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Integrating Sustainability through Ecological Architecture in Apartment

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Abstract (English)

The rapid population growth in Deli Serdang has led to increased demand for vertical housing like apartments. However, unsustainable apartment development can harm the environment. Therefore, it's crucial to integrate sustainability principles, such as ecological architecture and green technology, in apartment design and construction. Additionally, the presence of apartments necessitates commercial facilities like community malls to cater to residents' daily needs. Integrating community malls with apartments can foster a more inclusive and sustainable environment by offering essential services and products while considering environmental impacts. This integration not only addresses housing demands but also enhances residents' living conditions and preserves the local ecosystem's balance. Hence, a holistic approach emphasizing sustainability and ecological architecture is essential for developing and managing both commercial and residential buildings in Deli Serdang.

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Key Words
Apartment , Mall, Ecological Architecture, Sustainability.

1. Introduction

The inability to control population growth leads to an imbalance between the need for housing and the development of the region. Based on the 2022 Population Census, Deli Serdang has a population of 1,953,986 people, including residents living in-place, making it the second largest population in North Sumatra after Medan. Based on data from the Deli Serdang Central Statistics Agency, Percut Sei Tuan is the district that ranks fourth with the highest population density [1].

The development of the Mebidangro integrated area (Medan, Binjai, Deli Serdang, and Karo) is considered to bring a number of dilemmas. Despite having a positive impact nationally on sovereignty, defense, economy, and society, the development of Metropolitan Mebidangro is faced with problems such as increased urbanization, congestion, and declining environmental conditions. This rapid metropolitan development, while it has the potential to boost the economy through the accumulation of capital and activities, also attracts more residents to urbanize. The inability to control population growth in Deli Serdang is a challenge in realizing a balance between housing needs and regional development in this area [2]. Thus, the construction of apartments with shopping centers is needed to accommodate the increase in population and reduce pressure on residential land. By providing vertical housing that is integrated with commercial facilities, it is hoped that it can help reduce congestion and maintain environmental quality, as well as improve land use efficiency in the Mebidangro metropolitan area. Against this background, "Integrating Sustainability Through Ecological Architecture in Apartments" is the right step.

Integration is the process of merging that results in a complete or comprehensive unity. In English, the term "integration" refers to the achievement of perfection or wholeness.

It also includes the merger of various groups into a single regional entity and the formation of a common identity [3]. Sustainability involves meeting present needs in a way that does not compromise the ability of future generations to meet their own needs. It involves paying balanced attention to environmental, economic, and social aspects, which are key in achieving global sustainability [4].

The theme applied to the design of this apartment is Ecological Architecture. Ecological architecture integrates environmental awareness and sustainable use of natural resources within architectural design. [5]. Cowan and Ryan (1996) introduced principles of ecological design, emphasizing concepts such as designing solutions that are rooted in local conditions, using ecological accounting to guide design decisions, integrating nature into the design process, fostering a collaborative approach to design, and envisioning designs that harmonize with nature. [6]. The principles of ecological architecture according to Frick (2007) are energy saving, working with climate, respect for site, limitting new resources [7]. Sustainability is characterized as a developmental approach that satisfies current needs while safeguarding the capacity of future generations to meet their own needs. This involves a holistic assessment of environmental, economic, and social factors, all crucial for advancing global sustainability objectives.

An apartment is a multi-storey building in an environment, functionally divided horizontally and vertically. Each unit can be owned and used separately, but has a common area, a common object, and a common ground [8]. The apartment design will encompass various typologies including mid-rise buildings, studios, one-bedroom units, two-bedroom units, three-bedroom units, four-bedroom units, rental units, double-loaded corridor layouts, and slab buildings. [9].

2. Method

The approach used in Apartment Design involves a qualitative descriptive method. Qualitative research originates from observations in natural settings rather than from theoretical frameworks. Information gathered from these observations is analyzed to uncover meanings and concepts, presented descriptively and analytically, often avoiding numerical data. This method focuses on capturing and comprehending the unfolding processes within the observed environment. [10].

This study employs two types of data collection methods: primary data, gathered directly through observation and documentation, and secondary data, acquired via literature review and comparative analysis.

