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The Implementation of the Green Building Concept in the Design of the Politeknik Pelayaran Bangka Belitung

Tiara Millenia Loziska*[1], Zuber Angkasa [2], Sabrina Alifia Zahra[1]

[1]*Departement of Urban Development Planning, School of Architecture, Planning and Policy Development City, Bandung Institute of Technology, Bandung 40132, Indonesia*
[2]*Departement of Architecture, Faculty of Engineering, Muhammadiyah University of Palembang, Palembang, 30263, Indonesia*

*Corresponding Author: tiaraloziska02@gmail.com

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ABSTRACT

The province of Bangka Belitung Islands requires a high-quality human resource pool in the field of shipping and nautical studies. To support the education and competency development of human resources in the maritime sector, the construction of the Politeknik Pelayaran Bangka Belitung (POLTEKPEL BABEL) is deemed necessary. The POLTEKPEL BABEL school building is intended to be sustainable; it is recognized for using less energy and resources and producing fewer waste products than other types of structures. This research focuses on the implementation of the green building concept in the design of POLTEKPEL BABEL. The study employs a quantitative descriptive method and a design method that integrates systems with existing ecological processes on-site, including orientation, wall-to-window ratio (WWR), the cumulative value of Roof Thermal Transfer Value (RTTV) and Overall Thermal Transfer Value (OTTV), as well as technical planning assessments for green buildings. Both primary and secondary data are utilised in this research. The findings indicate that the design of POLTEKPEL BABEL incorporates the principles of green building by considering various indicators outlined in the technical guidelines for green building assessment. These indicators include the management of the site, quality of indoor air, efficiency in energy usage, waste management and use of eco-friendly materials. Consequently, the implementation of these principles in the design of POLTEKPEL BABEL is expected to support sustainable development encompassing environmental, energy, and occupant well-being aspects.

Keywords: Design, Green Building, POLTEKPEL, and Sustainable.

1. Introduction

Bangka Belitung Province, as an archipelago province, needs qualified human resources in the field of shipping and nautical, especially with the increasing use of sea transportation services. However, currently, shipping schools in Bangka Belitung Province still need to be expanded to the level of vocational education (SMK). To support education and the development of human resources competencies in the field of shipping and to open opportunities for local and outside the region to continue teaching in the field of shipping, it is necessary to build a maritime college in the form of Politeknik Pelayaran Bangka Belitung (POLTEKPEL BABEL) as an initial exploration. In line with this, the importance of making environmentally friendly buildings becomes the main focus of the POLTEKPEL BABEL development plan. POLTEKPEL BABEL will be directed to become

a sustainable school building. Sustainable school buildings are buildings that consume less energy, water, and resources and produce less waste than conventional buildings [1].

The concept of green building was proposed in the POLTEKPEL BABEL design as a response to environmental issues that have led to global warming. Since the green building idea is thought to promote safe, comfortable, healthy, and environmentally friendly structures, it has become a major motif in modern architecture [2]. The purpose of green building design includes efforts to achieve thermal comfort within the building while reducing environmental impact, with a target of consuming 50% less electricity than a comparable-sized conventional building without compromising the comfort and health of its occupants [3].

National rules expressly encourage and assist the promotion of the green building idea. PUPR Ministerial Regulation No. 21 of 2021, which addresses the Assessment of Green Building Performance, which contains the fulfilment of green building technical standards, the procedure for performance assessment in technical planning, construction implementation, utilisation, and demolition until obtaining green building rating and certification [4]. This concept will be applied to the design of POLTEKPEL BABEL so that it not only fulfils its function in the field of education but can also be beneficial to the environment.

This study focuses on the implementation of the green building concept in the design of POLTEKPEL BABEL, referring to the rating system assessment that regulates a variety of indicators. Although not all indicators of the assessment system will be discussed, this study will focus on some crucial aspects, including site processing, building efficiency, indoor air quality, the use of environmentally friendly materials, and waste management. The goal is to carefully analyse the implementation of this concept by following the standards and assessments that have been set in the applicable green building rating system.

2. Method

The research method employed in this study is a quantitative descriptive method. The data utilised consists of both primary and secondary data. Preliminary data is collected through observations of the existing site conditions, while secondary data is obtained from various literature used as references in the design process. Subsequently, the collected data will be processed to form a design in accordance with the applied concept. The basis for the building's implementation of the Green Building Concept (GBC) will be the evaluation of green building performance, with a focus on specific indicators like site processing, building effectiveness, interior quality of indoor air, the use of materials that are sustainable, and the management of waste.

3. Result and Discussion

3.1. The existing site conditions

The existing site is located on Gabek Raya Street, Selindung Village, Gabek District, Pangkalpinang City, Bangka Belitung Islands Province, with an approximate area of ± 8.2 hectares. The designated purpose of the existing location is a Higher Education Area (Source: Local Regulation of Pangkalpinang City No. 1 of 2012 concerning the Spatial Plan of Pangkalpinang City 2011-2030). The site has a setback of 4 meters from the road (GSB) and a 15-meter river buffer. The site holds potential as it is not far from Pangkalbalam Port, designated for higher education. It is also within the areas designated for ports warehousing, demonstrating its strategic value in terms of economic interests. The depiction of the site is shown in Figure 1.

