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Research Article

Design of Student Apartment Housing in Medan City, North Sumatra with A Green Architecture Theme

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Abstract: The increasing number of students in major cities such as Medan has created an urgent need for temporary housing that is adequate, comfortable, and sustainable. In response, the Indonesian government, through the Ministry of Public Works and Public Housing (PUPR), launched the "One Thousand Towers Program," which includes the development of rental apartment buildings (Rusunawa) for students. However, housing provision must go beyond quantity—it must also consider environmental aspects and the quality of life for its occupants. Therefore, a green architecture approach serves as the foundation for the design of environmentally friendly student housing. This project aims to create a vertical residential facility that not only fulfills the basic function of shelter but also supports learning activities, social interaction, energy efficiency, and environmental sustainability. The design applies key principles of green architecture such as natural lighting, cross ventilation, the use of eco-friendly materials, and the integration of green open spaces. In addition to double-room residential units, the building is equipped with supporting facilities such as study areas, a library, cafeteria, and rooftop garden. The design methodology integrates both primary and secondary data analysis, as well as a comprehensive site study covering climate, noise levels, circulation, and building orientation. The building form concept is developed modularly and efficiently through mass transformation, resulting in an inner court that provides natural light and air. Supported by energy-saving utilities, this design is expected to offer a student housing solution that is not only functional and aesthetic but also contributes to sustainable and high-quality urban development.

Keywords: Design; Green Architecture; Medan City; Student Housing; Sustainable Design.

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1. Introduction

The Government of Indonesia, through the Ministry of Public Works and Housing (PUPR), has launched a national strategic program to address the need for adequate housing, including for university students. One of its main initiatives is the "One Thousand Towers Program," which aims to construct 1,000 rental low-cost apartment towers (Rusunawa) within five years. This program is designed to anticipate the continuously growing population in Indonesia.

According to data from Statistics Indonesia (BPS) in 2024, the population growth rate in Indonesia was recorded at 1.11%, with a total population reaching 281.6 million people. This population surge demands sustainable housing infrastructure planning strategies, especially in areas surrounding higher education institutions, which have seen a significant increase in student numbers.

Unfortunately, the availability of housing that meets these criteria remains very limited. Many students are forced to live in boarding houses or rental accommodations that do not meet acceptable standards of comfort and sustainability. Furthermore, uncontrolled housing growth contributes to increased energy consumption and worsens environmental degradation in urban areas. Rusunawa (rental apartment housing) offers a temporary housing solution that not only ensures comfort but also serves as a medium for learning communal living, fostering discipline, and enhancing social interaction among students.

Therefore, there is a need to design vertical housing for students in the form of apartment buildings as one of the facilities that supports comprehensive educational activities. Currently, the availability of such student housing in Medan City is still very limited. For this reason, the development of student Rusunawa has become an urgent necessity to provide proper and strategically located accommodation, while also educating students to live more disciplined and socially engaged lives. However, apartment construction alone is not sufficient to meet quantitative needs. To create a sustainable living environment, a Green Architecture approach must be applied in the design of such housing.

Green Architecture is an architectural approach that reflects concern for nature and the surrounding environment. This approach emphasizes energy efficiency, sustainability, and holistic application in every aspect of the design process (Priatman, 2002). Green architecture aims to minimize the negative impact of buildings on human health and the environment by implementing eco-friendly and efficient design solutions (Rusadi, Purwatiasning, & Satwikasari, 2019).

According to Syarif and Amri (2017), green architecture also emphasizes the creation of ecological balance between humans, buildings, and the surrounding environment. This concept prioritizes the use of natural resources over artificial ones, with an awareness of the impact of non-renewable energy use on the future of the environment and future generations (Afifah, Anisa, & Hakim, 2018).

Rachmayanti and Roesli (2014) explain that the application of green architecture offers various benefits, such as energy savings, longer building durability, minimal maintenance, increased comfort and health for users, and contributions to the reduction of global warming.

In addition, Putri, Singgih, and Gunawan (2019) emphasize that one of the core principles of green architecture is the use of environmentally friendly materials that are renewable, recycled, cost-efficient, and energy-saving. Meanwhile, in the book Green Architecture: Design for a Sustainable Future by Brenda and Robert Vale, six key principles are outlined: conserving energy, working with climate, respecting the users, minimizing the use of new resources, and adopting a holistic approach.

The conceptual foundation for the design of this student apartment housing forms the basis for developing design ideas that involve analysis of key aspects such as function, form, structure, utilities, and circulation. In the initial stages, the analysis is directed toward identifying the main needs of students as primary occupants. The design aims to accommodate essential activities, including a comfortable and healthy living space, a quiet study area, a social interaction zone that fosters character development, and relaxation areas in green open spaces.

In addition, the green architecture approach serves as the core foundation of the design, applying principles such as energy efficiency, the use of natural lighting and ventilation, and the provision of green open spaces. Apart from its main function as a residence, this student apartment complex is also equipped with additional communal facilities such as a library, cafeteria, and green public spaces. These facilities are not only intended to support daily activities but also serve as an integral part of sustainability principles. By providing environmentally friendly and healthy interaction spaces, the design encourages a sustainable lifestyle and raises environmental awareness among students.

