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REDESIGN OF ABDULRACHMAN SALEH AIRPORT AS A SMART AND GREEN TRANSIT NODE WITH A BIOCLIMATIC APPROACH

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ABSTRACT

Abdulrachman Saleh Airport is the only airport serving the Greater Malang area. It plays a significant role as the main "gateway" to a region known for its rich tourism, historical value, and natural potential. However, this "gateway" identity is not yet fully reflected in the physical character or the current terminal building. The terminal fails to create a strong impression as a representative entrance and lacks coherence in both character and design unity. Therefore, a redesign of the airport area is necessary to rebuild its visual and functional identity as a key transportation hub. This design adopts a bioclimatic approach to ensure the building responds to Malang's climatic conditions while supporting the creation of a sustainable environment. The integration of smart building concepts is also applied to enhance spatial performance and efficiency through the use of environmentally friendly technology. Furthermore, the unification of the two terminal buildings into a single architectural identity becomes a key focus to improve accessibility for the passengers, visitors, and transportation modes. This strategy is expected to serve as a solution to the existing issues and strengthen Abdulrachman Saleh Airport's role as an adaptive gateway that aligns with its surrounding environment and keeps pace with future development.

Keywords: *Abdulrachman Saleh Airport, Redesign, Transportation Hub, Smart Bioclimatic, Sustainability.*

INTRODUCTION

Airports are facilities for aircraft to take off and land, with the minimum requirement of a runway or helipad, while larger airports are equipped with additional facilities such as terminals and hangars. According to ICAO Annex 14, an airport is a land or water area designated for the arrival, departure, and movement of aircraft. Indonesian Law No. 1 of 2009 defines airports as areas on land or water, within specified boundaries, that serve as locations for aircraft to take off, land, embark and disembark passengers, load and unload cargo, and facilitate inter- and intra-modal transfers, equipped with safety, essential, and supporting facilities. Furthermore, airports are vital infrastructure connecting regions, improving time and distance efficiency, and driving economic growth by attracting business, industry, and tourism activities (Ramadhani & Ariebowo, 2023; Fatimah & Rahayu, 2023).

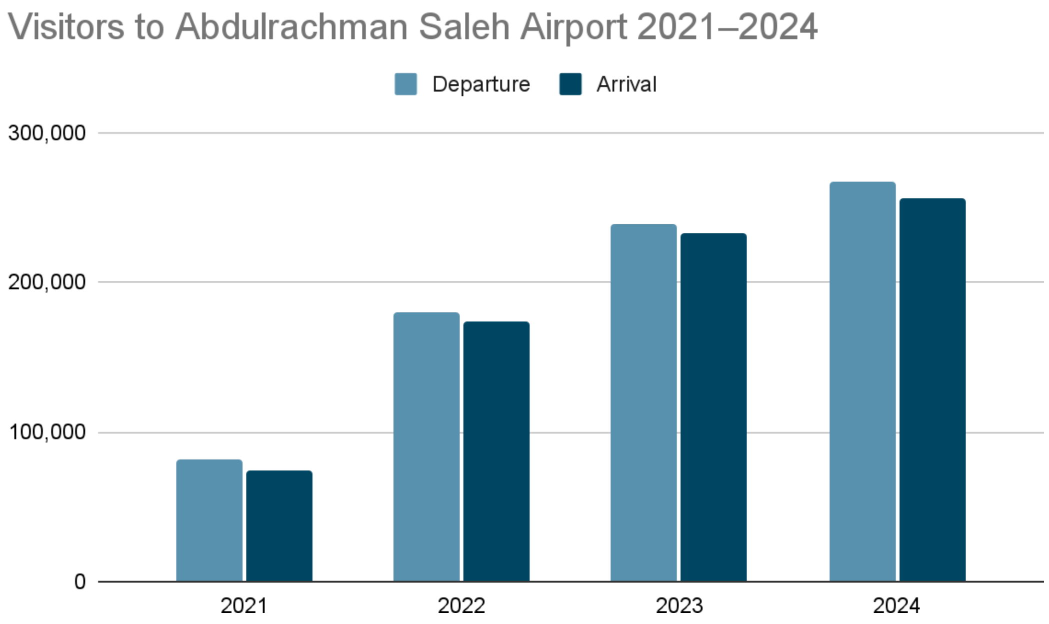
Abdulrachman Saleh Airport is located in Malang Regency, approximately 17 km from the city center. Initially serving as a military airbase, it benefited from natural fortifications and fog that concealed it from aerial observation. Constructed between 1937 and 1940 alongside other airbases, the airport began serving civilian flights in 1994 under PT Merpati Nusantara Airlines but halted operations in 1997 due to low load factors. Civil flights resumed in 2011 with the construction of a civil enclave worth approximately IDR 139 billion, while parts of the facility remain under Indonesian Air Force operation. The airport plays a key role in supporting tourism and regional connectivity in Malang Raya, contributing to local economic development.