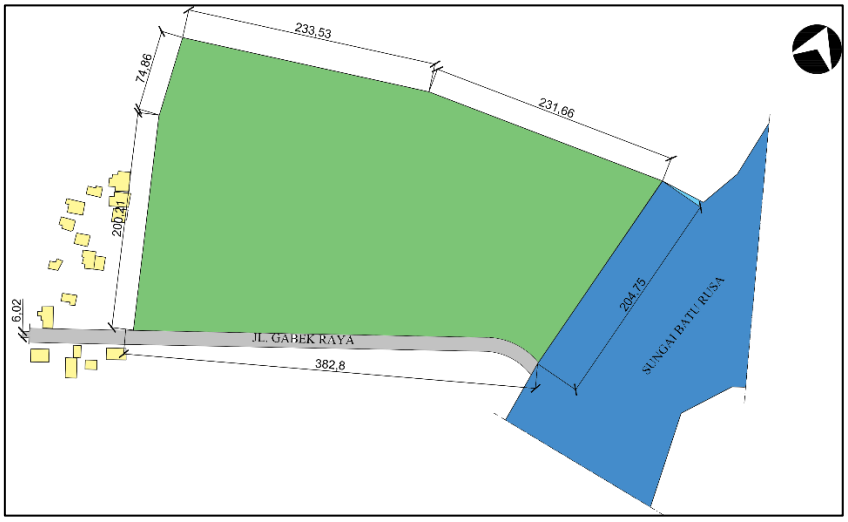

Figure 1 Existing Site

3.2. The implementation of the Green Building Concept in building

A. Building orientation

One concept in the macro design of green buildings is adaptability to the solar circulation pattern. Solar orientation significantly influences the positioning of the building. Building planners need to consider the direction of sunlight to optimise natural daylighting during the daytime. The orientation of the building, the shape and size of openings, as well as the area of openings affect the amount of natural light entering the building. In tropical regions, the optimal orientation is for the building to extend lengthwise from east to west. Consequently, the incoming light is diffuse and not overly intense[5]. However, it is also essential to ensure that the building can efficiently withstand the challenges of solar heat without completely blocking the light. Figure 2 shows an illustration of the solar circulation pattern on a processed site plan.

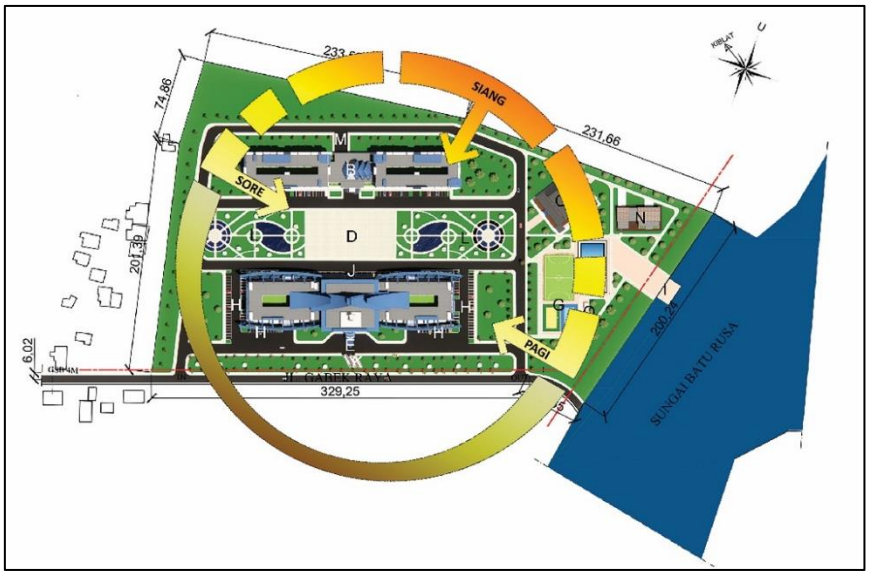

Figure 2 Solar circulation pattern on processed site

The parts of the building exposed to sunlight are the shortest sides of the building. This can be seen in Figure 3, where the shortest sides of the building exposed to sunlight are highlighted in red. The orientation of the POLTEKPEL BABEL building faces southeast to northwest. This portion will naturally receive more heat from the sun, necessitating appropriate measures to mitigate its impact. One solution that can be applied is the use of building materials with the ability to absorb solar heat effectively. By employing suitable materials, the transfer of heat into the building can be minimised, thus keeping the interior cool and comfortable.

Figure 3 Sun responsive building design

B. Site processing, including accessibility or circulation

In the assessment of site processing, the main focus of the research will be on the roof cover, pavement, and vegetation dominating the site. Regarding the roof cover, this study highlights the use of concrete tiles with a reflectance value of 0.35. Although initially planned for use, the evaluation indicates that the reflectance value of this roof cover exceeds the established requirements. Therefore, the decision was made not to claim its use. As for the pavement used on the site, grass blocks were chosen. Grass block is a material that can facilitate the absorption of water into the soil through grass-filled holes. Grass block can reduce the rate of soil erosion, especially on sloping terrain, and can impede the evaporation of soil water underneath. Thus, grass block can maintain soil moisture and water balance [6]. Furthermore, in the context of vegetation, the site is planned to be planted with various types of plants from local province-scale cultivation. The vegetation plan includes manilla grass, Albizia saman, Indian mahogany, bougainvillea, and Roystonea regia.