Design Problem Statement; Based on the background described above, the design problem can be formulated as follows: How can the principles of Green Architecture be applied to the design of student apartment housing in Medan City in order to create environmentally friendly residences? Moreover, how can the design of such housing not only function as a place to live, but also serve as a supportive facility for the academic and educational development of students?

The primary objective of designing this student apartment housing is to create vertical residential facilities that address the growing demand for student housing in Medan City, while also supporting the educational process and environmental sustainability through the application of Green Architecture principles.

Designing Student Apartment Housing in Medan City with the Application of the Green Architecture Theme

Medan City, as one of the metropolitan cities in Indonesia and a central hub of education in North Sumatra, experiences continual population growth along with an increase in student numbers each year. According to data from the Central Bureau of Statistics (BPS) of Medan City in 2023, the city's population exceeds 2.5 million people, with a continuously expanding education sector. This growth drives a rising demand for temporary housing that is decent, comfortable, and affordable for students.

However, land in urban areas is becoming increasingly scarce and expensive. Therefore, vertical housing solutions such as student apartment buildings are needed to ensure land-use efficiency. In the design of such apartments, the Green Architecture approach becomes highly relevant in addressing environmental and sustainability issues in urban areas. Green Architecture refers to design principles that prioritize energy efficiency, thermal comfort, natural lighting, water management, and the use of environmentally friendly materials.

These principles can be implemented in student apartment design through various strategies, such as orienting buildings to maximize natural lighting and cross-ventilation, using solar panels for electricity needs, applying rainwater harvesting systems, and providing green open spaces on both the ground level and rooftop gardens. Thus, the design not only fulfills the functional aspect of housing but also enhances the overall quality of the living environment.

Integrating Learning Facilities into Student Housing to Improve Educational Quality.

In addition to meeting housing needs, student apartments should also support academic activities. Students, as part of a productive generation, require spaces conducive to learning, both individually and collaboratively. Data from UNESCO (2022) indicates that psychologically and physically supportive learning environments can improve the effectiveness of learning processes by up to 25%. Therefore, ideal student apartments should not only offer residential units but also include flexible, informal learning spaces such as co-working spaces, reading rooms, and discussion areas.

These learning facilities function as an extension of the campus environment—more relaxed, yet still productive. This aligns with the characteristics of Millennial and Gen Z students, who prefer flexible, collaborative, and technology-integrated learning models. A study by Zakky (2020) reveals that today's students favor aesthetically designed learning spaces that are not rigid, and that support a comfortable and inspiring atmosphere.

Accordingly, student apartment housing should not merely serve as living quarters but should become part of an educational ecosystem that integrates seamlessly with students' daily lives. The combination of green architectural approaches with the provision of informal learning facilities within the residential space is expected to improve the well-being of residents, strengthen social interaction, and encourage students to engage in more focused and diligent learning.

2. Proposed Method

Design Process

The design process of the student apartment housing begins with data collection, which is divided into two types: primary data and secondary data. Primary data is obtained directly from the field through site observations and interviews (Yin, 2000 in Adriana & Tharo, 2018; Moleong, 2000 in Andriana et al, 2023) with students to understand their spatial needs and housing comfort. Meanwhile, secondary data is gathered through literature studies such as journals, books, and regulations to strengthen the theoretical and technical foundation of the design (Groat & Wang, 2000 in Nuraini, 2019; Nuraini, 2024).

The design is then carried out using a design method, which is a systematic process from needs analysis to final design development (Nuraini & Sudradjat, 2010; Groat & Wang 2000 in Nuraini, 2024; Nuraini, 2019). This method serves as a framework for critical and creative thinking in developing design solutions that are innovative, functional, aesthetic, and contextually relevant (Yin, 2000 in Wisdianti et al, 2024; Wisdianti, 2022). By integrating primary data, secondary data, and an appropriate design methodology, the resulting student

apartment housing design becomes responsive to social needs, environmentally sustainable, and technically and aesthetically feasible (Yin, 2000 in Alfiyyah et al, 2023; Aziizah et al, 2024; Prayoga et al, 2022; Permana et al, 2023).

Several stages or processes involved in the design of student apartment housing with a Green Architecture theme are illustrated in Figure 1. The functional zoning scheme of the Green Architecture-themed student apartment is presented in Figure 2.

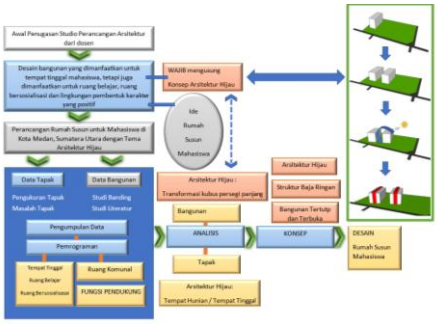

Figure 1. Design Process.
(Source: Author's Construction, 2025)

Figure 2. Two Functional Groupings of Student Apartment Housing
(Source: Author's Construction, 2025)

3. Results and Discussion

Site Review

The development of student apartment housing in Medan City remains limited, and it is expected that future projects will meet the criteria of green architecture, including the application of its principles to apartment designs. The selected site is located on Jl. Taqwa, Tanjung Rejo Subdistrict, Medan Sunggal District, Medan City, with a total site area of 12,000 m^2.

