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Banjar Traditional Architecture of the *Tadah Alas* Type in Cempaka, Banjarbaru, South Kalimantan

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ABSTRACT

Traditional Banjar architecture consists of eleven recognized house types, one of which is the Tadah Alas type. This study aims to identify and examine the architectural characteristics of a Tadah Alas traditional house located in Cempaka, Banjarbaru, South Kalimantan. Visually, the house exhibits differences from the commonly recognized Tadah Alas typology, prompting further investigation to verify its conformity. The research employs a comparative method by examining the architectural elements of the Cempaka house against established Tadah Alas characteristics as defined by cultural experts. Data were analyzed descriptively through narrative explanation and visual documentation, allowing for a systematic interpretation of observed features. The findings indicate that the house generally conforms to the Tadah Alas typology, with the exception of the panampik kecil space, which features a half-octagonal form. This configuration is unique and has not been identified in other known types of traditional Banjar houses, suggesting a local variation within the Tadah Alas typology.

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1. INTRODUCTION

The Banjar ethnic group in South Kalimantan has a variety of traditional architectures that are classified within the traditional Malay architectural group. Traditional Malay architecture can be found in the coastal areas of Riau and Sumatra [1], while traditional Banjar architecture originated and developed within the territory of the Banjar Kingdom [2], [3], [4]. Traditional Banjar architecture represents the identity, values, and local wisdom of its people.

Traditional Banjar architecture is rich in diverse forms and imbued with cultural symbolic values [2], [5], [6]. It is divided into eleven types, one of which is the Tadah Alas type. This type has several characteristics, including [7]: (1) a simple shield or pyramid-shaped roof, usually constructed with ironwood as the main frame, without a ridge, featuring a low and flat roof; (2) a raised stage construction 1–2 meters above the ground to anticipate swampy and flooding conditions; (3) a front room called a palataran (veranda or platform), typically an open or semi-open space used as a guest reception area; (4) a general layout consisting of a panampik (front), palidangan (main family room), padapuran (kitchen), and anjung (bedrooms); (5) the main construction material being ironwood and other local woods; and (6) simpler decorative variations compared to other types of Banjar houses, such as the absence of Bubungan Tinggi type.

In the Cempaka area of Banjarbaru, several traditional Banjar houses of the Tadah Alas type have been found. The Tadah Alas type is a form of traditional Banjar architecture that is widely replicated by the Banjar community, especially in the Cempaka area, which is an old settlement dating back to the 15th century [8]. One of these houses has a unique appearance that differs from the typical Tadah Alas type. This raises a research question: does this house still belong to the Tadah Alas category, or is it a new local variant? This research gap is important to explore within the framework of Banjar architectural typology.

The unique Tadah Alas house mentioned above is estimated to have been built before independence (prior to 1945). It originally belonged to H. Abdurrasyid (deceased) and is now inhabited by his third-generation descendant, Tuti Awaliah. Although it has undergone several repairs, most of the original shape, structure, and materials have been preserved. This house not only holds aesthetic and structural value but also contains architectural significance important to Banjar culture, thus its existence deserves documentation and preservation [9]. This research will contribute to efforts to preserve the heritage of traditional Banjar architecture, serve as a reference for further studies on traditional Banjar architectural treasures, and more broadly enrich the heritage of traditional Malay architecture.

2. METHOD

This study employs a comparative method, specifically comparing the *Tadah Alas* house in Cempaka with the architectural characteristics of the *Tadah Alas* type formulated by experts. Data analysis is carried out descriptively through narrative and visual documentation, by describing and interpreting the results of observations systematically. This study will be carried out through several stages of work that are designed systematically in order to obtain accurate and relevant data in comparing the *Tadah Alas* house in the Cempaka area, Banjarbaru, with the characteristics of the *Tadah Alas* house as formulated by cultural experts [7], [10]. The stages are as follows:

1) Preparation Stage. This stage involves preparing a structured work plan, conducting a literature review on traditional Banjar architecture, particularly the *Tadah Alas* house and compiling relevant references. The literature review aims to strengthen the theoretical framework and define the research variables.
2) Measurement and Visual Documentation. Detailed and comprehensive measurements of the *Tadah Alas* house in Cempaka were conducted using a measuring tape. Visual documentation was carried out through photography and video recording using a digital camera and a drone to capture the building's condition from various angles. The documentation covers the entire building, including both the exterior and interior, as well as its structure and construction.
3) Collection of Supporting Data. Supporting data were collected based on the measurement results (floor plans, elevations, sections, and building details), along with photographs and written documentation. These data are necessary to complete the details of the ornaments, building elements, and aspects that were not fully captured during the field measurements.
4) Structured Interviews. Structured interviews were conducted with the homeowner and individuals knowledgeable about the *Tadah Alas* house in Cempaka. The interviews were guided using a list of questions developed based on the required data framework, focusing especially on issues of authenticity, alterations, and local interpretations of the *Tadah Alas* house.
5) Data Depiction. The results of the field measurements were translated into two-dimensional technical drawings using AutoCAD. This depiction was conducted in detail, based on the results of the documentation and field measurements, and corroborated through relevant literature.
6) Comparative Analysis. The analysis was conducted by comparing the *Tadah Alas* house in Cempaka with the characteristics of the *Tadah Alas* house as defined by cultural experts [7], [9]. The comparative variables include: (1) roof shape; (2) type and construction materials; (3) spatial layout; and (4) decorative variety. This analysis was carried out descriptively and qualitatively to determine the extent of conformity or differences between the *Tadah Alas* house in Cempaka and the existing typology.

Thus, this study is expected to contribute to a deeper understanding of the characteristics of the *Tadah Alas* house in the Cempaka area, while also supporting efforts to preserve traditional Banjar architecture.

3. RESULTS AND DISCUSSION

3.1 General Description of Rumah *Tadah Alas* Cempaka

The Cempaka *Tadah Alas* House is located in Cempaka Village, Cempaka District, Banjarbaru City, South Kalimantan Province. Cempaka Village is approximately 47 km from Banjarmasin City and 7 km from the center of Banjarbaru City. Geographically, Cempaka District borders South Banjarbaru District to the north, Liang Anggang District to the west, Banjar Regency to the east, and Tanah Laut Regency to the south. The

Cempaka area has existed since the time of the Negara Dipa kingdom in the 15th century. The area gained prominence following the discovery of the Trisakti Diamond on August 26, 1965, by H. Madslam and colleagues [8], [11]. As an area with a long-standing settlement history, Cempaka is home to many cultural heritage sites, one of which is the traditional Banjar house. There are 15 traditional Banjar houses in the area, including unique houses that feature a diamond symbol on the front facade of the residential building [8].

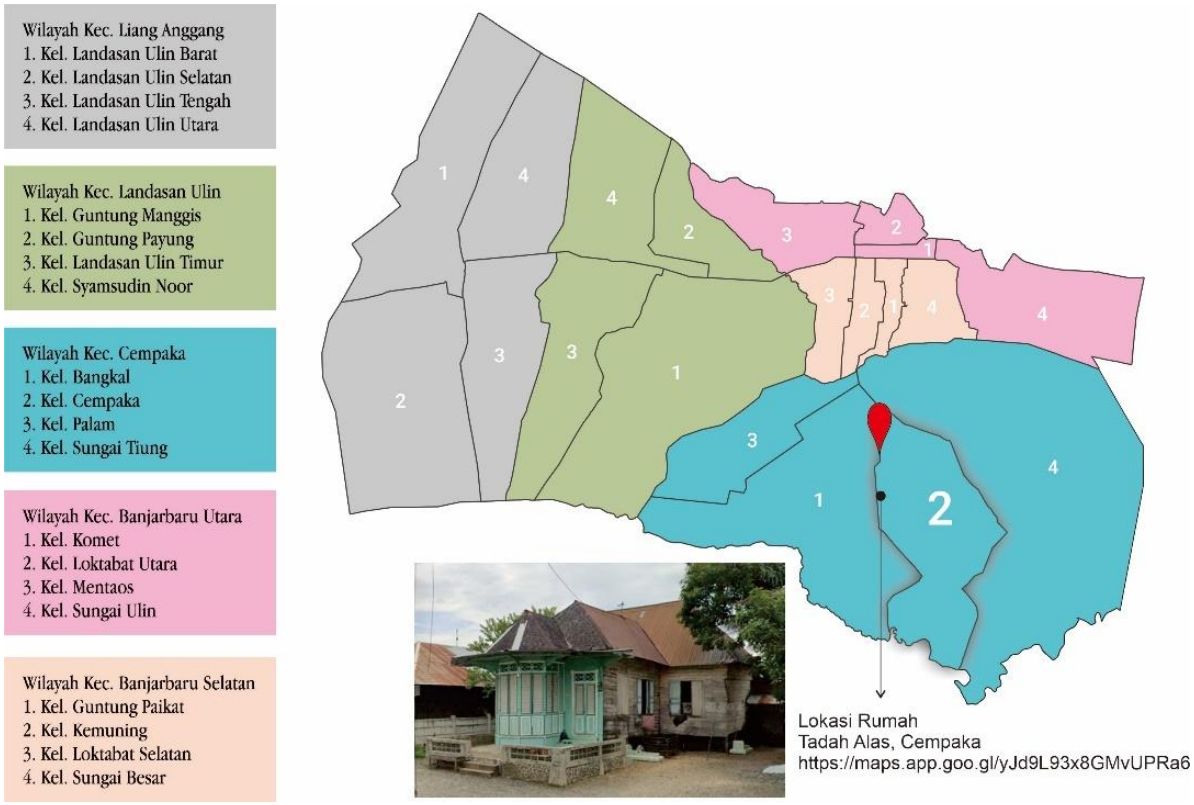


Figure 1. Location of the Cempaka *Tadah Alas* House
(Source: processed from *https://mwahyunz.id/unduh/peta-vektor-wilayah-kota-banjarbaru/*)

The *Tadah Alas* House, which is the focus of this research, is estimated to have been built prior to the Indonesian independence era, that is, before 1945. The original owner of the house was Mr. Haji Abdurrasyid (deceased), a prominent community figure known for his influence in the local environment, particularly in the fields of religion and social activities. Currently, the house is occupied by his granddaughter, Mrs. Tuti Awaliah, who represents the third generation of the family. The house is situated in a traditional residential area that was once the center of community activities, including religious gatherings, communal meetings, and cultural events. Although the house has undergone several repairs and minor renovations over the years, most of its original form, structure, and primary materials have been well preserved. The preservation of this house highlights the community's commitment to safeguarding its architectural heritage amidst modernization pressures. The existence of this house stands as a silent witness to the historical development and the social dynamics of community life in the Cempaka area. It embodies not only architectural values but also social and cultural narratives that have been passed down through generations. A depiction of the Cempaka *Tadah Alas* House is presented in Figure 2-8.

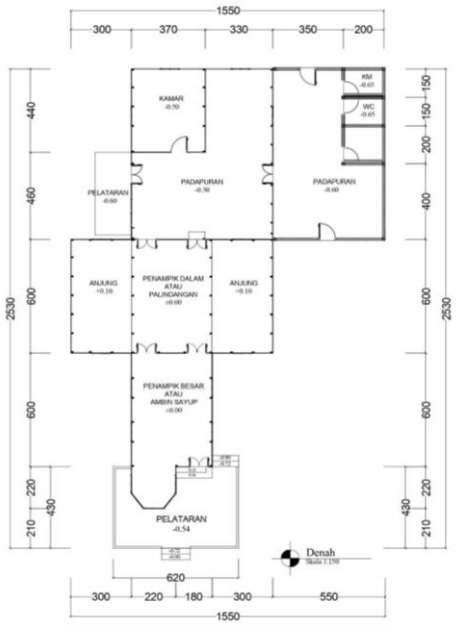


Figure 2. House Plan *Tadah Alas* Cempaka

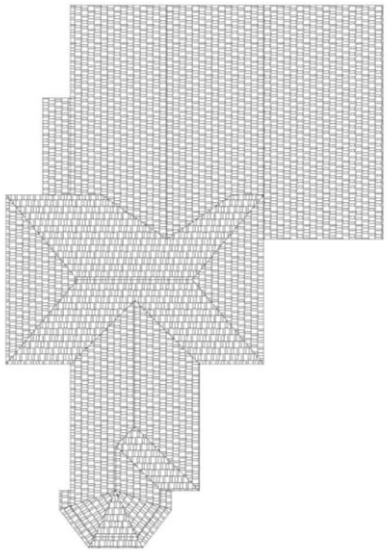


Figure 3. Top View of the Cempaka *Tadah Alas* House

Figure 4. Front View of the Cempaka *Tadah Alas* House

Figure 5. Rear View of the Cempaka *Tadah Alas* House

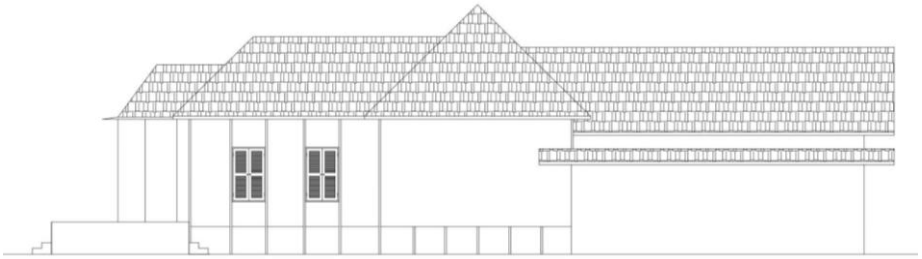


Figure 6. Right Side View of the Cempaka *Tadah Alas* House

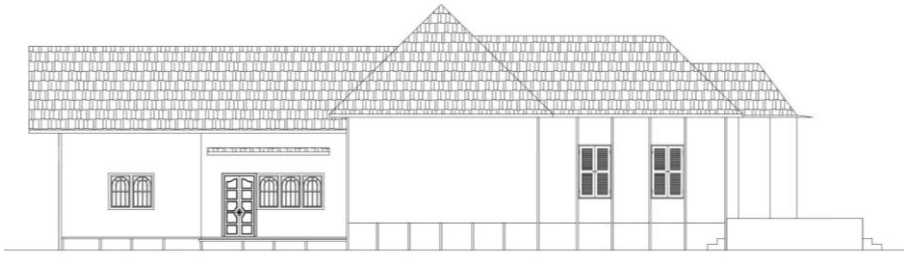


Figure 7. Left Side View of the Cempaka *Tadah Alas* House

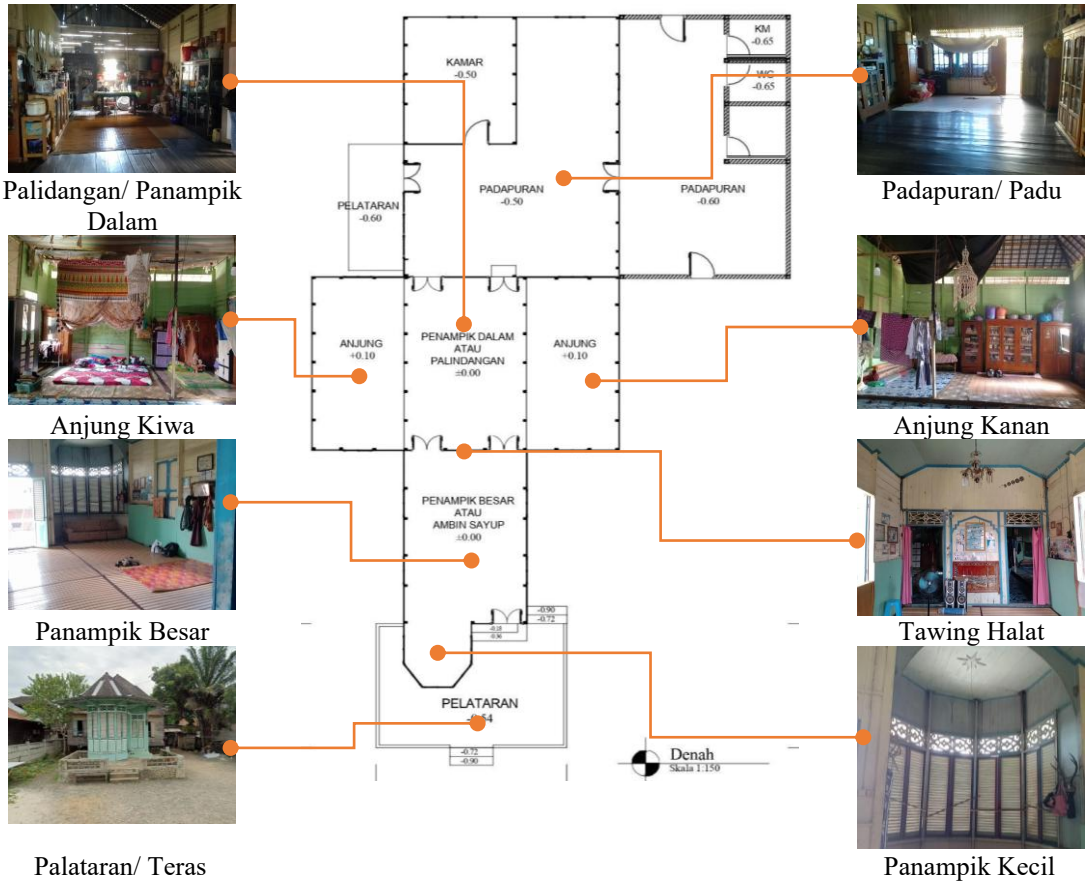


Figure 8. The rooms in the Cempaka *Tadah Alas* House

3.2 Characteristics of Traditional Banjar Architecture in the Cempaka *Tadah Alas* House

Before examining the architectural characteristics of the *Tadah Alas* type Banjar house in the *Tadah Alas* Cempaka area, it is first necessary to understand the characteristics of traditional Banjar architecture as represented in the *Cempaka Tadah Alas House*. There are 11 types of traditional Banjar houses [6], [7], [12]: *Bubungan Tinggi* type, *Gajah Baliku* type, *Gajah Manyusu* type, *Balai Laki* type, *Balai Bini* type, *Palimasan* type, *Palimbangan* type, *Anjung Surung* type, *Tadah Alas* type, Joglo type, and *Lanting* type. Except for *lanting* houses that float on water, the other ten types of houses are houses on stilts.

The architecture of the Banjar traditional house has the following characteristics [2], [7], [12], [13], [14]:

1) It is constructed on stilts.
2) It exhibits a symmetrical floor plan, with both front and rear access provided by stairs that have an odd number of steps.
3) Access to the house is restricted to two entry points: the main front door and the *padapuran* door at the rear. These doors align along the central axis of the symmetrical floor plan.
4) Ironwood is the principal construction material of the Banjar house, utilized not only for the foundation and the building enclosure but also as the roofing material.
5) The structure includes protruding *anjung* (side rooms) on both the left and right sides of the building, attached to the sides of the inner *panampik* room or *palidangan*. This configuration results in a floor plan that resembles a cross when viewed from above.

Based on the five characteristics of traditional Banjar architecture, the Cempaka *Tadah Alas* House exhibits four out of the five. The characteristic not present in the Cempaka *Tadah Alas* House is the parallel alignment of the front door and the *padapuran* door. Furthermore, there are several additional components (including spaces and forms) in the *Cempaka Tadah Alas House*. These additional components can be identified by comparing the characteristics of the *Tadah Alas* house, previously formulated by cultural experts, with those of the *Cempaka Tadah Alas House*.

3.2 Characteristics of the Traditional Architectural Type of *Tadah Alas* in Cempaka *Tadah Alas* House

The *Tadah Alas* Banjar Traditional House is believed to be a modern modification of the *Balai Bini* type [7], as evidenced by the similarity of the main ridge form and the transformation of the terrace into an overlapping front roof. The left and right side rooms, known as *Anjung Surung*, are constructed with roofs that overlap the main building. The general characteristics of the *Tadah Alas* House are as follows [7]: (1) It features a simple shield-shaped or pyramid-shaped roof, typically constructed from ironwood as the primary structural material, and lacks a ridge, instead having a low and flat roof; (2) It employs a stilt construction, elevated 1–2 meters above the ground, to accommodate swampy and flood-prone conditions; (3) a front room called a *palataran* (veranda or platform), typically an open or semi-open space used as a guest reception area; (4) a general layout consisting of a *panampik* (front), *palidangan* (main family room), *padapuran* (kitchen), and *anjung* (bedrooms); (5) the main construction material being ironwood and other local woods; and (6) simpler decorative variations compared to other types of Banjar houses, such as the absence of Bubungan Tinggi type. Illustrations of the Tadah Alas House, as described by cultural experts, can be found in Figures 9–12.