Table 1. Annual Passenger Data of Abdulrachman Saleh Airport

Year	Departure	Arrival	Total
2021	86.701	83.314	174.154
2022	176.341	170.369	355.398
2023	227.073	224.967	473.443
2024	245.712	240.436	520.893

(source:Technical Implementation Unit (UPT) of Abdulrachman Saleh Airport, 2025)

Chart 1. Visitors to Abdulrachman Saleh Airport 2021–2024



(source: Technical Implementation Unit (UPT) of Abdulrachman Saleh Airport, 2025)

Passenger data shows a steady increase from 2021 to 2024, following the COVID-19 pandemic, which highlights the need for terminal expansion. Currently, departure and arrival terminals are separated, causing inefficient circulation. The arrival terminal still occupies the old building, which has faded wall paint and requires floor elevation improvements, reducing visual comfort. The façade does not strongly reflect Malang's identity and lacks iconic landmark qualities, while contrasting designs between terminal buildings diminish visual coherence (LPSE Jawa Timur, 2023).

The façade of Abdulrachman Saleh Airport is predominantly characterized by blue-tinted glass windows and orange exterior cladding. Overall, the building lacks a distinct identity, such as the incorporation of architectural elements that represent Malang's local character. Consequently, Abdulrachman Saleh Airport is considered unable to serve as a unique attraction or landmark for the Greater Malang area, as its façade is neither iconic nor aesthetically appealing (Khoiriyyah, 2024).

Figure 1. Abdulrachman Saleh Airport Departure Terminal (source: Personal Documentation, 2025)

Figure 2. Abdulrachman Saleh Airport Arrival Terminal, 2025 (source: Personal Documentation, 2025)

A redesign is needed to enhance the airport's image as the gateway to Malang Raya while integrating sustainable principles through bioclimatic architecture. Malang's tropical climate, with mild temperatures averaging 19–29°C and high rainfall, offers potential for energy-efficient strategies such as natural lighting and passive ventilation. Airport energy consumption is relatively high, with HVAC systems accounting for up to 62.9% of total use. An example of successful implementation is Banyuwangi Airport, which utilizes natural ventilation and lighting for 95.5% of its floor area, resulting in a low Energy Use Intensity (EUI) of 59.9 kWh/m²/year (GBC Indonesia, 2025).

Bioclimatic architecture, as defined by Ken Yeang (1994) and Hyde (2000), is a design approach responsive to local climate conditions, aimed at achieving energy efficiency and thermal comfort. The process involves climate analysis, determining building form and orientation, selecting local materials, and incorporating natural openings. The smart bioclimatic strategy emphasizes intelligent design by leveraging natural variables such as wind, sunlight, temperature, and humidity to reduce reliance on mechanical systems.