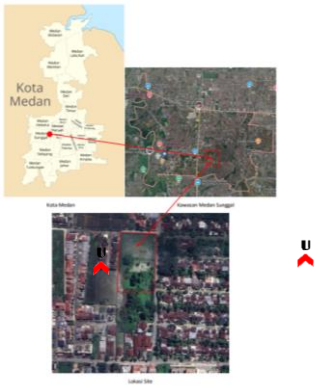

Figure 3. Site Location.
(Source: Processed by the Author based on Google The site has road access on the north and east sides, each with a width of 6 meters)

According to spatial planning regulations issued by the Medan City Government, the zoning regulations for this area include: a maximum Building Coverage Ratio (KDB) of 60%, a maximum Floor Area Ratio (KLB) of 10, a minimum Green Open Space (KDH) of 20%,

and a maximum building height of 20 floors or 80 meters. The boundaries of the site are as follows:

a. North Boundary : Residential houses and vacant land
b. East Boundary : Residential houses
c. South Boundary : Residential houses
d. West Boundary : Residential houses and vacant land

Site Dimensions:

Figure 4. Site Dimensions.
(Source: Personal Documentation, 2025)

Site Location Analysis

a) Sun Path Analysis

In the massing design process of the student apartment housing, consideration of the sun's path is a critical aspect to support thermal comfort, energy efficiency, and the implementation of green architecture principles.

In general, the sun moves from east to west, which makes the ideal building orientation aligned along the east–west axis. However, the student apartment building in this design is rotated 15° from the main site axis. This rotation aims to reduce direct sunlight exposure on the building's surface, especially during midday when solar radiation intensity is highest. By angling the building orientation, the longer facades do not directly face the east–west direction, which is a primary sunlight exposure path in tropical climates such as Medan.

This 15° rotation also helps create natural shading between buildings and provides better potential for cross ventilation within the residential units. The building's position, which is not directly aligned with the sun's path, allows for a more even distribution of natural light and reduces the need for artificial cooling during the day.

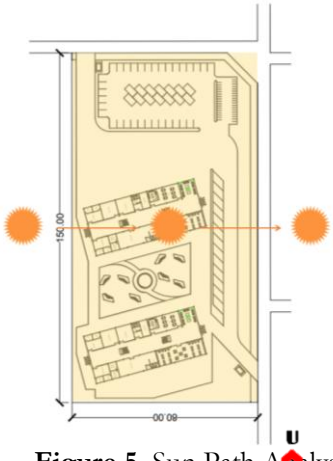

Figure 5. Sun Path Analysis.
(Source: Personal Documentation, 2025)

b) Wind Analysis

The wind flow pattern in northern Indonesia generally moves from the southeast toward the northwest, illustrated by a blue curve flowing across the site. This wind direction reflects common tropical wind patterns, particularly during specific seasons

in a city like Medan. Wind direction analysis is essential for supporting environmentally friendly and thermally efficient building designs.

In response to these conditions, several design solutions can be implemented, including planting trees as natural windbreaks to reduce strong gusts, creating comfortable corridor paths to enhance airflow in low-ventilation areas, and applying cross-ventilation systems to improve indoor temperature and air circulation. One way to achieve this is by incorporating void spaces as a supporting architectural element.

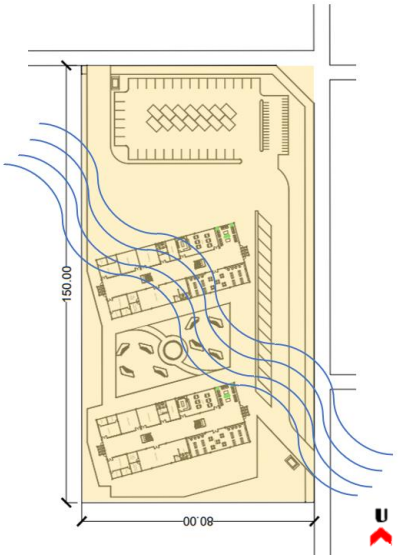

Figure 6. Wind Analysis.
(Source: Personal Documentation, 2025)

c) Noise Analysis

Noise levels around the site are considered high due to the presence of main roads on the north and east sides, which are frequently used by vehicles such as motorcycles and cars. A practical solution is to divide public and private zones based on noise intensity. Private areas are placed farther from the noise sources, as they require a higher level of tranquility.

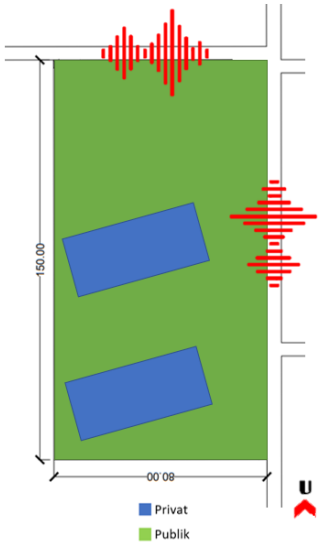

Figure 7. Noise Analysis.
(Source: Personal Documentation, 2025)

d) Circulation Analysis

The roads surrounding the site, such as Jl. Budi and Jl. Taqwa, are two-way streets with a width of 6 meters. Jl. Taqwa, located on the east side, is suitable to serve as the main entrance route, while Jl. Bayu, located on the north side, can function as the exit route.

