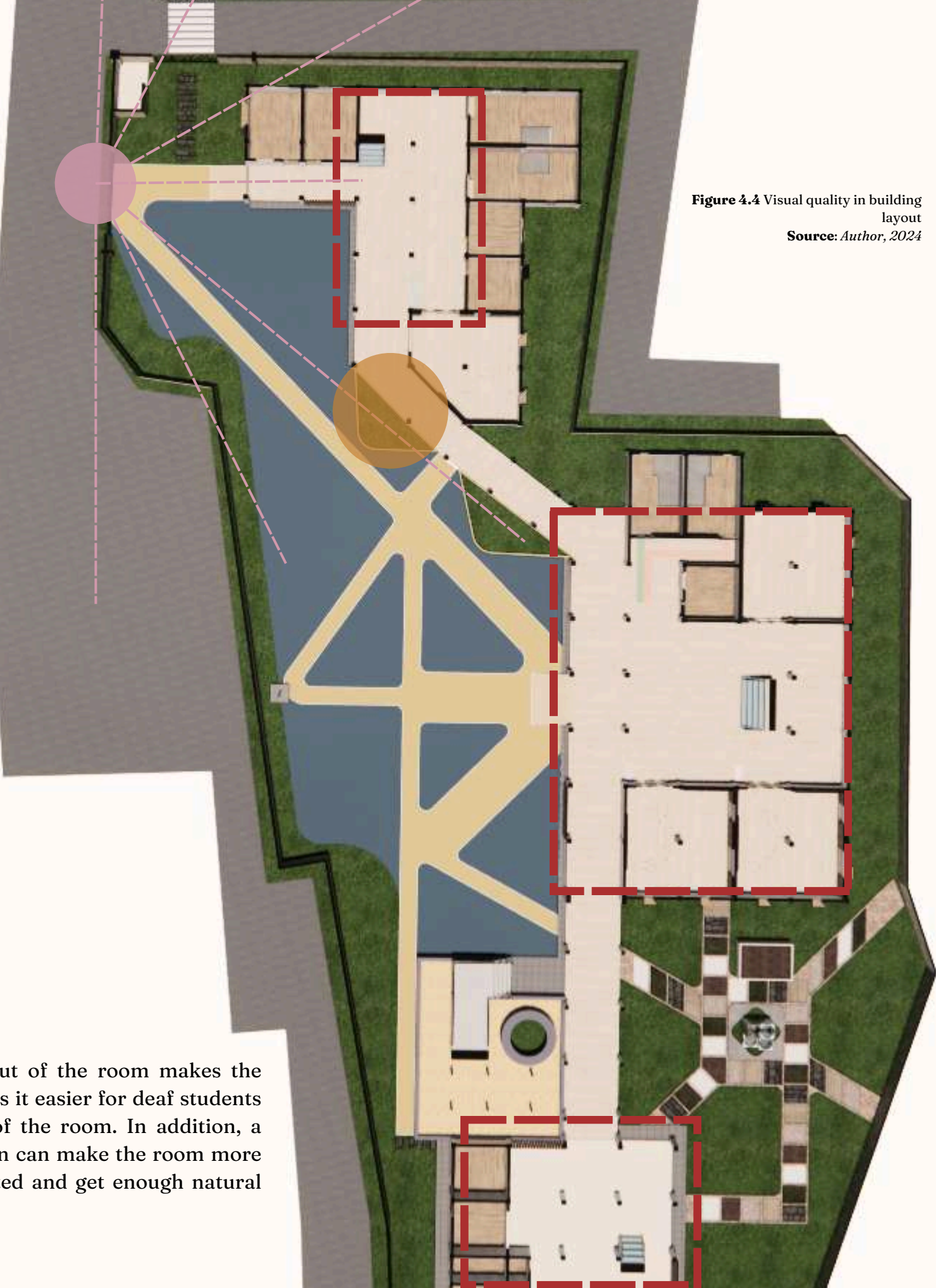


Figure 4.4 Visual quality in building layout
Source: Author, 2024

4.4 PROVIDING VISUAL QUALITY THROUGH COLOR AND MATERIAL

4.4.1 Color

Color plays an important role in visual navigation. The placement of a color that contrasts with the surrounding color can make these "wayfinder" more eye-catching. Therefore, this school uses a dominant matte white color as well as a wood color to be neutral and make the color of the "wayfinder" stand out.

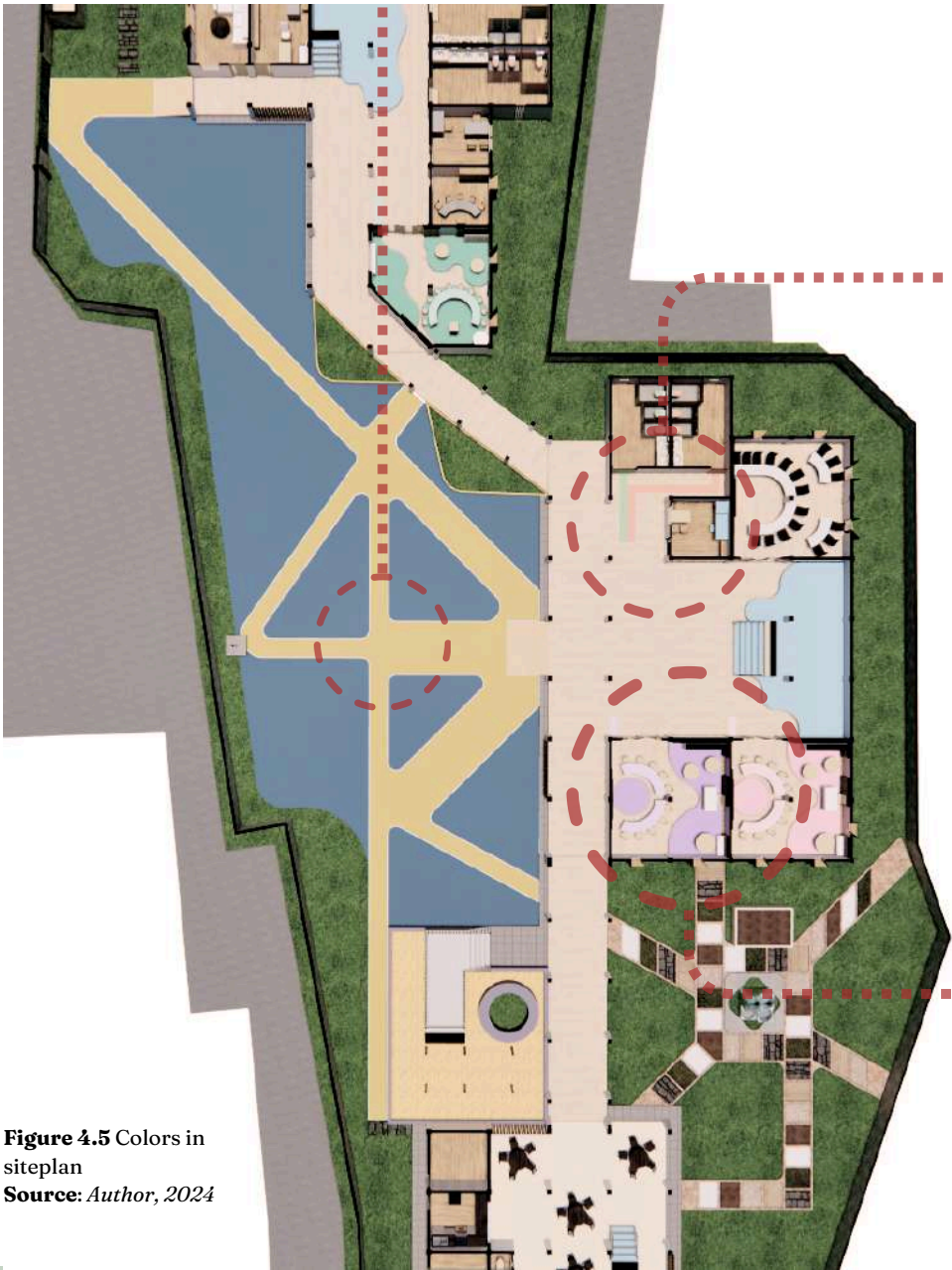


Figure 4.5 Colors in siteplan
Source: Author, 2024

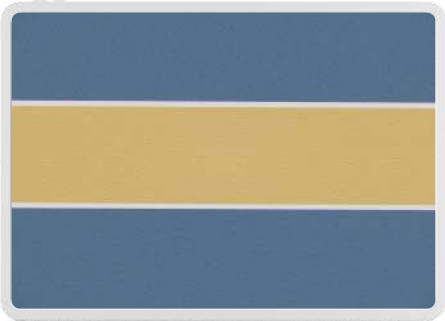


Figure 4.6 Color as a guide on school yard's landscape
Source: Author, 2024

The use of yellow in contrast to blue in the school yard landscape makes it easier for deaf students to determine their destination.



Figure 4.7 Color as a guide leading to the bathroom
Source: Author, 2024

The use of soft green and peach colors as direction markers to the toilet. The green color is for the boy's toilet while the peach color is for the girl's toilet. Both colors contrast with the surrounding wall and floor which are white and soft brown.



Figure 4.8 Different colors that represent different rooms
Source: Author, 2024

Use of different colors for each class. This makes it easier for deaf students to find their class even from different floors.

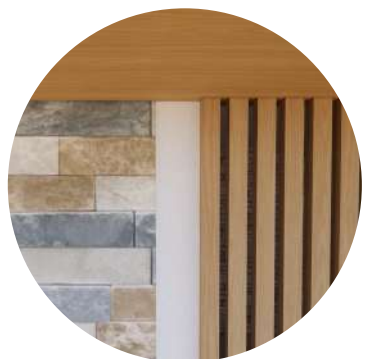
4.4.2 Building material

The use of materials with different textures and colors can provide a clear contrast and can also stimulate the sense of touch. The dominant wall is covered with rough plaster, so although it is white, the rough surface will reduce light reflection. Other material combinations include natural rocks and wood. These three materials have contrasting textures and colors.



The use of finish wall (pvc) with the rough plaster. Mostly used in the classroom

Figure 4.9 Wood texture and white rough plaster
Source: Author, 2024



The use of finish wall (multicolored natural rocks) with the wood facade. Mostly used for exterior wall.

Figure 4.10 Multi-colored natural rock texture, white rough plaster, and wood texture
Source: Author, 2024



The use of finish wall (natural rocks) with the wood facade. Used for interior wall.