3. Result and Discussion

3.1 Location Choosing

The design is located in Ismail Harun Ps V, Kenangan Baru, Kec. Percut Sei Tuan, Kab. Deli Serdang, Sumatera Utara (Figure 1) . This location provides a strategic setting for the project, offering proximity to urban amenities and natural landscapes. It serves as an ideal environment for implementing sustainable architectural solutions.

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Figure 1 Location of Planning Site

Previously planned as Citraland Gama City, this expansive 211.57-hectare property development integrates exclusive residential areas with modern business centers, shopping malls, apartments, schools, universities, hospitals, clubhouses, and water parks, aiming to create a self-sufficient community. [11]. The selected locations are intended for malls, apartments and hotels in accordance with the master plan (Figure 2).

Figure 2 Master Plan Citraland Gama City

To get the amount of space, a review of the carrying capacity of the site was carried out. The study was made based on the Regional Regulation of Deli Serdang Regency (table 1) [12].

Table 1 Regional Regulation of Deli Serdang Regency Number 6 of 2011

KLB	**KDB** **Maximum**	**KDH** **Minimum**	**GSB** **At least**
Determined by considering land/environmental carrying capacity, balance & harmony, and environmental safety & comfort	70 %	10 %	Front Border 1 m + Half width of the road (damija)
			Side Border 2 m
			Rear Border 3 m

The site capability as programmed in the site study is a total site area ± 2400 m². Therefore, the intensity of the land used in the site meets the regulations (table 2).

Table 2 Land Intensity

Aspects	**Limitation**	**Design**	**Limitation**	**Design**	**Status**
KDB	70 %	30 %	16870 m2	7372 m2	Fulfilled

KLB	-				
KDH	10 %	54%	24100 m2	13000	Fulfilled
GSB	1/2n + 1		6 m	28 m	Fulfilled

3.2 Detailed Area Program

Based on the analysis of the pattern and flow of activities for each function, it is obtained what rooms are needed and what space requirements are needed, such as access, lighting, ventilation, acoustics, and view (table 3).

Table 3 Room Program

BUILDING CATEGORIES	SPACE CATEGORIES	ROOM NAME	ACTIVITY	NATURE OF SPACE
APARTMENT	RESIDENTIAL UNITS	Bedroom	Sleep, Rest	Private
		Living Room	Hosting	Semi Private
		Bathroom	MCK	Service
		Kitchen/Pantry	Cooking, eating	Semi Private
		Living Room	Relax, Learn	Semi Private
		Balcony	Sunbathing, Relaxing	Semi Private
	GENERAL & SUPPORTING FUNCTIONS	Hall/ Lobby	Gathering/meeting point	Public
		Reception	Searching for Information	Semi-Public
		Waiiting Room	Waiting, sitting	Public
		Rest room	Defecating	Semi-Public
		Lobby Elevator	Waiting for the Elevator	Service
		User Elevator	Access to housing	Service
		Laundry Area	Washing the Iron	Public

		Swimming Pool	Swim	Public
		R. Private Work	Work	Private
		R. Public Works		Public
COMMUNITY MALL	GENERAL FUNCTIONS & VISITOR FUNCTIONS	Hall	Gathering/meeting point	Public
		Atrium	Gathering,,Exhibition	Public
		Rest Room	Defecating	Service
		Mosque	Worship	Public
		Freight Elevator	Transporting goods	Service
		Ladder	Vertical Syringe	Service
		Emergency Stairs	Emergency circulation	Service
	SHOPPING	Retail	Selling	Public

BUILDING CATEGORIES	**SPACE CATEGORIES**	**ROOM NAME**	**ACTIVITY**	**NATURE OF SPACE**
		Supermarket	Selling	Public
	FOODCOURT	Stand	Food Place	Public
		Cashier	Transaction	SemI Public
		Dining Area Indoor	Eat	Public
		Dining Area outdoor	Eat	Public
		Sink Room	Hand Washing	Public
		Toilet	Defecating	Service
SERVICE /	MEE AREA	Generator	Generator	Service

MANAGER	Room	installation	
	Panel Room	Panel installation	
	Pump Room	Plumbing installation	
	Operator Room	Operator Installation	
	AHU Room	AHU Installation	
	Warehouse	Storing goods	
	Janitor	Storing cleaning tools	
	CCTV Room	Security controls	
PENGELOLA / MANAGEMENT	R. Employees	Work	Private
	Manager Room	Work	Private
	Archive Room	Saving documents	Private
OUTDOOR	Car Parking	Parking	Service
	Motorcycle Parking	Parking	Service
	Loading dock	Supply goods	Service

3.2 Area Program Analysis

After analyzing the space needs for the activity group, an analysis and calculation of the amount of space needed for the apartment is carried out. This process involves a detailed evaluation of each activity group to ensure that each area has adequate space and fits their specific needs. After that, the total space required for the entire apartment is calculated, taking into account the efficiency of the layout and the comfort of the occupants (table 4).