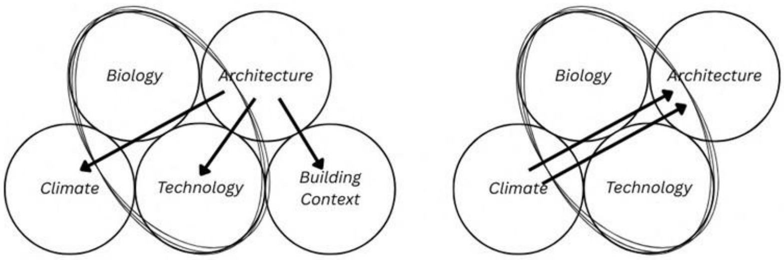


Figure 3. . Bioclimatic Design (Left) and Climate Responsive Design (Right) (source: Hyde, 2000)

By applying smart bioclimatic principles, Abdulrachman Saleh Airport is envisioned to become an efficient, environmentally friendly, and climate-adaptive transportation hub. This approach not only reduces energy consumption but also enhances the airport's modern and sustainable image while addressing functional needs and providing user comfort. (Hildayanti & Wasilah, 2022)

LOCATION DESCRIPTION

The determination of the site is guided by the Regional Spatial Plan (RTRW) of Malang Regency, which designates the vicinity of Abdulrachman Saleh Airport as a transportation zone and a priority area for the development of supporting facilities. This provision is stipulated in Malang Regency Regional Regulation No. 1 of 2024 concerning the RTRW for the 2024–2044 period, specifically in Article 49 Paragraph (11) Letter e, which emphasizes that urban area development must support the airport's operations. Accordingly, the surrounding environment is projected to evolve in accordance with the operational requirements and functions of the airport, encompassing improvements in accessibility, infrastructure, and land use planning. As such, the airport and its environs constitute a strategic area that fosters regional growth.

The redesign is situated on the existing airport site, located at Jl. Komodor Udara Abdul Rahman Saleh, Krajan, Bunut Wetan, Pakis District, Malang Regency. The site lies approximately 17 kilometers from the center of Malang City, positioned at astronomical coordinates 07°55'42"S 112°42'48"E. Geographically, it is encircled by several prominent mountains: Mount Semeru (3,676 meters above sea level) to the east, Mount Arjuno (3,339 meters) to the north, as well as Mount Kawi (2,551 meters) and Mount Panderman (2,045 meters) to the west. The airport stands at an elevation of approximately 518 meters above sea level, characterized by relatively flat topography (Brilian Zahra et al., 2017).

The surrounding context comprises predominantly rural landscapes, including plantations and agricultural land. The site retains substantial vegetation cover, contributing to a cooler microclimate. Access to the airport is provided via a 1.8-kilometer roadway from the main gate, with designated lanes for four-wheeled and two-wheeled vehicles. The four-wheeled vehicle lane is approximately 8 meters in width, while the two-wheeled vehicle lane measures about 3 meters (based on the author's direct measurements).

Abdulrachman Saleh Airport is well integrated into the regional transportation network, with connectivity to major arterial routes such as the Pakis main road and the Malang–Pandaan toll road. This facilitates efficient access to and from the city center as well as surrounding regions, including Pasuruan and Sidoarjo. Accessibility is further supported by various modes of transportation, notably private vehicles and airport taxi services.