C. Private Green Open Space plan

According to Ministerial Regulation No. 05/2008 concerning Guidelines for the Provision and Utilization of Green Open Space in Urban Areas, the definition of private green open space is green open space owned by specific institutions or individuals, the utilization of which is limited to certain groups, including gardens or the yards of community/private-owned houses/buildings planted with vegetation [7]. Private Green Open Space (RTH) is encouraged as a rainwater infiltration area on the site. Additionally, the establishment of private green open spaces is intended to preserve biodiversity and is aimed at managing the environment so that it does not become excessively hot during the daytime. As a result, many surfaces are hardened; conversely, during the night, it can be warmer as the tree canopies can retain the Earth's radiative heat [8]. In addition to 10% of the construction site area, the criteria for private Green Open Space must meet the building classification (construction Density, Green Area Ratio, Floor Area Ratio) specified in the approved regional spatial plan. Some trees planted on the site include indian mahogany for shading, bougainvillea for sound absorption and dust filtration, and Albizia saman for shading and sound absorption. The layout for private Green Open Space is illustrated in figure 4.

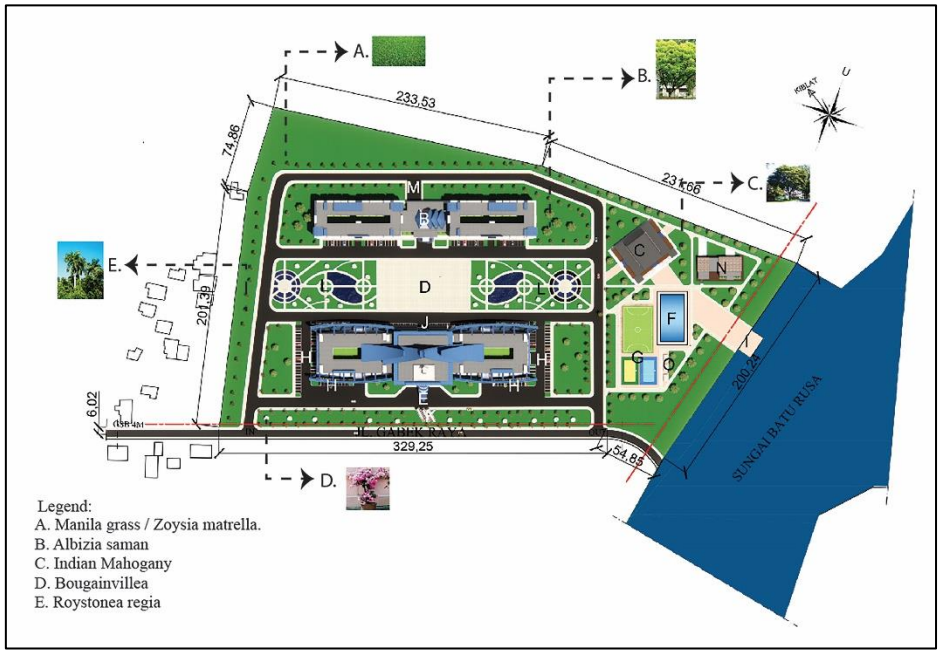

Figure 4 Private green open space plan

Moreover, as figure 5 shows, the Private Green Open Space (RTH) region is defined by its respective zone.

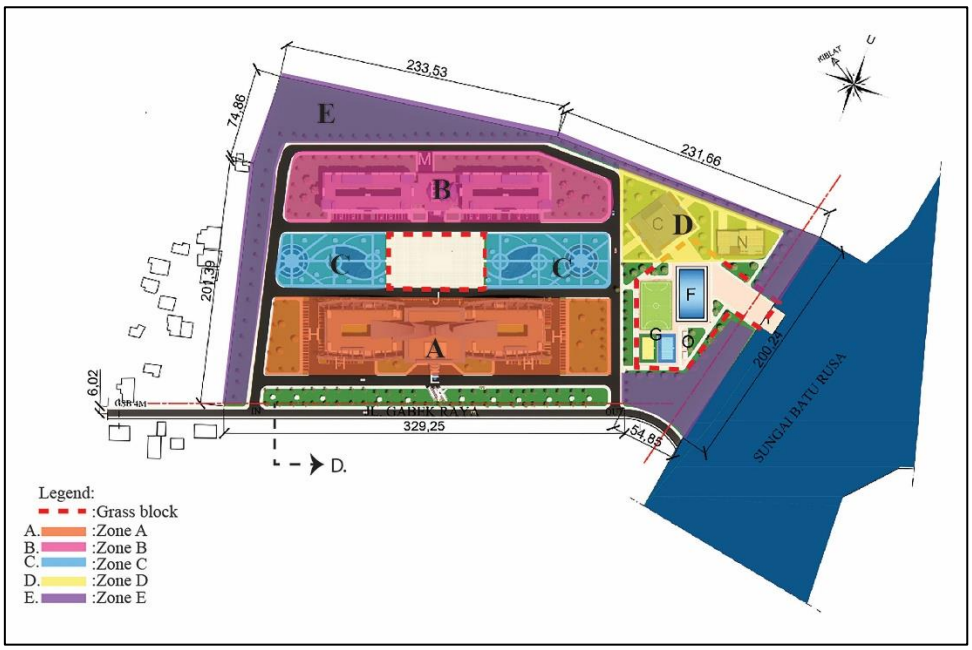

Figure 5 Division of each zone

The respective areas of each zone can be seen in table 1.