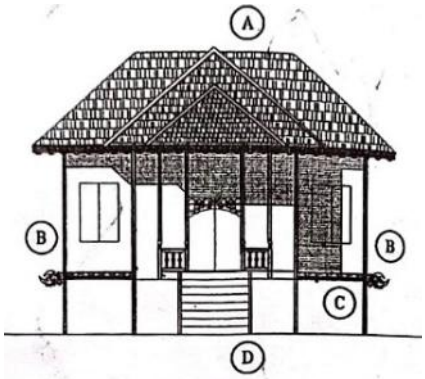


Figure 9. Front View of the *Tadah Alas* House
(source: Seman, 2011)

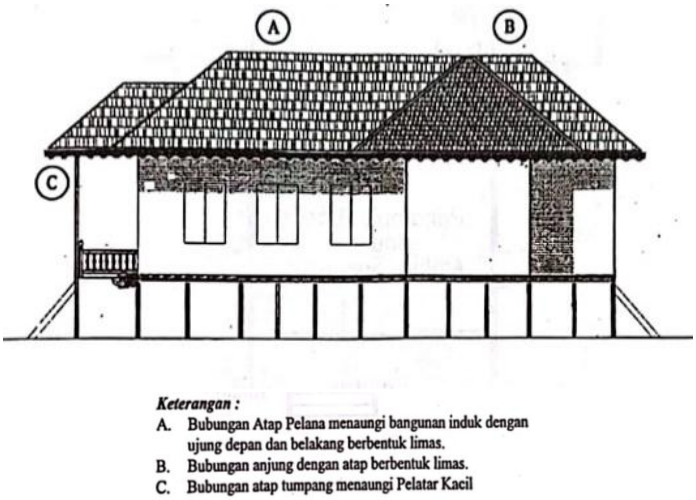


Figure 10. Right Side View of the *Tadah Alas* House
(source: Seman, 2011)

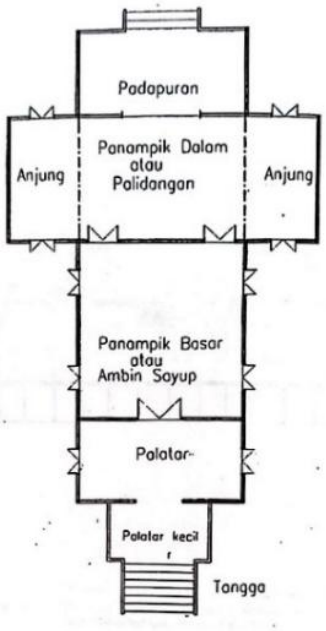


Figure 11. House Plan *Tadah Alas*
(source: Seman, 2011)

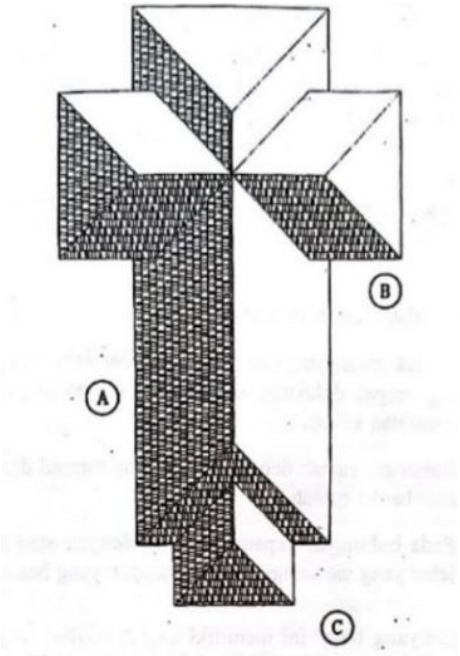
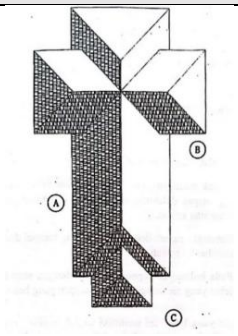
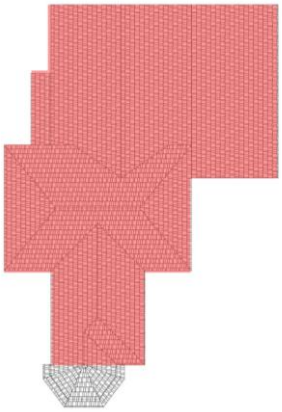
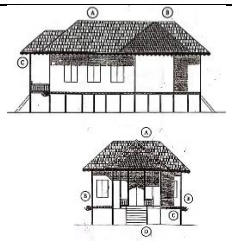
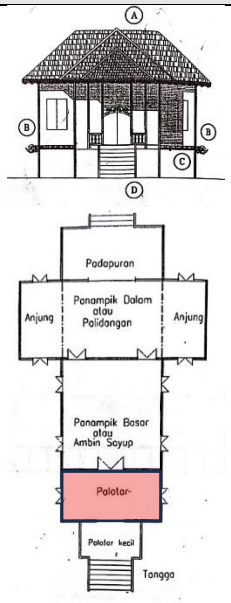
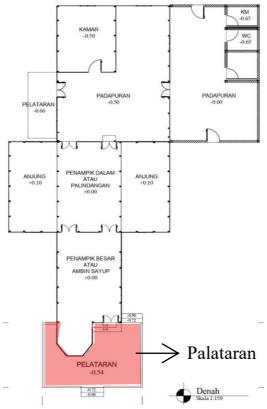
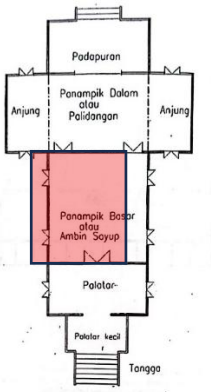
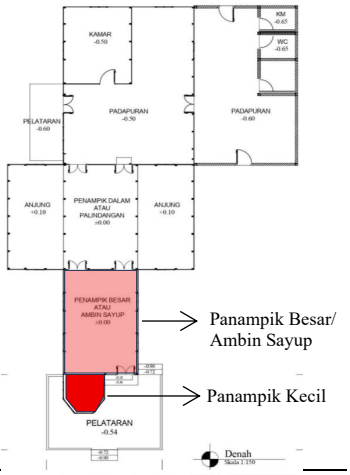
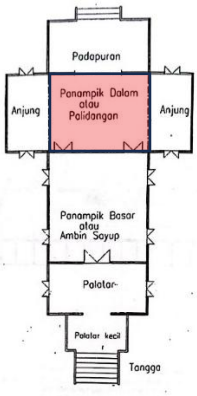
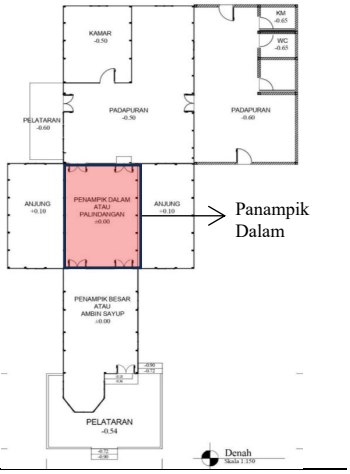


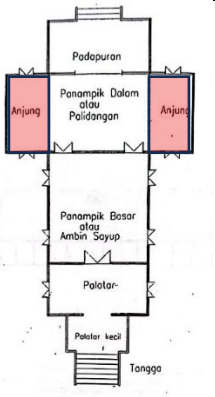
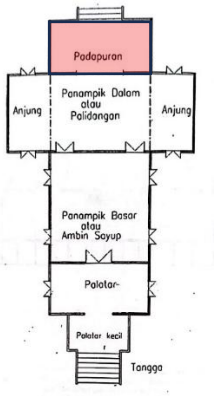
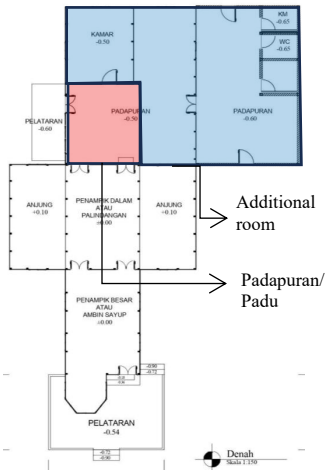
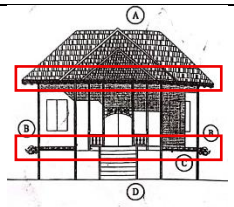
Figure 12. Top View of the *Tadah Alas*
(source: Seman, 2011)

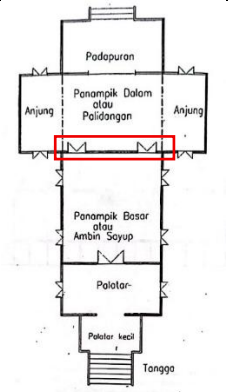
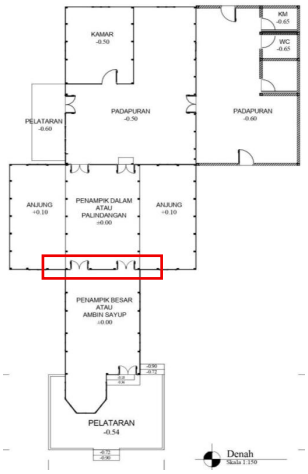
The Cempaka *Tadah Alas* House exhibits the characteristics typical of traditional Banjar houses and shares the same general typology as other *Tadah Alas* houses. Table 1 presents a comparison between the characteristics of *Tadah Alas* houses as identified by cultural experts and those of the *Cempaka Tadah Alas House*. The comparison is based on several variables, including roof shape, spatial layout (encompassing the *palataran, panampik kecil, panampik besar, panampik dalam, anjung*, and *padapuran*,), as well as decorative elements and ornaments.

Tabel 1. Comparative Study Between General Characteristics of Tadah Alas House and Cempaka Tadah Alas House

No.	General Characteristics of *Tadah Alas* House		Characteristics of Cempaka *Tadah Alas* House	
1.	The roof shape comprises a shield roof that forms a *cacak burung* (cross) pattern. It does not include a ridge roof. The roof of the *panampik* room is the same height as that of the *anjung* room. Both the roof frame and covering material are constructed entirely from ironwood shingles (*Eusideroxylon zwageri*).		The roof shape is primarily characterized by a shield roof that forms a *cacak burung* (cross) pattern. An additional roof is present at the rear of the building, although the original form remains clearly visible. The roof of the *panampik* room is lower than that of the *anjung* because the width of the *panampik* room is smaller than the width of the *anjung*. A small *panampik* room is covered by an octagonal half-cone roof. The entire frame is constructed from ironwood. For the roof covering, most of it consists of ironwood shingles combined with zinc sheets.	
2.	*Tadah Alas* houses are generally built on stilts, raised 1–2 meters above the ground, to accommodate swampy conditions and prevent flooding.		The Cempaka *Tadah Alas* House also employs a stilt construction. Originally, the height of the stilts likely reached 1–2 meters above the ground surface; however, due to sedimentation caused by annual flooding, this height has gradually decreased over time. In contrast, the additional rooms are not built on stilts but rest directly on the ground.	

No.	General Characteristics of *Tadah Alas* House		Characteristics of Cempaka *Tadah Alas* House	
2.	The protective roof of the courtyard (terrace) is designed in the form of a small shield roof, which is a distinctive architectural feature of the *Tadah Alas* House.		The palataran (terrace) differs in form from Banjar houses in general. The courtyard of the Cempaka *Tadah Alas* house is constructed using river stones and concrete, resembling the terraces of houses built in the center of Banjarbaru City. This *palataran* is open and not covered by a roof.	 
3.	Beyond the *Pelatar* (terrace) room is the *Panampik Besar*, also known as the *Ambin Sayup* room		Beyond the *Pelatar*, you will find the *Panampik Kecil* and *Panampik Besar*, also known as the *Ambin Sayup* rooms. The presence of the *Panampik Kecil* room, which has a half-octagonal shape, is a distinctive feature of the Cempaka *Tadah Alas* House, setting it apart from other *Tadah Alas* houses in general.	
4.	After passing through the *Penampik Besar*, one enters the *Palidangan*, also known as the *Panampik Dalam* or *Ambin Dalam*. A wall, called *Tawing Halat*, separates the *Panampik Besar* from the *Palidangan* room [15], [16].		After passing through the *Penampik Besar*, one enters the *Palidangan*, also known as the *Panampik Dalam* or *Ambin Dalam*. A wall, called *Tawing Halat*, separates the *Panampik Besar* from the *Palidangan* room [15], [16].	

No.	General Characteristics of *Tadah Alas* House		Characteristics of Cempaka *Tadah Alas* House	
5.	On both the right and left sides of the *Palidangan* room, there are private rooms that serve as bedrooms for family members, known as the *anjung*. The *anjung* on the left side is called *Anjung Kiwa*, while the one on the right is called *Anjung Kanan*.		On both the right and left sides of the *Palidangan* room, there are private rooms that serve as bedrooms for family members, known as the *anjung*. The *anjung* on the left side is called *Anjung Kiwa*, while the one on the right is called *Anjung Kanan*.	
6.	The rearmost room of the *Tadah Alas* House is the *Padapuran*, also known as the *Padu* room. This room serves as a space for cooking and food preparation. On the back wall, there is a gate with stairs that provide access in and out of the house.		The rearmost room of the *Tadah Alas* House is the *Padapuran*, also known as the *Padu* room. This room serves as a space for cooking and food preparation. On the back wall, there is a gate with stairs that provide access in and out of the house. In Cempaka *Tadah Alas* House, structural developments have been made on both sides of the *Padapuran* room. A terrace has been added to the left side, while a bedroom and bathroom have been added to the right. The building materials used for these additional rooms are not ironwood but concrete.	
7.	The *Tadah Alas* house features simpler decorative variations compared to other types of Banjar houses. As shown in the accompanying image, ornaments are placed at the lower end of the roof, known as *pilis*. Additional ornaments are also located at the base (*pilis bawah*), complemented by *rumbai pilis*.		The Cempaka *Tadah Alas* House does not feature decorative motifs on the lower edge of the roof or at the base. Ornamentation is found only on the *tawing halat*, which serves as a partition between the *Panampik Besar* room and the *Panampik Dalam* or *Palidangan*. . The *tawing halat* typically indicates the social status of the house's occupants—the	

No.	General Characteristics of *Tadah Alas* House	Characteristics of Cempaka *Tadah Alas* House
	The *Tadah Alas* house includes a *tawing halat*, which serves as a partition between the *Panampik Besar* room and the *Panampik Dalam* or *Palidangan*. *Tawing halat* is commonly regarded as an indicator of the social status of the house's occupants—the more elaborate its ornaments, the higher the status of the residents in society [15], [16], [17]. 	more elaborate its ornaments, the higher the occupants' standing in society [15], [16], [17]. The *Tadah Alas* house is regarded as a people's house; thus, the ornaments on its *tawing halat* are less elaborate than those found on the *tawing halat* of *Bubungan Tinggi* and *Gajah Baliku* houses [2]. The ornaments on the *tawing halat* of the Cempaka *Tadah Alas* House take the form of a forehead adorned with plant motifs. 

The comparative analysis indicates that the Cempaka *Tadah Alas* House closely resembles traditional Banjar architecture of the *Tadah Alas* type. However, the Cempaka *Tadah Alas* House possesses distinct characteristics in terms of shape and spatial arrangement. Its uniqueness is attributed to several factors, including:

1. The presence of a *Panampik Kecil* room, which has a half-octagonal shape and is covered by a shield roof that forms an octagonal cone.
2. The roof design is similar to that of *Tadah Alas* houses in general, as it lacks a ridge and is primarily defined by a shield roof forming a *Cacak Burung* shape (cross). In most *Tadah Alas* houses, the roof of the *Panampik* room is level with the roof of the *Anjung* room due to their identical widths. In contrast, in the Cempaka *Tadah Alas* House, the *Panampik* room's roof is lower than the *Anjung* room's roof, as the *Panampik* room is narrower than the *Anjung* room.

4. CONCLUSION

Based on the findings of this research and discussion, it can be concluded that the Cempaka Tadah Alas House represents the traditional Banjar house of the Tadah Alas type, generally preserving the characteristics of its original architecture. These characteristics include its raised construction, shield roof shape or simple pyramid without a ridge, and elongated spatial layout consisting of a Palataran, Panampik, Panampik Besar (or Ambin Sayup), Palidangan (also known as the Panampik Dalam or Ambin Dalam), and Padapuran, with an Anjung flanking the Palidangan room. Additionally, the Cempaka Tadah Alas House features highly simplistic decorative elements.

However, the Cempaka Tadah Alas House possesses unique architectural features that distinguish it from other buildings of its type. These include the presence of a Panampik Kecil room with a half-octagonal shape and an octagonal conical shield roof, as well as a difference in roof height between the Panampik and Anjung rooms, which results from their differing widths. Thus, the Cempaka Tadah Alas House can be categorized as a traditional Banjar Tadah Alas house that has undergone structural adaptations to accommodate the needs of its occupants while still preserving the fundamental principles of traditional Banjar architecture of the Tadah Alas type.

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Urban Canyon Configurations for Sustainable Tropical Cities: A Simulation for Design Practice

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ABSTRACT

Urban overheating and limited daylight access are persistent challenges in rapidly densifying tropical cities. This study examines the influence of urban canyon geometry—including building width-to-length ratio, corridor width, and lateral spacing—on surface temperature dynamics and daylight performance. Using Autodesk Forma, 27 building massing configurations were simulated under standardized conditions with a fixed building height of 30 meters and a footprint of 900 m². Surface temperatures were measured at corridor and rear façade points at 10:00 a.m. and 2:00 p.m., while daylight performance was assessed using sun hours and daylight potential indicators. The results indicate that compact building forms with minimal spacing exacerbate heat accumulation and restrict daylight access, whereas configurations with greater spatial permeability enhance both thermal and lighting performance. The optimal configuration featured an elongated building ratio of 1:3, a narrow corridor width of 15 meters, and wide lateral spacing of 30 meters, achieving corridor surface temperatures as low as 33°C and daylight performance values of up to 66%. Beyond its analytical findings, this study highlights the practical applicability of Autodesk Forma as an accessible and user-friendly tool for early-stage massing studies. Compared to more complex simulation platforms such as ENVI-met or CFD, Autodesk Forma enables architects and designers to conduct simple yet effective climate-responsive analyses during the initial phases of building and site design, thereby supporting sustainable urban development in tropical contexts.

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1. INTRODUCTION

The geometric configuration of urban environments plays a pivotal role in determining microclimatic conditions, particularly in tropical humid cities where elevated moisture levels exacerbate heat stress. Among the most influential urban form parameters are building aspect ratio (height-to-width ratio of an urban canyon), canyon width, and the spacing between buildings. These factors collectively shape airflow, solar exposure, and heat accumulation. High aspect ratios reduce the sky view factor, limiting both longwave radiation loss and air circulation, thereby intensifying the urban heat island (UHI) effect and increasing near-surface air temperatures [1], [2] In narrow canyons, inadequate ventilation hampers convective heat dissipation and traps anthropogenic heat, which raises cooling energy demand and reduces outdoor thermal comfort [3], [4].

Canyon width has a dual role in thermal performance. Narrow corridors enhance shading, reducing direct solar radiation on buildings and pedestrian areas, which in turn lowers cooling loads [1], [5]. However, excessive narrowness impedes air circulation and prevents heat dissipation, especially in humid tropical climates where latent cooling is already limited [4] [2]. Consequently, urban designers must consider not only

geometrical proportions but also supplemental cooling strategies, such as the integration of vegetation and water elements, which can alter wind dynamics and improve the surface energy balance [6]. Similarly, the spacing between buildings significantly affects urban thermal dynamics. Wider spacing facilitates airflow and reduces heat buildup, but it also exposes surfaces to greater solar radiation, potentially increasing surface temperatures [1] [2]. Conversely, compact arrangements increase shading and reduce radiative gain but may restrict ventilation, causing stagnant heat zones [4], [5]. This underscores the necessity for balanced spatial arrangements in tropical design, optimizing both shading and ventilation to mitigate thermal discomfort [3] [6].

Urban densification is widely acknowledged as a major contributor to elevated surface temperatures and the intensification of UHI effects. High-density development, characterized by extensive impervious surfaces and minimal green cover, limits natural cooling mechanisms and increases heat retention. These changes in land use and surface material explain why rapidly growing urban centers often experience significantly higher land surface temperatures than adjacent rural areas [7]. In metropolitan cores, reduced vegetation and increased thermal mass exacerbate these effects [8]. Furthermore, building height, particularly in high-rise environments, interacts with form and material to shape energy flows and thermal storage. While density influences daytime heating, building height governs nighttime heat retention [9]. Effective thermal management in such contexts requires height-sensitive solutions, such as reflective materials, shading devices, and ventilation corridors. Urban design should respond to the thermal contributions of high-rise structures through sustainable material selection and energy-efficient configurations [10].

Remote sensing studies provide robust evidence supporting the link between urban geometry and microclimatic outcomes. Gerçek et al. demonstrate that compact urban forms with limited vegetation and high impermeability strongly correlate with increased UHI intensity [11]. Similarly, Ridwan et al., using Landsat data, show that the spatial concentration and morphology of built environments significantly affect thermal retention, with denser areas showing more pronounced UHI effects [12]. These findings reinforce the need for urban form reconfiguration as a complementary strategy to vegetation-based cooling. Morphological studies further highlight how building layout, orientation, and block positioning affect ventilation and convective heat transfer. Rana et al. found that the spatial arrangement of buildings influences airflow paths and thus the effectiveness of outdoor cooling [13]. Yang et al. add that urban expansion and densification contribute to global warming through the reinforcement of UHI [14]. Braun et al. argue that deliberate management of building density and integration of green infrastructure are essential to reduce urban heat and achieve spatial efficiency [15]. Despite growing literature in this field, there remains a lack of studies exploring the simultaneous effects of aspect ratio, canyon width, and spacing on thermal performance in tropical cities. This study aims to address that gap by assessing the combined influence of these geometric variables on surface temperature in humid environments.

The hypothesis guides the present research that optimal combinations of building form and spacing can effectively lower surface temperatures and enhance microclimatic comfort, even within dense urban configurations. While previous studies often examine individual parameters in isolation, this study employs a combinatorial approach that reflects the complexity of real urban conditions. By simulating different urban geometries, the study seeks to generate empirical evidence supporting climate-responsive urban design. To achieve this objective, the research employs a combination of parametric modeling and performance-based environmental simulation. Unlike conventional studies that focus on isolated variables, this approach integrates multiple geometrical dimensions in assessing their thermal effects. The focus on high-rise configurations typical of tropical urban centers ensures the study's relevance to cities undergoing rapid densification, such as those in Indonesia. The integration of architectural form with environmental data contributes to a broader sustainability agenda by providing design recommendations that reduce UHI and energy use. This study highlights how accessible digital tools support data-driven early design and foster collaboration for climate-responsive urban planning.

This study employs Autodesk Forma, a cloud-based platform enhanced with artificial intelligence, to simulate surface temperature, daylight potential, and sun hours under diverse urban canyon configurations. Models were standardized with a 30-meter building height and a 900 m² footprint, while corridor widths (15 m, 30 m, 45 m) and side spacing (0 m, 15 m, 30 m) were systematically varied. Simulations at 10:00 a.m. and 2:00 p.m. captured diurnal solar exposure. Although previous studies have explored individual parameters such as aspect ratio, orientation, or canyon width, few have investigated their combined effects in tropical high-density contexts. Moreover, most existing analyses employ advanced tools like ENVI-met or CFD, which remain complex and less accessible to practitioners, leaving a gap in early-stage design applications. Addressing this gap, the present study demonstrates how integrated geometric variations, specifically width-to-length ratio, corridor width, and side spacing, shape both thermal and daylight performance. The findings aim to provide architects, planners, and policymakers with evidence-based strategies for climate-responsive urban design, while contributing to the broader discourse on environmental resilience. This approach simplifies

early-stage design by linking microclimate data with spatial logic, enabling practical decisions without advanced technical tools. It bridges academic insights and professional workflows to support livable tropical cities.