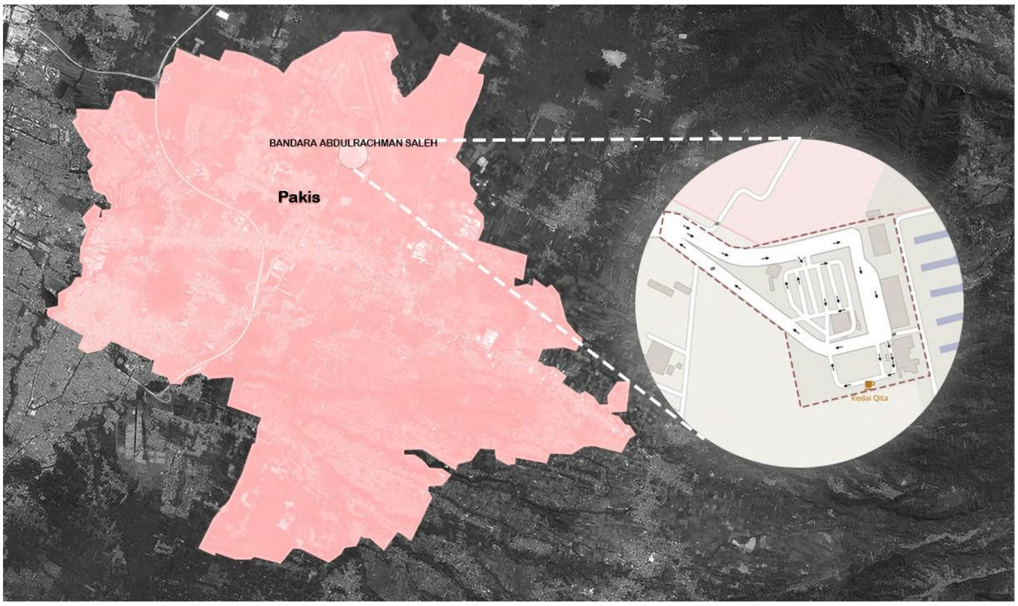


Figure 4. Site Location (Source: Author)

THE SITE ANALYSIS

The process of site synthesis serves as the concluding stage of site evaluation, where data from diverse analytical aspects are integrated into a cohesive framework. This stage consolidates findings from physical characteristics, environmental quality, social and cultural patterns, as well as applicable regulations, to establish a zoning plan that aligns with the project's objectives. By merging these layers of information, designers can formulate spatial divisions that not only address functionality but also enhance environmental sustainability and user comfort.

Rather than viewing each analysis in isolation, site synthesis treats them as interrelated components, ensuring that the resulting spatial arrangement reflects the unique identity of the site. The zoning output derived from this stage becomes a strategic reference for subsequent planning, guiding decisions from conceptual design to technical detailing. Furthermore, this approach enables adaptability, allowing the plan to respond to evolving user demands or policy adjustments. In essence, site synthesis bridges analytical insight with creative design execution, transforming multi-dimensional site data into a spatial framework that is efficient, harmonious, and resilient. The outcome provides both a practical and conceptual foundation, ensuring the proposed design remains contextually responsive and sustainable over time.