Figure 4.11 Wood texture, white rough plaster, and natural rock texture
Source: Author, 2024

4.5 PROVIDING VISUAL QUALITY THROUGH LIGHTING

4.5.1 Clerestory window and light shelf

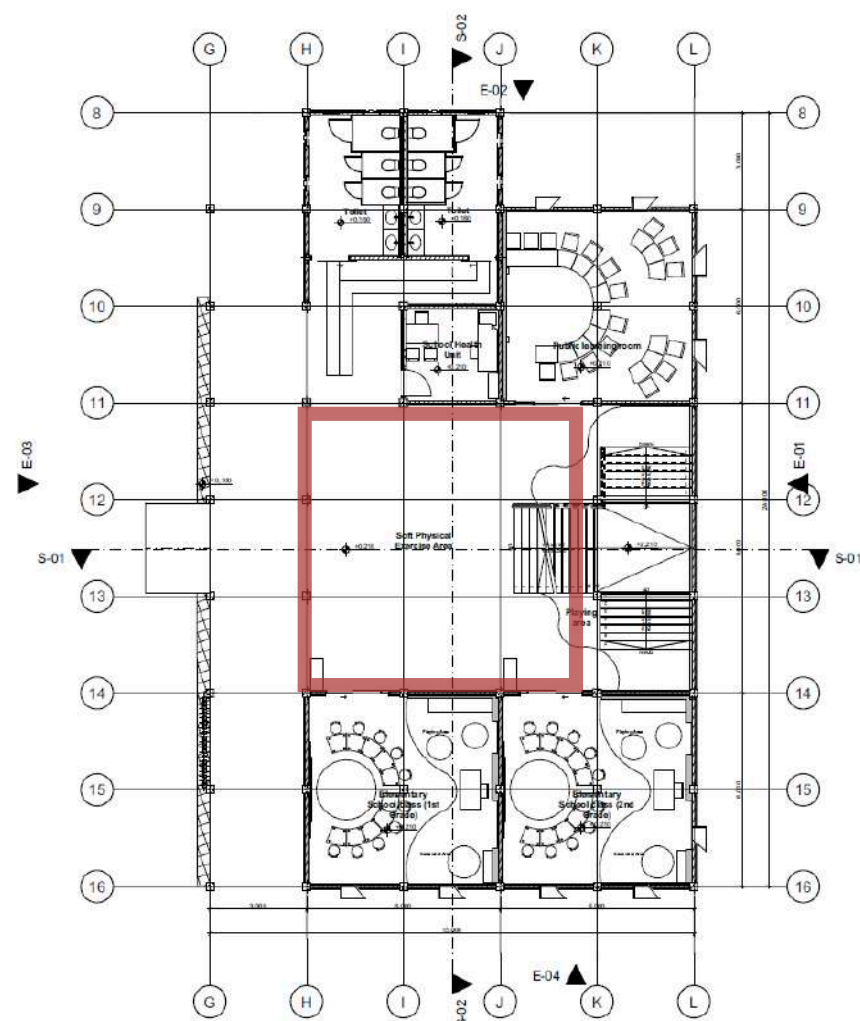


Figure 4.12 Ground floor of the main mass that showing where the void is
Source: Author, 2024

The area framed by the red line on the ground floor floor plan drawing on the side is an area that can be used for soft physical exercises such as gymnastics or dancing. For this kind of physical exercise, deaf students need good lighting to be able to clearly see the details of the instructor's movements. Since this area is on the ground floor, and is in the center of the building mass, it would be difficult to rely only on conventional windows. Therefore, this area is made into a void and a clerestory window is provided on the roof, so that sunlight from the roof can illuminate this area.

The clerestory window is placed facing north and south so as not to get direct sunlight that can make it hot and also glare. Although facing north and south, there is still the possibility of direct sunlight, so a light shelf is needed. This light shelf is useful for reflecting sunlight that enters through the window to the ceiling of the roof which is then reflected again to the areas below.



Figure 4.13 The placement of clerestory windows and the light shelves
Source: Author, 2024

Detail of clerestory window and light shelf

The clerestory windows are located on the top floor in the north and south of the building. The windows on the south side are higher than the north side, because the morning sun often tends to rise slightly to the north, so to avoid direct sunlight, the north side windows are smaller. To reduce the effect of heat from the sun, these windows are coated with anti-UV window film. On the inside of this window, there is additional frames that functions as a light shelf. This window is connected with metal plate to the additional beam structure of the roof structure.

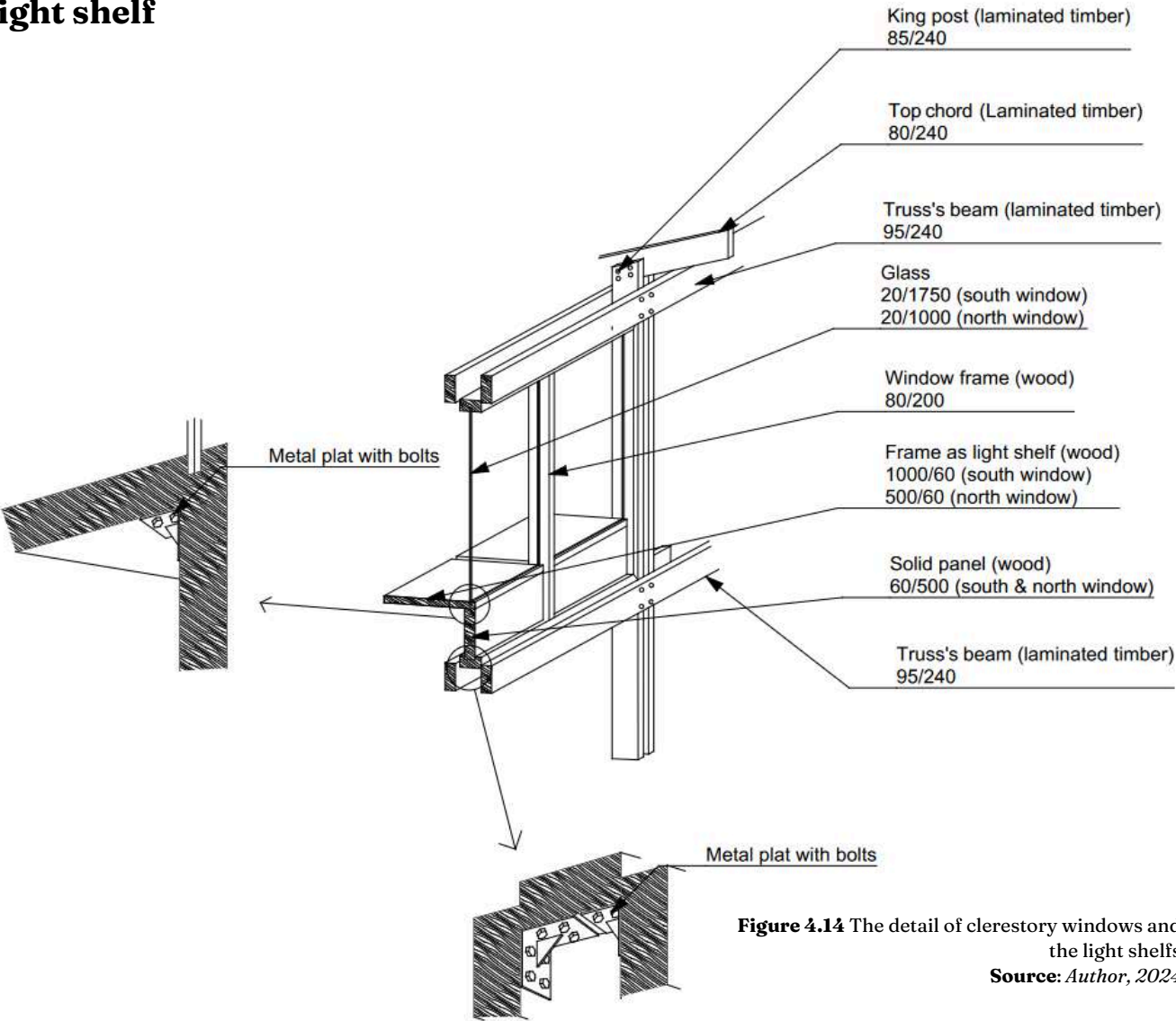


Figure 4.14 The detail of clerestory windows and the light shelves
Source: Author, 2024