Table 1. Green zone area

No.	Green Area Zone	Area (m^2)
1	Zone A	4. 149, 2
2	Zone B	5. 529
3	Zone C	3. 425, 56
4	Zone E	18. 434, 04
5	Area Grass Block	8. 665, 05
	Total overall	**42. 143, 81**

Based on the analysis of the total available green area, which amounts to 42,143.81 m^2, it can be observed that the Politeknik Pelayaran Bangka Belitung has allocated a significant amount of land for green areas within the project site. Additionally, there is around 52% of green, open area on the property.The presence of such extensive green open space will not only provide aesthetic benefits but also make a positive contribution to creating better air quality and establishing a more comfortable and productive learning and working environment for all users of the Politeknik Pelayaran Bangka Belitung.

D. Provision of pedestrian pathways

A well-designed pedestrian pathway system will reduce dependence on vehicles, increase the use of pathways by pedestrians, and improve environmental quality through user-friendly design. Additionally, this system will support local social and economic activities and contribute to better air quality in the area [9]. According to the Guidelines for Pedestrian Facility Planning in Urban Areas by the Ministry of Public Works (1995), pedestrian ways, or pedestrian paths, are pathways designated for pedestrians to enhance the smoothness, safety, and comfort of pedestrian movement, providing services to pedestrians [10]. On this site, there is a 2.5-meter-wide pedestrian pathway that connects various vital facilities such as the main building, dormitories, gardens, prayer room, sports facilities, changing rooms, and boats. The provision of this pathway aims to facilitate access for visitors and enable smooth connectivity between buildings and facilities in this area. Additionally, this pedestrian pathway is integrated with plots or lots in the vicinity, ensuring good accessibility and seamless connectivity between areas. The provision of pedestrian pathways on the site can be seen in figure 6.

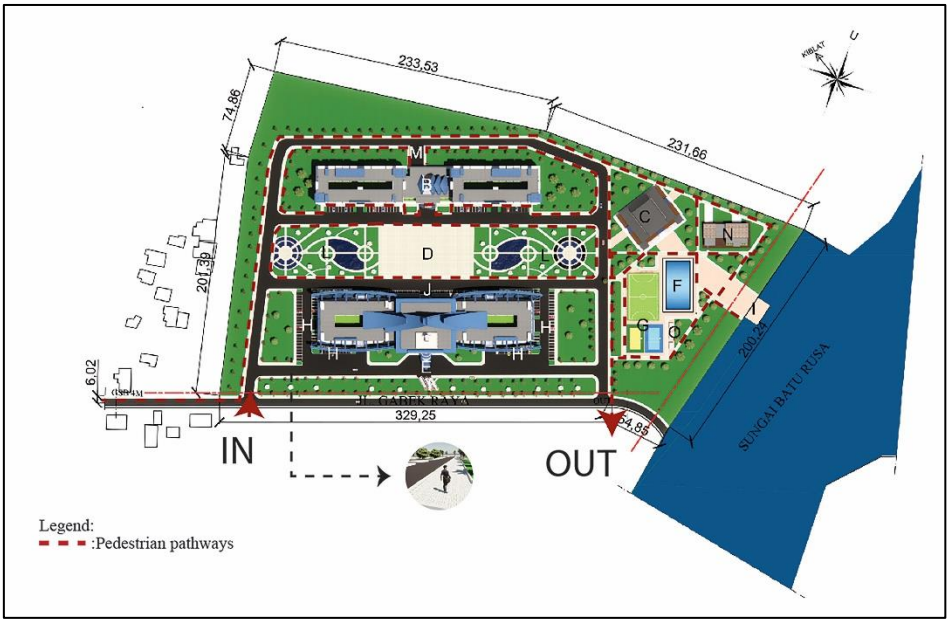

Figure 6 Pedestrian pathways

E. Provision of parking area

The site provides parking spaces designated for cars, motorcycles, and buses. The parking plan will be situated near the building to facilitate visitors' access to these parking areas. The number of car parking spaces is 134 units. Motorcycle parking spaces provided are 80 units, and bus parking spaces are 3 units. The provision of parking at the building is necessary to meet the parking needs of building users. The parking construction utilizes grass blocks, chosen to allow rainwater absorption in the parking structure. Additionally, in line with green building principles, the parking area includes designated spaces for electric vehicle charging and bicycle parking to encourage the use of eco-friendly transportation. This sustainable approach not only reduces the carbon footprint but also promotes the efficient use of resources by integrating permeable surfaces that support natural water infiltration and reduce runoff [11]. Figure 7 illustrates the detailed layout.