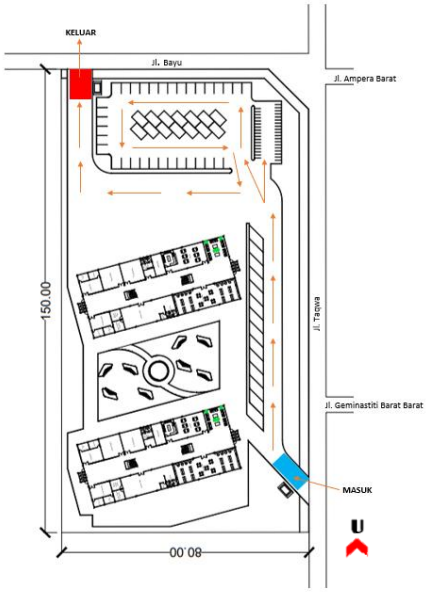

Figure 8. Circulation Analysis.
(Source: Personal Documentation, 2025)

Space Program Overview

Based on the spatial program, the student apartment housing includes several types of facilities as follows:

a) Primary Facilities

Table 1. Primary Facilities.

No	Facility	Area (m²)
1	Room Type 7 x 7 (112 Rooms)	5,488
Total	5,488	

(Source: Personal Documentation, 2025)

b) Supporting Facilities

Table 2. Supporting Facilities.

No	Facility	Area (m²)
1	Library	154.197
2	Auxiliary Room	283.392
3	Prayer Room	156.708
4	Garden	259.2
5	Cafeteria	72.861
6	Public Restroom/WC	192
Total	1,118.358	

(Source: Personal Documentation, 2025)

c) Management Facilities

Table 3. Management Facilities.

No	Facility	Area (m²)
1	Lobby	14.76
2	Head Office	10.67
3	Staff Office	23.16
4	Meeting Room	18.783
5	Lounge	21.21
6	Waiting Room	4.692
7	Pantry	9.72
8	Management Res-troom/WC	48
Total	150.995	

(Source: Personal Documentation, 2025)

d) Service Facilities

Table 4. Service Facilities.

No	Facility	Area (m²)
1	Security Post	3.876
2	Storage	57.6
3	Electrical Panel Room	50
4	CCTV Room	30
5	Janitor Room	30
6	Water Pump Room	50
7	Maintenance Room	70
8	Public Toilet	6.936
Total	298.412	

(Source: Personal Documentation, 2025)

e) Outdoor Space

Table 5. Outdoor Space.

No	Facility	Area (m²)
1	Visitor Motorcycle Parking	500
2	Visitor Car Parking	810
3	Management Motorcycle Parking	50
4	Management Car Parking	202.5
Total	1,562.5	

(Source: Personal Documentation, 2025)

f) Total Area

Table 6. Total Area.

No	Facility	Area (m²)
1	Main Space	5,488
2	Supporting Space	1,118.358
3	Management Space	150.995
4	Service Space	298.412
5	Outdoor Space	1,562.5
Total	8,618.265	

(Source: Personal Documentation, 2025)

Building Form Concept

The transformation of the building form in the design of this student apartment housing is carried out through a simple and rational geometric approach. The goal is to optimize spatial functionality, natural lighting, cross ventilation, and to support a modern and efficient green architecture concept.

Initially, the building mass is derived from a rectangular cube, as this shape is structurally efficient, easy to modulate, and supports functional organization. This basic form serves as

the foundation for further mass development. The mass is then divided into two separate volumes to create gaps for air circulation and natural lighting. This separation also creates an intermediate space, which is later developed into an inner courtyard that facilitates airflow and social interaction among residents.

Next, both building masses are rotated 15° relative to the site's main axis. This rotation aims to minimize direct sunlight exposure from the east and west. The rotated mass is then repeated three times to form three parallel building blocks. A central connecting mass is added, functioning as a vertical and horizontal circulation core. This connector also acts as a buffer against sunlight and strengthens inter-block connectivity within the site. The transformation process is illustrated in Figure 9.

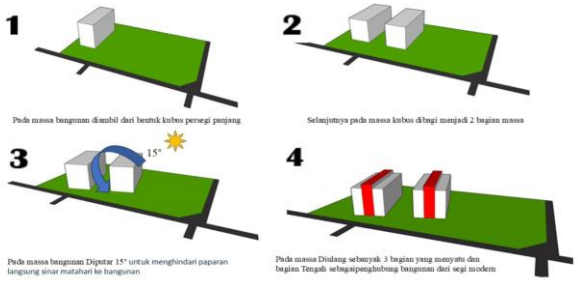

Figure 9. Building Form Transformation Process.
(Source: Personal Documentation, 2025)

Space Concept

The unit layout is designed using a double-room type, which includes two bedrooms, a living room, a kitchen, a bathroom, and a balcony. In the development of spatial design, dense vegetation is planted around the site to create a cooler and more comfortable environment. The spatial arrangement is tailored to support the residents' daily activities, ensuring optimal space functionality and providing a sense of safety and comfort, especially for students. Moreover, each room is designed to maximize access to natural lighting.