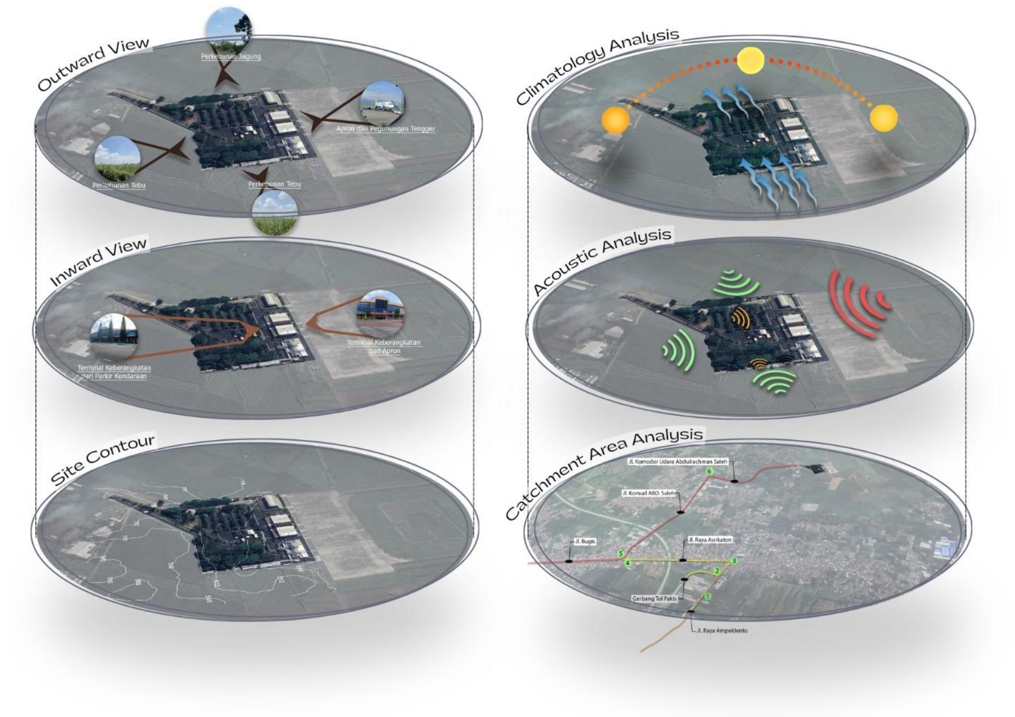


Figure 5. Multi-Layered Site Analysis (source: Personal Documentation, 2025)

CONCEPTUAL APPROACH AND WARFARE THEME

The conceptual approach of this design emphasizes a strategic and adaptive response to environmental conditions, ensuring harmony between the building and its surrounding context. The design aims to create spaces that remain comfortable while minimizing energy consumption, achieved through a series of well-planned measures that address climatic challenges in a deliberate and integrated manner. By applying bioclimatic principles, the architecture operates as a coordinated system in which form, material selection, and spatial configuration work together to optimize natural resources and reduce environmental impact.

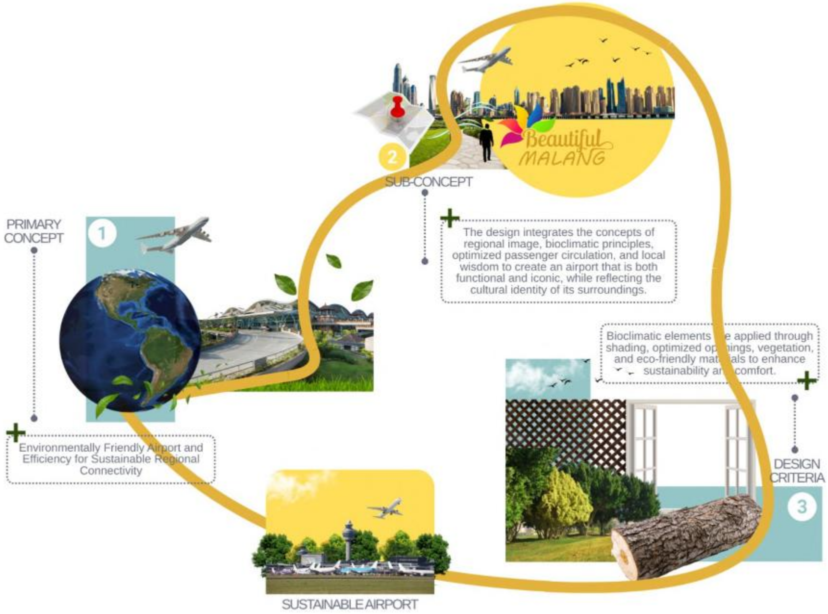


Figure 6. Conceptual Framework (source: Personal Documentation, 2025)

The design of Abdulrachman Saleh Airport adopts passive environmental strategies to maintain thermal comfort and efficiency throughout the building. Natural ventilation is utilized to facilitate airflow, daylight is maximized through carefully positioned openings, and thermal mass materials help stabilize internal temperatures. Low-emissivity (low-E) glass is incorporated in fenestration systems to reduce heat gain from solar radiation while maintaining high levels of natural light transmission, thereby enhancing energy efficiency and minimizing reliance on mechanical cooling. Shading elements and vegetation are integrated to moderate solar exposure and improve the microclimate, while spatial planning ensures seamless circulation for users. These elements are not applied in isolation but function collectively, allowing the building to adapt effectively to varying climatic conditions. This approach reinforces the idea that resilient design is achieved through purposeful planning, where every architectural component contributes to environmental balance and long-term sustainability.