Table 4 Area Program Analysis

Category building	Zone	Space type	Sum Room	Space area	Circulation	Subtotal area
Apartment	Studio type	Total overall area of type 1 studio = 20 x 160 units				3200
	1 br	Total area of type 1 br = 26.50 x 48 units				1272
	2 br	Total area of type 2 br = 53,625 x 64 units				1716

	3 br	Total area of type 3 br = 74,425 x 32 units				2381.6
	Penthouse	Total area of penthouse type = 95,225 x 2 units				190.45
	General and supporting functions	Hall/ lobby	1	100	30%	130
		Reception	1	3	30%	3.9
		Waiiting room	1	50	30%	65
		Rest room	2	30	30%	39
		Lobby elevator	8	180	20%	216
		User elevator	10	150	20%	180
		Laundry area	2	280	30%	364
		Co.working space	1	250	30%	325
		Total				1322.9
	Swimming pool	Swimming pool	2	500	30%	650
		Men's rinse place	5	4.05	30%	5.265
		Women's rinse place	5	4.05	30%	5.265
		Men's changing places	5	7.8	20%	9.36
		Women's changing place	5	7.8	20%	9.36
		Sunbathing area	2	50	30%	65
		Men's lavatory	1	1.25	20%	11.22
		Women's lavatory	2	2.5	20%	7.32
		Total				762.79
Community mall	General functions	Hall	1	100	30%	130
		Atrium	1	300	30%	390
		Rest room	2	30	30%	39
		Mosque	1	30	20%	36
		Freight elevator	2	7.48	20%	8.976
		Ladder	2	37.99	20%	45.588
		Emergency staircase	2	36	20%	43.2
	Shopping	Retail	40	800	30%	1040
		Anchor tenant	1	400	30%	520
	Food court	Stand	30	600	30%	780
		Cashier	30	120	30%	156
		Indoor dining area	1	200	30%	260
		Outdoor dining area	1	40	30%	52
		Sink room	2	6	30%	7.8
		Toilet	2	24	30%	31.2
		Total				3539.764

Service and manager	me	Total	345.6
	Non-technical Division	Total	187.08

Category building	Zone	Space type	Sum Room	Space area	Circulation	Subtotal area
	Security Division	Total				78.36
	Outdoor	Apartment car parking	300	3750	100%	7500
		Community mall car parking	150	1875	100%	3750
		Car parking manager	20	250	100%	500
		Motorcycle Parking	100	200	100%	400
		Total				12150
Overall total						44990.4
	Engineering Division	Total				68.4

3.3 Mass composition

The arrangement of the building masses is aligned with site regulations and the intended theme for the design. This approach ensures that the building adheres to the relevant regulations while embodying the desired concept and aesthetics. Consequently, the building will harmonize with its surroundings while meeting the necessary technical standards and functions. These adjustments are crucial for balancing architectural creativity with compliance to established rules. The following outlines the mass composition for the apartment design. (Figure 3).