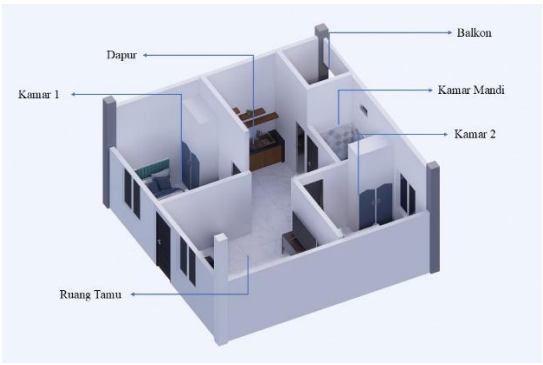

Figure 10. Interior Space Concept.
(Source: Personal Documentation, 2025)

Concept of Open Space Management in Student Dormitory Complexes

The management of open spaces within student dormitory complexes is a crucial element in creating a healthy, comfortable, and livable residential environment. In this design, the open courtyard is transformed into a multifunctional green area that not only enhances the visual appeal of the surroundings but also serves as a space for social interaction. Strategically arranged trees provide natural shade and contribute to improved air quality. Meanwhile, integrated seating elements—such as benches combined with concrete planters—offer comfortable and functional spots for students to study, engage in discussions, or simply relax.

The design of this open space also considers visual aesthetics and accessibility, featuring pedestrian pathways that encircle the garden, thereby establishing harmonious connectivity between different areas. This concept aligns with the principles of green architecture and psychological approaches in communal housing design, recognizing the critical role of outdoor spaces in fostering a healthy social environment and supporting students' daily activities.

Figure 11. Open Space Management in Student Dormitory Complexes
(Source: Personal Document, 2025)

Concept of Parking Area Management in Student Dormitory Complexes

The parking area within student dormitory complexes serves not only as a space for vehicles but also needs to be designed with user comfort and environmental sustainability in mind. In this concept, the parking area is spacious and well-organized, featuring an efficient circulation system to prevent congestion and enhance safety. Beyond its primary function, landscape elements such as trees are systematically planted along the perimeter and between parking zones to provide natural shading, reduce surface heat, and enhance visual appeal. This design reflects an integrative approach that balances utility and comfort, while supporting the creation of a more humane, green, and environmentally friendly dormitory environment.

Figure 12. Parking Area Management in Student Dormitory Complexes
(Source: Personal Document, 2025)

Clean Water Utility Concept

The clean water utility system for this student apartment utilizes a water supply from PDAM (local water utility company). This water supply is first collected in an underground reservoir tank. From there, it is pumped to a rooftop storage tank and subsequently distributed to each apartment unit. The clean water utility concept is shown in Figures 11 and 12.

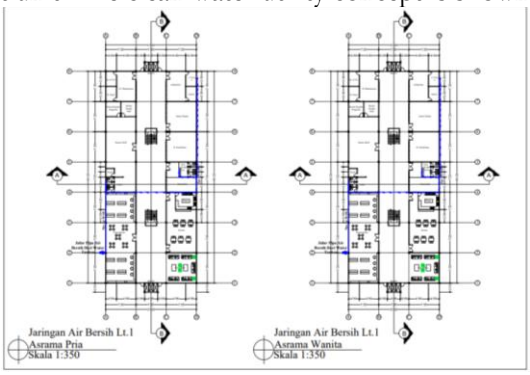

Figure 11. Clean Water Utility Plan – Ground Floor.
(Source: Personal Documentation, 2025)

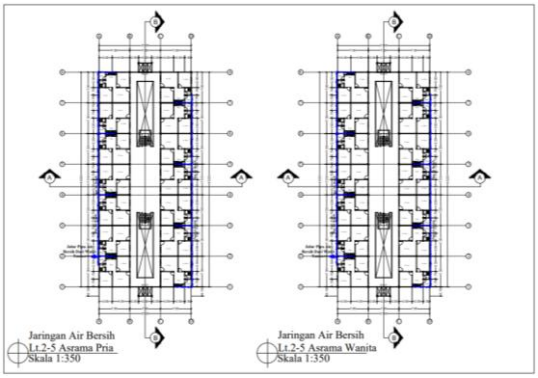

Figure 12. Clean Water Utility Plan – Floors 2–5.
(Source: Personal Documentation, 2025)

Wastewater Network / Greywater Management Concept

The student apartment building is not located within the coverage area of a centralized wastewater management system. Therefore, the wastewater disposal system is managed independently within the site. To address this condition, the greywater drainage system is designed to channel wastewater into a designated collection tank located in the building's utility area.

Domestic wastewater generated from activities such as washing, bathing, and sink usage is collected in the tank, where it undergoes a preliminary filtering and sedimentation process. The treated water is then recycled for non-potable uses, such as irrigating plants and green open spaces within the apartment complex. This system not only reduces dependence on clean water from the local utility (PDAM) for non-consumptive needs but also supports more efficient and environmentally friendly water resource management. The greywater management concept is illustrated in Figures 13 and 14.