2. METHOD

The influence of building geometry, orientation, and distance on the urban thermal climate is gaining attention in architectural and environmental research. Simulation methods such as parametric modeling and CFD are important for understanding the interaction between building form and microclimate behavior. These approaches allow researchers to explore the impacts of urban form on environmental parameters such as solar radiation, airflow, and thermal comfort [16], [17], [18]. To initiate a consistent simulation framework, parametric urban configurations must be developed. Variations in height-to-width (H/W) ratios, spatial layouts, and orientations are systematically modeled using simulation tools such as ENVI-met and CFD-based platforms [19], [20]. These configurations are evaluated using standardized thermal comfort indices, including the Physiologically Equivalent Temperature (PET), Universal Thermal Climate Index (UTCI), and Predicted Mean Vote (PMV) [17], [21], [22]. By examining diverse morphological typologies such as linear blocks, courtyards, and dispersed forms, researchers can identify how combinations of design parameters influence microclimatic conditions.

A critical component of simulation-based research is model calibration and validation. To ensure analytical accuracy, simulated outputs, such as surface temperatures and wind velocities, must be validated against empirical field data. Several studies have achieved such validation through in-situ measurements within urban canyons or along pavements [18], [23], confirming the reliability of simulation tools for informing architectural decision-making. Recent advancements integrate machine learning algorithms to capture non-linear dynamics between urban form and thermal behavior, further refining model accuracy and interpretability [24], [25]. These techniques facilitate a nuanced understanding of how urban geometry affects pedestrian-level sun exposure and ventilation [16], [26].

Contemporary research has moved beyond single-variable studies toward multidimensional analyses that reflect the interaction of multiple urban design factors. By embedding meteorological data into three-dimensional parametric models, simulations can replicate real-time thermal environments across diverse urban morphologies, from dense commercial zones to low-rise residential areas [27]. This allows for dual-scale evaluations, for example, assessing the cooling benefits of courtyards in winter or the advantages of larger setbacks during summer. These methods emphasize the integration of thermal comfort considerations into early urban design processes, linking spatial planning with environmental performance and energy efficiency [6].
This study adopts Autodesk Forma as the primary simulation platform. As a cloud-based, AI-supported design environment, Autodesk Forma enables early-stage environmental assessments and spatial planning within a Building Information Modeling (BIM) framework. Its application in architectural research has grown, especially for analyzing how modifications in form and layout impact urban microclimates.

In their work on Local Climate Zones and morphological thresholds, Silva & Ferraz (2024) employed Autodesk Forma to simulate various land-use patterns, showing how spatial and vegetative interventions can significantly reduce air temperatures [28]. Similarly, Kurniawan et al. demonstrated how Autodesk Forma was used in an integrated design approach for the IKN Nusantara project, allowing designers to visualize and assess multiple design strategies rapidly [29]. By enabling precise modeling of massing and façade characteristics, Autodesk Forma facilitated iterative evaluation of energy and thermal performance.

One of Autodesk Forma's strengths lies in its ability to simulate complex urban conditions, including solar radiation, wind dynamics, and heat retention. This capability allows designers to explore and optimize various geometric configurations, such as building orientation and spacing, for improved outdoor thermal comfort. When used alongside parametric tools or machine learning algorithms, simulation data from Forma can support high-resolution urban-scale thermal analyses.

This study used three massing models to represent different building width-to-length ratios: Model A (1:1), Model B (1:2), and Model C (1:3), as shown in Figure 1. Each model maintained a consistent building height of 30 meters (equivalent to five stories) and a footprint of 900 m². The models were differentiated by variations in frontal and lateral spacing, 15 m, 30 m, and 45 m for the former; 0 m, 15 m, and 30 m for the latter, resulting in configurations resembling urban canyons. Orientation was inherently addressed through corridor alignment.

The simulation examined surface temperature, sun hours, and daylight potential as key dependent variables, representing environmental performance and outdoor thermal comfort. These metrics were evaluated under the specific climatic conditions of central Malang, East Java, Indonesia. Simulations were conducted for two distinct time intervals 10:00 a.m. and 2:00 p.m. to account for diurnal temperature fluctuations and pedestrian-level microclimatic dynamics.

A descriptive comparative method was employed to analyze and contrast results across all simulation scenarios. The output was visualized using Autodesk Forma's built-in tools, including heat maps and tabular data, to illustrate the spatial distribution of thermal variables. These visualizations facilitated the identification of thermal performance trends under different morphological configurations, particularly within a tropical humid context.

This study employs Autodesk Forma not only for its capacity to simulate solar exposure and thermal conditions but also to demonstrate its practical applicability for architects and designers during early massing studies. Unlike advanced research-oriented tools such as ENVI-met or CFD, which are often complex and primarily used in academic contexts, Autodesk Forma is freely accessible and user-friendly, making it suitable for practitioners. By utilizing this platform, the study highlights how simple simulations can guide architects toward climate-responsive design decisions at the initial stages of building and site planning.

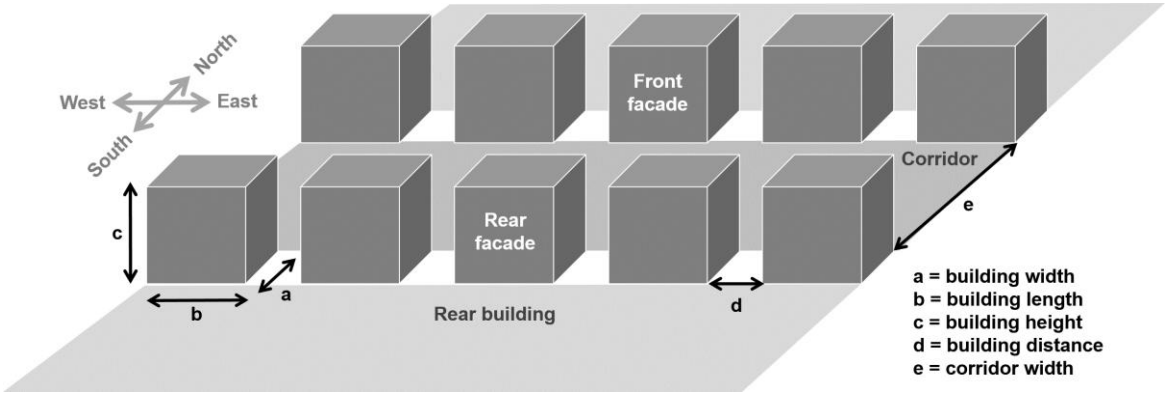

Figure 1. Urban Canyon and Building Configuration Simulation Model

3. RESULTS

This study investigates the microclimatic performance of various building configurations by simulating 27 combinations of width-to-length ratios, corridor widths, and side spacings using Autodesk Forma. These configurations were evaluated under tropical conditions for their influence on surface temperature, solar exposure, and daylight potential. Results were obtained through standardized simulations at two time points: 10:00 a.m. and 2:00 p.m. (Figure 2), representing morning and afternoon peak heating periods. This section presents key findings structured into five themes. Together, these findings aim to inform passive design strategies that enhance urban livability in dense tropical environments.

3.1. Impact of Building Width-to-Length Ratio

The ratio between a building's width and length substantially affects how sunlight is distributed across urban canyon surfaces. Models with elongated proportions (1:3) recorded lower surface temperatures, especially during the morning period. For instance, Model C3.1, with a 1:3 ratio, showed corridor temperatures of 33°C at 10:00 a.m., while a compact 1:1 configuration like Model A1.1 maintained higher readings at 34°C. Elongated buildings offer longer façades and deeper canyons that enable solar exposure to be staggered throughout the day, reducing radiant concentration. This phenomenon has been recognized in previous studies emphasizing that form influences solar irradiance and air ventilation within canyons [22]. More rectangular layouts allow for improved airflow, especially when combined with effective corridor spacing, which helps dissipate accumulated heat. Conversely, compact forms (1:1) create tightly enclosed spaces that retain more heat, particularly during afternoon hours.

3.2. Influence of Corridor Width and Side Spacing

Corridor width and building side spacing are significant modifiers of thermal performance. Narrow corridors (15 m) provided enhanced shading from adjacent buildings, reducing direct solar penetration and contributing to lower corridor temperatures. For example, Models with 15 m corridors and 30 m spacing (e.g., C3.1) consistently produced morning temperatures 1°C cooler than their 45 m counterparts (e.g., C3.3). This finding supports previous claims that while wider corridors can facilitate airflow, they also expose more surfaces to sunlight, especially when paired with minimal side spacing [30], [31]. In terms of side spacing, configurations with 30 m gaps yielded rear façade temperatures 1°C lower than zero-spacing cases. This effect

stems from enhanced air movement and reduced surface-to-surface radiant exchange, as supported by [32], [33].

3.3. Diurnal Variations in Surface Temperature

A consistent trend across all configurations was a rise in surface temperature from morning to afternoon. Rear façade temperatures often increased slightly more than those of the corridor, indicating differential heat retention. For example, Model C2.1 showed an increase from 33°C to 34°C in corridor temperature and from 35°C to 36°C in rear façade temperature between 10:00 a.m. and 2:00 p.m. These diurnal dynamics underscore the importance of building geometry and orientation. Although orientation was held constant in this study, geometric variation alone created notable differences in thermal behavior. Prior research emphasizes that urban blocks with reduced sky view factors (SVF) tend to trap heat more intensely, particularly in the afternoon [34], [35].

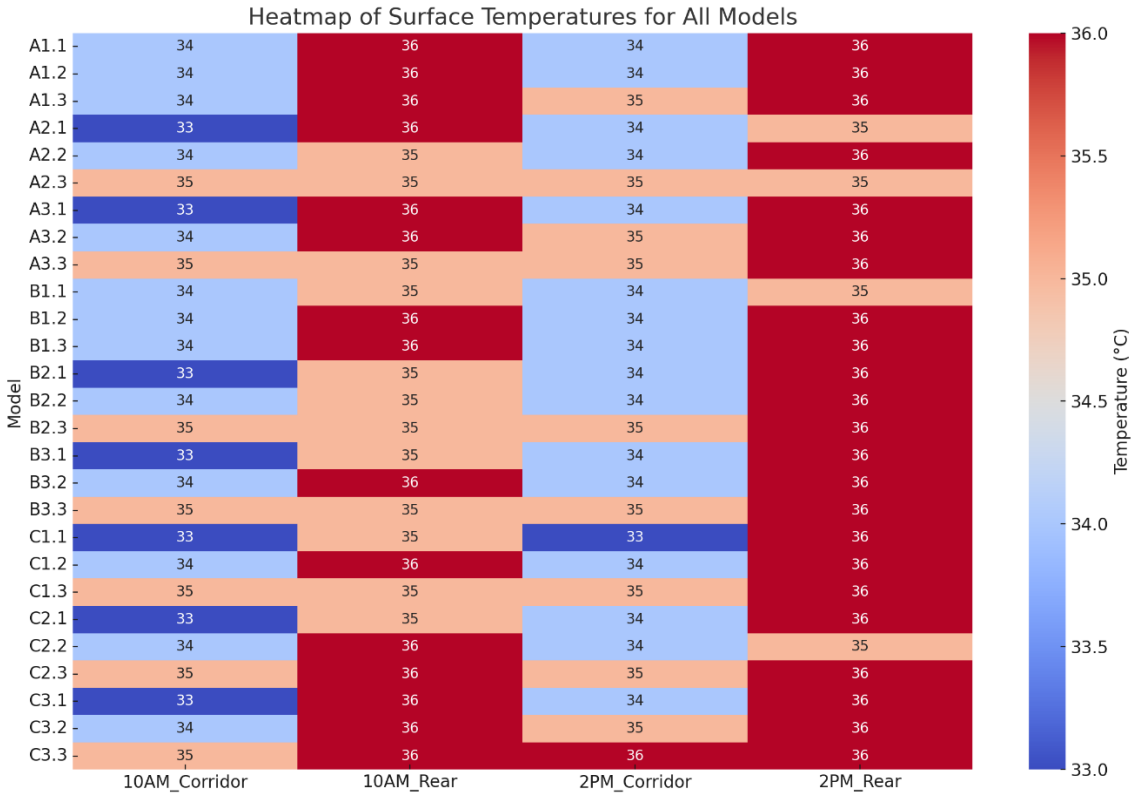

Figure 2. Surface Temperature for All Models at 10:00 a.m. and 02:00 p.m.

3.4. Identification of Optimal Configuration

Among all models, C3.1, combining an elongated form (1:3), narrow corridor (15 m), and wide side spacing (30 m) delivered the most balanced thermal performance. This model achieved 33°C in the morning and only 34°C in the afternoon in corridor zones, with rear façades peaking at 36°C. The cooling efficiency of this configuration lies in its spatial porosity and vertical shading. Narrow corridors maximize shadowing, while wide lateral gaps enhance airflow. These findings reinforce recommendations from previous studies suggesting that integrated manipulation of width-to-length ratios and spacing yields the best thermal outcomes [22], [36].

3.5. Daylight Potential and Sun Hours Analysis

Daylight simulations highlighted the trade-off between spatial compactness and solar access (Figure 3). Compact configurations (e.g., Model A1) yielded the highest daylight performance, with over 60% of surfaces scoring above 37 in daylight potential. However, they also exhibited extreme sun hour polarization, with a large share of surfaces receiving either minimal or excessive sunlight. To visualize these differences, Figure 4 presents the total surface area exposed to various durations of direct sunlight, revealing the dominance of either very short or very long exposure in compact models. Figure 5 complements this by showing the percentage distribution of sun exposure per model, helping identify configurations that achieve more even sunlight access. Finally, Figure 6 compares the performance of all models across three key exposure categories:

low (0–1 hours), optimal (3–6 hours), and high (9+ hours), offering a clear benchmark for evaluating sunlight accessibility. Models such as B2 and C2, which featured moderate corridor width (30 m) and side spacing (15 m), demonstrated more balanced solar exposure profiles. These results align with research by [2], who found that geometric moderation improves daylight quality while avoiding overheating. Furthermore, Huang et al. (2021) stress that an optimal corridor width provides a beneficial compromise between shading and visibility of the sky dome [25]. Across all models, configurations with greater spacing generally shifted sunlight exposure towards intermediate durations, improving daylight quality without compromising thermal comfort. Models B3 and C3 confirmed this by achieving consistent daylight scores and avoiding extremes seen in more compact alternatives.

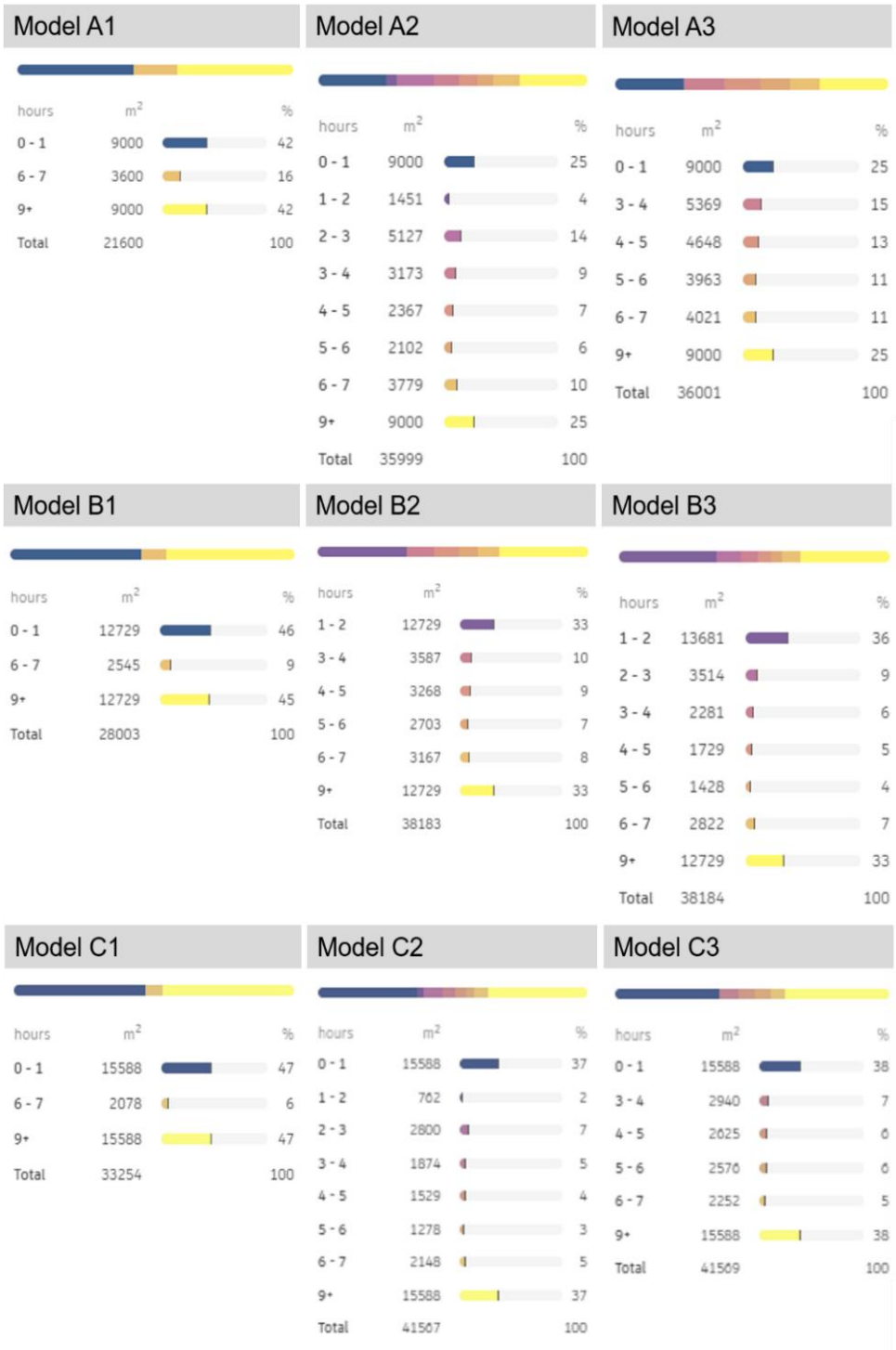

Figure 3. Sun Hours Simulation Results

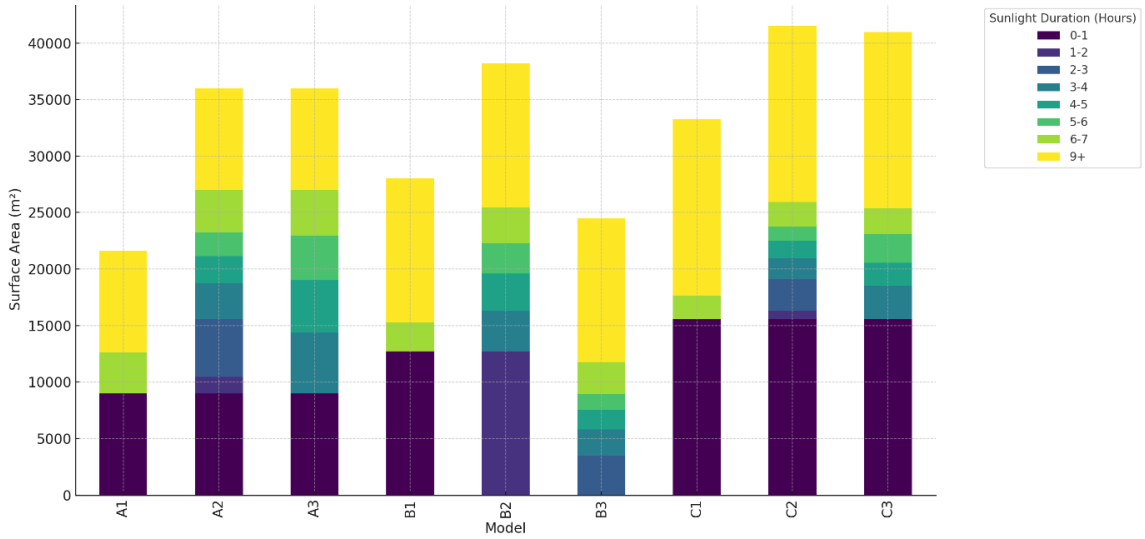

Figure 4. Distribution of Sunlight Duration Across Building Models

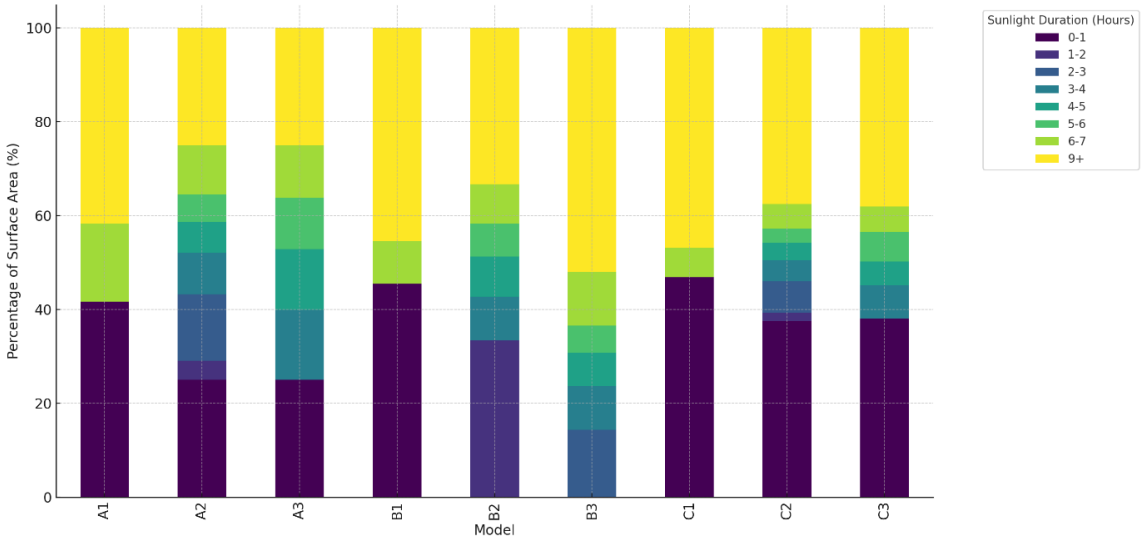

Figure 5. Percentage Distribution of Sunlight Duration per Model

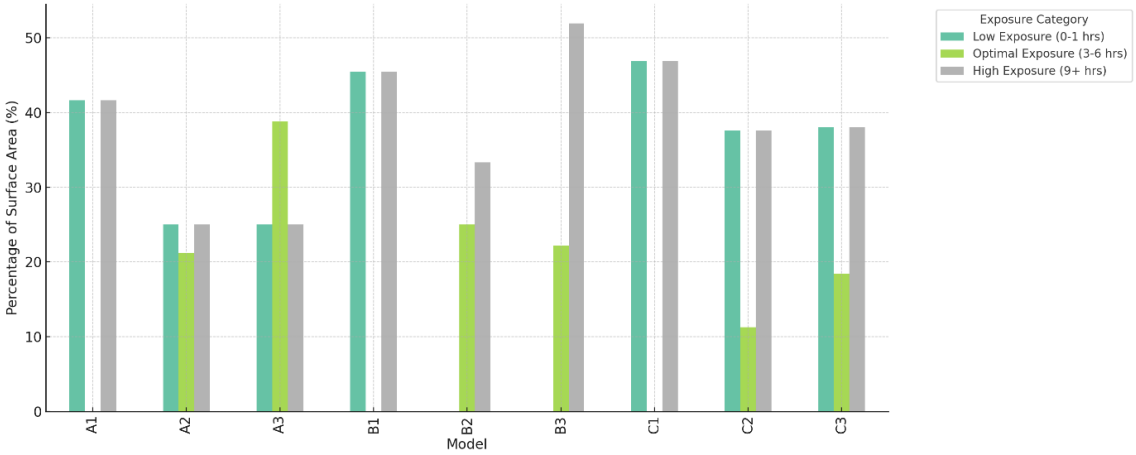

Figure 6. Sunlight Exposure Performance Comparison Across Models

This analysis confirms that geometry alone, even without material or vegetation interventions, has a significant influence on urban canyon microclimates. Key takeaways include:

1. Elongated buildings perform better in dissipating heat.
2. Narrow corridors enhance shading but must be paired with lateral spacing for ventilation.
3. Spatial permeability improves both thermal and daylight performance.
4. Model C3.1 offers the best overall configuration for hot, humid urban contexts.