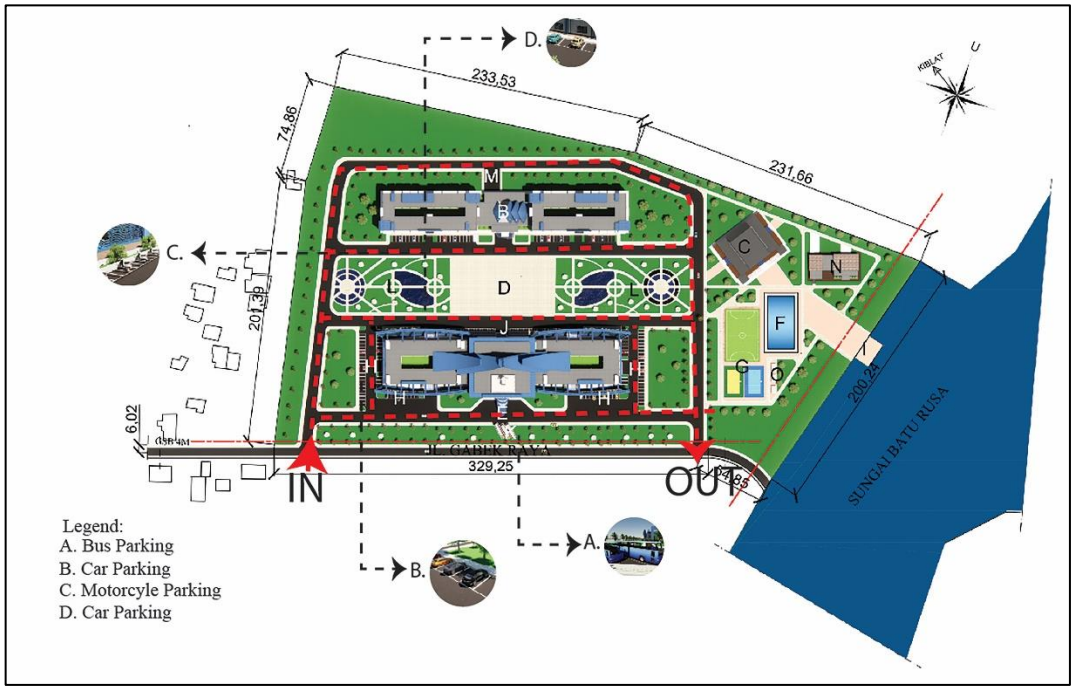

Figure 7 Provision of parking facilities

3.3 Energy usage efficiency

Energy usage efficiency aims to achieve optimal energy utilization in line with the building's function, while also reducing negative environmental impacts and saving costs from excessive energy use. According to Regulation of the Minister of Public Works and Public Housing No. 2 of 2015, the energy usage efficiency in green building accurately considers the cumulative values of Roof Thermal Transfer Value (RTTV) and/or Overall Thermal Transfer Value (OTTV) [12]. A cumulative maximum of 35 Watt/m2 is permitted for both OTTV and RTTV. Table 2 presents the OTTV values for the Politeknik Pelayaran Bangka Belitung (POLTEKPEL BABEL) building.

Table 2 Calculation of OTTV (Overall Thermal Transfer Value)

No	Side	Conditions through the walls Watt A	Conditions through openings Watt B	Radiation through openings Watt C	Total Watt D= A+B+C	Total facade area m^2 E	OTTV $Watt/m^2$ D/E
1	North	26,663.92	1,582.70	6,348.89	34,595.51	1,112.00	31.11
2	Northeast	3,688.25	-	-	3,688.25	462.00	7.98
3	East	11,587.12	167.58	766.08	12,520.78	462.00	27.10
4	Southeast	-	-	-	-		
5	South	18,496.22	2,048.20	7,605.54	28,149.97	1,064.00	26.46
6	Southwest	-	-	-	-	816.00	-
7	West	12,337.60	670.32	6,648.48	19,656.40	512.00	38.39
8	Northwest	-	-	-	-	816.00	-
	Total	72,773.12	4,468.80	21,368.99	98,610.91	5,706.00	17.28

In Table 2, the OTTV values from various sides of the building can be seen. The total OTTV value from all sides of the building is 17.28 Watt/m2. An OTTV value lower than the maximum limit of 35 Watt/m2 indicates

that the Politeknik Pelayaran Bangka Belitung (POLTEKPEL BABEL) building has been designed with consideration of green building principles and energy efficiency. Meanwhile, Table 3 explains the RTTV calculations from various sides of the building. The total RTTV calculation is 7.47%.

Table 3 Calculation of RTTV

No	Side	Total opening area m^2 F	WWR (%) F/E
1	North	64.60	5.81
2	Northeast	36.48	7.90
3	East	6.84	1.48
4	Southeast	47.12	10.20
5	South	83.60	7.86
6	Southwest	82.84	10.15
7	West	27.36	5.34
8	Northwest	77.52	9.50
Total		426.36	7.47

3.4 Indoor air quality

The indoor air quality (IAQ) can affect the physical conditions and activities of building occupants. On the other hand, good IAQ contributes to a healthier environment, supporting better physical comfort and cognitive function [13]. It can enhance concentration, reduce absenteeism, and create a more pleasant indoor atmosphere, ultimately leading to improved performance and satisfaction among occupants. Air quality must be planned in accordance with applicable standards and regulations to prevent discomfort and lower productivity. Indoor air quality in green building spaces also encompasses smoking restrictions within the building, control of CO2 and CO substances indoors, and regulation of the use of refrigerants [14]. No-smoking signs have been prominently placed in various areas within the building. The strategic placement of these signs, as visible in the figure 8, ensures that every visitor or occupant is informed about the implemented no-smoking policy. This step aims to establish a healthy and comfortable environment for everyone inside the building.