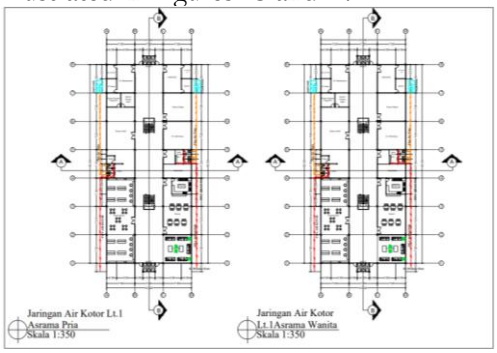

Figure 13. Wastewater Network Plan – Ground Floor.
(Source: Personal Documentation, 2025)

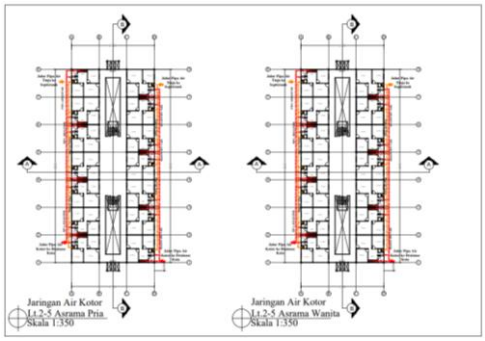

Figure 14. Wastewater Network Plan – Floors 2–5.
(Source: Personal Documentation, 2025)

Electrical Energy Utility Concept

For the electrical energy utility system, the distribution system in this student apartment building incorporates solar panels to conserve energy. This system is also an integral part of the green architecture concept applied in the design. The electrical utility concept is illustrated in Figure 15.

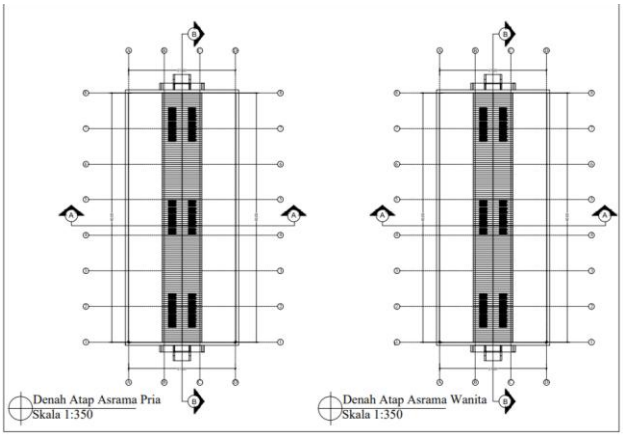

Figure 15. Electrical Utility Plan.
(Source: Personal Documentation, 2025)

Design Visualization

The student apartment designed under the theme of green architecture follows the established design concepts.

a. Site Plan

The site plan shows two access points: the entrance is located on the east side, while the exit access is on the north side.

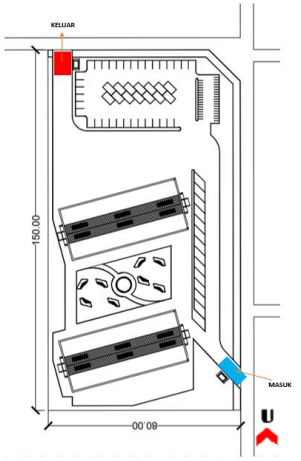

Figure 16. Site Plan.
(Source: Personal Documentation, 2025)

b. Layout Plan

The spatial arrangement in the layout plan uses multiple building masses, where the primary facility—student residential units—is located on the second floor. Meanwhile, supporting facilities and the management office are positioned on the ground floor. The building itself is placed farther away from sources of noise, as it requires a higher degree of tranquility for the residents.

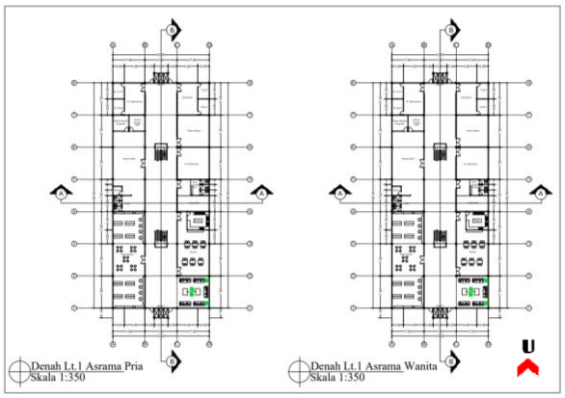

Figure 17. Layout Plan 1.
(Source: Personal Documentation, 2025)

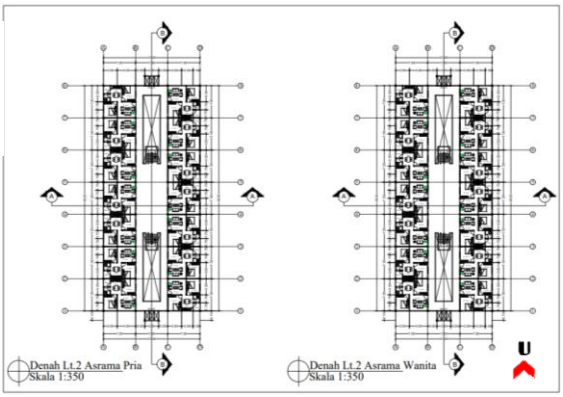

Figure 18. Layout Plan 2.
(Source: Personal Documentation, 2025)