These results form the empirical basis for the subsequent discussion, which will explore the theoretical, practical, and policy implications of these findings.

4. DISCUSSION

This study set out to explore how variations in urban canyon configurations influence microclimatic performance in dense tropical environments. By simulating 27 geometric arrangements using Autodesk Forma, the research offers evidence-based insights into how building form, corridor width, and side spacing interact to shape surface temperatures and daylight access. As reflected in the article's objectives, this discussion highlights the simulation's role in informing design strategies that contribute to thermal comfort and urban sustainability.

4.1. Geometrical Influence on Microclimatic Dynamics

Urban canyons are defined by the spatial interplay between buildings and the voids they frame. The results demonstrated that elongated building forms (1:3 width-to-length ratio) consistently achieved better thermal outcomes than compact (1:1) forms. These configurations distribute solar exposure across longer façades, reducing localized heat accumulation and enhancing airflow, both of which are critical for tropical cities where overheating is prevalent [22]. The thermal efficiency of elongated forms affirms that sustainable urban design is not solely dependent on materiality or vegetation, but can also be achieved through deliberate shaping of built form. This supports the broader agenda of urban sustainability by promoting passive cooling solutions that reduce energy demand for mechanical ventilation [37].

4.2. The Role of Corridor Width and Side Spacing in Urban Canyon Design

Corridor width and side spacing emerged as key spatial parameters with direct influence on thermal behavior. Narrow corridors (15 m), especially when paired with 30 m side spacing, yielded the lowest surface temperatures during morning and afternoon simulations. These findings counter conventional assumptions that wider spaces always improve ventilation and comfort [30]. Instead, the interaction of narrow, shaded corridors and well-ventilated lateral gaps proved most effective. As highlighted by [31], building shade can be just as crucial as air movement in mitigating heat. Additionally, studies by [32], [33] confirm that increased spacing improves the SVF, facilitating radiative cooling and better convective airflow. These findings have major implications for early-stage design in tropical cities, where land pressure often encourages compactness at the expense of thermal comfort.

4.3. Heat Retention and Temporal Microclimate Dynamics

The consistent increase in surface temperatures from 10:00 a.m. to 2:00 p.m. across all models illustrates typical diurnal heat accumulation patterns in urban environments. However, the rate of increase varied significantly by configuration. Models with greater spatial permeability, especially Model C3.1 which exhibited more moderate thermal fluctuations. In contrast, compact, tightly spaced models retained more heat, particularly at rear façades. This aligns with findings by Bajšanski et al. (2019) and Roslan et al. (2018), who reported that low SVF and restricted airflow limit the ability of surfaces to release absorbed heat [34], [35]. These temporal behaviors reinforce the need for designers to anticipate not just peak-hour conditions, but the thermal lag and retention characteristics of different urban canyon forms. Such insights are critical for sustainable tropical urbanism, where 24-hour comfort can reduce the need for energy-intensive cooling systems and improve livability. Incorporating these principles during the design phase contributes directly to the sustainability goals outlined in the article's title.

4.4. Thermal and Daylight Trade-offs in Canyon Configurations

A central tension in urban canyon design is balancing shading (which reduces heat) with daylighting (which reduces energy use for lighting). The study found that compact forms like Model A1 delivered high daylight scores but also experienced extreme sunlight exposure disparities. Conversely, configurations like B2 and C2 showed more balanced solar exposure without substantial losses in daylight potential. These results

echo the observations of Wu and Liu (2023), who noted that daylight access and thermal comfort are often in conflict within dense urban morphology [2]. Huang et al. further emphasized that corridor width modulates both sun hours and daylight scores [25]. As such, designers must calibrate massing and spacing to mediate these competing priorities. In the context of *design practice*, this trade-off becomes a crucial parameter. Instead of relying on aesthetic or density-driven templates, simulation tools like Autodesk Forma enable data-informed decisions that harmonize light, heat, and space, which are key features of sustainable tropical design.

4.5. Performance Validation of the Optimal Scenario (Model C3.1)

An elongated block with 15 m corridor width and 30 m side spacing of model C3.1 emerged as the most efficient configuration in balancing thermal and daylight performance. Its ability to maintain corridor temperatures of 33–34°C while achieving moderate daylight levels makes it a compelling model for tropical cities aiming to reduce energy use without compromising comfort. This finding validates theoretical frameworks that advocate for integrated form-based solutions. Studies by Khraiwesh & Genovese (2023), Devi et al. (2023), and Xu et al. (2019) argue that geometry can serve as a passive regulatory mechanism in climate-responsive urbanism [22][36][38]. By aligning these findings with practical simulation outputs, the research bridges theoretical knowledge with design application.

4.6. Implications for Design Practice Using Autodesk Forma

The integration of Autodesk Forma in this study exemplifies how simulation tools can inform early design decisions. Compared to more complex and time-consuming platforms like ENVI-met or CFD software, Forma offers a balance of usability and environmental accuracy, suitable for iterative design evaluations. Rodrigues Silva & Barbosa Ferraz (2024) and Kurniawan et al. (2024) highlight the role of such platforms in democratizing environmental modeling, especially for practitioners without access to high-performance computing [28], [29] In this study, Forma was used to visualize and quantify subtle differences in thermal behavior and lighting exposure across building layouts, enabling designers to explore “what-if” scenarios before physical construction begins. This approach directly supports the article’s objective of using simulation for design practice, and positions Forma as a practical tool for architects and planners addressing urban heat in tropical regions.

4.7. Contribution to Sustainable Tropical Urbanism

By demonstrating how basic form manipulation can significantly alter microclimatic outcomes, this study offers a scalable, cost-effective strategy for tropical urban sustainability. Rather than relying on post-occupancy solutions (e.g., mechanical cooling or retrofitted shading), the research advocates for proactive geometric calibration in the planning phase. This aligns with the broader literature that calls for climate-responsive planning rooted in morphological logic [18], [37]. As cities in the tropics grow denser and hotter, the need for integrated, low-tech solutions becomes ever more urgent. Moreover, the emphasis on configuration over construction materials allows these insights to be applied in resource-constrained settings, making the research both globally relevant and locally actionable.

4.8. Limitations and Directions for Further Research

While the study successfully isolates geometric influences, it does not account for material reflectivity, wind dynamics, or vegetation, which also shape microclimates. Future research should include these variables and test configurations in multiple tropical cities with varying urban densities and cultural contexts. Field validation through in-situ data collection could further strengthen the applicability of these findings. Additionally, integrating human comfort indices such as PET or UTCI would extend the environmental data into experiential metrics.

This discussion reinforces the core message of the article: urban canyon configurations are a vital determinant of environmental quality in tropical cities. Through simulation-driven design practice, designers can optimize building forms not just for density or aesthetics, but for thermal comfort, daylighting, and sustainability. The results affirm that sustainable tropical urbanism can be achieved through spatial intelligence, particularly when tools like Autodesk Forma are embedded early in the design process. As exemplified by Model C3.1, small adjustments in geometry yield significant benefits, providing a replicable strategy for cities facing the compounded challenges of heat, density, and limited resources.

5. CONCLUSION

This study aimed to examine how variations in urban canyon geometry namely building width-to-length ratio, corridor width, and side spacing, which affect surface temperature and daylight potential in tropical urban settings. Simulation results revealed that the most thermally comfortable configuration featured an

elongated building form (1:3), a narrow corridor (15 m), and wide lateral spacing (30 m), achieving corridor surface temperatures as low as 33°C and daylight scores up to 66% in the highest category. Conversely, dense layouts with minimal spacing produced higher surface temperatures, up to 36°C, and reduced daylight performance. Models such as C3.1 consistently demonstrated superior microclimatic outcomes across both thermal and lighting metrics. These findings underscore the critical role of spatial permeability and form orientation in enhancing urban environmental quality. The study's use of 27 massing configurations enabled a comprehensive evaluation of interaction effects between massing and spacing, offering a robust comparative framework. Importantly, Autodesk Forma was employed not only for its capacity to simulate solar exposure and thermal conditions but also to demonstrate its practical applicability for architects and designers during early massing studies. Unlike complex research-oriented tools such as ENVI-met or CFD, Autodesk Forma is free, accessible, and user-friendly, making it suitable for practitioners. By leveraging this platform, the study highlights how simple simulations can guide architects toward climate-responsive design decisions at the initial stages of building and site planning.

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Architecture and Sustainability Pathways for Rural Development in Indonesia

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ABSTRACT

Rural landscapes in Indonesia reflect the coexistence of strong agrarian traditions and the pressing need for sustainable development, requiring approaches that integrate ecological, spatial, and socio-economic systems. Ciambar District in Sukabumi Regency, West Java, serves as a representative case study, characterized by agricultural activities such as rice, cassava, and durian cultivation, extensive forest areas, and ecotourism potential, including Curug Luhur Waterfall. Despite these assets, the district faces persistent challenges, including inadequate infrastructure, unequal access to clean water, and heavy reliance on small-scale agriculture. From the perspective of architectural sustainability, Ciambar must be re-envisioned as an integrated landscape of productive, ecological, and social spaces. Approaches such as productive landscapes, ecological infrastructure, and low-impact ecotourism demonstrate how spatial and architectural interventions can simultaneously support livelihoods, conserve ecosystems, and enhance local resilience. This study aims to identify, analyze, and map the potentials of Ciambar District based on natural resources, human capital, and local governance capacity. The findings are expected to provide a comprehensive assessment of existing strengths and opportunities, along with strategic recommendations for sustainable environmental development that supports the local economy while aligning with broader sustainability frameworks.

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1. INTRODUCTION

Rural landscapes in Indonesia reflect both the persistence of traditional agrarian practices and the urgent need for sustainable development amid rapid socio-economic transitions. The concept of rural itself is tied to a low density area where the social hierarchy and roles, such as gender, religion, race, ethnicity, and class, which are often overlooked in rural development conversations [1]. Ciambar District, located in Sukabumi Regency, West Java, offers a critical case study in this discourse. Situated at an altitude of approximately 700 meters above sea level and covering 3,820 hectares, the district's spatial and socio-economic structure is dominated by rice fields, cassava and durian plantations, and extensive forest areas. These resources are complemented by ecotourism attractions such as Curug Luhur waterfall, which holds potential to diversify livelihoods through nature based tourism. Despite this wealth of resources, Ciambar faces persistent challenges

including infrastructure deficits, inequitable access to clean water, and economic dependency on small-scale agriculture. These issues situate Ciambar as a representative case of rural Indonesia, where natural endowments coexist with systemic vulnerabilities, thereby demanding an integrated approach that merges architectural landscape planning, sustainability frameworks, and socio-economic empowerment [2]. This study aims to identify, analyze, and map the potential of Ciambar District, based on natural resources, human resources, and the authority of the local government. The study is expected to provide a comprehensive discussion of existing strengths and opportunities, as well as deliver targeted recommendations for sustainable environmental development that will enhance the economic sector.

Several aspects will be the focus of this study, including agricultural potential, plantation potential, tourism potential, creative industry potential, and human resource potential that can support regional development. The local government uses local economic development to discover and capitalize on the region's potential, increasing community welfare while promoting regional growth, particularly in rural areas that are mostly dominated by agricultural operations [3]. Through a holistic and data-driven approach, particularly using secondary data, this study is expected to make a tangible contribution to the local government and other stakeholders in formulating policies and development strategies for Sukabumi Regency.

In rural settings, architecture extends beyond the construction of buildings to encompass landscapes, infrastructures, and spatial systems that mediate interactions between people and the environment. Sustainable architectural discourse emphasizes ecological sensitivity, adaptive design, and socio-economic resilience as interdependent components of development [2]. This study adopts that perspective, positing that Ciambar's future development hinges on reconceptualizing its agricultural, ecological, and social spaces as interconnected systems. Such integration is particularly salient as agriculture remains the backbone of the local economy, yet diversification into ecotourism and small-scale industries has become increasingly essential to strengthen livelihoods. The adaptive capacity of local communities is both distinctive and multifaceted, serving as a bridge between conservation efforts and the sustainable utilization of ecosystem services. Spatial design can be used to mediate buildings and communities, as it facilitates community involvement and a feeling of belonging [4]. When communities are actively engaged in co-management and co-production processes, their participation strengthens socio-ecological resilience, thereby supporting the long-term availability of resources for ecotourism as well as food systems and agroecosystems. In creative placemaking, community participation is often regarded as a mandatory tool in changing community perception towards the development of a place [5]. Moreover, socio-ecological resilience plays a pivotal role in ensuring the sustainability of ecotourism [6].

The global policy framework of the United Nations' Sustainable Development Goals (SDGs) provides an analytical lens for situating Ciambar's developmental trajectory. Among the 17 SDGs, three are especially relevant to Ciambar: SDG 8 on decent work and economic growth, SDG 11 on sustainable cities and communities, and SDG 13 on climate action. Aligning local strategies with these global targets ensures that Ciambar's development contributes not only to regional prosperity but also to broader sustainability agendas [7], [8]. Against this backdrop, the objective of this study is to identify, analyze, and map the district's potentials and challenges through the lens of architecture and sustainability, while formulating recommendations that reinforce local strengths and address existing gaps.

The relationship between architecture and sustainability has been the subject of considerable scholarly debate over the last two decades. Sustainable architecture is increasingly defined not only by its technical efficiency but also by its ability to embed ecological and socio-economic resilience within spatial systems [2]. Sustainable architectural principles are applied to the development of an urban area, which automatically fulfills the needs of creating a healthy city [9]. Scholars emphasize that sustainability in rural settings requires integrating ecological design principles into landscapes, infrastructure, and settlements, thereby producing spatial configurations that are adaptive and regenerative rather than extractive [10], [11].

Architecture in rural contexts often functions at the scale of landscapes rather than isolated buildings. Productive landscapes agricultural spaces that combine food production, ecological services, and social uses are considered central to sustainable rural development [12]. These landscapes align with the idea of multifunctionality, where agriculture contributes simultaneously to livelihoods, biodiversity conservation, and cultural identity. Furthermore, architectural approaches to rural infrastructure increasingly emphasize "green infrastructure," defined as interconnected networks of natural and semi-natural systems that deliver ecosystem services while supporting human needs [8].

Rural development literature highlights the necessity of embedding sustainability principles in economic diversification, community participation, and environmental management [13]. In Indonesia, rural economies remain predominantly agricultural, but the volatility of commodity markets and environmental degradation pose risks to long-term viability. Diversification into ecotourism and small-scale enterprises has been identified as a critical pathway to enhance resilience [14], provided that such strategies are anchored in community empowerment and ecological conservation.

Participatory approaches have been increasingly acknowledged in both sustainability science and architectural practice as essential for ensuring the legitimacy and effectiveness of interventions [11]. Studies demonstrate that rural communities are more likely to embrace sustainability initiatives when they are involved in the design, planning, and management of spaces [15]. For Ciambar, integrating participatory mapping with architectural landscape analysis provides an avenue for reconciling top-down planning with bottom-up knowledge, creating outcomes that are both spatially coherent and socially relevant.

The SDGs serve as a unifying framework for linking local rural development with global sustainability objectives. Empirical studies in Southeast Asia show that aligning rural development strategies with SDG targets can enhance resilience, particularly when interventions address employment, infrastructure, and ecological conservation in tandem [13]. In the context of Ciambar, this alignment underscores the potential of architecture and sustainability approaches to serve as mediating frameworks between global policy and local realities.

2. METHOD

This study employed a descriptive-analytical study design that integrates spatial observation, participatory mapping, and secondary data analysis. The rationale for using a descriptive analytical approach lies in its ability to synthesize empirical field observations with theoretical frameworks of architecture and sustainability, thereby producing a holistic understanding of Ciambar's potentials and constraints. Fieldwork was conducted across key sectors of Ciambar's landscape, including agricultural fields, plantation areas, forest ecosystems, ecotourism sites, and community infrastructure. Observational data were systematically recorded with respect to land-use patterns, the physical condition of built and natural environments, and infrastructural systems such as road connectivity, water distribution networks, sanitation, and public facilities. This approach is consistent with established practices in landscape architecture study, where spatial analysis is grounded in empirical field data [10].

A participatory mapping component was incorporated to ensure the inclusion of local knowledge and aspirations. Participatory mapping in rural areas, especially done by locals, provides a more relevant data that will in turn be a more contextual and usable resource [16]. This was operationalized through focus group discussions with residents, interviews with community leaders, and consultations with district officials. Participatory approaches are increasingly emphasized in sustainable architecture and planning as they facilitate shared ownership and enhance the cultural legitimacy of proposed designs [11]. Data triangulation was achieved by comparing field observations, spatial analysis, and stakeholder narratives, thereby strengthening the validity of findings.

3. RESULTS AND DISCUSSION

The analysis revealed that Ciambar District embodies both significant potentials and structural challenges, positioning it as a landscape of opportunities constrained by systemic limitations.

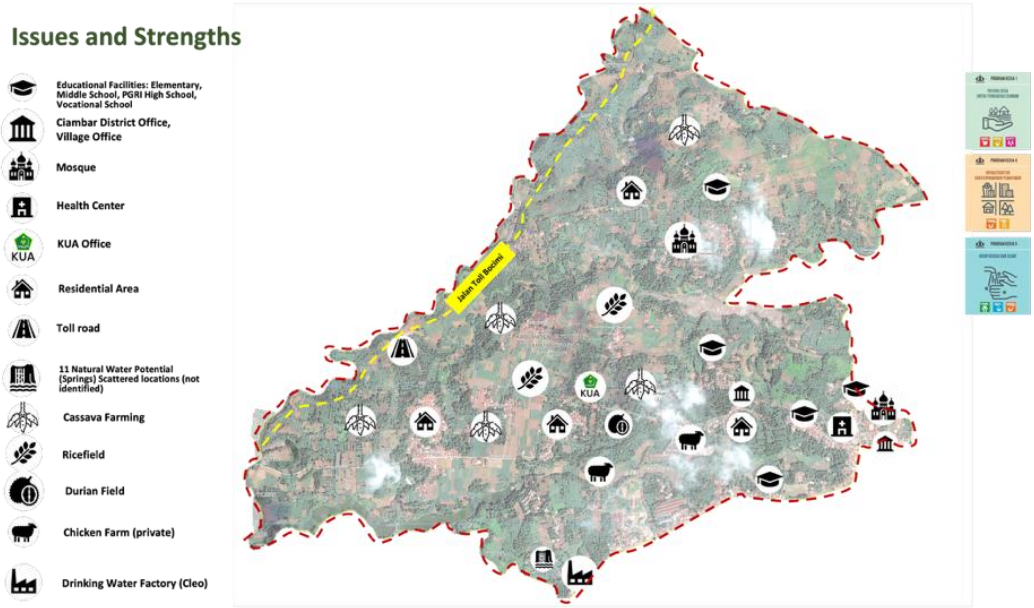

Figure 1. Mapping Strengths and Issues in Ciambar District

Agriculture emerged as the dominant sector, with rice, cassava, and durian plantations forming the foundation of household livelihoods. Cassava, in particular, plays a strategic role in the local economy, not only as a subsistence crop but also as a raw material for micro, small, and medium enterprises (MSMEs). Products such as modified cassava flour (mocaf), kecimpring, and opak are increasingly integrated into local value chains. However, the growth of these enterprises is constrained by inadequate access to hygienic production spaces, limited financial capital, and insufficient capacity in digital marketing platforms. Similar patterns of constrained agribusiness development have been observed across rural Indonesia, where infrastructural deficits undermine the potential of agricultural value chains.