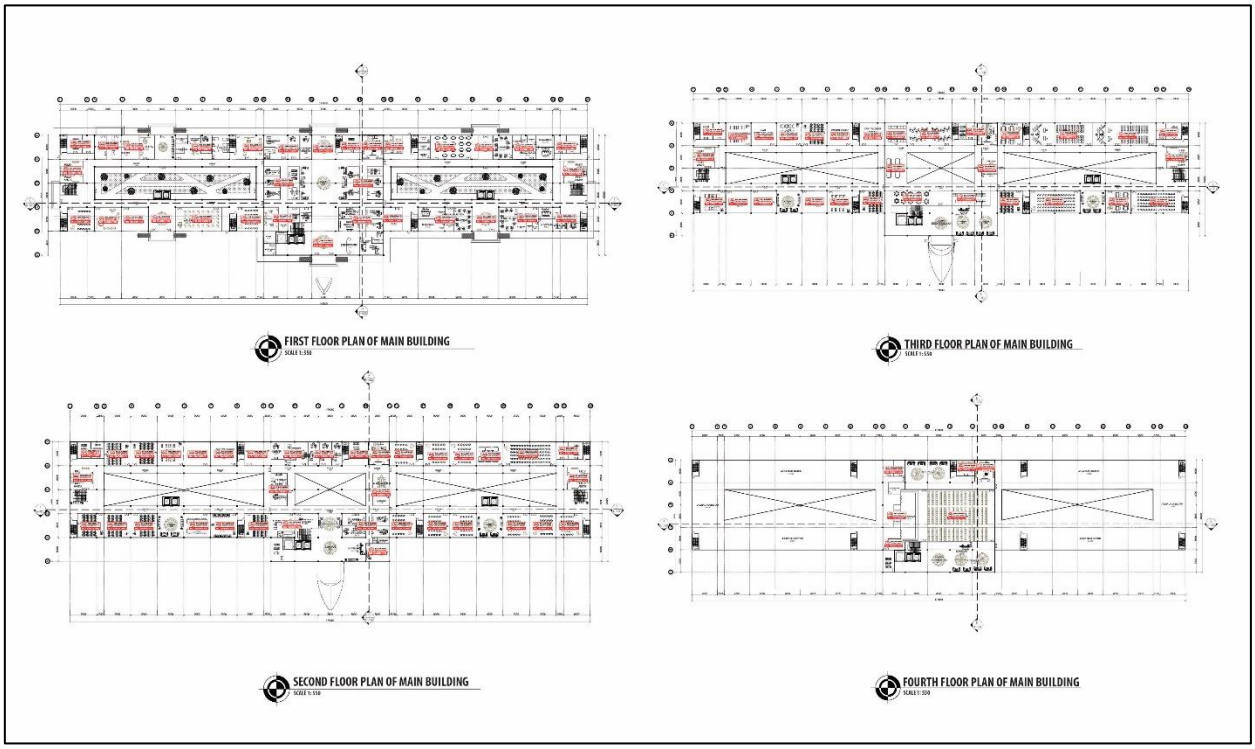

Figure 8 No smoking area within the building

As for the dimensions of the no-smoking signs provided, they are depicted in the figure 9.

Figure 9 No smoking signs

A designated smoking area is still provided, but it is separated from the building. This area is located in the green open space provided on the site. The smoking area on the site can be seen in Figure 10.