4.5.2 Angled window



Figure 4.15 The angled windows
Source: Author, 2024

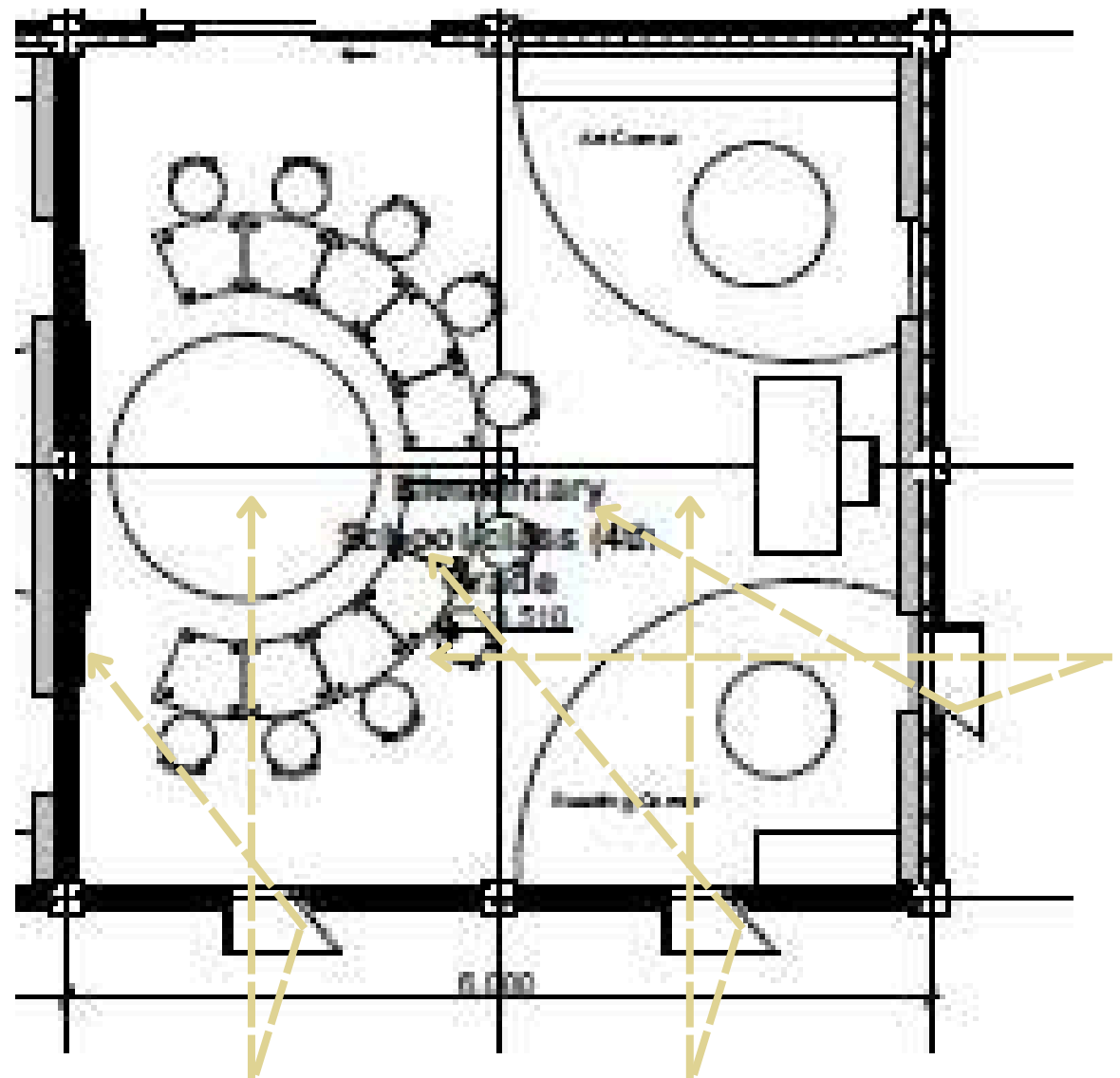


Figure 4.16 The scheme hoe the angled windows work
Source: Author, 2024

The use of angled windows is intended to reduce direct light by reflecting the incoming light. The reflected light will be directed towards the areas where deaf students focus in the classroom, such as the blackboard area and also the sensorial area or reading corner. The window frames are also made to protrude outwards which in addition to “catching” and “directing” the reflected light, also functions as sun shading.

4.6 PROVIDING SENSORY QUALITY THROUGH LANDSCAPE

4.4.1 Sensory garden

The sensory garden was created to maximize the ability of the senses including maximizing their remaining sense of hearing. The garden is divided into five main groups of areas, namely, touch area which contains plants with different textures; taste area which contains plants that can be eaten directly; sight area which contains plants with striking colors; noise area which contains plants that produce white noise when blown by the wind; and smell area which contains plants with fragrant and distinctive fragrances. The five areas are interconnected by barefoot paths consisting of various textures to stimulate the soles of their feet to increase sensitivity to vibrations. In the center of the garden is a fountain with different heights to provide an understanding of height differences.

- Legend:
- A: Touch area
 - B: Taste area
 - C: Sight area
 - D: Noise area
 - E: Smell area
 - F: Smell and sight area
 - G: Barefoot path
 - H: Water fountain

Figure 4.17 The sensory garden and its divisions
Source: Author, 2024

A



Figure 4.18 The detail of touch area
Source: Author, 2024

It consists of plants that have unique textures such as aloe vera, succulent, sensiviera, and lady fern.

B



Figure 4.19 The detail of taste area
Source: Author, 2024

It consists of edible plants that have different flavors such as lemongrass, rosemary, papermint, tomato, citrus, and asoka flower.

C



Figure 4.20 The detail of sight area
Source: Author, 2024

Consists of plants that have striking colors such as frangipani, roses, hibiscus, sunflowers, bird of paradise, asoka, gardenia, and anthurium.

D



Figure 4.21 The detail of noise area
Source: Author, 2024

It consists of plants that will make a soft sound when blown by the wind such as bamboo and panicum prairie sky.

E



Figure 4.22 The detail of smell area
Source: Author, 2024

t consists of plants that emit a distinctive and quite strong fragrance such as frangipani, rose, gardenia, jasmine, rose moss, mirabilis jalapa, and orange blossom.

G



Figure 4.23 The detail of barefoot path
Source: Author, 2024

Paths that have various textures ranging from gravel, grass, cobble stone, bamboo slats, cord wood cobbles, and sand that can stimulate the sensitivity of the foot sensor.

4.4.2 Playground



Figure 4.24 The detail of playground area
Source: Author, 2024

Balance logs
(train balance)

Free flow area within
sand box
(train tactile
sensitivity)

Multi-level platform
(visual perspectives
from various heights)

slider, swing, trampoline, spinner, ball's net
(physical exercise in fun way)