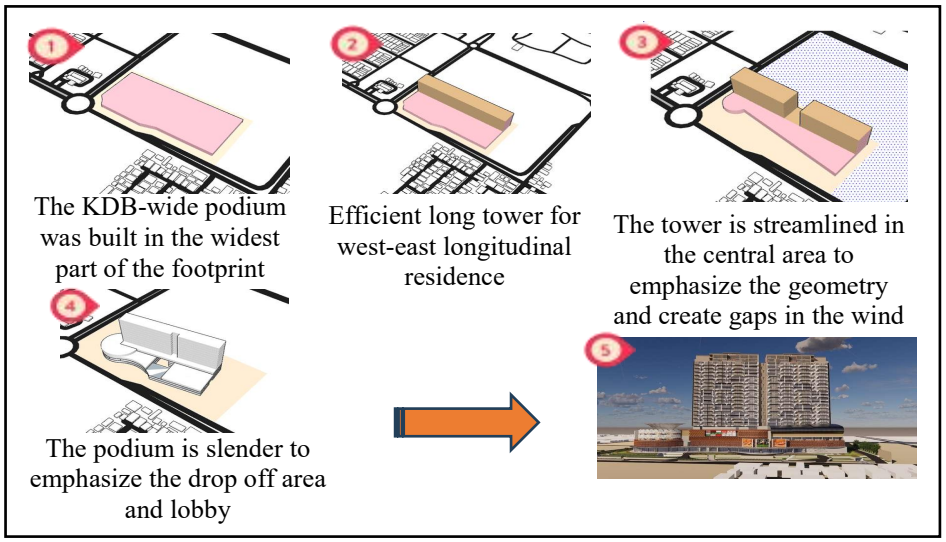

Figure 3 Mass Composition

3.4 Zoning Site

The division of zoning and functions in the building is carried out based on the needs and circulation paths in it. This aims to ensure that each building area can function optimally according to its designation. For accessibility, the division is carried out based on the nature of the space in the building, so that each space can be easily accessed according to its function. With this approach, it is hoped that each element of the building can support the overall comfort and efficiency of use (Figure 4).

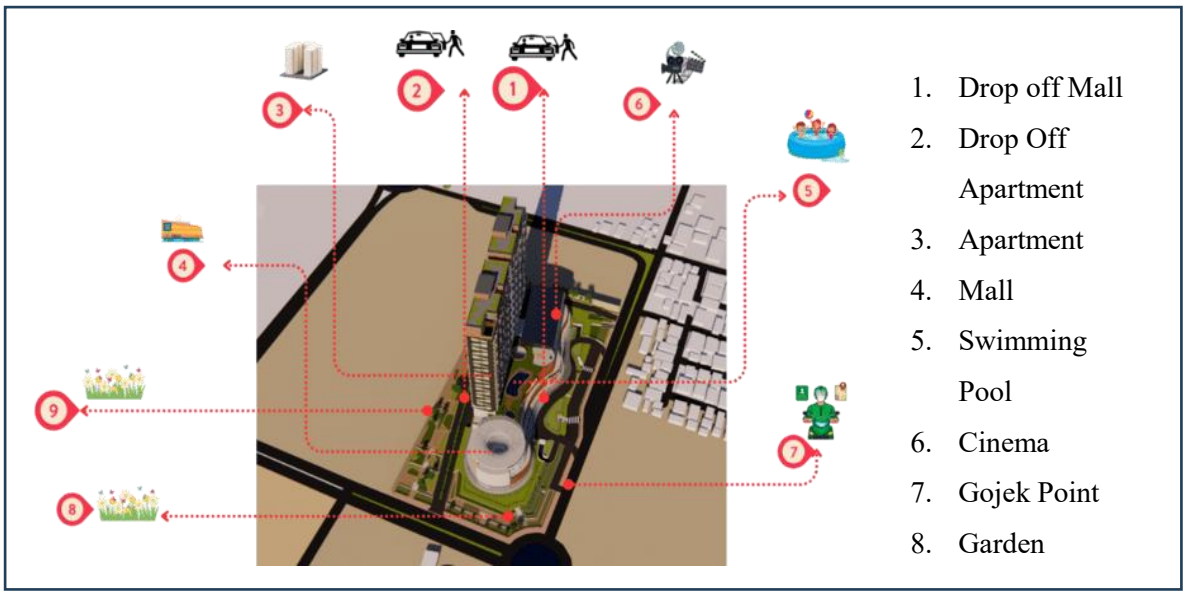

Figure 4 Zoning Site

3.5 Theme Implementation

The orientation of the building is made to extend from east to west to avoid solar radiation (Figure 5). This optimization of the orientation and shape of the building is able to save a total of 36% of energy, including reducing the cooling load by 8% to 11% [13].

Figure 5 Building Orientation

For buildings facing east and west, secondary skins are given. In addition, ventilation is provided to reduce humidity in spaces that require natural lighting by using shading and fins, which effectively reduces excessive light. The use of inner court is also applied to allow natural light to enter the room, thereby increasing lighting efficiency and occupant comfort (Figure 6).