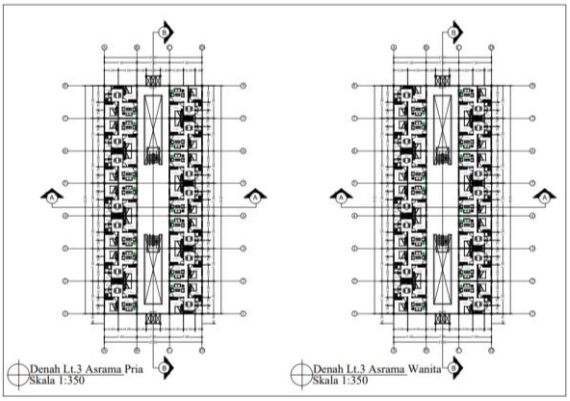

Figure 19. Layout Plan 3.
(Source: Personal Documentation, 2025)

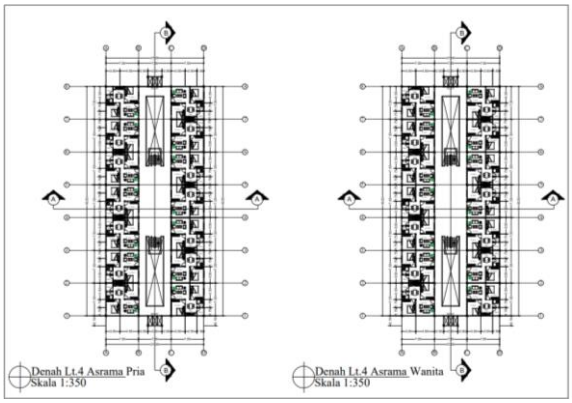

Figure 20. Layout Plan 4.
(Source: Personal Documentation, 2025)

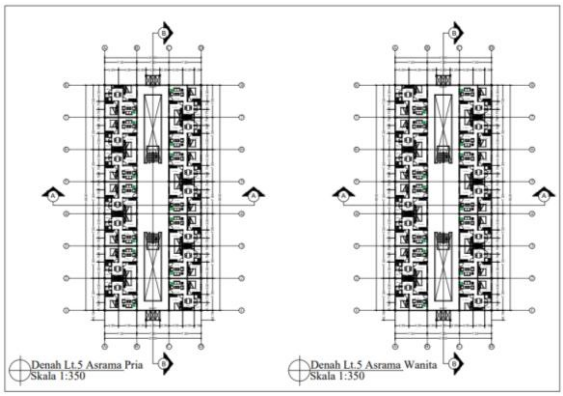

Figure 21. Layout Plan 5.
(Source: Personal Documentation, 2025)

c. Elevations

The elevation views of the student apartment building show the access points for both entrance and exit located on the west side of the building.

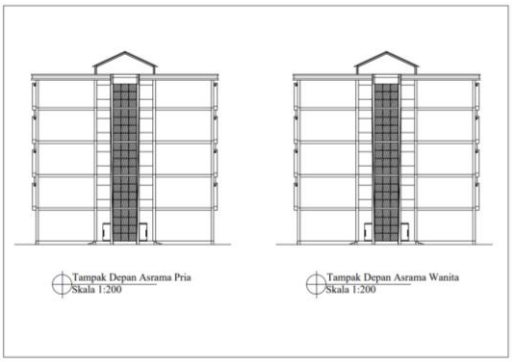

Figure 22. Front Elevation of the Residence.
(Source: Personal Documentation, 2025)

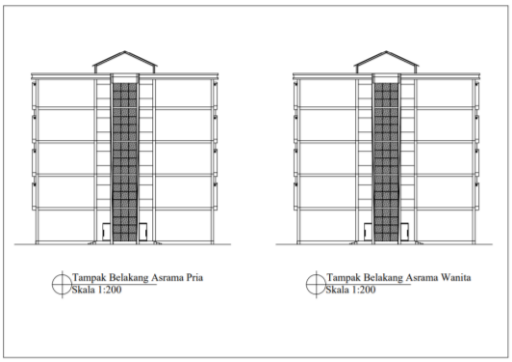

Figure 23. Rear Elevation of the Residence.
(Source: Personal Documentation, 2025)

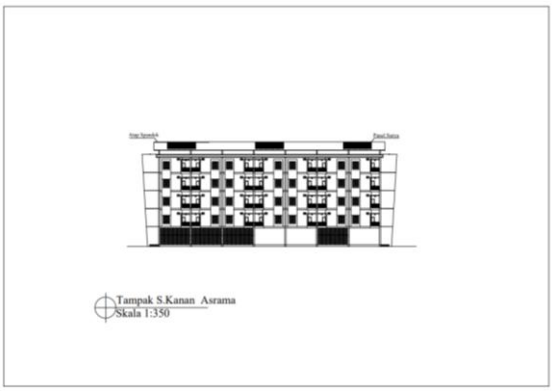

Figure 24. Right-Side Elevation of the Residence.
(Source: Personal Documentation, 2025)

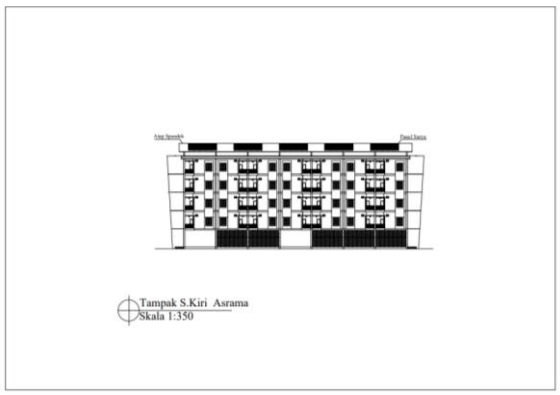

Figure 25. Left-Side Elevation of the Residence.
(Source: Personal Documentation, 2025)

d. Sections

The sectional views of the student apartment building illustrate the structural system used. The substructure employs a footplate foundation, while the main structure uses reinforced concrete (rigid frame). The upper part of the building features a concrete roof slab and spandek roofing, supported by a light steel truss system.