4.7 STRUCTURE DETAIL

4.7.1 Structure axonometry

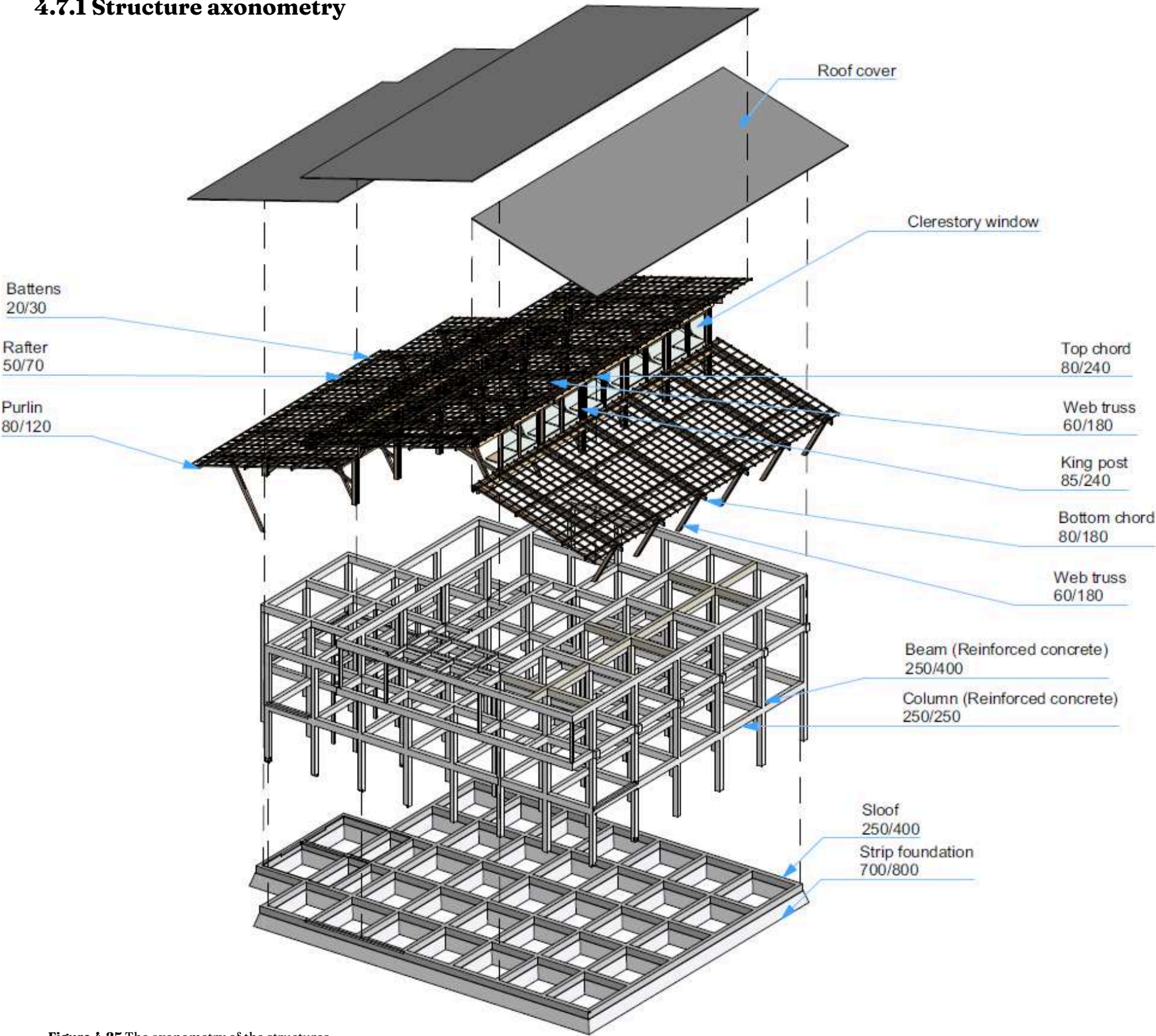


Figure 4.25 The axonometry of the structures
Source: Author, 2024

4.7.2 Roof detail

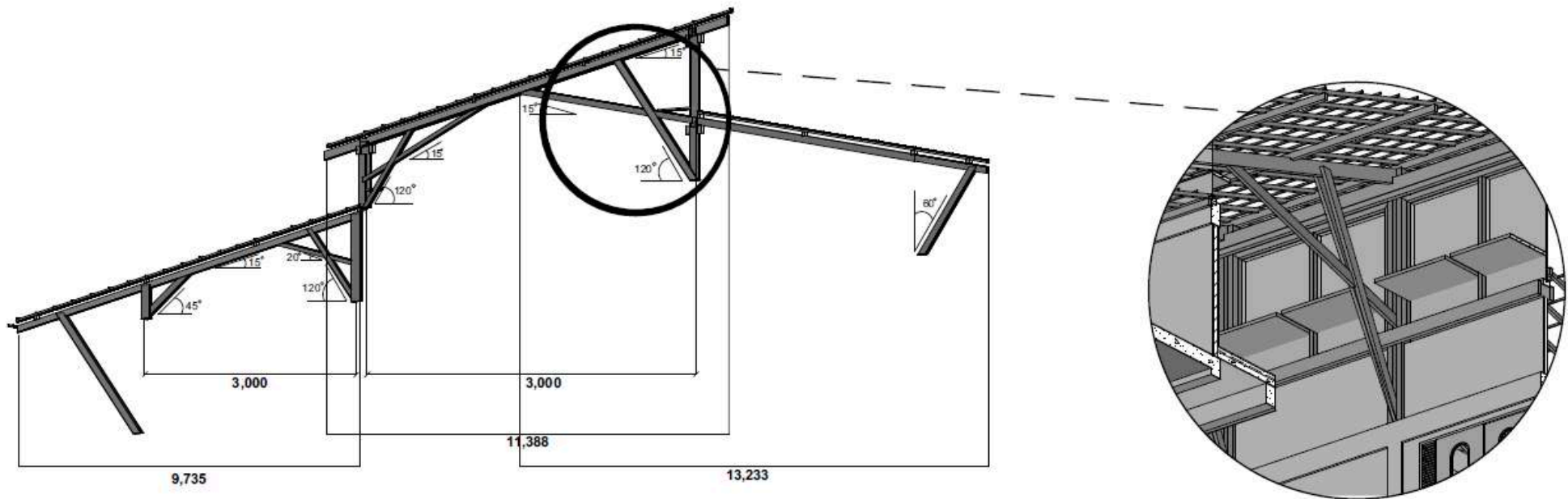


Figure 4.26 The detail of the roof structure
Source: Author, 2024

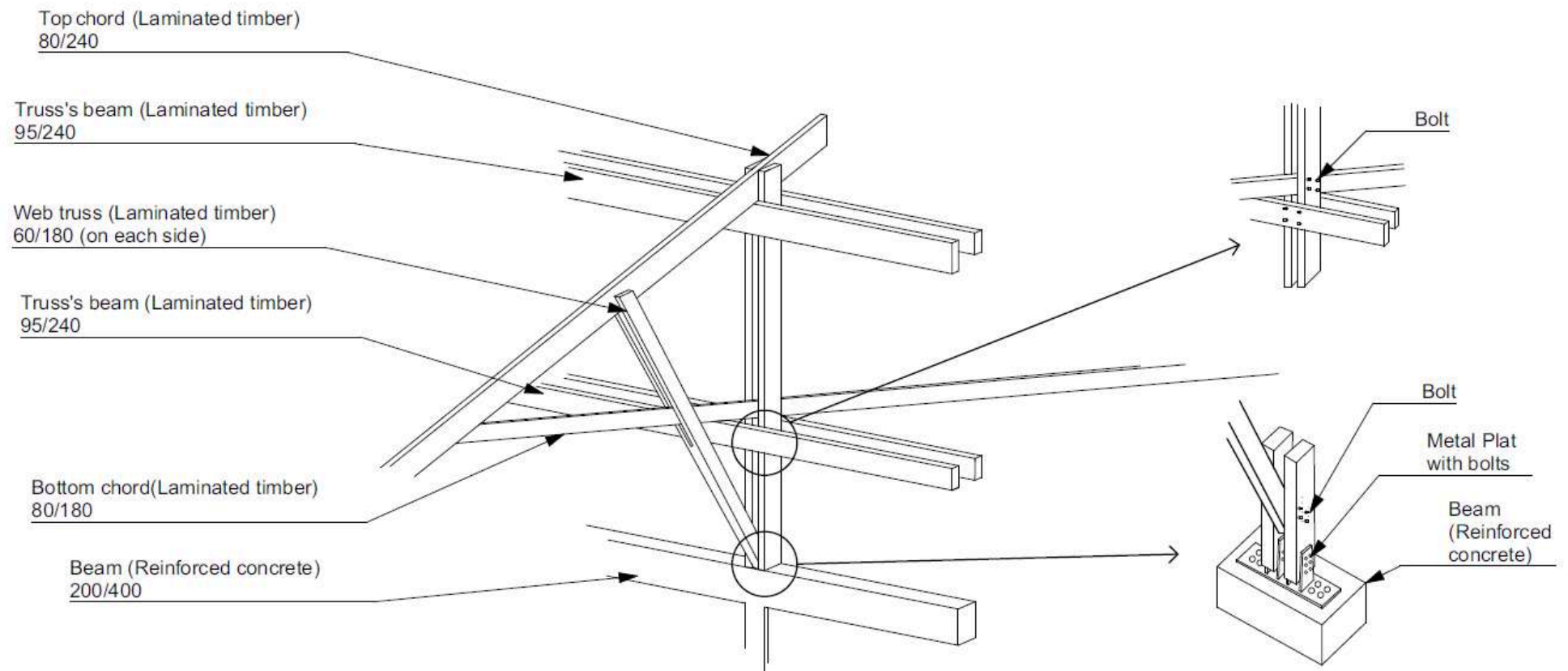


Figure 4.27 The joint detail of the roof structure
Source: Author, 2024

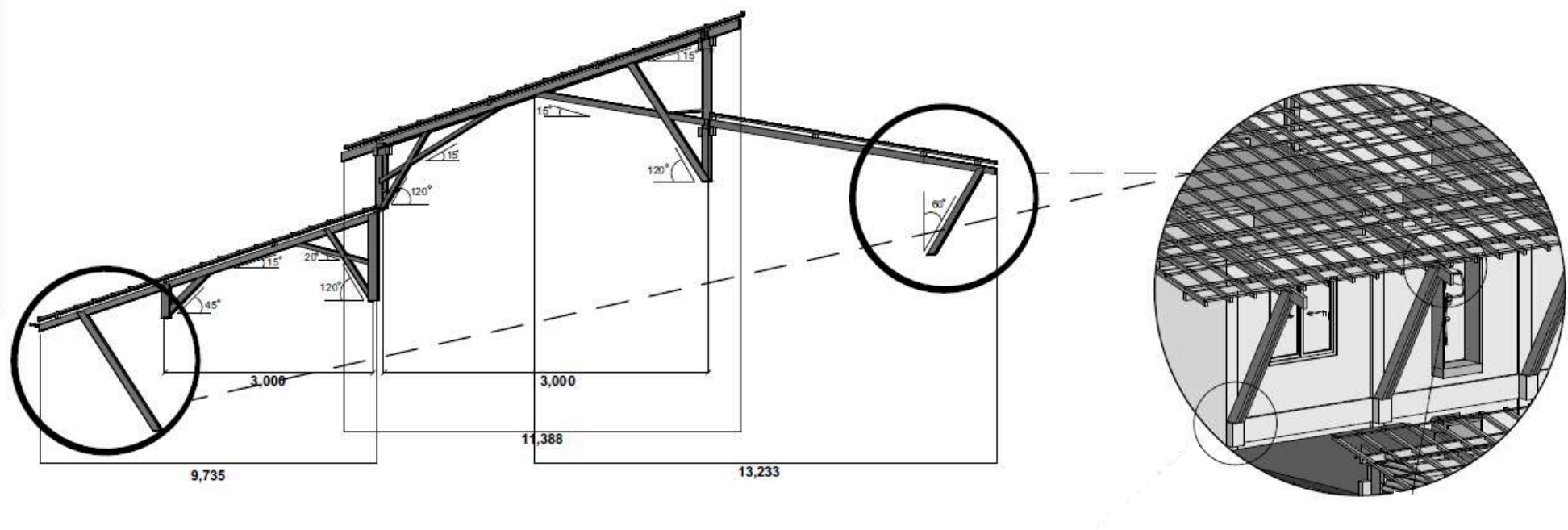


Figure 4.28 The detail of the roof structure
Source: Author, 2024

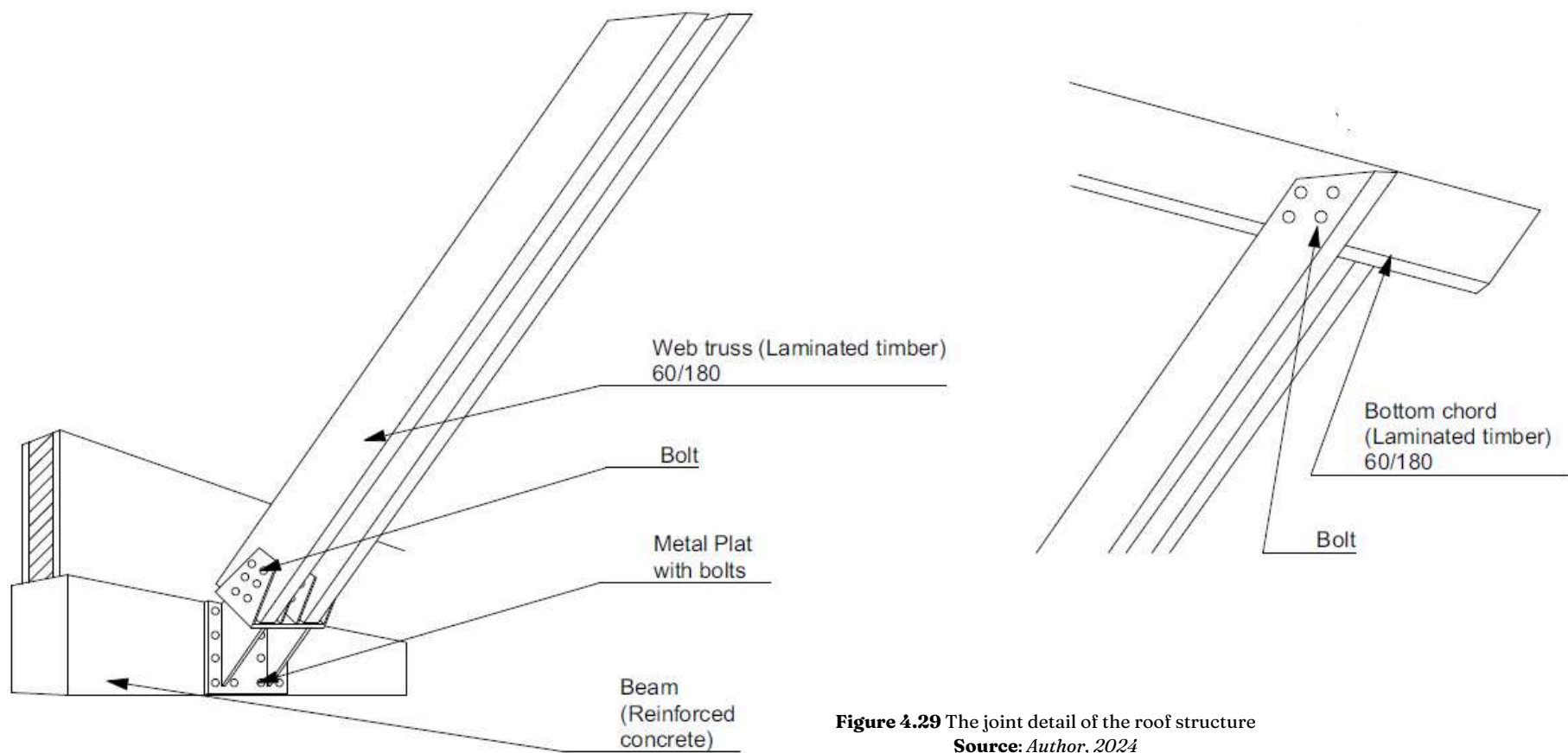
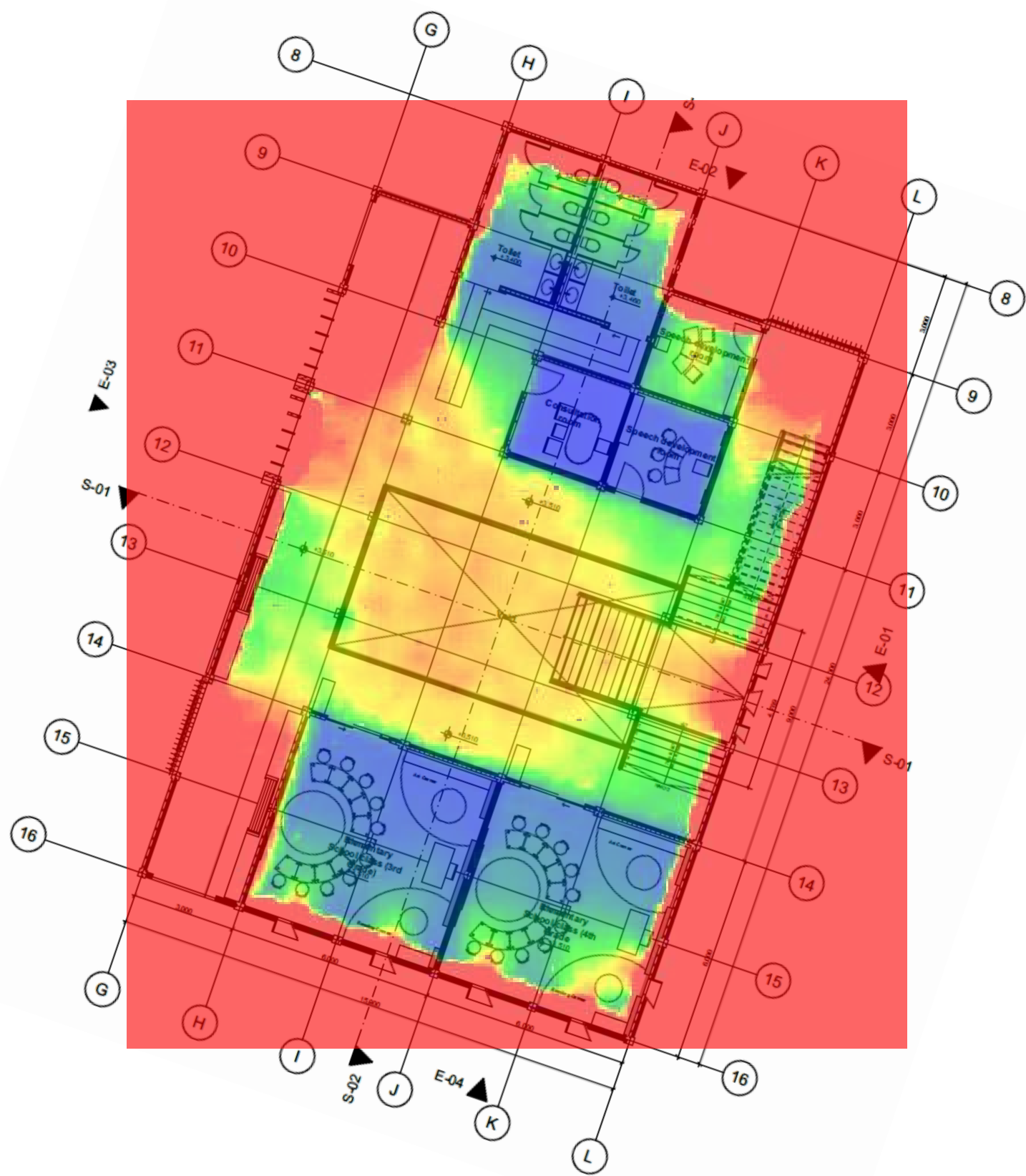