The presence of Curug Luhur waterfall and surrounding forest ecosystems represents a strong potential for ecotourism. The area's natural assets could be developed through eco-architectural interventions such as environmentally sensitive trails, community-managed visitor facilities, and interpretive signage. Empirical studies from other Indonesian regions demonstrate that ecotourism, when coupled with ecological architecture, can enhance rural livelihoods while safeguarding biodiversity. Nonetheless, infrastructural barriers such as poor road conditions and the lack of accommodation facilities limit the viability of expanding ecotourism. Without careful spatial planning, there is also a risk that tourism development could exacerbate ecological degradation rather than contribute to sustainability [8].

Ciambar possesses 11 natural springs that could potentially provide sustainable sources of water for households and agricultural irrigation. However, several of these springs are under private control, resulting in inequitable distribution. Approximately 20 households were documented as lacking access to clean water, while 90 households continue to rely on communal sanitation facilities. These deficiencies compromise public health and hinder the growth of MSMEs that depend on hygienic processing environments. Studies have shown that inadequate access to water and sanitation is a persistent constraint on rural development across Southeast Asia [13].

Infrastructure, which in rural Indonesia has not experienced significant development in the last 20 years [17], emerged as the most significant limiting factor. Many inter-village road connections remain unpaved, restricting the mobility of residents and the transportation of agricultural products. This infrastructural weakness not only reduces market accessibility but also hampers the district's ability to attract tourists. Similarly, access to basic services such as healthcare and education remains uneven, further constraining socio-economic mobility. These findings align with broader studies indicating that infrastructural deficits are among the most critical barriers to sustainable rural development.

The findings of this study highlight the importance of reimagining Ciambar District through the lens of architecture and sustainability. In architectural terms, the district is not merely a collection of agricultural fields, forests, and settlements, but rather a dynamic landscape of interconnected productive, ecological, and social spaces. Sustainable architecture provides a framework to design and manage these relationships so that they enhance both resilience and functionality [2], [10].

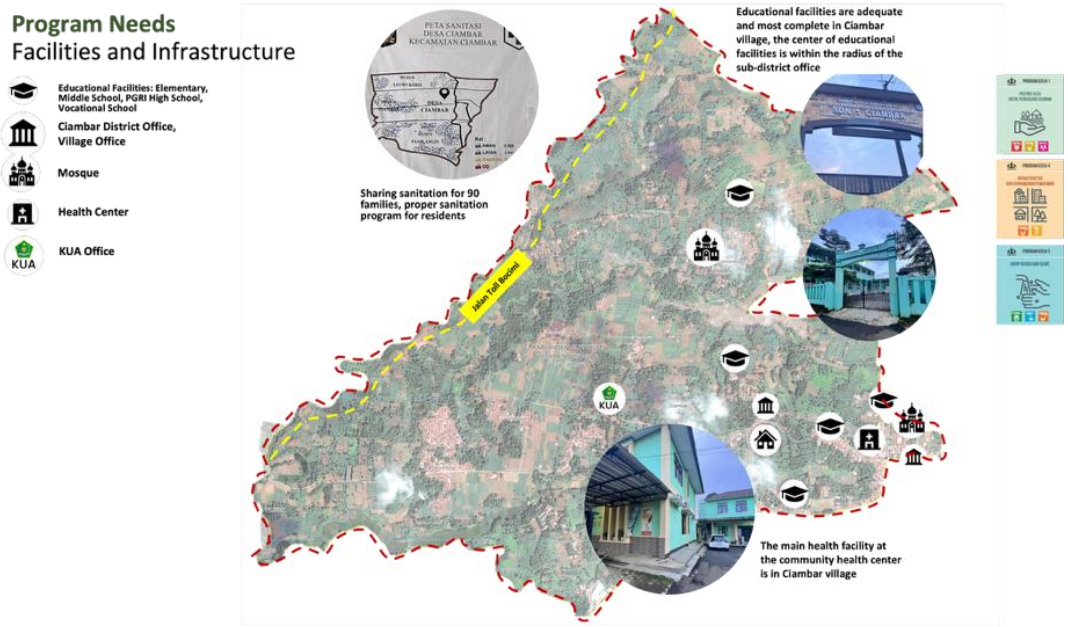

Figure 2. Program Needs in Ciambar District

One of the central arguments in the discourse of sustainable architecture is the notion of productive landscapes, that perform multiple ecological, economic, and social functions simultaneously [12]. For Ciambar, this means that cassava and durian plantations should not be regarded only as economic assets but also as potential educational and tourism spaces. Farm based education programs could introduce principles of agroecology to schoolchildren, while architectural interventions such as multi-purpose pavilions could integrate food processing, community gatherings, and visitor experiences. This multifunctional approach aligns with global calls to integrate food systems, ecological services, and social infrastructures in rural design [18].

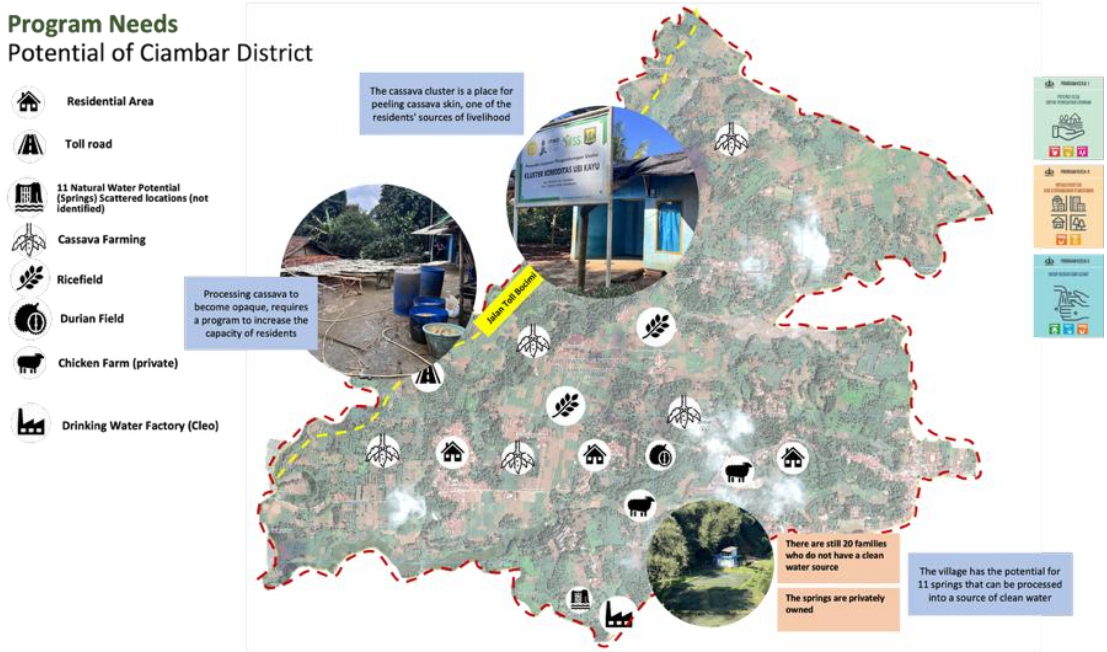

Figure 3. Mapping Strengths based on Program Needs in Ciambar District

Ecotourism development in Ciambar, particularly around Curug Luhur, illustrates the potential of ecological architecture. By adopting low impact design strategies such as elevated walkways, local material construction, and renewable energy integration, visitor facilities could blend with the natural landscape while minimizing environmental degradation. Study on community based ecotourism in Bali and other parts of Indonesia demonstrates that such architectural approaches can yield significant socio-economic benefits without compromising ecological integrity. Importantly, community participation in both design and management must be emphasized, since ecotourism that marginalizes local stakeholders often results in inequitable outcomes [11].

Infrastructure deficiencies in Ciambar must also be reframed through the perspective of green infrastructure. Rather than treating infrastructure as purely technical systems, sustainable design approaches emphasize its multifunctionality. Roads, for instance, could be designed as ecological corridors that integrate drainage channels, green strips, and pedestrian pathways. This is consistent with contemporary scholarship that frames green infrastructure as a means to enhance resilience, biodiversity, and human well-being simultaneously [8]. For Ciambar, such a reorientation could address mobility constraints while strengthening ecological connectivity.

Table 1. Summary of Spatial Issues, Potentials, and Development Needs in Ciambar District

Sector	Key Issues	Existing Strengths / Potentials	Identified Program Needs
Livelihood and Local Economy	Cassava processing remains traditional with low added value and limited production capacity among residents.	A cassava commodity cluster exists and serves as one of the main sources of livelihood for the community.	Capacity-building programs are needed to improve cassava processing techniques and develop value-added agro-industrial products.

Water Resources and Clean Water Access	Around 20 households do not have access to clean water due to limited communal infrastructure and private ownership of springs.	The village possesses 11 natural springs with strong potential to be developed as clean water sources.	Community-based clean water infrastructure and shared water resource management systems are required.
Sanitation	Approximately 90 households still rely on shared sanitation facilities.	Basic sanitation infrastructure is already available in several parts of the village.	Household-scale sanitation improvement and hygiene awareness programs are necessary.
Education Facilities	Educational facilities are unevenly distributed across the district.	Ciambar Village functions as the educational center with relatively complete facilities within the sub-district service radius.	Improved accessibility and supporting facilities are needed for residents in peripheral areas.
Health Facilities	Health services are concentrated in the village center, limiting access for outer areas.	The main community health center is located in Ciambar Village.	Expansion of health service coverage and improvement of supporting health infrastructure are required.
Infrastructure and Accessibility	Local road connectivity remains limited in certain areas.	The district benefits from strategic access through the Bocimi Toll Road.	Enhancement of local road networks is needed to support mobility and economic activities.
Institutional and Public Facilities	Public services remain centralized and require travel from remote settlements.	Key public and religious institutions are already established within the district.	Decentralization and strengthening of village-level public services are needed.
Agriculture and Natural Resources	Agricultural activities are dominated by primary production with limited diversification.	Fertile agricultural land and strong farming traditions characterize the district.	Sustainable agriculture and diversification programs are required to increase resilience and productivity.
Settlement and Housing	Housing quality varies across different settlement areas.	Rural settlement patterns show strong social cohesion and community structure.	Integrated housing improvement programs linked with sanitation and clean water provision are needed.

The role of architecture in supporting MSMEs also deserves emphasis. The design and provision of shared hygienic processing spaces could dramatically improve the quality and competitiveness of local products. These facilities should integrate ecological principles such as natural ventilation, energy efficiency, and modular adaptability. Architectural studies in Southeast Asia have shown that such catalytic spaces not only enhance production capacity but also foster social interaction and innovation within communities. By linking physical spaces with socio economic empowerment, architecture becomes a driver of local development.

The integration of Ciambar's potentials and challenges with the Sustainable Development Goals (SDGs) underscores the global relevance of local action. Efforts to diversify agriculture and strengthen MSMEs directly contribute to SDG 8 on decent work and economic growth. The reorganization of village spaces through ecological architecture supports SDG 11 on sustainable cities and communities. Conservation of forest and water resources, together with low-carbon tourism development, advances SDG 13 on climate action. This reinforces the argument that architecture and sustainability must be viewed as systemic interventions that bridge the local and global scales of development [13].

4. CONCLUSION

Ciambar District epitomizes the paradox of rural Indonesia: rich in natural and cultural resources but constrained by infrastructural and socio-economic vulnerabilities. This study has demonstrated that an architectural and sustainability perspective provides a valuable framework for reimagining the district's

development trajectory. By treating agricultural areas as multifunctional productive landscapes, developing ecotourism with ecological sensitivity, and rethinking infrastructure as green corridors, Ciambar can transition toward a sustainable rural model. The empowerment of MSMEs through architecturally designed shared facilities further highlights the intersection between space, economy, and society. Such interventions not only improve economic outcomes but also foster social cohesion and innovation, reinforcing the role of architecture as both a spatial and socio-economic catalyst.

The implications of this study extend in two directions. At the practical level, it offers spatially grounded strategies for policymakers and local communities, emphasizing the integration of ecological design, community participation, and sustainability principles. At the academic level, it contributes to the discourse on rural architecture and sustainable development by demonstrating how spatial analysis and participatory methods can inform transformative pathways in resource-rich but infrastructure-poor regions. Future study could expand this study through quantitative assessments of environmental impacts, exploration of financing mechanisms for sustainable infrastructure, and comparative analysis with other rural districts in Indonesia and Southeast Asia. Such work would deepen the understanding of how architecture and sustainability can be operationalized in diverse rural contexts. In conclusion, Ciambar District holds the potential to become a model of sustainable rural development where architecture transcends its conventional definition of buildings to encompass landscapes, infrastructures, and socio-economic systems. Through the integration of spatial design, ecological principles, and community empowerment, Ciambar could demonstrate a replicable framework for advancing rural resilience in Indonesia while contributing to global sustainability agendas. Sustainable economic development is an effort to improve the community's economic welfare without compromising the quality of the environment and available natural resources.

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Sustainable Landscape Study of Sindang Barang Cultural Village, Bogor Regency

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ABSTRACT

Sindang Barang Cultural Village is a local cultural settlement located in Tamansari District, Bogor Regency, covering an area of approximately 8,600 square meters. The village comprises 29 traditional Sundanese buildings and is characterized by a harmonious atmosphere and a community that strongly upholds inherited cultural traditions. Beyond its function as a cultural tourism destination, Sindang Barang serves as a living settlement where daily activities are closely intertwined with the preservation of Sundanese values passed down through generations. Its existence is crucial in the context of cultural conservation, as it provides a tangible example of the coexistence of traditional architecture, cultural practices, and environmental harmony. This study aims to examine the ecosystem conditions of Sindang Barang Cultural Village within the context of community life. A descriptive research method was employed, utilizing direct observation and literature review through general observations of the settlement. The findings indicate that Sindang Barang Cultural Village exhibits a distinct Sundanese residential landscape character, physically expressed through the form, layout, and continuity of traditional Sundanese architecture.

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1. INTRODUCTION

Indonesia is known as a country consisting of many islands, which has a wealth of traditions, culture, and customs of the people spread throughout the archipelago. Indigenous peoples are norms that have been held from generation to generation until now and are considered sacred by certain community groups. This sacredness is not only reflected in the belief in God Almighty, but also in efforts to maintain balance and harmony with their environment (nature). Culture in an area essentially influences the formation of residential environments. Community habits related to the surrounding environment are usually different from the culture of other communities, so that the arrangement of space in community settlements is greatly influenced by the outlook on life of the local population. Cultural landscapes describe the relationship between natural heritage and cultural heritage in a broad spatial unity and long time. Natural heritage includes natural forms such as mountains, mountain ranges, forests, lakes, and deserts. Meanwhile, cultural heritage is the result of human work in the form of traditions, beliefs, and lifestyles (Indonesian Heritage Conservation Charter, 2003). Cultural landscapes can be understood as a representation of community life in managing their environmental

systems, so that harmony with nature and the preservation of cultural identity are realized. The diversity of flora and fauna, their ecosystems, and cultural richness are potential and can serve as a basis for sustainable development (Wakyudi,2021).

Architecture in Indonesia is known as traditional or vernacular architecture which is created and developed by local communities based on the knowledge, culture, and traditions of the people in the area. Traditional architecture shows the relationship between humans and their history in the field of buildings and settlements. Traditional architecture reflects the cultural values, beliefs, and needs of the local community by utilizing materials from the surrounding environment and building techniques that have been taught from generation to generation. This is because tradition is the spirit of a culture and without tradition it is impossible for a culture to live and last (Artininggrum, 2012).

Traditional architecture is influenced by the location, culture, and function of the building. The differences in traditional buildings depend on the use of natural materials, unique decorations, and spatial arrangements that maintain the style of the past and the application of reuse methods in designing new buildings, so that the building can be considered as one of the manifestations of traditional architecture. Traditional architecture is the result of human work, creativity, spontaneity and emotion as one of the elements of human culture, as well as the interaction between the natural physical environment and the skills and abilities of society to form knowledge (Zain, 2014). The importance of preserving and understanding cultural heritage in the architectural design process to create buildings that reflect the identity and needs of the local community (Lake, 2016).

The cultural values of a community influence the evolution of traditional architecture that emerges from the living habits of its people. Traditional architecture is a building concept that emphasizes aspects of local traditions and culture. These aspects of local culture and tradition include factors such as location, weather, materials, culture, beliefs, and others. Settlements are one of the results of cultural landscapes. Cultural landscapes are the result of complex historical processes (Rapoport, 1992). Traditional settlements are one of the landscapes of the face and character of the site formed from the life activities of its people which are part or the total living environment of humans and other creatures. One type of landscape is a cultural landscape that is closely related to the cultural community that occupies the landscape (Lavrenova, 2019).

The development of culture-based vernacular architecture in its application is inseparable from aspects of curiosity, both from economic, social, and environmental aspects. However, vernacular architecture now faces the challenge of modernization. The current of modernization has the greatest influence on changes in the cultural landscape in Indonesia (Awalia et al., 2018; Nur et al., 2022). It is crucial to understand the various characteristics and assess the destruction of the formed cultural landscape, in order to minimize concerns about the cultural landscape (Hasibuan et al., 2017; Asrina et al., 2017; Lavrenova, 2019; Nasution et al., 2019). One cultural landscape significantly impacted by the current of modernization is the landscape of traditional indigenous community organizations (Chanet et al., 2022; Nur et al., 2022). Therefore, sustainable landscape studies are crucial as a culturally based architectural conservation approach in Indonesia. A relational approach has been applied to understand the sense of place inherent in traditional houses or settlements (Ahmet, 2013; Kidd and Evans, 2010; Lavrenova, 2019). The landscape character approach has also been studied to uncover and understand traditional settlement landscape patterns in various indigenous communities in Indonesia (Agustine and Gunawan, 2016; Hasibuan et al., 2017; Asrina et al., 2017; Istiqamah et al., 2020; Nur et al., 2022; Pratiwi et al., 2019). This approach is essential for determining local government policies in preserving traditional settlement landscapes, which are gradually undergoing changes in patterns, materials, and activities of indigenous communities. One of the traditional settlement landscapes that has a fairly large area is the traditional settlement landscape of the Sundanese people.

One of the traditional settlement objects of the Sundanese people is the Sindang Barang Cultural Village, a miniature local cultural object located in Tamansari District, Bogor Regency, with an area of 8,600 square meters. The Sindang Barang Cultural Village area contains 29 traditional Sundanese cultural buildings known for their beautiful atmosphere and the people who firmly maintain their traditions. This village is not only a tourist destination, but also a living space where people live their daily lives while maintaining Sundanese cultural values that have been passed down from generation to generation. As a miniature Sundanese cultural village, the existence of the Sindang Barang village is very important in the context of cultural preservation, because this village offers a real example of how architecture and culture can go hand in hand while maintaining natural harmony. Based on this background, it is necessary to conduct research on sustainable landscape studies with the aim of this study being to examine the sustainable landscape in the Sindang Barang Cultural Village, Bogor, an effort to find an approach to the preservation and conservation of nature and culture.

2. METHOD

The research location is in the Sindang Barang Cultural Village, Jalan Raya Sindangbarang, Pasir Eurih Village, Tamansari District, Bogor Regency, West Java.

Figure 1. Research location

The method used in this research is descriptive, conducted through observation and literature review. The observation method involved observation and interviews with managers at the research location. The interviews involved direct interaction with the managers of the Judi Barang cultural village area to gather information about the area's management and sustainability. Literature was also reviewed from various relevant sources on the research topic.

3. RESULTS AND DISCUSSION

3.1. Condition of the Sindang Barang Village Settlement

The traditional settlement of the Sundanese people is depicted in the pattern of traditional Sundanese villages in general, which are grouped with the location of the houses one after another, having two rows facing each other separated by a yard or courtyard (Adiwilaga, 2010 in Ilham et.al, 2012). The settlement is an area known as a traditional residence, where the buildings still use natural materials taken from the environment around the village. This area has clear boundaries and a shape that has meaning in accordance with the architecture of traditional Sundanese houses.

The Sindang Barang village settlement area has a different character from the Sindang Barang cultural village area. The conditions around the Sindang Barang village area have a modern residential character. Houses around the Kampung Jadang Barang area have been built with facades and use different materials than the buildings in the Sindang Barang village. The Sindang Barang cultural village is part of the surrounding villages in the umbulan or babakan category that maintains Sundanese customs and culture. In Sundanese society, the formation of villages through a process that begins with the emergence of umbulan (a settlement unit consisting of approximately 1-3 houses and their surroundings), then babakan (4-10 houses). From babakan, it develops into lembur (10-20 houses), then kampung (more than 20 houses). Finally, the village is formed as a development of kampung or a collection of several kampungs. (Ekadjati, 1995).