Figure 6 Inner Court

The use of Rainwater Harvesting (RWH) systems in buildings makes water use more efficient (Figure 7). Rainwater harvesting is an important part of determining the environmental friendliness of a building. This system allows the buried rainwater to become a source of reusable water reserves, thus contributing to water conservation. In addition, rainwater harvesting provides significant potential for environmental and economic benefits [14].

Figure 7 RWH on the building

The use of vegetation on the site has a crucial role in increasing thermal comfort in buildings. Plants such as Acacia and Ketapang Kencana serve as effective shaders, reducing direct solar radiation entering the room and lowering the temperature inside (Figure 8). In addition, palm plants are used as natural directors of wind, improving air circulation and natural cooling [15]. Meanwhile, shrubs not only provide visual beauty but also help absorb heat from hard surfaces, such as concrete, which can affect the ambient temperature of the building. In addition to the aesthetic benefits, the use of this vegetation also plays an important role in filtering air pollution, maintaining air quality around buildings, and improving overall environmental conditions.

Figure 8 Vegetation on Buildings

The use of solar panels in buildings as a source of electricity backup can make a significant contribution to energy savings in tropical countries such as Indonesia, which are rich in sunlight throughout the year (Figure 9). By converting solar energy into electricity through photovoltaic technology, solar panels not only provide a clean and renewable energy source, but also reduce dependence on limited fossil energy. It is not only economical in the long term but also provides energy security by providing power reserves during power outages or other emergency conditions, supporting sustainable development goals as well as reducing the global carbon footprint [16] .

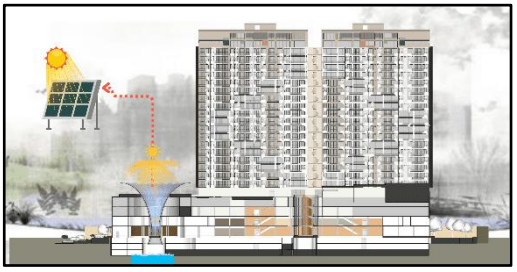

Figure 9 Use of Solar Panels in Buildings

Low e-glass is applied to the glass of the building (Figure 10). 'Low-e' coatings are widely employed in double-glazed windows to minimize heat loss radiated from the inner pane to the outer pane through the air gap. These coatings come in two primary types. The 'hard' coating utilizes a thin layer of tin oxide, which exhibits an emissivity ranging from approximately 0.15 to 0.2. In contrast, the 'soft' coating features an extremely thin and transparent layer of silver, nestled between layers of metal oxide, offering an emissivity of around 0.05 or superior. [17].

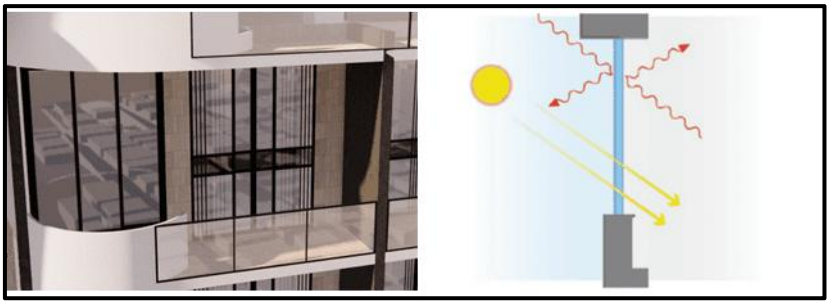

Figure 10 Use of Low e-glass in buildings

4. Conclusion

In order to meet the needs of housing and shopping facilities, apartments in Citraland Gama City are very important. The existence of this apartment is not only to provide modern residential and shopping facilities in accordance with the times, but also to emphasize the importance of ecological architectural themes. This apartment not only serves as a residential and shopping facility, but also reflects environmental awareness by implementing environmentally friendly design. With the theme of ecological architecture, energy efficiency, sustainable use of materials, and optimal land planning are considered. Thus, this modern market not only meets commercial needs but also supports environmental sustainability in Citraland Gama City.

5. Acknowledgment
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6. Conflict of Interest
The author expressly states that this manuscript is not influenced by conflicts of interest or financial support from outside parties. This guarantees freedom and integrity in writing, ensuring that the content of the manuscript is based solely on objective research and analysis.

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