Figure 4.29 The joint detail of the roof structure
Source: Author, 2024

4.8 SIMULATION AND CHECKLIST

4.8.1 Velux



The simulated area is the second floor of the main building. From the velux test results, the void section is yellow which means it is bright enough, so the light can reach the ground floor. For the classroom section, the part near the window is quite bright, while the other side is darker. Therefore, the bright side is made for book reading activities, sensorial areas, and also discussion areas. There are some parts that are colored red, because they are semi-open corridor areas or use curtain walls with large glass. To reduce heat gain, the glass in this building is coated with window film to reduce solar heat absorbed into the building.

Figure 4.30 The result of velux simulation
Source: Author, 2024

4.8.2 Lighting cheklist

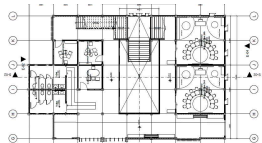
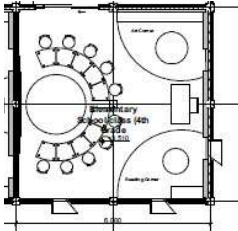
Aspect	Specification	Application	Design
Lighting	Minimum lighting for rooms with intense communication and reading activities is 350 lux	Using square plan with atrium to maximize the daylighting.	
		Using higher windows with external sunscreen as slat or roller sunscreen to reduce glare and direct sunlight.	
	Not cause distraction in the form of glare, backlight, direct sunlight	The use of external sunscreen as slat or roller sunscreen, shading, or etc.	
		Balancing the daylight using multiple light sources.	
	Contrast background and make the color as a wayfinding	Avoid glossy surface or color	
		Use dark color next to light color to absorb the reflective light.	
	Do not use to much color	Use light shelf to avoid or reduce the direct sunlight	
		Use contrast colors with human skin, such as green and blue.	
			

Table 4.1 The checklist of lighting specification and its implementation in the desain

Source: Author, 2024

Table 4.1 The checklist of lighting specification and its implementation in the desain
Source: Author, 2024

4.9 RENDER

4.9.1 Exterior



Figure 4.31 The rendering of exterior
Source: Author, 2024

4.9.2 Interior



Figure 4.52 The rendering of interior
Source: Author, 2024



Figure 4.33 The rendering of interior
Source: Author, 2024

4.9.3 Cut renders



Ground floor plan cut



First floor plan cut



Second and mezanine floor plan cut

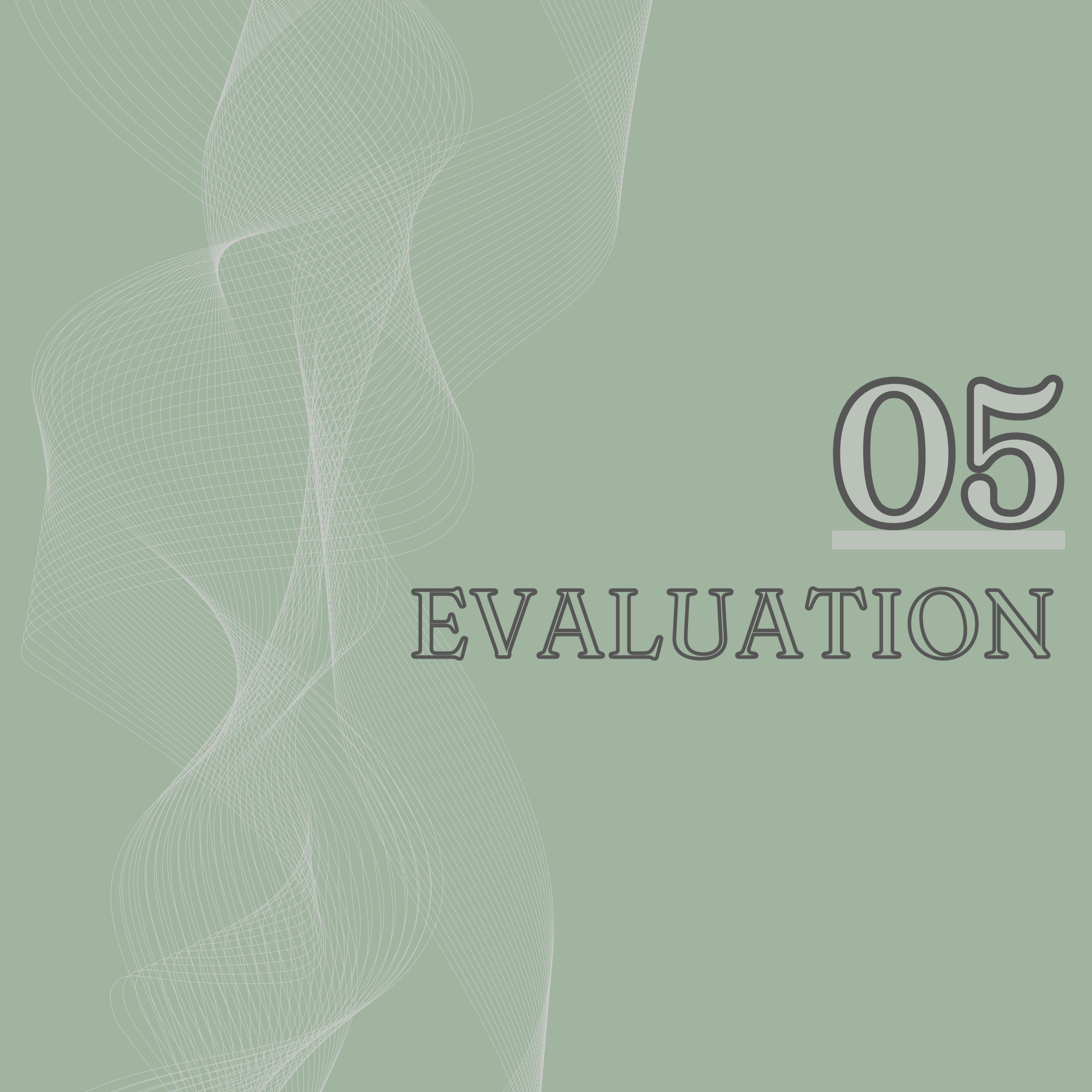


Main mass section



Ground floor plan cut of main mass

Figure 4.34 The rendering of the 3d cut
Source: Author, 2024



05

EVALUATION

Evaluation Design Notes

5.1 SUB-PRIMER MASS' S FLOOR PLAN AND TOILET

- Why is the teacher's room on the first floor, while the pre-childhood classroom is on the ground floor and separated from the other kindergarten classes?
- Toilets that are mixed between adult and children's toilets are uncommon

5.2 INTERIOR DETAIL AND ADDITIONAL ARTIFICIAL LAMP

- Add interior details to recognize material differences
- Use artificial lights to illuminate low-light areas in the classroom

5.3 DESIGNING THE NEGATIVE SPACE

- Back yards become negative space if not designed
- Provide windows or doors to the backyard so that teachers can supervise deaf students