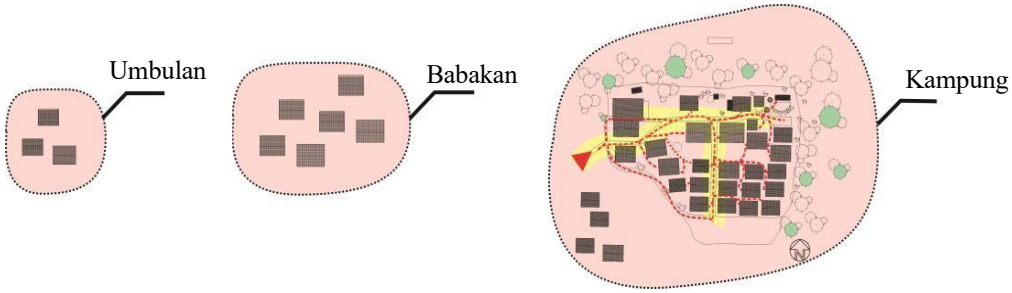

Figure 2. The beginning of the formation of the village
Source: Ekadjati, Edi S (1984)

The initial process of village formation typically consists of one to three houses, called umbulans. Several umbulans then form a babakan, generally consisting of five to six houses. A settlement unit, called a kampung, consists of dozens of houses, open spaces, places of worship, rice barns, livestock pens, gardens, rice paddies, and other surrounding physical infrastructure closely related to the settlement. The layout of traditional settlements is influenced by cultural and traditional values, including aspects of mutual cooperation in development and environmental maintenance, traditional philosophies that oversee and protect the community, the use of local materials, spatial patterns that facilitate social interaction and traditional community activities, and family values that emerge in daily life (Wenda,2021)

3.2. Landscape Characteristics of the Sindang Barang Cultural Village Settlement

Cultural landscapes have characteristics that reflect the communities within them. The traditional culture of indigenous peoples is the accumulation of efforts to harmonize humans and nature, shaped by their environment. Cultural landscapes represent a fusion of the dynamics of human life and natural formations. Within them lies human wisdom in managing social systems and organizing space within their environment (Platcher & Rossler, 1995). Landscape characteristics are patterns of elements that appear repeatedly in a particular landscape, which are formed from the interaction between nature and human activities. Landscapes with prominent characters can be influenced by the interaction between the main features and supporting features in the landscape. Landscape characteristics include tangible and intangible aspects of several periods, individual and group aspects provide a historical character and help provide cultural understanding. Landscape character is measured from the distance of scale patterns and the relationship of details and site materials, to understand the cultural landscape, it can be studied based on 13 components of the cultural landscape. (Page, et al, 1998:53). The physical characteristics of a settlement demonstrate a unique cultural identity that depends on the local social community, creating an atmosphere that demonstrates the socio-cultural diversity that is its distinctive characteristic (Savitri & Ekomadyo, 2021)

The character of a place as an element of location values that is widely studied in terms of physical (building elements) and non-physical concerns feelings and experiences that shape views or assessments of the area. This can be connected to the phenomenon of genius loci which reveals how humans perceive their place of residence and create meaning. Place is considered a deeper form than space not only from a physiological perspective, but also from a psychological and even spiritual perspective. This situation is influenced by several factors, such as cultural background, relationships between people, and existing preferences. Therefore, the meaning of appreciating a place is not only limited to fulfilling functional needs, but also involves feelings of enjoyment, connection, appreciation, and the desire to maintain or preserve existing artifacts (Ali et al., 2022).

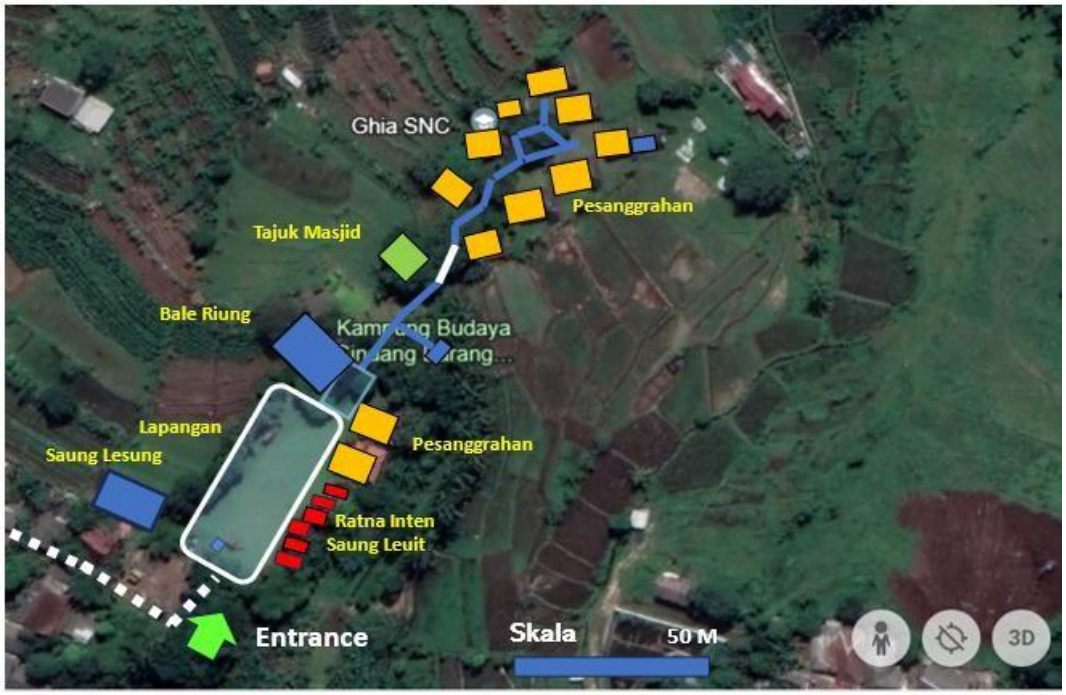

Figure 3. Layout of Sindang Barang Cultural Village
(source: Google Earth, 2023 and Analysis, 2025)

The character of the Sindang Barang cultural village settlement landscape physically still displays traditional Sundanese buildings including bale riung, leuit, pesanggrahan in the form of Sundanese houses, Tajug (mosque/prayer room). Each building faces each other and is separated by a yard in the form of an open field and yard.

Figure 4. Buildings in the Sindang Barang Cultural Village
Source: Personal documentation, 2024

Field observations indicate that the buildings in the Judi Barang cultural village are currently in need of repair and minor maintenance. Several of the buildings that have been damaged and demolished include the imah gede, a traditional Sundanese house. Traditional architecture reflects local culture, which generally implements environmentally friendly architectural concepts because the community lives in harmony with nature (Handayani et al., 2021).

3.3. Settlement Pattern of Sindang Barang Cultural Village

The development of traditional architecture with a foundation of cultures and norms that are very sacred in traditional societies will greatly influence the behavior of space or place in each region. Thus, the life and behavior of a traditional society is a reflection of the development of its traditional architecture. The pattern of traditional Sundanese villages is generally arranged by paying attention to the concept of place and customs. These villages often have houses facing the main road or a place of worship located in the center of the settlement. According to Anwar Adlwllaga (2010) the traditional settlement pattern of Sundanese people generally shows that the houses are built side by side, with two rows facing each other and separated by a yard that has a divan and several rows of houses. The majority of ordinary houses have a fairly large yard, but there are some that do not have it, so that the boundaries of the yard area between one house and another are less clear. In this West Java area, besides rows of houses and open areas, there are also other buildings such as mosques, meeting places (bale patemon), rice storage areas (lumbung), livestock pens, public toilets (MCK), gardens, fish ponds (balong), rice fields, and various other physical facilities that are closely related to the residence.

The Sindang Barang cultural village in Bogor is a miniature Sundanese settlement that maintains its traditions since ancient times. The settlement pattern depicted in the Sindang Barang cultural village in Bogor reflects Sundanese customs and traditions, connected to the surrounding landscape. The landscape around the Kampung Sindang Barang area remains pristine, with elements including rice fields, gardens, and yards directly connected to the community's settlements as spaces.

Sindang Barang Cultural Village is one of the 20 traditional villages in West Java. Sindang Barang Cultural Village is one of the communities that still maintains the local cultural aspects of the Pajajaran kingdom, where there are 78 historical sites of Pakuan Sindangbarang, traditional ceremonies (Serentaun traditional ceremony, Neteupken traditional ceremony, Pabeasan traditional ceremony, and various other traditional ceremonies), and various traditional Sundanese arts (Prasetyo, 2011). The settlement of Sindang Barang cultural village is surrounded by rice fields and mixed gardens that function as a food supply as well as functioning as a yard. Based on the beliefs of the Sundanese people, the philosophy of this village settlement pattern has the concept of weak-cai, Luhur handap. Lemah-cai has the meaning where weak is the element of land which means a place for people to live while cai is water which means rice fields that have springs for the continuation of the community. While Luhur Handap: A concept that literally means top-bottom, this concept shows the hierarchy of placement of a location based on its level of importance/function. (Kustianingrum et al., 2013). The Sindang Barang cultural village settlement has several water sources that are used by the community for household needs and agricultural activities by the surrounding community. Traditional Sundanese architecture has its own aesthetic and exotic value, seen from its originality and uniqueness. These values can be marketed to tourists as the region's authentic potential (Nuryanto et al., 2016).

3.4. Sustainable Development of Sindang Barang Village Landscape

The sustainable development of the Sindang Barang Cultural Village is carried out through revitalizing facilities, increasing collaboration, and diversifying cultural tourism activities involving the local community, such as arts training and providing educational tour packages for schools. Development also focuses on utilizing historical and environmental potential, holding traditional competitions, and establishing accommodations to support the local economy and preserve Sundanese cultural heritage:

a) Holistic Design Approach

Manage the landscape in an integrated manner, taking into account various biophysical and social elements. A holistic development approach in the Sindang Barang cultural village must integrate the biophysical and socioeconomic elements of the surrounding community.

b) Collaboration Between Stakeholders

Involving various parties such as local communities, professionals, and the private sector to ensure sustainability is integrated into landscape planning and management. The problem of the Sindang Barang cultural village lies in the sustainability of the area's landscape. The landscape of the Sindang Barang cultural village has not experienced much change. However, there is damage to buildings that are not maintained so that collaboration is needed by stakeholders to carry out development through planning in accordance with the preservation and tourism development policies of government agencies.

c) Adaptive Design

In developing the landscape of the Sindang Barang cultural village, a study of the surrounding area's development is necessary to formulate a design that adapts to the surrounding conditions. This requires designing a landscape that is resilient and adaptable to local climate conditions.

4. CONCLUSION

The residential landscape of Sindang Barang Cultural Village is one of the local cultural miniature objects located in the Tamansari District, Bogor Regency. There are 29 traditional Sundanese cultural buildings known for their beautiful atmosphere and the people who really maintain their traditions. The character of the residential landscape of Sindang Barang Cultural Village physically displays traditional Sundanese buildings including imah gede, bale riung, leuit, pesanggrahan in the form of Sundanese house buildings, Tajug (Mosque/prayer room). The typology of residential buildings in Sindang Barang Cultural Village has the form of hunan jolopang, Julang Ngapak, Capit Gunting and gado bangkong. The sustainable lanaksp design approach of Sindang Barang Village includes a holistic design approach, collaboration between stakeholders and adaptive design.

A study of sustainable landscapes in the Sindang Barang cultural village in Bogor Regency requires research on the role of the community around the Sindang Barang cultural village in preserving the culture of the settlement as an effort to conserve the area.

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Sustainable Architecture in Domestic Liquid Waste Management for Environmental Health

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ABSTRACT

Harjatani Heritage Estate is a residential area located in Margatani Village, Serdang, Kramatwatu, Serang Regency. One of the main issues in this housing area is the poorly organized wastewater drainage system, caused by inadequate drainage flow in the surrounding environment, which has the potential to pollute the area with domestic wastewater. Domestic wastewater, commonly referred to as greywater, originates from household activities such as bathing, washing, and kitchen use. Waste management, both domestic and industrial, remains a serious environmental challenge in Indonesia. One alternative approach to addressing this issue is through natural wastewater management integrated into sustainable architectural planning for environmental health. This study employs a qualitative research method using observational techniques and data analysis. The analysis includes site conditions, surrounding environmental characteristics, and landscape planning as an application of sustainable architecture principles, supported by AutoCAD-based design exploration and interviews with local community representatives. The results indicate that landscape planning plays a significant role in supporting sustainable architecture as an environmentally responsive solution for domestic wastewater management.

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1. INTRODUCTION

Margatani Village experiences environmental pollution caused by poorly managed domestic wastewater from household activities, resulting in clogged drainage, frequent flooding during the rainy season, unpleasant odors, and potential health risks[1] [2][3] . Based on the statement, research is needed on "Sanitation Planning as Domestic Wastewater Management[4] in Housing in the Margatani Village Area, Kramatwatu, Serang. Case Study: Harjatani Heritage Estate Housing.

Sustainable architecture can create healthy and environmentally friendly buildings and environments. Sustainable environments emphasize the protection and conservation of nature and efforts to reduce the negative impacts caused by human activities. This includes ecosystem preservation, reducing greenhouse gas emissions, and protecting biodiversity. In architecture, it is an important aspect that must be considered in designing buildings. In addition to planning sanitation facilities [5] such as toilets and hand washing facilities, there are several things that need to be considered related to sanitation in architecture such as: Drainage and

wastewater disposal systems in buildings must be well designed, to ensure that wastewater is disposed of efficiently and safely so as not to pollute the surrounding environment[6] :

- Architectural design must consider efficient water use, such as the use of water-saving sanitation equipment. In addition, rainwater collection for use in sanitation purposes such as toilet flushing or watering plants.
- Architectural design must take into account cross ventilation to ensure good air circulation in the building, thereby reducing the risk of disease spread and maintaining indoor air quality.
- Architectural design must consider the ease of cleaning and maintenance of sanitation facilities. Building materials that are easy to clean, surfaces that are resistant to moisture, and spatial arrangements that facilitate access for cleaning and maintenance of sanitation equipment.

According to Paola Sassy [7], there are the Principles of Sustainable Architecture, such as:Land Use dan Ecology, Energy,Water, Material, Health, Material,and Community.

2. METHOD

Harjatani Heritage Housing is one of the areas located in Margatani Village, Serdang, Kramatwatu which has 55 families. The assumption is that each family consists of 4 family members. The condition of domestic waste (household) in Margatani Village is quite bad and quite polluting the environment.

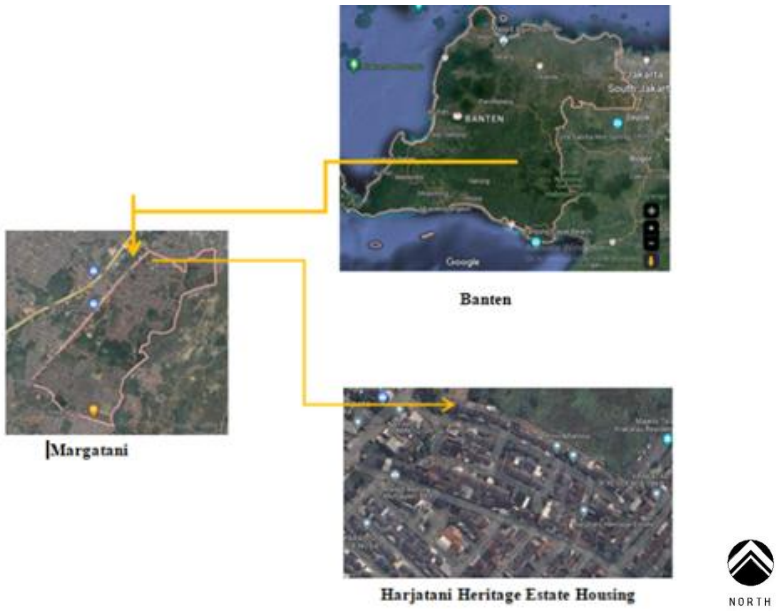

Figure 1. Research Location, Harjatani Heritage Estate Housing
(source: processed by author from Google Maps)

The tools and materials used in this study included writing tools for documentation, a measuring tape and ruler for recording dimensional data, a meter tape for measuring longer distances, a compass for determining orientation and direction, a camera for visual documentation of site conditions, and a map of the Harjatani Heritage Estate housing area to support spatial analysis and location referencing.

The type of research used in this study is qualitative research with observation, and interviews with local community officials, Analysis of the environmental condition space program in accordance with the facilities and infrastructure needed.

The data required in this study consists of primary data and secondary data. Primary data is obtained by analyzing problems in accordance with the aspects of sustainable architecture and the profile of the Harjatani Heritage Housing Area, Margatani Village, Serdang, Kramatwatu, Serang. Secondary data is obtained from the Analysis of the Housing Environment Area and Harjatani Heritage Serdang-Serang, Banten. After the data analysis was carried out, a spatial Analysis of the Design of Liquid Waste Management Architecture was carried out in the Harjatani Heritage Estate housing area also using Auto Cad software.

3. RESULTS AND DISCUSSION

3.1. View Analysis

Based on the view analysis in the area, there is water pollution and increased water discharge caused by the flow of domestic household wastewater and blocked water channels. This can be seen in the following image.

Figure 2. Domestic Wastewater Pollution
Harjatani Heritage Estate Housing (source: author)

3.2. Analysis based on the theory of Sustainable Architecture principles

Aspects of sustainable architecture use the Principles of Sustainable Architecture (Paola Sassi 2006) [8] there are 6 Principles of Sustainable Architecture, such as; Land Use and Ecology Analysis, Energy, Water, Material, Health, and Community.

3.2.1. Land Use and Ecology Analysis

Strategic Issues in Land Use & Ecology are; Use of brownfield sites,Reuse of existing buildings, Appropriate density, Investment in landscaping, public transport, new pedestrian routes, Effects on micro-climates. Here is the Analysis Table of Land Use and Ecology:

Tabel 1. Land Use and Ecology Analysis (source: author)

Land Use and Ecology	Problem Analysis	Sustainable Architecture
1. Use of brownfield sites	the existence of abandoned land	Architecture Landscape Planning
2. Reuse of existing buildings	The existence of the existing Security Post Building which is no longer in use	Reuse [9] the Security Post Building for another function
3. Appropriate density	There is still space/land that has not been used	Architecture Landscape Planning and public support facilities[10]
4. Investment in landscaping	This empty land/space is still not in use	Landscape arrangement with green open space [11] vegetable planting, planning of reservoirs and reservoir pools as a result of liquid waste pollution
5. Public transport	Public transportation is available in the area (public transportation and online motorcycle taxis)	Planning a Shelter as a transit place to wait for public transportation
6. New pedestrian routes	Route to Research Area (Sustainable Architectural Plan) does not exist yet, The absence of the Role of Sustainable Architecture causes Impacts on the microclimate; clogged water channels cause increased water discharge and	Landscape planning in the form of routes and footpaths

	during the rainy season cause flooding and liquid waste pollution.

3.2.2. Energy Analysis

Natural ventilation, passive solar energy, and planting vegetation were applied to enhance comfort and reduce energy consumption. Water circulation and storage were optimized for environmental efficiency[12] . Here is the Table of Energy Analysis;

Tabel 2. Energy Analysis (source: author)

Energy	Problem Analysis	Sustainable Architecture
1. Renewable energy sources	Domestic liquid waste that is not disposed of properly can be caused by water pollution and air pollution.	Planning good circulation of liquid waste disposal, planning water storage tanks and ponds for rainwater harvesting [13]
2. Use of natural ventilation	The existing security post building and the planning of the water reservoir require natural ventilation for further monitoring as well as for lighting and air conditioning.	The existing security post building and the planning of the water reservoir require natural ventilation for further monitoring as well as for lighting and air conditioning.
3. Use of passive solar energy [12]	There is a lot of sunlight coming towards the research area because it is still an empty space or land that has not been used.	Landscape planning with planting vegetation as an environmental filter so that the surrounding environment is not too hot.[11]
4. User-Friendly Building Management Systems	Domestic liquid waste circulation management is very poor due to poor circulation (clogged water channels).	Planning of reuse and recycling systems for water[14] and existing buildings
5. Exploiting the constant ground temperature	As a result of land being empty for too long, it can cause environmental damage, the land is not well managed.	Sustainable Landscape Planning with Vegetation Planting (Garden Planning) [11]
6. Use of planting for shading and cooling	land Eksisting is an empty space or land that has not been used	Landscape planning with planting vegetation as an environmental filter to make the surrounding environment cool. [15]

Based on the Land Use-Ecology Analysis and Energy Analysis, data was obtained in the form of Site Plan Images, Topography, Existing Wastewater Channels in the Area.

1. Existing Area

a. Site Plan Existing
The area of research is ± 430 meters squere area according to the figure 3.

b. Topography Existing
The Topography Eksisting include: Eksisting Ground, Eksisting Building (Security post), new Buliding (New Security Post), and Get Entrance Housing.