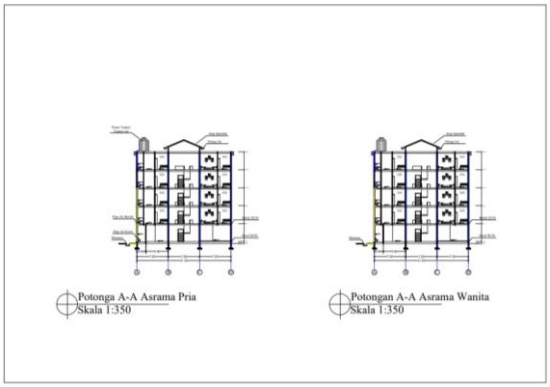

Figure 26. Section A–A.
(Source: Personal Documentation, 2025)

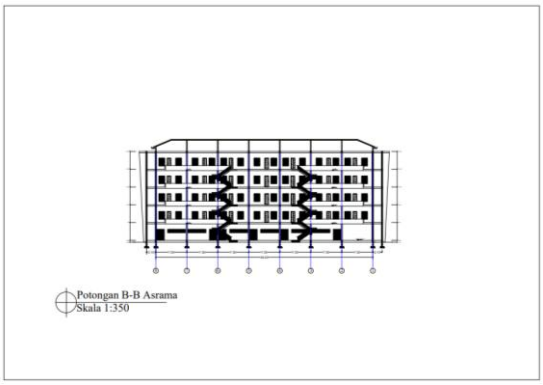

Figure 27. Section B–B.
(Source: Personal Documentation, 2025)

e. Perspective Views

The following are several 3D visualizations of the Student Apartment designed under the Green Architecture theme:

Figure 28. Eye-Level Perspective View.
(Source: Personal Documentation, 2025)

Figure 29. Eye-Level Perspective View.
(Source: Personal Documentation, 2025)

Figure 30. Site Entrance View.
(Source: Personal Documentation, 2025)

Figure 31. Parking Area Perspective View.
(Source: Personal Documentation, 2025)

Figure 32. Parking Area Perspective View.
(Source: Personal Documentation, 2025)

Figure 33. Parking Area Perspective View.
(Source: Personal Documentation, 2025)

Figure 34. Garden Perspective View.
(Source: Personal Documentation, 2025)

Figure 35. Garden Perspective View.
(Source: Personal Documentation, 2025)

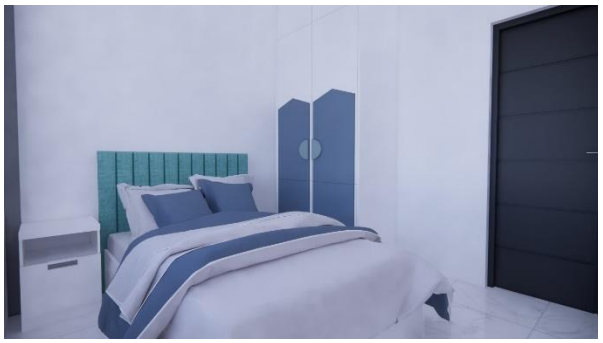

Figure 36. Bedroom Interior View.
(Source: Personal Documentation, 2025)

Figure 37. Kitchen Interior View.
(Source: Personal Documentation, 2025)

Figure 38. Living Room Interior View.
(Source: Personal Documentation, 2025)

4. Conclusions

Constructing apartment housing (rusun) for economically disadvantaged students can serve as a viable solution to provide them with decent accommodation and improve their social quality of life. These student apartments facilitate closer relationships among university peers and foster positive social interactions. In the design process, it is essential to apply green

architecture principles, both in outdoor and indoor spaces, to create a comfortable, safe, and functional living environment tailored to the needs and activities of students.

In line with this, the design of a student apartment in Medan City is a direct response to the urgent need for adequate, affordable, and sustainable housing in urban areas, particularly with the increasing number of students and limited land availability. While the government's "Thousand Towers Program" serves as a foundation, housing design must go beyond a purely quantitative approach. It requires a thoughtful design strategy that emphasizes environmental quality and resident well-being.

By implementing Green Architecture principles, the student apartment is designed to ensure energy efficiency, access to natural lighting and ventilation, the use of environmentally friendly materials, and the provision of green open spaces. The housing concept not only serves as a residence but also includes supporting facilities such as a library for study, green spaces for relaxation, and areas that encourage social interaction among students.

The design process is carried out comprehensively using primary and secondary data, site analysis, and building mass transformation to achieve optimal configurations in terms of lighting, air circulation, and spatial zoning. The structure and utilities of the building are also designed to be efficient, durable, and environmentally friendly, including the use of solar panels and a water recycling system.

With a design concept that integrates residential and educational functions within a sustainability framework, this student apartment is expected to offer a long-term solution to student housing challenges in major cities like Medan, while also contributing to the creation of healthier, more energy-efficient, and competitive urban environments.

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