5.1 SUB-PRIMER MASS'S FLOOR PLAN AND TOILET

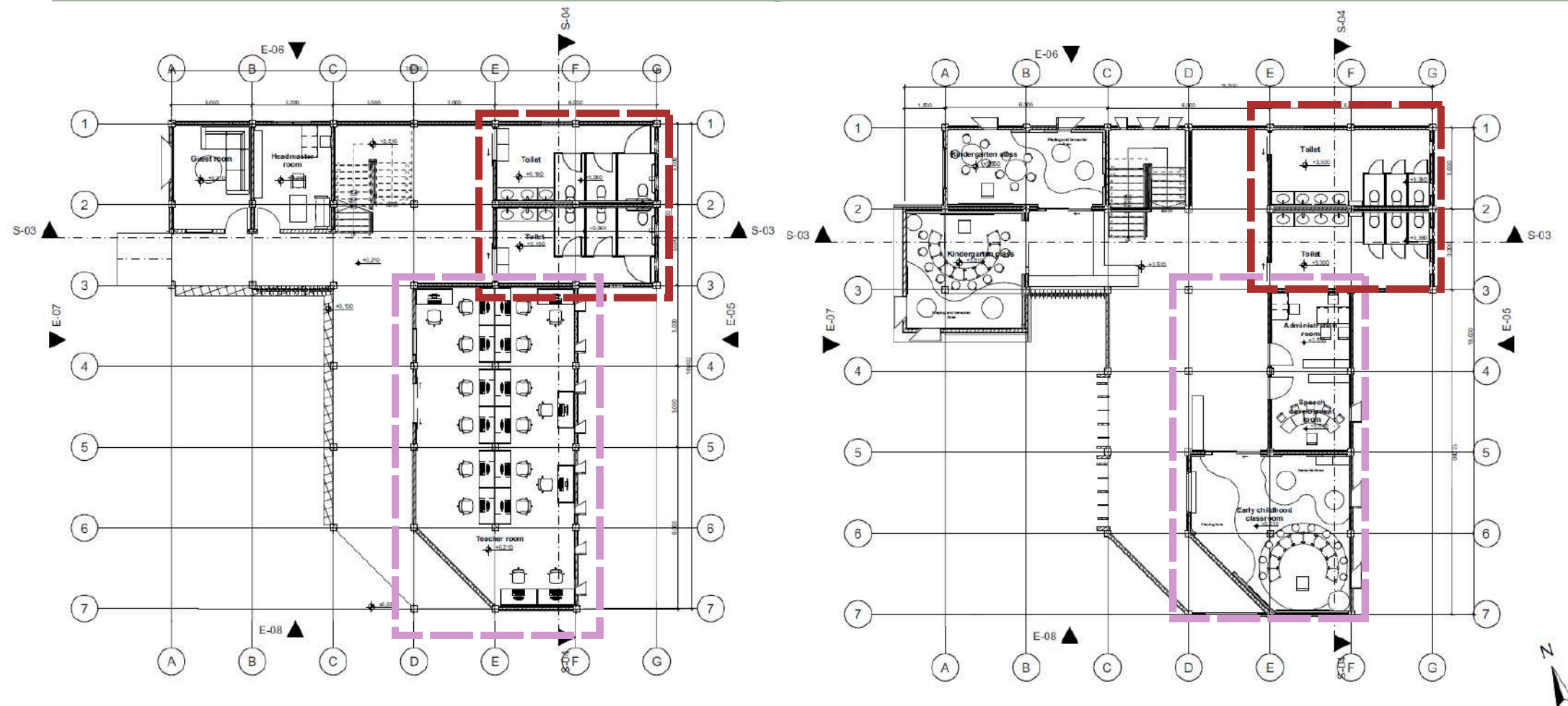


Figure 5.1 The relocation of the rooms in sub-primer mass

Source: Author, 2024



The teacher's room was moved to the ground floor, while the pre-school classroom, administration room, and speech development room were moved to the upper floor. The relocation of these spaces also facilitates clearer semi-public and private zones, with the learning spaces being located on the more private upper floors.



In addition to separating the private and semi-public zones more clearly, the transfer of these spaces makes the toilets on the ground floor all adult toilets, while those on the upper floors are specifically for students. These adult toilets can be used by teachers, employees, guests, and the disabled as they are accessible. Meanwhile, the toilets on the upper floors and the toilets in the mass of the primary building are all student-only toilets.

5.2 INTERIOR DETAIL AND ADDITIONAL ARTIFICIAL LAMP

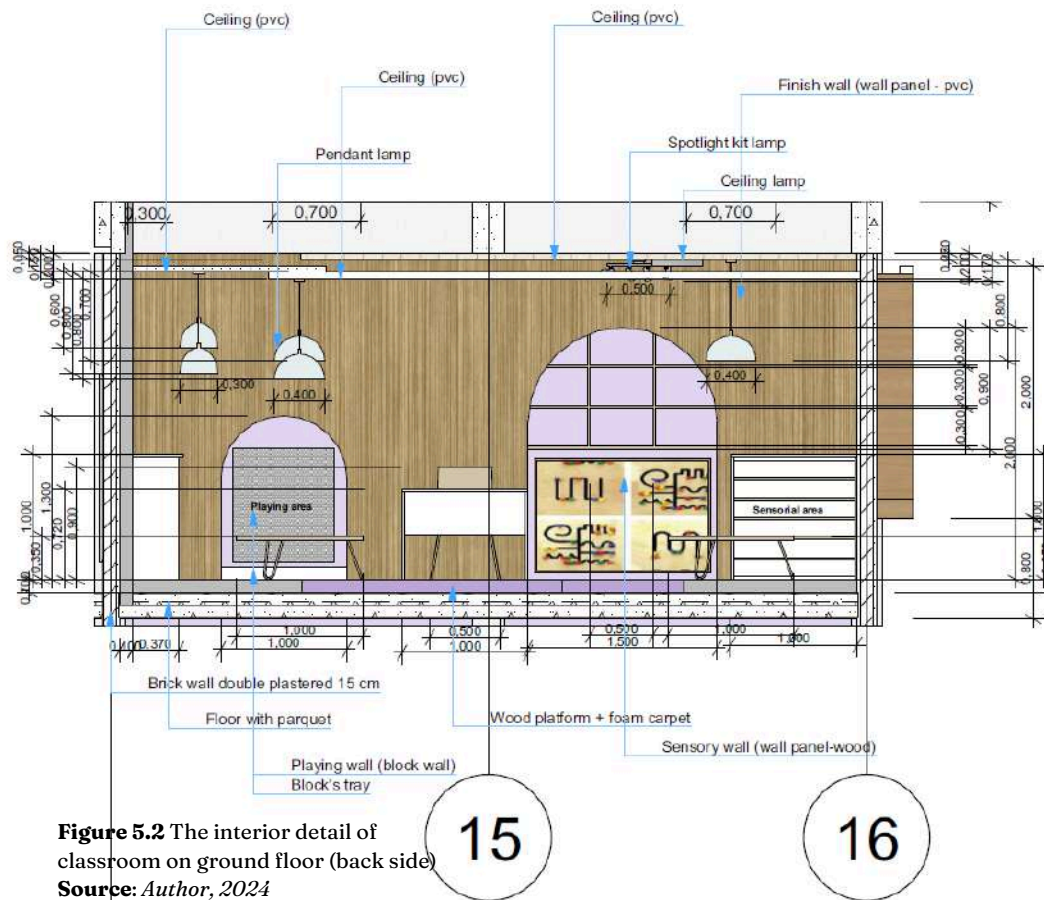


Figure 5.2 The interior detail of classroom on ground floor (back side)
Source: *Author, 2024*

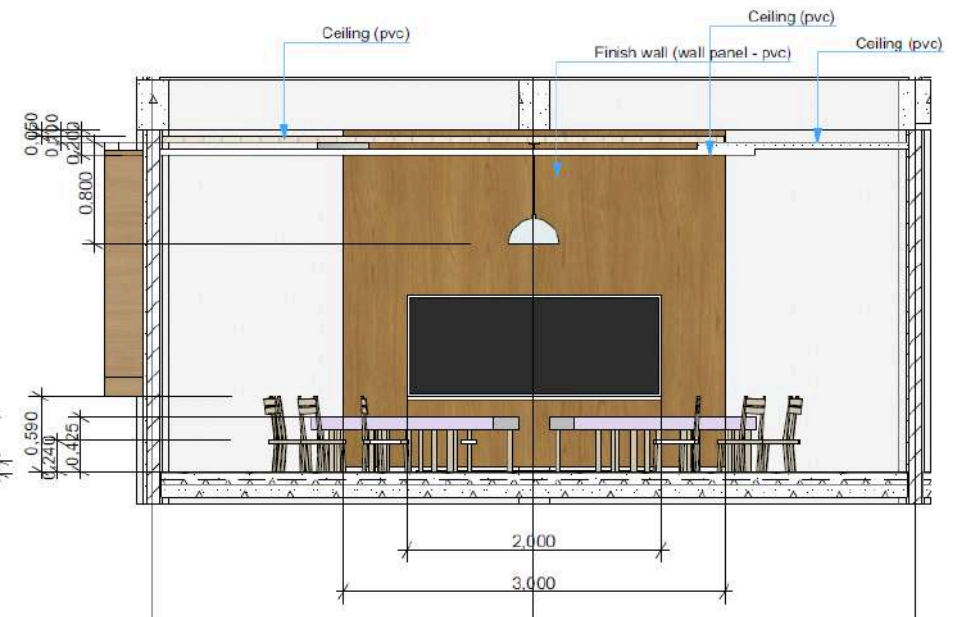


Figure 5.3 The interior detail of classroom on ground floor (front side)
Source: *Author, 2024*

Through these interior details, it can easily show the details of the use of different materials and colors of each room, especially the classrooms. In addition, we can also see the use of additional pendant lamps in the classrooms to illuminate areas that are less exposed to sunlight.

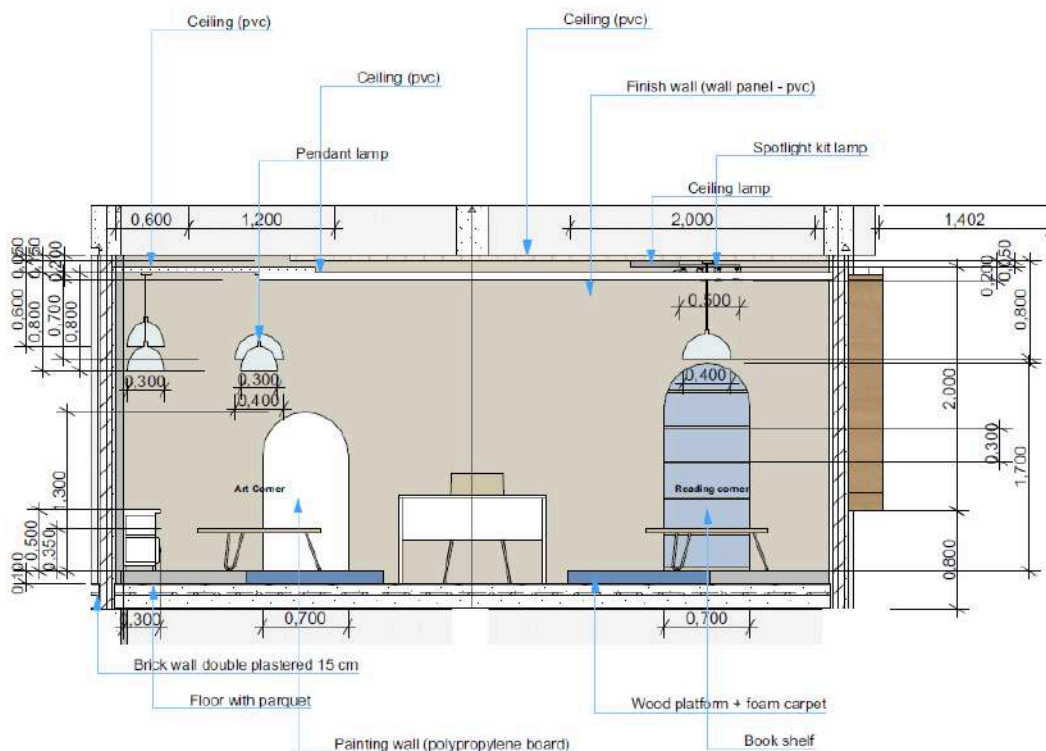


Figure 5.4 The interior detail of classroom on first floor (back side)
Source: *Author, 2024*