Figure 7. Local Identity Concept (source: Personal Documentation, 2025)

DESIGN THEME

The proposed redesign of Abdulrachman Saleh Airport adopts the theme of an *intelligent and sustainable building*. The "intelligent" aspect emphasizes the integration of bioclimatic design strategies tailored to the airport's local climatic context—Malang's average temperature of 24°C, high humidity, and consistent solar exposure—allowing for passive ventilation, natural daylighting, and thermal insulation to optimize energy performance and indoor comfort. As the primary gateway to Greater Malang, the airport is envisioned to function not only as a transportation hub but also as a regional landmark, characterized by a distinctive architectural identity and improved spatial circulation to enhance passenger and visitor experience. This design approach positions Abdulrachman Saleh Airport as a model for sustainable airport architecture in Indonesia, reinforcing the region's commitment to environmental responsibility and modern urban development.

IMPLEMENTATION OF CONCEPT IN DESIGN

The terminal's architectural identity draws from "Malang, the City of Flowers", expressed through a roof design composed of flower petal modules that serve not only as visual symbols but also as structural elements, shading devices, and natural daylight regulators. Between some of these petals, hidden skylights made of low-E glass are subtly integrated, allowing diffused natural light to enter without causing excessive heat gain. The skylight area is intentionally minimized, as the building already features extensive side openings along its longitudinal walls, thereby preventing potential overheating while still ensuring adequate daylighting.

At the central axis, the roof transforms into a large arch formed by the intersection of the building's column grid lines, creating a spatial and structural focal point that reinforces the monumental character of the terminal as a city-scale public facility. A single opening at the center of the roof directs rainwater into a rainwater harvesting system, where the collected water is stored for non-potable uses such as toilet flushing, reducing surface runoff and improving water efficiency. Beneath this opening, the main floor accommodates a public waiting area, combining environmental performance with user comfort. This integration of symbolic form, structural clarity, and bioclimatic strategy establishes the terminal as a sustainable architectural statement that resonates with Malang's floral identity.