3.2.3. Water Analysis

Wastewater management included planning new channels, reservoirs, and rainwater harvesting to reduce flooding and water pollution. Here is the Table of water analisys;

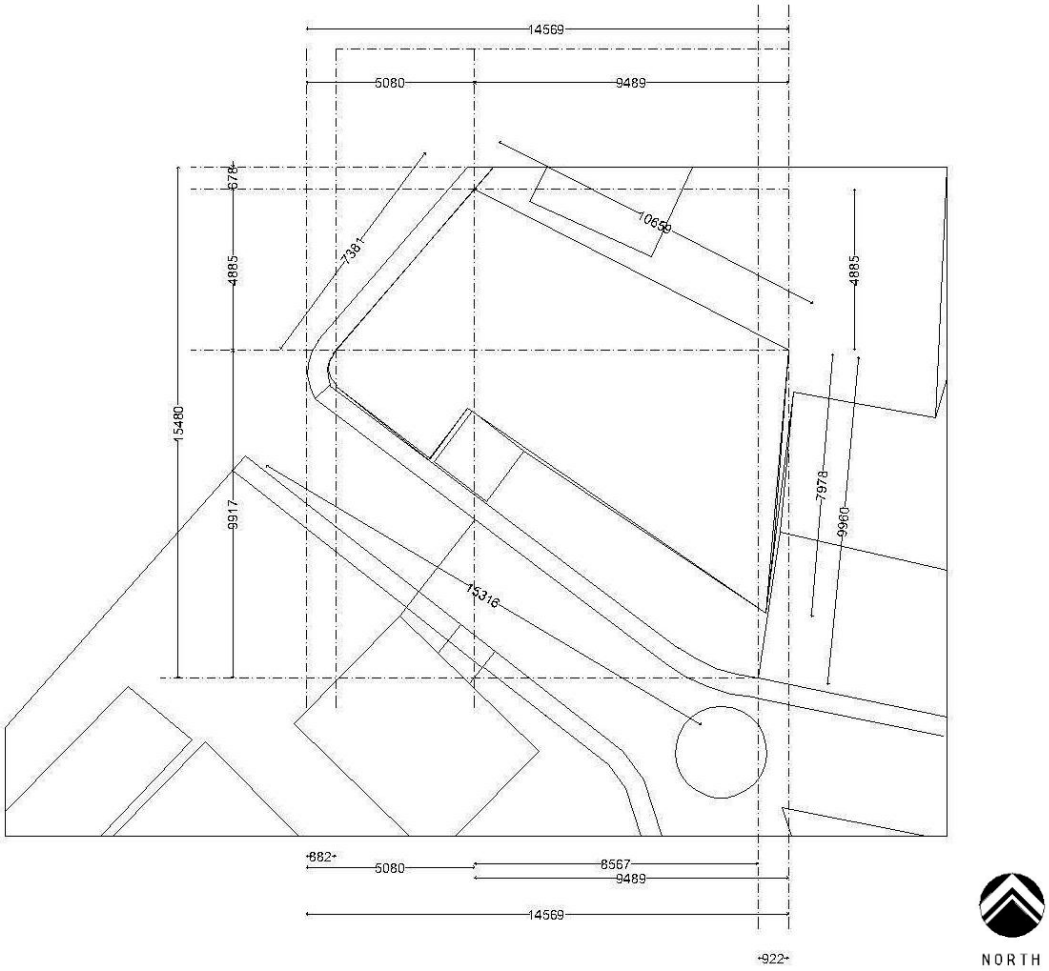

Figure 3. Eksisting Site Plan (Source: Author)

Figure 4. Topography Existing (Source: author)

Tabel 3. Water Analysis (source: author)

Water	Problem Analysis	Sustainable Architecture
• Comfort for building inhabitants	Domestic liquid waste that is not managed properly can cause water pollution and air pollution The impact of poor water circulation causes increased rainwater discharge and liquid waste.	Planning good circulation of liquid waste disposal, planning water storage tanks and ponds for rainwater harvesting [13] .
• Maximum use of natural light	The impact of poor water circulation causes increased rainwater discharge and liquid waste.	Planning good circulation of liquid waste disposal, planning water storage tanks and ponds for rainwater harvesting [16] .
• Minimizing rain water run off	The impact of poor water circulation causes increased rainwater discharge, resulting in flooding during the rainy season	

Based on water analysis, data was obtained in the form Eksisting of household wastewater circulation Analysis;

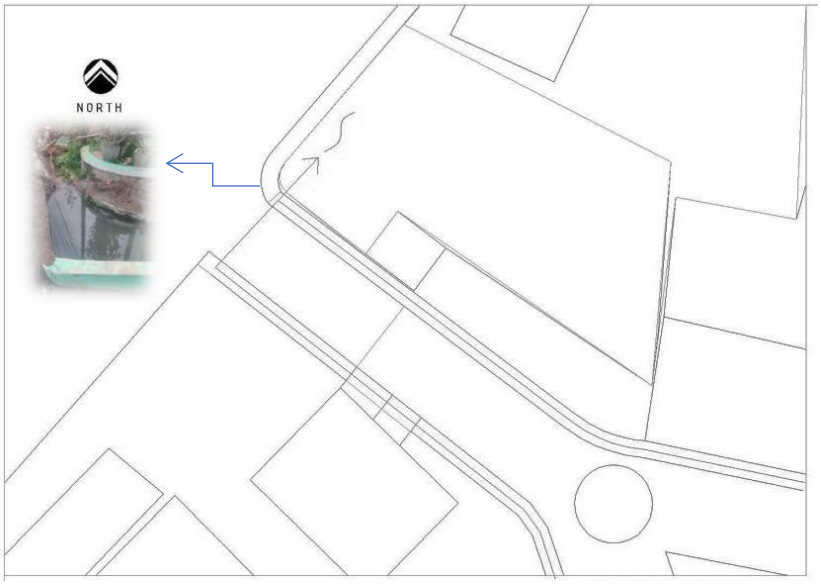

Figure 7. Household wastewater circulation Analysis (Source: author)

From Figure 7, we can see the drain is blocked so it flows into the gutter. Increased water discharge can flow towards vacant land and can cause flooding.

3.2.4. Material Analysis

Sustainable and recycled materials were applied for construction, including clay bricks and recycled furniture, ensuring durability and environmental safety. Here is the Table of Material Analysis:

Tabel 4. Material Analysis (source: author)

Material	Problem Analysis	Sustainable Architecture
• Conservation of natural resources	Planning a reservoir building requires building materials that are strong, environmentally friendly, but also resistant to liquids (waterproof), so you can use building materials that are natural resources such as clay and materials that can be recycled.	Use of bricks (made from clay) in planning the walls of a reservoir building [18]
• Use of recycled materials		Use of furniture in the garden (landscape planning area) using recycled materials such as plastic waste[19]
• Low embodied energy materials		Sand Spandek Roof [20], [21]
• Renewable materials from a verifiable source		Brick wall
• No ozone-depleting chemicals		Sand spandex roof, brick walls

3.2.5. Health Analysis

Measures included maintaining indoor air quality, sanitation facilities, and user comfort through proper layout and maintenance. Here is the Table of Health Analysis;

Tabel 5. Health Analysis (source: author)

Health	Problem Analysis	Sustainable Architecture
• Comfort for building inhabitants	Poor water drainage circulation has an uncomfortable impact on health because it causes water pollution and air pollution.	Pay attention to Sustainable Architectural Planning by paying attention to user comfort and the environment by planning water reservoirs and pools as well as landscaping.
• Maximum use of natural light	There are existing buildings that have not been reused with glass opening materials.	Reuse existing buildings with different functions and maintain glass materials and pay attention to ventilation.

3.2.6. Community Analysis

Local communities and stakeholders were involved in planning and managing wastewater and landscape areas, fostering awareness and participation. Here is the Table of Community Analysis;

Tabel 6 Community Analysis (source: author)

Community	Problem Analysis	Sustainable Architecture
• Consultation with the local community • the design professions	Consultation, socialization, and consensus have been carried out by community officials up to stakeholders (sub-district government officials) regarding the clogged water channels, but until now no solution has been found.	Discussions, socialization, and consensus have been carried out by community officials up to stakeholders (sub-district government officials) regarding clogged water channels, but until now no solution has been found.
• Mixed development	The development of a mixed building requires a very large area of land, while	Landscape planning according to its function

	this empty land is estimated to only be used for planning related to Sustainable Architecture.	
• Contribution to the economic and social well-being of the community	This research land has not contributed to economic and social welfare.	Planning Community Based (surrounding community) in landscape management including liquid waste circulation, Reuse the old Security Post Building as a Small Prayer Room
• Amenity of the wider area	There is no community involved other than local community officials. Local officials such as Security complain that the nearest place of worship is not yet available around the site area, the presence of security on rotating duty requires the nearest place of worship.	
• Visual amenity space	This research space does not yet provide facilities that encompass activities or planning related to the role of sustainable architecture.	Landscape planning according to its function
• Aesthetic excellence	This research area has not shown aesthetic advantages related to the Role of Sustainable Architecture.	
• Collaborative enterprise involving all the design professions	This research area has not yet involved experts based on the design theme.	Local communities work together with Academics, Architectural Planning Consultants and Contractors as providers of goods and services to address environmental problems in the Research area

Based on the analysis above (Tabel 3,4,5, and 6), the Sustainable Architectural Role Planning is obtained in the form of; Reuse (Reuse of old buildings / old Security Post) which can be used for small prayer rooms, Mini Bus Stop Planning as access for people using Public Transportation, Landscape Planning, New wastewater channels, and Reservoirs and ponds based on the following information:

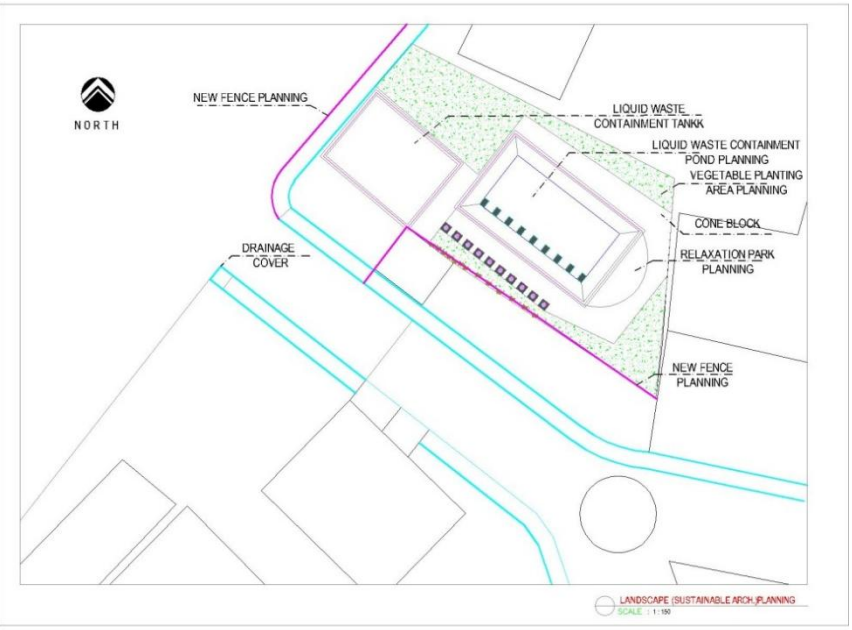

Figure 8. Landscape Planning (Source: author)

a. Landscape Planning

1. Softscape; in the form of natural elements such as planting vegetation with planting types of vegetables as a natural investment.
2. Hardscape; in the form of planning a reservoir and a wastewater reservoir that can also function as rainwater harvesting that can be reused, Fence Planning and Drainage Cover Planning as aesthetics and Architectural Role functions.

b. New Wastewater Channel

From the discussion of the analysis of water channel problems, it is necessary to plan a new wastewater channel as shown in the following image.

Figure 9. New Wastewater Channel (Source: author)

3.3. Critical Reflection

The proposed sustainable architectural strategies are conceptually appropriate, their implementation depends on land availability, financial support, and long-term maintenance by local authorities and the community. In the long term, integrated wastewater management and landscape-based solutions have the potential to improve environmental quality and public health; however, their sustainability depends on continuous community participation and system maintenance.

4. CONCLUSION

The problem of domestic liquid waste that has the potential to pollute the air, land, and air can be resolved through the application of sustainable architecture principles, including landscape planning (softscape and hardscape), waste and rainwater management, reuse of existing buildings, and the provision of public facilities based on community participation. In addition, sustainable architecture is implemented through the reuse of existing buildings, the provision of public facilities to support transportation, and a community-based approach by involving the community in environmentally conscious landscape management.

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Lubuk Pahoman Streetscape Design Based on Lampung Saibatin Tribe Cultural Motifs

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ABSTRACT

Since the Dutch East Indies colonial period, Teluk Betung Sub-district has played a significant role as an economic center and has been recognized as a historic old town in Lampung. In line with Sustainable Development Goal (SDG) 11.4 and Bandar Lampung City Regional Regulation No. 2 of 2019, preserving the historical character of the old city amid rapid modernization requires a culturally grounded streetscape design as a key expression of urban identity. Despite this potential, Teluk Betung faces several challenges, including the erosion of Lampung cultural identity due to transmigration, as well as disorganized spatial conditions such as street vendors occupying sidewalks and illegal parking along traffic lanes. This study aims to identify existing potentials and problems and to develop a culture-based streetscape design. The research adopts the landscape planning method proposed by LaGro (2008), encompassing the stages of preparation, inventory, analysis, synthesis, and concept development. The design proposal focuses on Way Lubuk Pahoman Street, where cultural principles are translated into a streetscape landscape concept, resulting in a site plan and three-dimensional visualization incorporating Lampung Saibatin cultural motifs.

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1. INTRODUCTION

Streetscapes play a critical role in shaping urban identity, functioning not only as transportation infrastructure but also as public spaces that accommodate social, cultural, and economic interactions. International urban design scholarship emphasizes that streets are fundamental elements in forming place identity and collective memory, particularly within historic urban environments (Lynch, 1960; Carmona, 2019). From a cultural landscape perspective, streets are understood as living cultural artifacts in which historical layers, social practices, and symbolic meanings are continuously produced through everyday urban life (Taylor & Lennon, 2011). As such, streetscape design becomes a strategic medium for preserving cultural identity while responding to contemporary urban demands.

Teluk Betung Sub-district in Bandar Lampung has held a strategic role since the Dutch East Indies colonial era as an economic and administrative center. Following the end of the Lampung War in 1857, Teluk Betung developed into the capital of the Lampung Residency and later emerged as one of Lampung's historic old city areas [1]. Its urban structure reflects historical connectivity between governmental, commercial, and port-related activities, positioning streets as key visual and functional corridors. However, recent urban

development has largely prioritized physical growth and economic activities over cultural preservation, resulting in the gradual erosion of local identity within everyday urban spaces, particularly streetscapes [2].

Streetscape landscapes are therefore a key component in defining the visual character and identity of urban areas. Way Lubuk Pahoman Street, the focus of this study, functions as a secondary collector road connecting major urban routes, including Jenderal Sudirman Street, Jenderal Gatot Subroto Street, and Ir. H. Juanda Street. Despite its strategic location within the historic old city, the existing geometric and spatial conditions of the street do not fully comply with road design standards, as evidenced by inconsistent sidewalk widths, fragmented pedestrian space, and conflicting uses between mobility and commercial activities.

The research area is located in North Teluk Betung, one of five sub-districts in Bandar Lampung City where the Saibatin tribe is historically and culturally rooted [3]. Lampung culture is characterized by two main traditional groups, namely the Pepadun and Saibatin tribes. The Saibatin tribe, meaning "one soul" or "one pride," adheres to a hereditary leadership system based on paternal lineage [9]. One of its most distinctive cultural symbols is the siger crown, which features seven peaks symbolizing authority and leadership [10]. These cultural motifs represent not only visual symbols but also cultural narratives that can inform spatial organization and user experience within urban landscapes.

Previous streetscape studies in Indonesia have predominantly focused on physical upgrading, aesthetic enhancement, or compliance with technical and regulatory standards. In many cases, cultural elements are applied as surface decoration rather than integrated as formative drivers of spatial structure and functional performance. In contrast, international cultural landscape studies emphasize that local cultural narratives should actively inform circulation patterns, spatial hierarchy, and behavioral dynamics within public spaces. Despite this, there remains a limited body of applied design research that systematically translates indigenous cultural motifs into functional and spatial streetscape strategies, particularly within historic urban corridors in Southeast Asian cities.

In response to Sustainable Development Goal (SDG) 11.4, which emphasizes the protection and preservation of cultural heritage [8], as well as Bandar Lampung City Regulation No. 2 of 2019 concerning the preservation of Lampung customs and cultural arts, there is a clear need for streetscape design approaches that integrate cultural values into everyday urban infrastructure. Streets, as the most visible and frequently used public spaces, provide an effective medium for implementing cultural preservation strategies in a tangible and experiential manner.

This research addresses the identified gap by developing a culture-based streetscape design that positions Lampung Saibatin cultural motifs as generative design elements rather than symbolic ornaments. The study aims to (1) identify the physical, socio-cultural, and environmental potentials and constraints of Way Lubuk Pahoman Street; (2) analyze how these factors inform spatial and functional design decisions; and (3) propose a culturally grounded streetscape design that strengthens urban identity while improving accessibility, safety, and the overall quality of public space. Through this approach, the study contributes an applied, context-specific model for integrating cultural landscape principles into streetscape design within historic urban environments.

2. METHOD

This study employs a qualitative, design-based research approach within the field of landscape architecture planning and design. The final project research was conducted in the North Teluk Betung District of Bandar Lampung City on Way Lubuk Pahoman Street. The research framework follows the contextual planning process proposed by LaGro (2008), consisting of preparation, inventory, analysis, synthesis, and design development. This approach allows site-specific conditions and socio-cultural values to directly inform design outcomes. Primary data were collected through field observation, semi-structured interviews, and questionnaires. Interviews with cultural experts and local stakeholders were conducted to understand the symbolic meanings and ethical principles of Lampung Saibatin cultural motifs. Questionnaires distributed to site users captured perceptions related to comfort, accessibility, safety, and cultural visibility. Secondary data included spatial plans, legal documents, climatic data, and previous studies.

Qualitative data were analyzed thematically to identify recurring issues and potentials related to pedestrian comfort, cultural perception, activity patterns, and spatial conflicts. These themes were then translated into design criteria. For example, user concerns regarding pedestrian safety and sidewalk obstruction directly informed the reconfiguration of circulation patterns and sidewalk dimensions. SWOT analysis was applied to synthesize internal factors (physical condition, cultural assets, accessibility) and external factors (regulatory support, economic activity, urban development pressure) into strategic design directions. Carrying capacity analysis was used to quantitatively assess the spatial limits of parking and food court functions, ensuring that proposed activities remain compatible with pedestrian movement and public space quality. The combination of these methods supports both strategic and spatial decision-making in streetscape design.

3. RESULTS AND DISCUSSION

3.1. Site Analysis and Synthesis

The analysis reveals that Way Lubuk Pahoman Street possesses strong historical and cultural potential due to its location within the old city and its role as a connector between major urban axes. However, inconsistent sidewalk widths, informal vendor occupation, and unmanaged parking significantly reduce pedestrian comfort and safety. These constraints directly informed the design strategy to standardize sidewalk dimensions, reorganize parking zones, and introduce traffic-calming spatial elements.

Existing vegetation contributes positively to microclimatic comfort but obstructs visual corridors toward culturally significant landmarks. Consequently, selective vegetation management and replanting strategies were adopted to balance environmental performance with visual clarity and cultural legibility.

3.2. Cultural Motif Transformation and Design Strategy

Lampung Saibatin cultural motifs, particularly the Siger crown and tapis patterns, were transformed into spatial and geometric design elements. The zig-zag configuration derived from the tapis motif was applied to paving patterns and pedestrian circulation to slow movement and encourage experiential engagement with cultural elements. This cause–effect relationship demonstrates how cultural narratives directly inform spatial behavior within the streetscape.

3.3. Critical Discussion

While the proposed design strengthens cultural identity and spatial order, its implementation faces challenges related to informal economic activities and long-term maintenance. Without consistent policy enforcement and community participation, cultural elements risk becoming symbolic rather than functional. Additionally, this study focuses on design outcomes and does not quantitatively evaluate post-implementation social or economic impacts, which should be addressed in future research.

3.4. Inventory

Legal Aspects

The legal aspects of the landscape design of Jalan Way Lubuk Pahoman refer to various applicable regulations. Based on the Provincial Spatial Planning (RTRW) of Lampung for 2021–2041, the research location in the North Teluk Betung District is included in Urban Area Section (BWK) G, with the primary function as a densely populated settlement, city government center, higher education, trade, and services as regulated in the Bandar Lampung City Regional Regulation No. 4 of 2021. Law No. 2 of 2022 regarding Roads classifies Jalan Way Lubuk Pahoman as an urban road with a secondary collector function, which serves as a link between service centers and land transportation hubs in urban areas. Bandar Lampung City Regional Regulation No. 2 of 2019 emphasizes the importance of preserving Lampung's customs, arts, and culture, including the application of characteristic ornaments of the Saibatin Tribe on physical elements of the city such as gates, monuments, buildings, and signboards. This is in line with Sustainable Development Goal (SDG) 11 target 4 which emphasizes the preservation of cultural and natural heritage in urban areas, relevant to the role of Jalan Way Lubuk Pahoman as a visual corridor of the historic old town in Lampung.

Physical Aspects

The physical aspect in the inventory is the aspect related to the existing site conditions and characteristics from various factors. The city of Bandar Lampung has experienced area development that impacts its suitability and regional division. The results of the area development in the city of Bandar Lampung based on data BPS Bandar Lampung City 2023, indicate that the research site has undergone changes in the area, thus shifting into the scope of Enggal District with an elevation of 100 meters above sea level.

The scope of the site has characteristics of lowland topography located in the central urban area. The topographic section of the site itself has an elevation difference of 1 meter from sea level. This results in a site slope of 0.004%, which is below 1%, thus it can be categorized as a condition with flat topography.

The city of Bandar Lampung has river flow directions with the river's upstream area located in the West and the downstream area in the South. According to data obtained from the Central Statistics Agency of Lampung Province, the maximum rainfall from 2014 to 2022 is documented. This data provides an overview for further analysis that will be used as a basis for formulating more effective water resource management policies and natural disaster mitigation at the site. Hydrology at the site consists of a closed drainage system under the sidewalk. This is to prevent flooding/surface runoff into the vehicle lanes, with water flowing from the north to the south of the site.

The project site is situated within an integrated sports area, an educational area, and a bustling food court area. This has become one of the factors leading to new activities such as a free parking area and vendors along the route. As a result, the dimensions of the road as an access point and mobility have changed. The road area is classified as a secondary collector road with the size and dimensions of the existing road at the site. The site itself serves as a visual orientation point in the historical city, crossed by three visual axis points, namely the government axis, the axis of the historic old port, and the tourism axis. The scope of the site area that serves as the orientation point for the three main routes in its historical development.

According to the Meteorology, Climatology, and Geophysics Agency of Bandar Lampung City, the area around the Way Lubuk Pahoman landscape area, Teluk Betung Utara District has a humid tropical climate influenced by the monsoon winds (Asian Monsoon), with an average annual temperature of 27.12°C and air temperatures ranging from 23°C to 32°C. It has an average annual humidity of 82.66%. The lowest recorded rainfall in Bandar Lampung City is 82.10 mm in October, while the highest recorded rainfall over 31 days is 442.20 mm in January.

Biophysical Aspects

The biophysical aspects in inventory include various environmental factors aligned with biological ones that play a crucial role in ecological management. Here are some biophysical aspects that are usually taken into account in the inventory:

Existing vegetation describes the scope of the research area in the landscape area of Jalan Way Lubuk Pahoman, Teluk Betung Utara District, Bandar Lampung City, which has a fairly diverse type of vegetation. The types of vegetation around the design area are dominated by the Ketapang Kencana (Terminalia mantaly) vegetation formation. The condition of existing tree vegetation on the site is quite lush, as seen from the growth rate of its plants. However, the fertility level of the vegetation on the site is not balanced with the management of the area, causing the broad tree canopies around the site to significantly obstruct the visuals and sightlines of users while passing through. Meanwhile, the Existing Wildlife explains that the landscape area of Jalan Way Lubuk Pahoman, Teluk Betung Utara Subdistrict, Bandar Lampung City falls within a commercial zone, where there is a food court area within it. This becomes a factor in attracting cats to visit the site area, which is closely related to the potential availability of food.