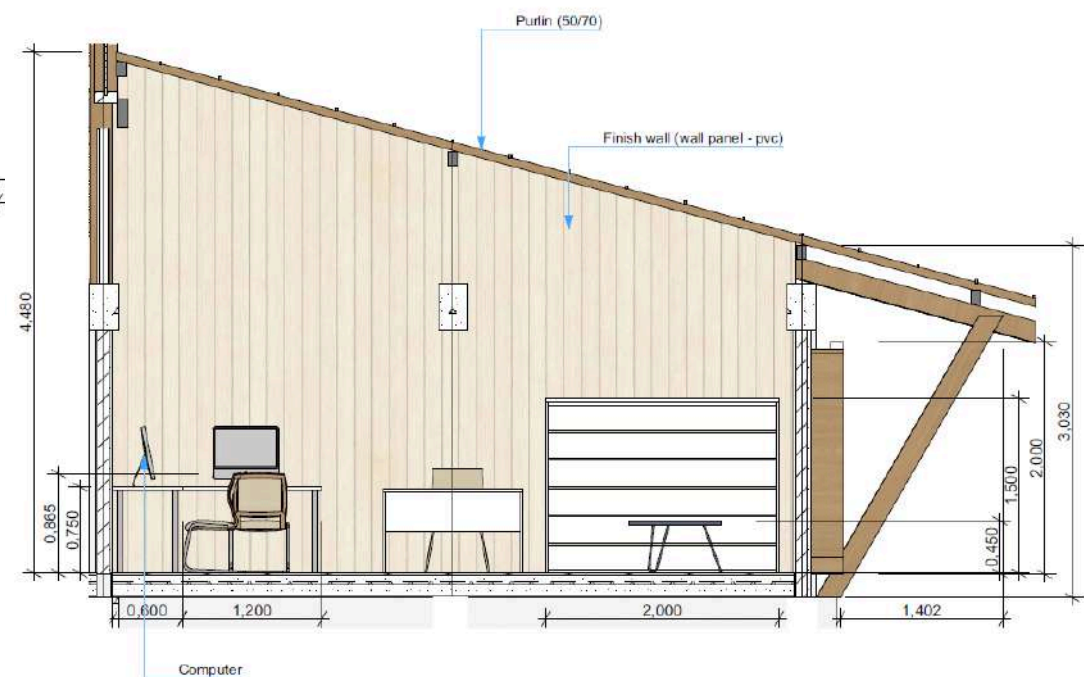


Figure 5.5 The interior detail of classroom on second floor (back side)
Source: *Author, 2024*

Through the electricity plan on the ground floor, additional electrical circuits for pendant lamps in the classrooms of the main building can be seen. In addition, the arrangement of lights in the sub-primary building mass also changed slightly due to the relocation of the teacher's room to the ground floor and the pre-school classroom to the first floor.

LEGEND

Electricity source panel

Genset

Electricity meter box

Ceiling lamp type 1

Ceiling lamp type 2

Ceiling lamp type 3

Ceiling lamp type 4

Wall mouth lamp

Pendant lamp

Main electricity circuit

Sub electricity circuit

Lamp circuit

Socket with pilot light

Socket with 1 pole switch

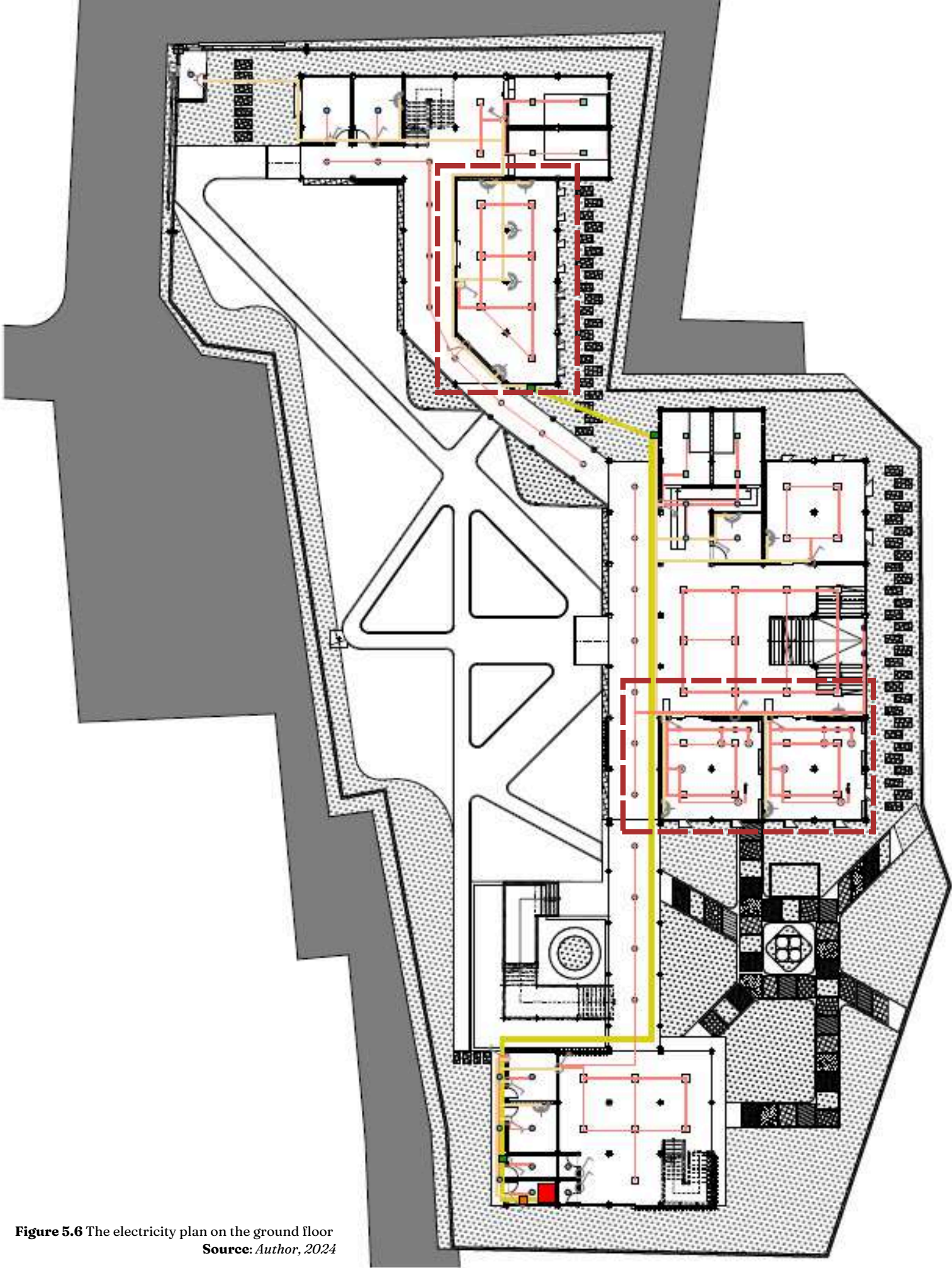
1 pole switch

2 pole switch

3 pole switch

4 pole switch

Figure 5.6 The electricity plan on the ground floor
Source: Author, 2024

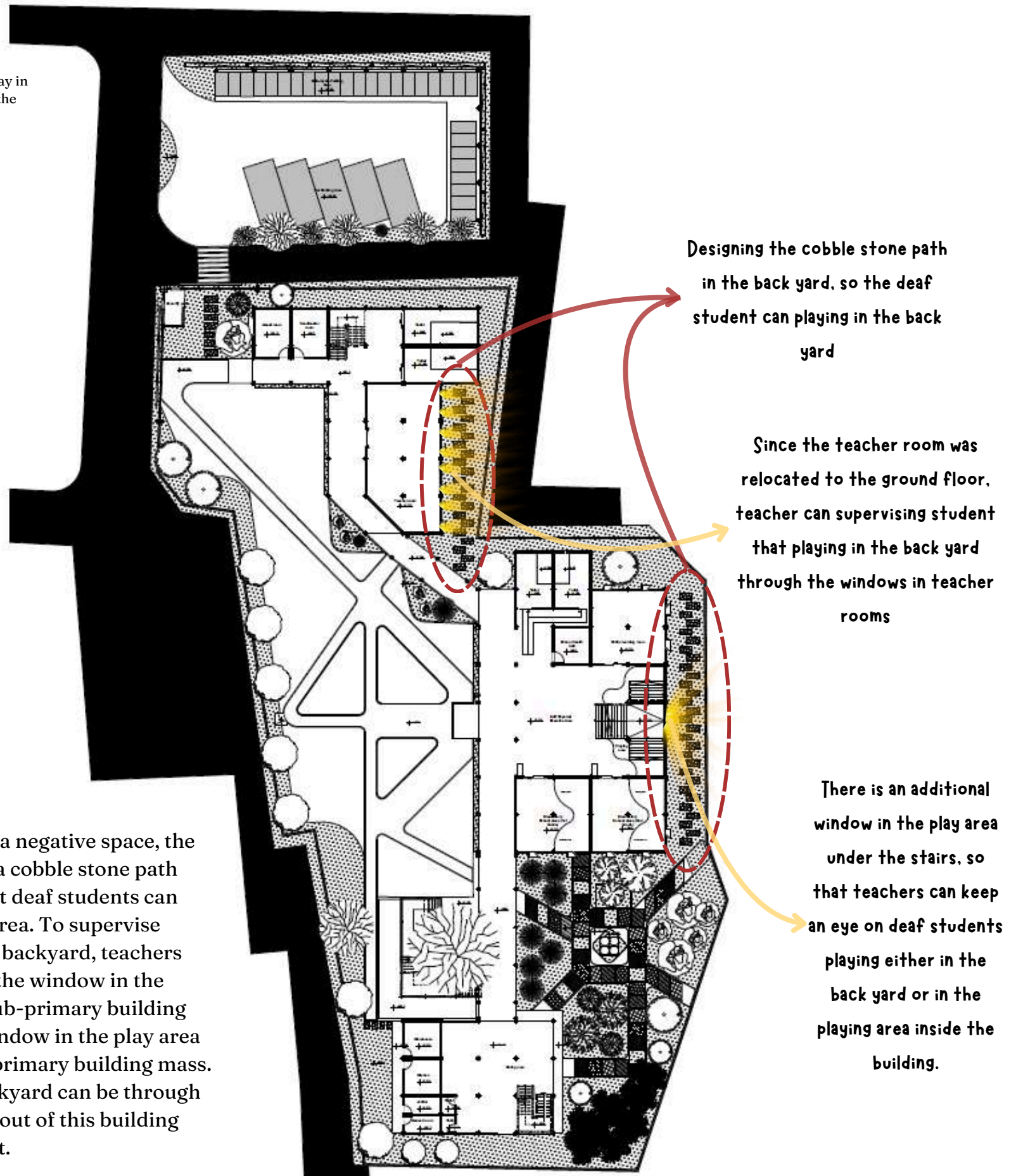


5.3 DESIGNING THE NEGATIVE SPACE

Figure 5.7 The cobble stone pathway in the back yard and windows facing the back yard

Source: Author, 2024

In order not to become a negative space, the backyard area is given a cobble stone path and some plants, so that deaf students can explore the back yard area. To supervise children who are in the backyard, teachers can supervise through the window in the teacher's room in the sub-primary building mass or through the window in the play area under the stairs of the primary building mass. While access to the backyard can be through anywhere, since the layout of this building uses a semi-open layout.