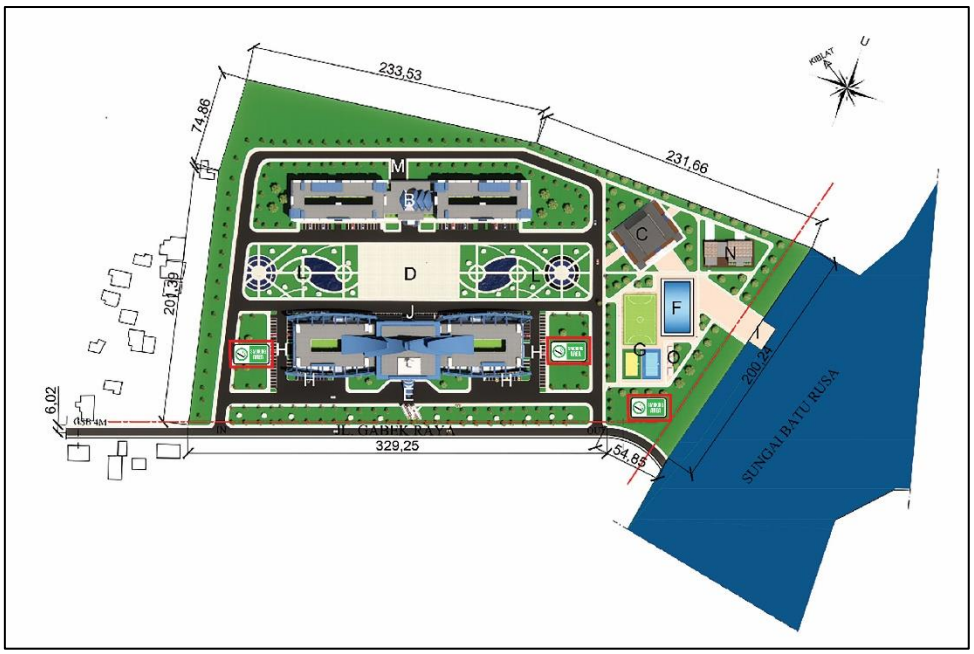

Figure 10 Smoking area on the site

3.5 *Environmentally friendly materials*

Using materials that are sustainable is seen to be the most crucial step in the construction process. The use of sustainable construction supplies seeks to reduce the negative impact of toxic compounds on occupants' comfort and well-being. [15]. Materials that are devoid of dangerous compounds and ecologically beneficial are used in the Green Building Concept (GBC). Figure 11 indicates how materials were used in the construction of the Politeknik Pelayaran Bangka Belitung (POLTEKPEL BABEL) building.

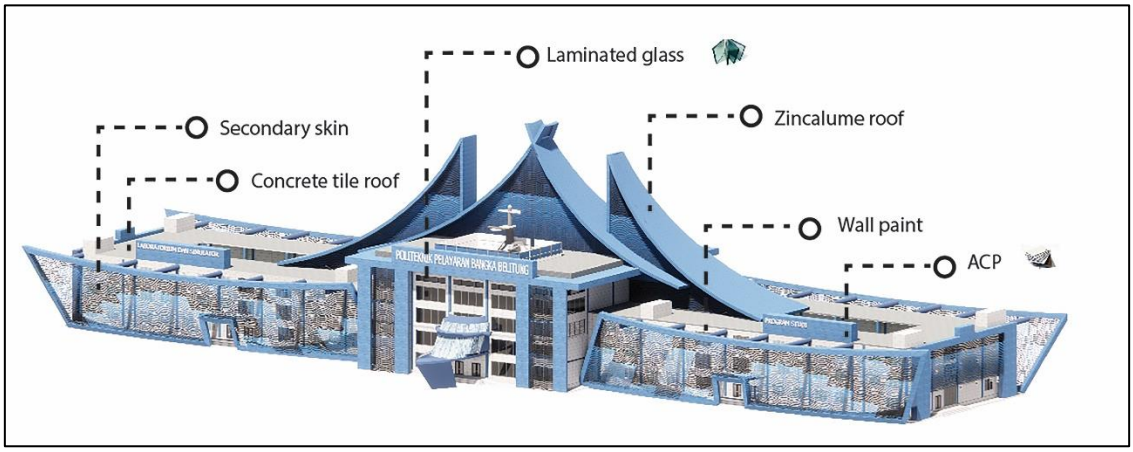

Figure 11 Use of building materials

The many kinds of construction materials utilized are listed in Table 4.

Table 4 Application of Construction Materials

No.	Material	Function
1	Laminated glass	Glass material uses laminated glass. This glass can reduce the entry of ultraviolet rays into the building.
2	*Aluminium Composite Panel (ACP)*	The brick wall material is coated with Aluminium Composite Panel (ACP). This is applied to reduce the transmission of solar heat into the building.
3	Wall paint	Wall covering uses wall paint that is free from harmful substances.
4	Concrete tile roof	The roof uses concrete tiles with a reflectance value of 0.35-0.45.

3.6 Waste management

Waste management in green buildings aims to safeguard the health of occupants, protect the environment, and alter the behavior of users in green building structures [14]In waste management, the implementation of the 3R principle (Reduce, Reuse, Recycle) is planned. Therefore, facilities for waste handling will be provided in the building and on the site in the form of three waste bins: organic waste, inorganic waste, and hazardous waste bins. The provision of these facilities aims to support waste reduction efforts and the reuse of waste, especially plastic and paper waste. The illustration of the planned placement of waste handling facilities in the building can be seen in the following image.