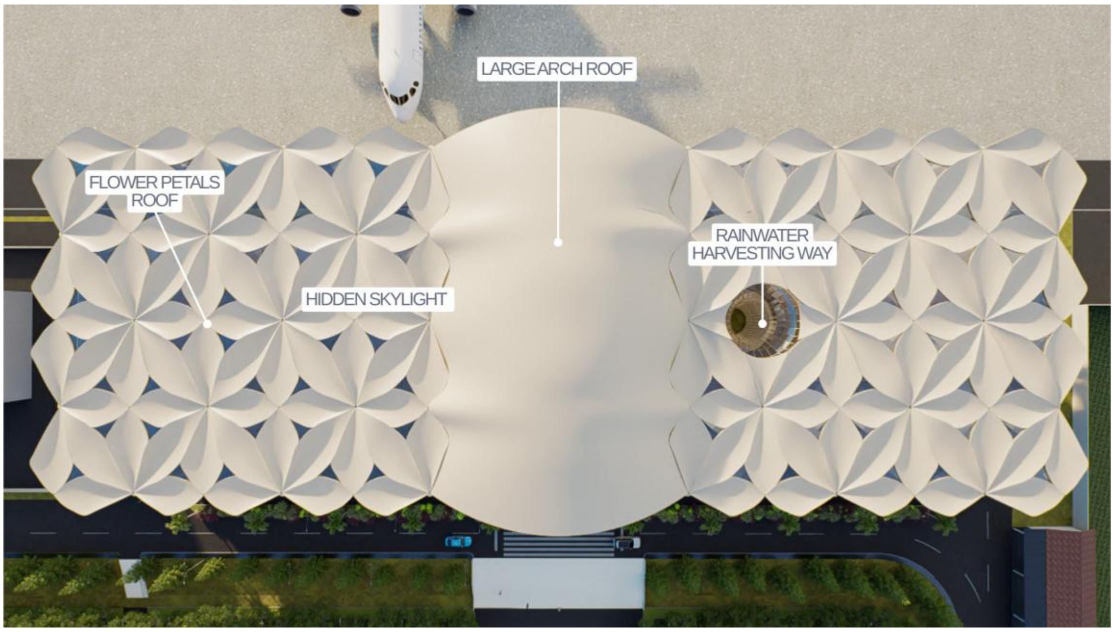


Figure 8. Roof Concept Implementation (source: Personal Documentation, 2025)

Figure 9. Bird's-Eye Perspective (source: Personal Documentation, 2025)

In this redesign, the previously dispersed parking areas are consolidated into a single, spacious, and well-organized parking zone. This area is divided into two main sections. The first section accommodates staff parking, VIP four-wheeler parking, four-wheeler departure parking, and motorcycle parking. The second section is designated exclusively for four-wheeler arrival parking, ensuring smoother traffic circulation and minimizing potential congestion between incoming and outgoing vehicles.

Separating these two sections is a central median in the form of a landscaped garden, featuring a statue of Abdulrachman Saleh as both a tribute and an educational element for visitors regarding the figure behind the airport's name. This median is precisely aligned with the central axis of the terminal building, creating a seamless visual continuity from the entrance gate to the main terminal. Such placement not only reinforces visitor orientation but also enhances the monumental character of the airport, making the statue a symbolic focal point that greets every arrival.

Figure 10. Mr. Abdulrachman Saleh Statue on Parking Median (source: Personal Documentation, 2025)

At the drop-off area of Abdulrachman Saleh Airport, the façade design integrates two complementary elements: the use of Low-E glass on the terminal's exterior walls and cascading vertical vegetation from the upper-level canopy. Low-E glass was selected for its ability to reflect solar heat radiation without compromising natural daylight, thus enhancing indoor thermal comfort while reducing cooling loads. Meanwhile, the green layer partially enveloping the façade provides both aesthetic value and functional benefits, acting as an additional thermal buffer and filtering dust and airborne pollutants from the exterior environment.

Landscape elements are also emphasized in the roadway median at the drop-off zone. Rows of pointed-leaf plants in a green and purple palette are densely arranged, serving as a visual divider while guiding vehicle circulation safely and efficiently. Beyond their functional role, these plantings enrich the visual identity of the entrance area and contribute to improved air quality and microclimatic comfort. The combination of modern materials such as Low-E glass with natural elements reinforces the notion that the terminal is conceived with a sustainable design approach—prioritizing user comfort, energy efficiency, and harmonious integration with its surrounding environment.

Figure 11. Low-e Glass and Vegetation Application on Airport Building (source: Personal Documentation, 2025)

The airport terminal interior is designed with a bioclimatic approach, integrating natural elements and passive strategies to achieve thermal comfort, efficient lighting, and a welcoming atmosphere. On the left side of the image, the roof structure utilizes glulam wood modules shaped like flower petals, which not only reinforce the architectural identity of the terminal but also take advantage of wood's environmentally friendly properties and high thermal insulation capacity. Between these roof modules, hidden skylights with low-E glass are incorporated to maximize natural lighting while minimizing excessive heat gain. These skylights are strategically positioned to reduce glare and ensure even heat distribution, thereby supporting daylight energy savings.

The space is further enhanced by an inner garden that functions as a visual shade element, a natural air filter, and a humidity regulator. The presence of vegetation indoors creates an evaporative cooling effect and strengthens the visual connection between users and nature, aligning with biophilic design principles.