06

ATTACHMENT

6.1 PLAGIARISM CHECK LETTER



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SURAT KETERANGAN HASIL CEK PLAGIASI

Nomor: 2423957557/Perpus/10/Dir.Perpus/VI/2024

Bismillaahirrahmaanirrahiim

Assalamualaikum Wr. Wb.

Dengan ini, menerangkan Bahwa:

Nama : Yushinta Latifa Aureliana
Nomor Mahasiswa : 20512044
Pembimbing : Prof. Noor Cholis Idham, ST., M.Arch., Ph.D., IAI
Fakultas / Prodi : Teknik Sipil dan Perencanaan/ Arsitektur
Judul Karya Ilmiah : Design of Special Needs School with Bioclimatic Architecture Approaches in Yogyakarta to Optimize Sensory Quality for The Deaf Student

Karya ilmiah yang bersangkutan di atas telah melalui proses cek plagiasi menggunakan **Turnitin** dengan hasil kemiripan (*similarity*) sebesar **12 (Dua Belas) %**.

Demikian Surat Keterangan ini dibuat untuk dapat dipergunakan sebagaimana mestinya.

Wassalamualaikum Wr. Wb.

Yogyakarta, 7/29/2024

Direktur



Muhammad Jamil, SIP.



07

REFERENCES

- Almusaed, A. (2011). Biophilic and Bioclimatic Architecture, Analytical Therapy for The Next Generation of Passive Sustainable Architecture. Springer Science & Business Media. <https://doi.org/10.1007/978-1-84996-534-7>
- Archdaily. (2012). Deyang School for Deaf & Intellectually Disabled Children.
- Archdaily. (2021). Alfreton Park Community Special School.
- Archdaily. (2023). Lovell International School.
- Badan Standarisasi Nasional. (2020). SNI 6197-2020: Konservasi energi pada sistem pencahayaan. <https://akses-sni.bsn.go.id/viewsni/baca/8069>
- BAPPEDA. (2023a). Jumlah Sekolah. https://bappeda.jogjaprovo.go.id/dataku/data_dasar/cetak/478-jumlah-sekolah
- BAPPEDA. (2023b). Penyandang Masalah Kesejahteraan Sosial dan Sarana Kesejahteraan Sosial. https://bappeda.jogjaprovo.go.id/dataku/data_dasar/cetak/105-penyandang-masalah-kesejahteraan-sosial-dan-sarana-kesejahteraan-sosial
- Bavelier, D., & Neville, H. J. (2002). Cross-modal plasticity: where and how? *Nature Reviews Neuroscience*, 3 (6), 443–452.
- Bottari, D., Heimler, B., Caclin, A., Dalmolin, A., Giard, M.-H., & Pavani, F. (2014). Visual change detection recruits auditory cortices in early deafness. *NeuroImage*, 94, 172–184.
- Damayanti, P. A. (2015). SEKOLAH DASAR LUAR BIASA (SDLB) DI KOTA SEMARANG DENGAN PENEKANAN DESAIN UNIVERSAL. *Canopy: Journal of Architecture*, 4(2), 1–8.
- Dinas Pendidikan Pemuda dan Olahraga DIY. (n.d.). Rekapitulasi Data Siswa ABK Pendidikan Khusus (SLB) Mulai dari Jenjang TK - SMA Tahun 2023/2024. Retrieved April 28, 2024, from <https://dikpora.jogjaprovo.go.id/pklk/pkslb/data/tahun/10>
- EVERYTHING You Need to Know About Schooling For a Deaf or Hard of Hearing Child. (n.d.). AMERICAN SCHOOL FOR THE DEAF. Retrieved April 26, 2024, from <https://www.asd-1817.org/deaf-schools>
- Goyal, J. (2023). Passive Strategies for Building Design in Tropical Climates: A Comprehensive Guide. NOVATR. <https://www.novatr.com/blog/passive-design-strategies-tropical-climate>
- Handoko, J. P. S., & Ikaputra. (2019). Prinsip Desain Arsitektur Bioklimatik pada Iklim Tropis. *Langkau Betang*, 6(2). <https://doi.org/10.26418/lantang.v6i2.34791>
- Hansel Bauman. (2010). DeafSpace Design Guidelines. 1(15).

- Harahap, R. M., Santosa, I., Wahjudi, D., & Martokusumo, W. (2020). STUDY OF INTERIORITY APPLICATION IN DEAF SPACE BASED LECTURE SPACE CASE STUDY: THE CENTER OF ART, DESIGN & LANGUAGE IN ITB BUILDING. *Journal of Accessibility and Design for All*, 10(2).
- Heimler, B., Striem-Amit, E., & Amedi, A. (2015). Origins of task-specific sensory-independent organization in the visual and auditory brain: neuroscience evidence, open questions and clinical implications. *Current Opinion in Neurobiology*, 35, 169–177.
- Karns, C. M., Dow, M. W., & Neville, H. J. (n.d.). Altered Cross-Modal Processing in the Primary Auditory Cortex of Congenitally Deaf Adults: A Visual-Somatosensory fMRI Study with a Double-Flash Illusion. *Journal of Neuroscience*, 32(28), 9626–9638.
- Kemenkes. (2019). Sering Tak Jelas Dengar Suara Orang Termasuk Tuli. <https://p2ptm.kemkes.go.id/informasi-p2ptm/sering-tak-jelas-dengar-suara-orang-termasuk-tuli>
- Lechner, N. (2015). HEATING, COOLING, LIGHTING Sustainable Design Methods for Architects (4th ed.). John Wiley & Sons, Inc.
- Martinz, L. B., & Gaudiot, D. M. S. F. (2012). The Deaf and The Classroom Design: A Contribution of The Built Environmental Ergonomics for the Acessibility.
- Marzouk, Y. S., El-Sherbiny, E., & Refaat, T. (2024). The Architecture Design Checklist of Classrooms for Children with Cochlear Implant in Rehabilitation Centers. *Results in Engineering*.
- Millar, C. (2021). Creating the perfect school library space. BookTrust. <https://www.booktrust.org.uk/news-and-features/features/2021/may/creating-the-perfect-school-library-space/>
- Nasution, F., Anggraini, L. Y., & Putri, K. (2022). Pengertian Pendidikan, Sistem Pendidikan Sekolah Luar Biasa, dan Jenis-Jenis Sekolah Luar Biasa. *Jurnal EDUKASI NONFORMAL*, 03.
- NATSPEC. (2022). UNIVERSAL DESIGN: LIGHTING. [https://www.natspec.com.au/attachments/category/64/NTN_DES_042 Universal design - Lighting.pdf](https://www.natspec.com.au/attachments/category/64/NTN_DES_042_Universal_design_-_Lighting.pdf)
- Naurah, Y. R. (2023). Perancangan Sekolah Kebutuhan Khusus Penyandang Tunaganda Yayasan Sayap Ibu dengan Pendekatan Arsitektur Bioklimatik di Tangerang Selatan, Banten.

- Pawitro, U., Nitya, A., Septiandi, T., & Hernomo, A. (2014). Kajian Ekspresi Ruang Luar dan Ruang Dalam pada Bangunan Masjid Al – Irsyad Kota Baru Parahyangan Ditinjau Dari Sustainable Design. 2(2), 1–12.
- PERMENDIKNAS. (2008). Standar Sarana dan Prasarana untuk Sekolah Dasar Luar Biasa (SDLB), Sekolah Menengah Pertama Luar Biasa (SMPLB), dan Sekolah Menengah Atas Luar Biasa (SMALB).
- Pratiwi, R. P., & Murtiningsih, A. (2016). Kiat Sukses Mengasuh Anak Berkebutuhan Khusus. AR-Ruzz Media.
- Ratodi, M., & Hapsari, O. E. (2017). IDENTIFIKASI BEST PRACTICE DESIGN BERDASAR HADITS SEBAGAI PANDUAN PERANCANGAN ARSITEKTUR. Nature, 4.
- Ruck, N., Aschehoug, Ø., Aydinli, S., Christoffersen, J., Courret, G., Edmonds, I., Jakobiak, R., Kischkoweit-Lopin, M., Klinger, M., Lee, E., Michel, L., Scartezzini, J.-L., & Selkowitz, S. (2000). Daylight in Buildings. Lawrence Berkeley National Laboratory.
- Savero, R. R., Antaryama, I. G. N., & Soemardiono, B. (2020). REVIEW ON DESIGN STRATEGIES OF ENERGY SAVING OFFICE BUILDING WITH EVAPORATIVE COOLING IN TROPICAL REGION. IPTEK The Journal of Technology and Science.
- Shiell, M. M., Champoux, F., & Zatorre, R. J. (2016). The Right Hemisphere Planum Temporale Supports Enhanced Visual Motion Detection Ability in Deaf People: Evidence from Cortical Thickness. Neural Plasticity.
- Sudiarta, I. I. N. (2016). Penghawaan alami. 1–24.
- Syafriyani, Rahmayanti, Mutmainnah, N., & Saputra, W. (2013). Evaluasi performa penghawaan alami pada ruang kelas persiapan anak disabilitas pendengaran slb ypac manado. 1(1), 16–20.



**DESIGN
DOCUMENT**

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