Cultural-Social Aspects

The socio-cultural aspects in inventorying include various elements related to the social and cultural life of the area users. Here are some important socio-cultural aspects in the inventory process: In general, public and social facilities in Bandar Lampung are available and able to meet the basic needs of the community. However, there are several aspects that need to be improved, especially in terms of maintenance, revitalization, and equal distribution of facilities throughout the city. The following is the distribution point of public and social facilities around the site area.

The existing condition of the site is an area of residential, educational, government institutions, and sports facilities that creates active activities. The site's busy and strategic location in the city center creates a new pattern of activities around the site, which is used as free parking land and a food court area without considering other users. Looking at the division of the area covered, the research location is included in the historic old city of Lampung. However, the remaining cultural elements are only found in the pedestrian paths with motifs of Lampung's cultural ships. The application of this pattern also violates the customary law of Lampung culture.

3.5. Analysis

Analysis and Synthesis of Physical Aspects

The physical aspect is the first aspect analyzed in the design. The analysis is conducted using a descriptive map analysis method with the aspects discussed, namely, topography, hydrology, accessibility and circulation, road dimensions, and climatology.

The city of Bandar Lampung has a slope topography dominated by flat areas. This is in accordance with the planning of the area within the urban scope and integrated sports area. The existing drainage flow conditions run from the North to the South with a closed drainage system under the pedestrian path and there is an artificial hydrology in the form of a swimming pool around the site area. The implementation of closed drainage in the urban area is quite appropriate. The width of the road is not yet compliant, and the existing condition of the sidewalk at the site also has varying dimensions. In the western direction, the existing sidewalk measures only 1.8 m, unlike the eastern sidewalk which is already up to the standard of 2.5 m.

Looking at the existing road conditions on site, the Way Lubuk Pahoman road itself serves as a connector between local roads in the surrounding area as a circulation route. The existing condition of the site

has lush vegetation that serves as climate amelioration to lower temperatures, assist in long-term carbon storage, and break wind within the area.

Analysis and Synthesis of Bio-Physical Aspects

The biophysical aspect is the second aspect analyzed in the landscape design of Jalan Way Lubuk Pahoman based on the cultural motifs of the Lampung Saibatin tribe. The analysis used is descriptive analysis with aspects discussed including animal populations and types of vegetation. Analysis and synthesis of vegetation reveal that the landscape design area of Way Lubuk Pahoman has several types of vegetation within it. The vegetation formation on the site is dominated by tree-type vegetation with a sufficiently wide and tall canopy, serving as a microclimate regulator, reducing noise from the highway, providing shade, acting as a windbreak, and serving as a barrier between the road and the area.

The site location that is within an urban scope with commercial areas like food courts becomes a factor in attracting cats as a source of food. Therefore, ecological balance of the area through road landscape design by applying sufficient vegetation and green spaces is necessary.

Analysis of Socio-Cultural Aspects

The last aspect discussed is the analysis of the socio-cultural aspects in the design of the Way Lubuk Pahoman Street landscape based on the cultural motifs of the Lampung Saibatin tribe. The analyzed aspects include facilities and utilities, activity patterns, and cultural characteristics. The analysis and synthesis of facilities and utilities can be seen from the existing conditions of the public facilities and social facilities around the site, which are considered adequate, as evidenced by the active area and many visitors. However, the adequate facilities are still not sufficient to support the utilities of the surrounding site.

Analysis and synthesis of activity patterns are viewed from the surrounding area around the activity site, with active activities occurring during the morning and evening hours, with user activities as street mobility. This is evidenced by direct research and the distribution of questionnaires that active activity patterns occur at certain times. The analysis and synthesis of cultural patterns, based on the results of interviews conducted by archaeologist I Made Gunandi at the Lampung Museum, explains that the Lampung tribe is a tribe that has many patterns and iconic cultural elements. One of them is the pattern of Lampung script.

SWOT Analysis

Way Lubuk Pahoman Street has strong social, cultural, and economic potential, particularly through the presence of areas that can be developed into a center for SMEs or food courts. Its strategic location in the city center as a secondary collector road makes it an important visual orientation point with high accessibility to trade, government, residential, and integrated sports areas. Additionally, this location has significant historical value as part of the old town of Teluk Betung, making it potential to elevate the cultural identity of Lampung Saibatin in its landscape design.

The main issues in this area include the presence of street vendors on the sidewalks that disrupt pedestrians' comfort, illegal parking areas that cause traffic jams, and the lack of Lampung cultural identity in the landscape elements. The material conditions and motifs used on the existing sidewalks do not meet the technical standards or the cultural ethics of Lampung Saibatin, thus requiring design improvements that are safe, comfortable, and in accordance with cultural values.

The site location has legal support as a secondary collector road that passes through important axes (government, tourism, and historic ports) and is situated in a city planning area with a strategic function as a regional trade and service center. This opens up opportunities for the development of areas that combine the cultural identity of Lampung Saibatin with economic functions through the provision of integrated commercial space and public facilities.

The development of areas with potential can lead to environmental damage due to visitor activities, land conflicts with surrounding areas, and the erosion of cultural identity due to foreign influences and modernization. Without proper management, these threats could undermine the effectiveness of landscape design as a medium for cultural preservation. Therefore, the design must consider aspects of environmental management, legal boundaries, and consistent cultural preservation strategies.

Capacity Support Analysis

The analysis of carrying capacity in the landscape design of Way Lubuk Pahoman Street focuses on economic management of the food court sector and parking areas to determine the maximum visitor capacity so that the area remains conducive and does not exceed capacity. Space programming is divided into three main functions: primary function as the identity of the historic old city area through the visualization of Lampung culture on the street landscape; secondary function to support the economic sector through the

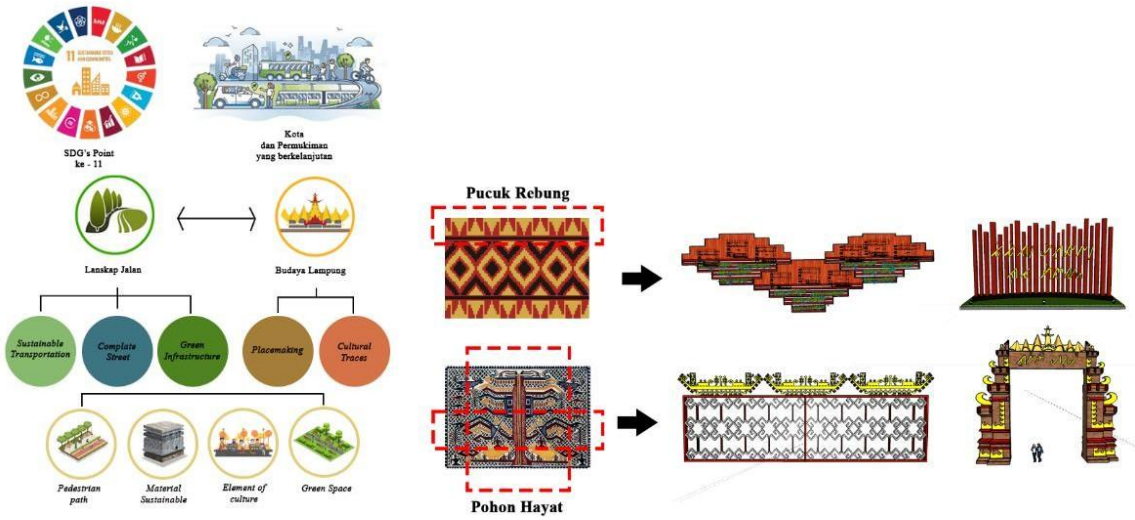
provision of food court areas; and supporting functions in the form of facilities and utilities that support activities in the area.

3.6. Concept

Basic Concept

The site area is the landscape of Jalan Way Lubuk Pahoman which consists of vehicle lanes, pedestrian lanes, road ownership space (rumaja), and green areas. The basic concept presented in this design is 'Bring Story Back To Life,' aimed at preserving cultural heritage in the design of street landscapes as a visual of the historic old city in line with SDG's 11 point 4 and the Regional Regulation of Bandar Lampung City No. 2 of 2019. In order to achieve the design objectives, the main design concept at the site is supported by a green street concept with a culturally-based approach as stated in SDG's 11 point 4 as shown in Figure 1 section (a). This concept consists of culture and green infrastructure, sustainable transportation, and placemaking. The more applied principle of landscape design for Way Lubuk Pahoman Street is culture and green infrastructure (Sustainable Cities and Communities) with consideration of the legal status of the area and patterns of user activity.

The concept of transforming the pattern shapes on the ground is taken from the motifs of boats and the traditional Siger of the Saibatin tribe, which are transformed into a zig-zag shape similar to the Pucuk Rebung tapis pattern. This transformation is applied because the patterns that support the zig-zag shape aim to slow down users as they traverse the area to enjoy the cultural elements that will be created within the space. The application of the zig-zag shape from the rebung tapis pattern is also applied to the paving design and the ornaments within it. The created transformations are applied both visually and spatially. The application of the tapis pattern in design can be seen in Figure 1 section (b).

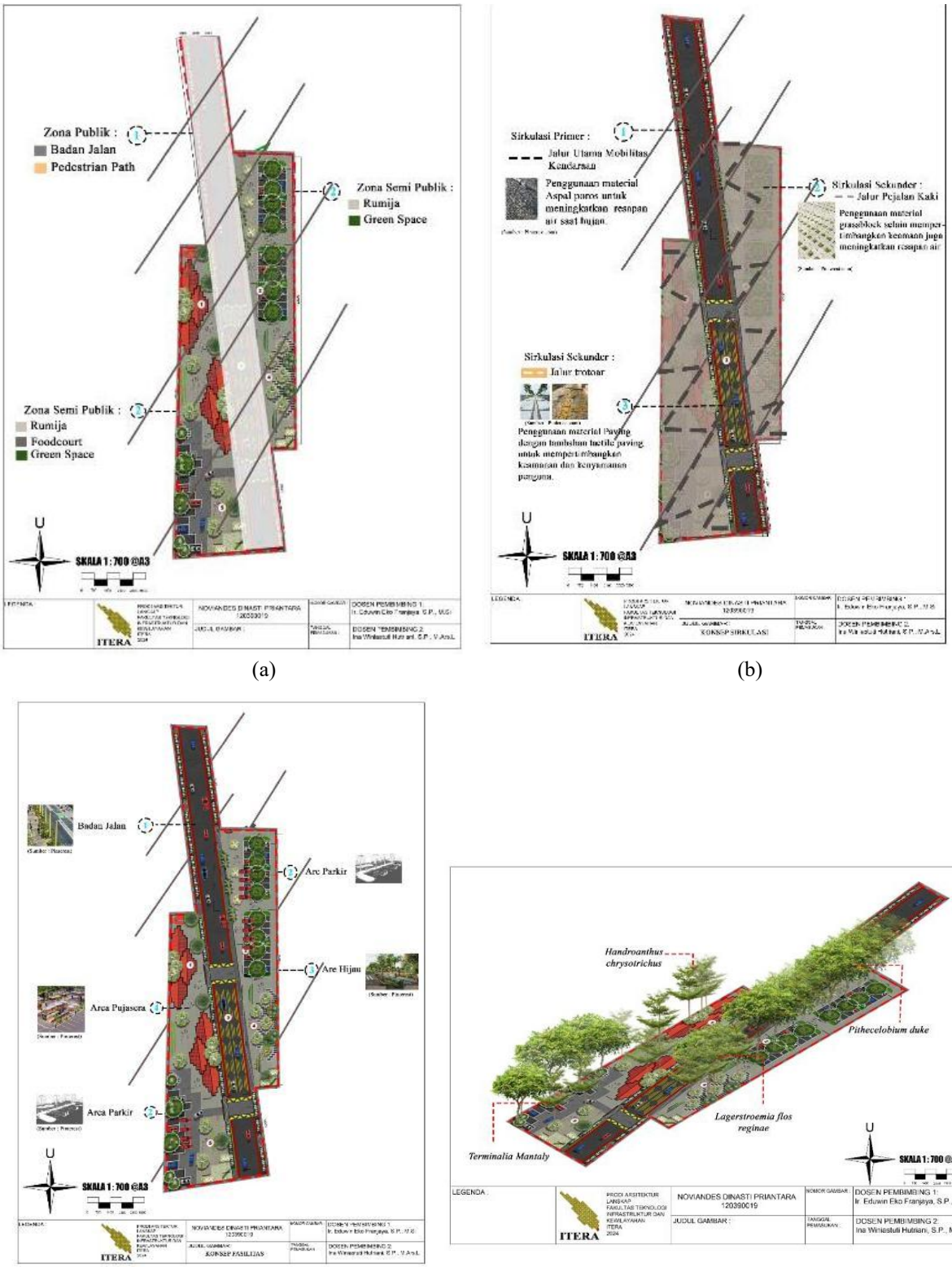


(a) (b)

Figure 1. (a) Supporting Concept and (b) Transformation of the Motif Shape of Tapis in design (source: author)

- **Concept of Development Plan**
  The zoning plan in the area is determined by the area size, surrounding activities, and spatial needs of the users. The zoning division on the site is categorized into public and semi-public areas. The zoning concept of the design can be seen in Figure 2 part (a).
- **Accessibility and Circulation Plan**
  The concept of circulation is divided into two, namely primary circulation and secondary circulation. Primary circulation refers to the roadway used as access for users' mobility. Meanwhile, secondary circulation is the circulation that accommodates pedestrians within the site area. The circulation concept map can be seen in Figure 2 part (b).
- **Space and Facility Plan**
  The spatial concept will be adjusted to the space requirements of the activities of users around the site. The existing activities have not yet been fully accommodated by the availability of space and its facilities. The spatial concept and facilities can be seen in Figure 2 part (c).
- **Vegetation Plan**

The selection of vegetation in its implementation in design can be derived from the patterns or shapes of the typical Lampung Banyan tree motifs. The selection of vegetation is adjusted to its arrangement as a visual aspect of the road landscape. For the selection of vegetation on the site, it is categorized into two areas, namely the pedestrian path and greenspace as shown in Figure 2 section (d).



(a) (b)

(c) (d)

Figure 2. (a) Zoning Plan Concept, (b) Concept of Circulation Plan, (c) Facility Plan Concept, and (d) Concept of Vegetation Planning (source: author)

3.7. Recommendation

Thus, these concepts become references in design planning. In the design concept that is created, the main objective is to create harmony between human needs, cultural preservation, ecosystem sustainability, and to create an engaging experience for users while traversing the area. The resulting design is divided into 4 spatial segments with visualizations of each segment shown in the image below.

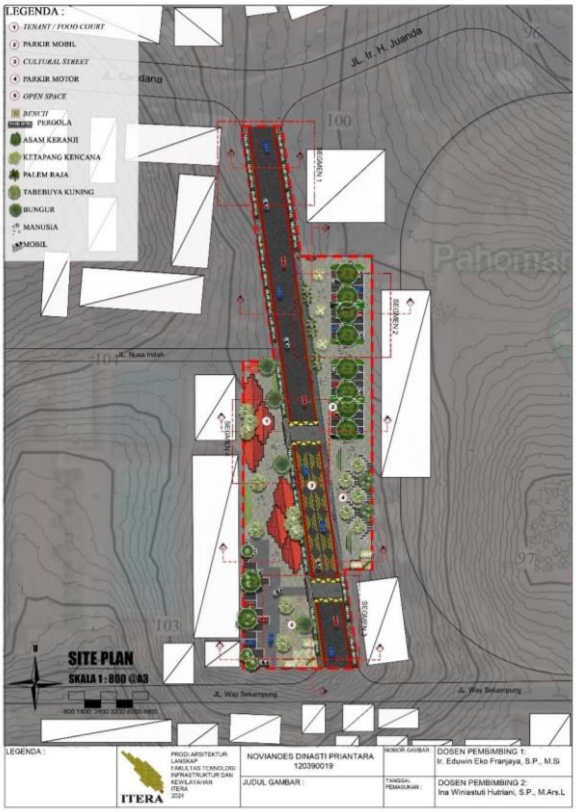
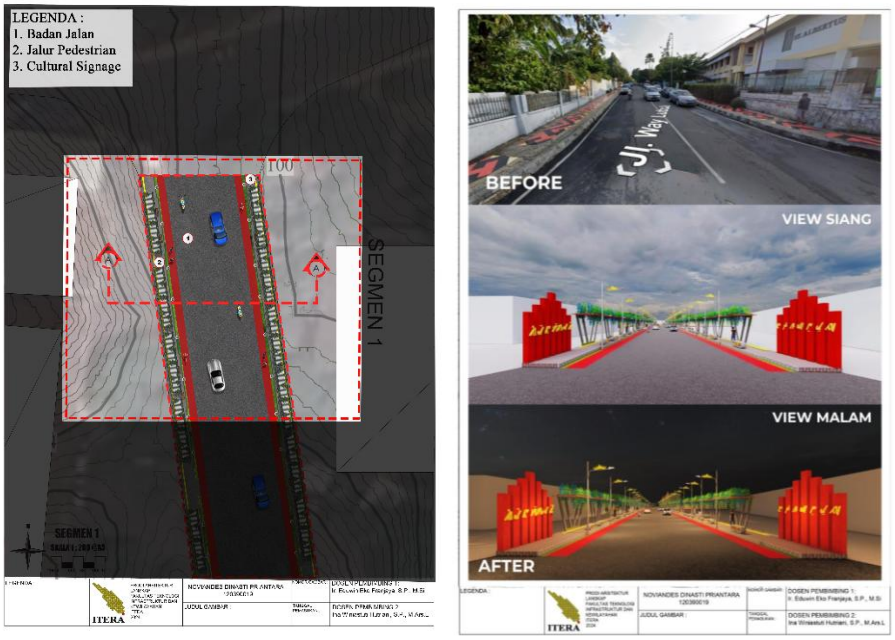


Figure 3. Final Siteplan (source: author)



(a) (b)

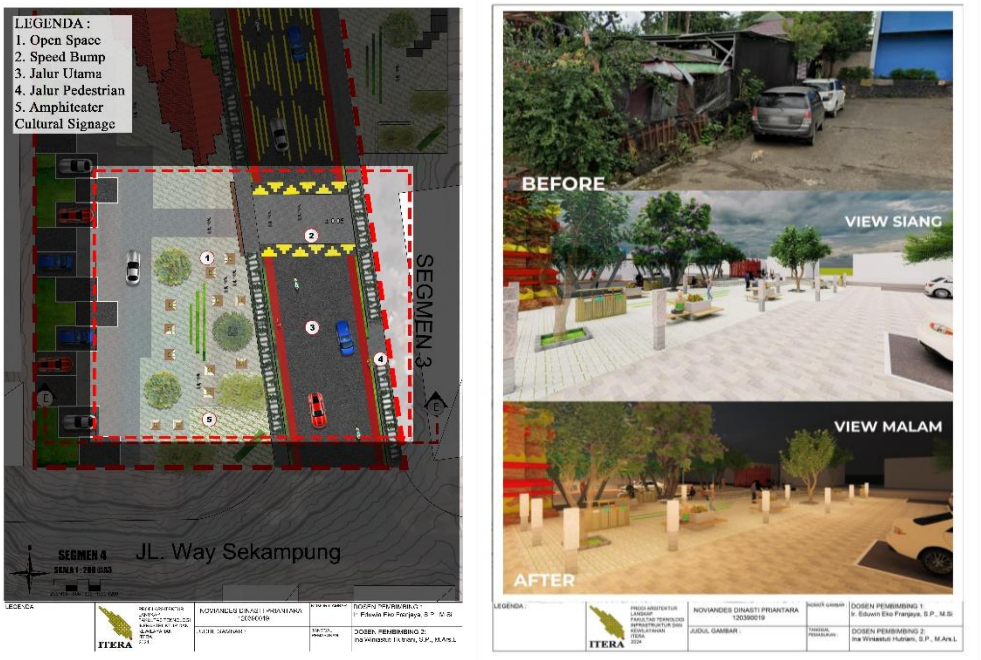
Figure 4. (a) Segment 1 Details and (b) Visualization of Segment 1 Perspective (source: author)

Segment 1 details are located on the road area on the northern side of the site, adjacent to the educational area which consists of vehicle lanes, pedestrian paths, bike lanes, and cultural open spaces covering an area of 977,631 m^2. To provide a clearer depiction of the situation in the design, the author presents the detailed perspective results of segment 1 taken from the north direction of the site.

(a) (b)

Figure 5. (a) Segment 2 Details and (b) Visualization of Segment 2 Perspective (source: author)

Detail segment 2 is the parking area which includes car parking, disability parking, and bicycle parking area. In addition, in the area of detail segment 2, there is a cultural open space area that provides visual signage for the Siger Tower of the Saibatin Tribe as a cultural hallmark. Detail segment 2 itself has a total area of 896,449 m^2.



(a) (b)

Figure 6. (a) Segment 3 Details and (b) Visualization of Segment 3 Perspective (source: author)

Segment 3 details are located on the southern side as the main access route to the area that is directly connected to Way Sekampung Road. The area of segment 3 consists of the main route, pedestrian way, entrance area to the food court, parking area, and cultural open space with a total area of 1,234,878 m^2.

(a) (b)

Figure 7. (a) Segment 4 Details and (b) Visualization of Segment 4 Perspective

The food court area itself can be seen in detail in segment 4, which is located on the eastern side and consists of tenants and a food court area with a total area of 953,420 m^2. From a visual perspective, segment 4 is the food court area on the western side of the site.

4. CONCLUSION

This research demonstrates that integrating Lampung Saibatin cultural motifs as generative design tools can effectively address spatial disorder, pedestrian safety issues, and cultural identity loss within a historic urban streetscape. The synthesis of qualitative analysis, SWOT strategy, and carrying capacity assessment resulted in a segmented streetscape design that balances cultural preservation, accessibility, and economic activity.

The novelty of this study lies in its applied methodological approach, which positions indigenous cultural motifs as drivers of spatial structure and user experience rather than decorative elements. By linking site constraints directly to design strategies, this research contributes a context-specific yet transferable model for culturally grounded streetscape design in historic urban areas. Future studies are encouraged to evaluate long-term social, cultural, and economic impacts following implementation.

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