On the right side of the image below, the ceiling features a patterned wood slat arrangement that not only creates a harmonious visual rhythm but also functions as an acoustic control element, reducing noise within the terminal's active zones. This area also showcases Malang tourism signage promoting key destinations such as Pantai Teluk Asmara, utilizing the passenger trolley retrieval area as an effective medium for regional promotion. Through this approach, the terminal is envisioned not merely as a transportation facility, but as a climate-responsive public space that also embodies the cultural identity of its surrounding region.

Figure 12. Bioclimatic Elements at Airport's Interior (source: Personal Documentation, 2025)

A gamelan installation is also incorporated within the interior space, functioning as a representation of the local cultural identity and as a means to curate a distinctive spatial experience. Its strategic placement in the arrival area is intended to evoke an immediate perception of Malang's atmosphere and character upon entry to the terminal. Beyond its decorative role, the presence of the gamelan serves as a symbolic reminder of the region's rich artistic and cultural heritage, thereby reinforcing the airport's position as a cultural gateway that extends a visually immersive welcome to incoming passengers.

Figure 13. Local Wisdom's Element, Gamelan (source: Personal Documentation, 2025)

The use of glulam timber for the roof structure supports the principles of bioclimatic design. Glulam timber offers excellent thermal insulation properties, contributing to passive indoor thermal comfort, while also being an environmentally responsible material made from engineered wood lamination, thus reducing solid timber waste.

Structurally, glulam possesses high strength and durability, enabling wide-span constructions without excessive intermediate columns. This allows for a more open and flexible interior space within the terminal while providing architectural freedom to realize the flower petal roof modules that define the building's visual identity.

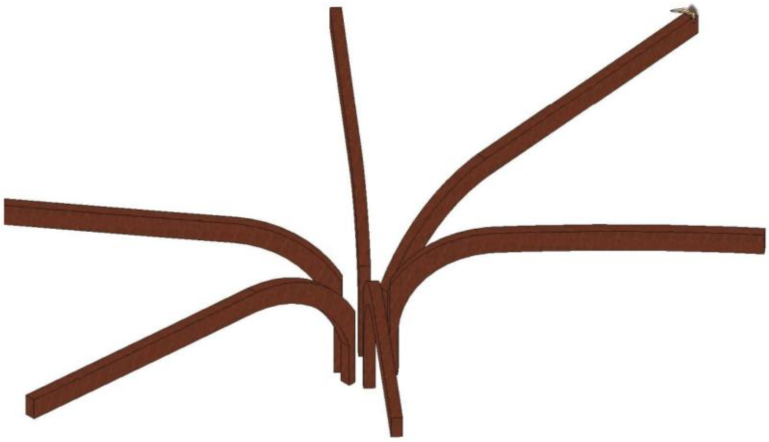


Figure 14. Glulam Timber (source: Personal Documentation, 2025)

CONCLUSION AND SUGGESTIONS

The redesign of Abdulrachman Saleh Airport is based on a comprehensive analysis of its functions, service reach, and the site's potentials and constraints, which are then integrated with a bioclimatic approach. The resulting passenger terminal design not only meets operational standards and user comfort requirements but also reflects the regional identity through contextual form and aesthetics. Bioclimatic principles are applied to optimize thermal comfort, energy efficiency, and harmonious interaction with the surrounding environment. Through well-planned spatial arrangements, circulation systems, and appropriate material selection, the design aims to enhance both the functional and visual performance of the airport while supporting sustainable regional development.

For optimal implementation, continuous coordination is required among airport management, local government, and other stakeholders, particularly in ensuring compliance with safety and comfort standards. Furthermore, the maintenance of bioclimatic elements—such as shading vegetation and natural ventilation systems—should be prioritized to preserve the building's environmental performance. It is also recommended that the design be adaptable to future technological advancements and evolving passenger needs, ensuring that the airport remains functional, relevant, and responsive to the dynamics of the aviation industry.

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