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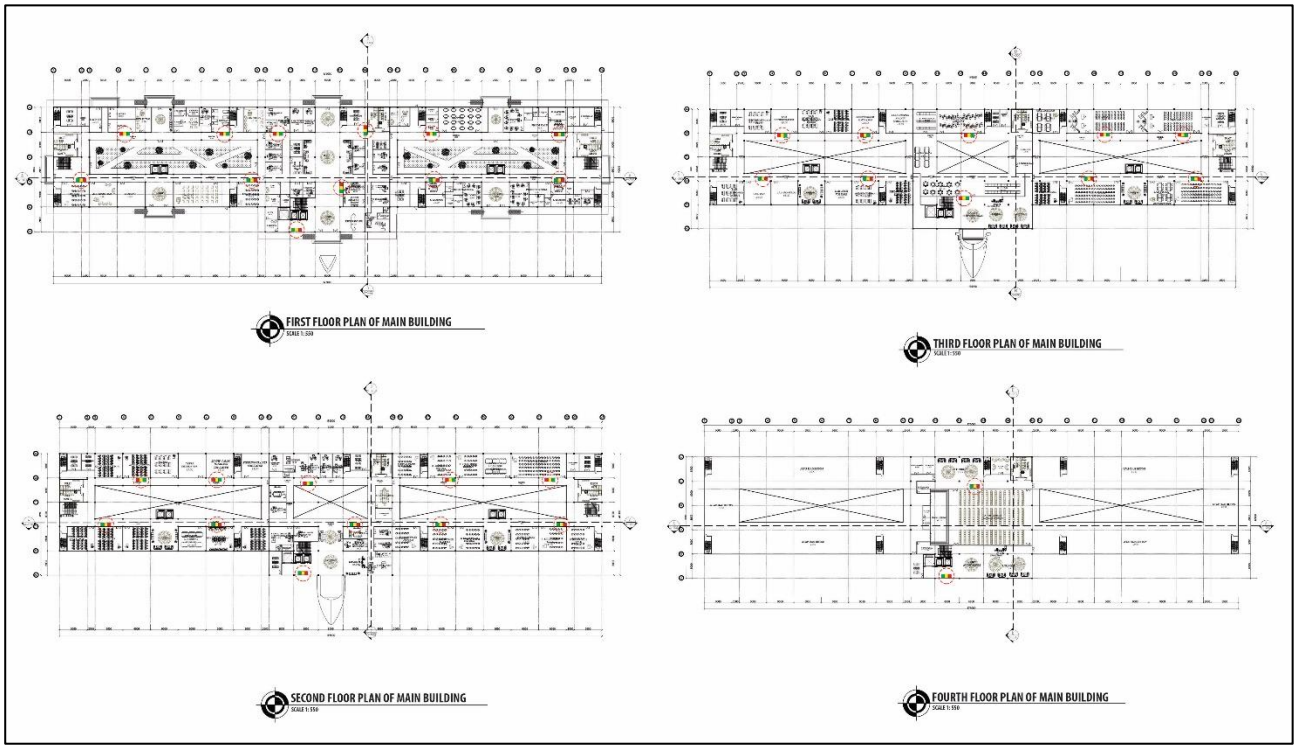

Figure 12 Placement of trash bin facilities in buildings

Additionally, temporary waste containers are provided on the site, comprising bins for organic waste, inorganic waste, and hazardous waste. The placement of temporary waste disposal area on the site can be seen in Figure 13.

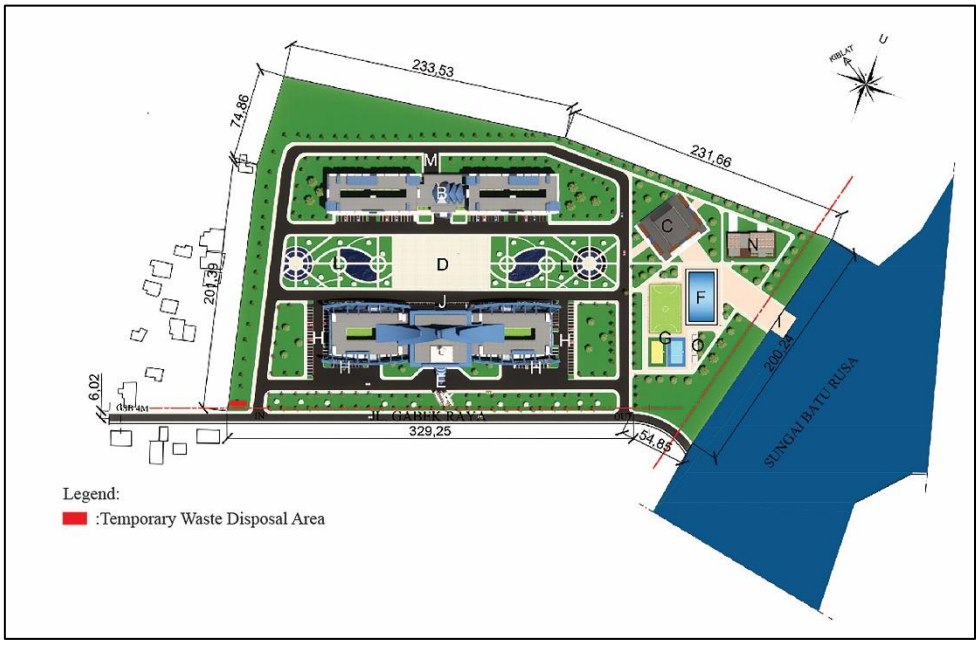

Figure 13 Placement of temporary waste disposal area

4. Conclusion

Designing the Politeknik Pelayaran Bangka Belitung incorporates the principles of green building by considering several indicators outlined in the technical guidelines for green building assessment. These indicators encompass site management, including sub-indicators such as building orientation, site processing

with accessibility or circulation, plans for private Green Open Space (Ruang Terbuka Hijau - RTH), provision of pedestrian pathways, and parking areas. Additionally, there are energy efficiency indicators involving the calculation of Overall Thermal Transfer Value (OTTV) and Real Thermal Transfer Value (RTTV) to assess building efficiency.

Furthermore, there are other indicators such as indoor air quality, the use of environmentally friendly materials, and waste management. Thus, the implementation of these principles in the design of the Politeknik Pelayaran Bangka Belitung is expected to support sustainable development, encompassing environmental, energy, and occupant well-being aspects.

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6. Conflict of interest

The authors of this journal declare that there are no conflicts of interest related to the preparation and publication of this manuscript.

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