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Effectiveness Of Building Openings In Achieving Thermal Comfort In Semi-Outdoor Spaces: A Case Study Of Taman Dayu Hotel, Indonesia

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Abstract
Thermal comfort in tropical hospitality buildings presents significant challenges due to persistently high temperatures and humidity levels. Semi-outdoor spaces, frequently integrated into hotel designs, rely primarily on natural ventilation and spatial openness to regulate environmental conditions. However, the effectiveness of building openings in supporting passive thermal performance varies depending on configuration, orientation, and airflow continuity. This study investigates the relationship between building opening configurations and measured thermal conditions across different spatial typologies at Taman Dayu Hotel, Indonesia. A field-based mixed-method approach was employed, combining quantitative environmental measurements with qualitative architectural analysis. Air temperature and relative humidity were recorded in indoor, semi-outdoor, and outdoor spaces, while opening size, distribution, cross-ventilation potential, and shading conditions were documented through direct observation. Comparative analysis was conducted to evaluate how spatial permeability and airflow pathways influence thermal performance. The findings indicate that semi-outdoor spaces with opposing openings and unobstructed airflow paths exhibit more stable and moderate thermal conditions compared to spaces with single-sided openings. Cross-ventilated corridors and restaurant areas demonstrate improved passive performance, while fully open zones without adequate radiation control record higher temperatures despite large opening areas. The results emphasize that opening size alone does not ensure thermal moderation; rather, effective airflow continuity, spatial configuration, and integration of shading strategies are critical in achieving passive thermal performance. This study provides empirical evidence supporting the optimization of opening design strategies in tropical hospitality architecture to reduce reliance on mechanical cooling systems.

Keywords: Building openings, Natural ventilation, Thermal comfort, Hotel.

INTRODUCTION

Tropical urban environments are increasingly exposed to rising temperatures and intensified heat stress, affecting both indoor and transitional building spaces. High humidity combined with limited air movement exacerbates thermal discomfort, particularly in naturally ventilated environments (Nur Azizah et al., 2025). Urban microclimatic degradation caused by dense built forms and reduced airflow further contributes to elevated thermal loads in outdoor and semi-outdoor spaces (Mosca et al., 2025).

Semi-outdoor spaces function as transitional climatic buffers between interior and exterior environments. Unlike fully enclosed indoor areas, these spaces are directly influenced by air temperature, humidity, solar radiation, and wind movement. Their environmental performance is therefore strongly determined by spatial configuration and permeability. Studies conducted in tropical Singapore demonstrate that increased perimeter openness and spatial porosity significantly enhance airflow velocity and improve thermal moderation in semi-outdoor environments (Gamero-Salinas et al., 2022). Vertical and horizontal breezeways, characterized by well-oriented and unobstructed openings, were identified as among the most effective typologies for promoting continuous air movement.

Similar findings have been reported in traditional semi-open residential alleys in China, where highly permeable configurations facilitate stable airflow distribution under warm–humid conditions (Ma et al., 2025). However, openness alone does not universally guarantee optimal thermal conditions. Research on university building retrofits indicates that reducing excessive openness during cooler periods can stabilize internal temperatures and improve environmental performance (Ge et al., 2025).

These findings suggest that the effectiveness of openings depends not only on size but also on configuration, orientation, and seasonal adaptability.

Beyond permeability, geometric characteristics such as building orientation and vertical clearance significantly influence airflow preservation and heat accumulation. Wind-aligned openings have been shown to maintain higher air velocity compared to misaligned layouts (Azad & Karimimoshaver, 2025), while insufficient ceiling height may contribute to thermal buildup despite large opening areas. In addition, shading elements and vegetation integration play essential roles in reducing solar radiation and moderating outdoor thermal stress (Mosca et al., 2025; Priandani et al., 2024).

Natural ventilation remains one of the most important passive cooling strategies in tropical architecture. Nevertheless, empirical evidence suggests that the number of openings alone does not determine ventilation effectiveness; rather, the distribution of inlets and outlets and the continuity of airflow paths are more decisive factors (Nur Azizah et al., 2025; Özer, 2025). Field-based evaluations of outdoor and transitional environments further confirm that airflow and radiant control jointly shape perceived thermal conditions (Eslamirad et al., 2022).

Despite the growing body of research on semi-outdoor thermal performance, most studies focus on residential buildings, educational campuses, or urban public spaces. Limited research has specifically examined the relationship between building opening configurations and thermal conditions in operational hospitality environments located in hot–humid climates. Hotel buildings present unique spatial typologies and semi-outdoor transitional zones that may respond differently to passive ventilation strategies.

Therefore, this study investigates the effectiveness of building openings in influencing thermal conditions across various spatial types at Taman Dayu Hotel, Indonesia. By combining field measurements with architectural analysis of opening configurations, this research aims to identify how spatial permeability, orientation, and cross ventilation potential contribute to passive thermal performance in tropical hospitality buildings.

Literature Review

Semi-Outdoor Spaces and Microclimatic Performance

Semi-outdoor spaces serve as transitional zones that mediate environmental exchange between indoor and outdoor conditions. Unlike fully enclosed indoor spaces, these environments are directly influenced by air temperature, humidity, solar radiation, and wind movement. Their thermal performance depends largely on spatial openness and environmental exposure.

Research in tropical Singapore shows that spatial porosity and perimeter openness significantly increase airflow velocity in semi-outdoor environments (Gamero-Salinas et al., 2022). Spaces designed with unobstructed breezeways and well-oriented openings demonstrate enhanced air circulation compared to partially enclosed configurations. Similar findings are reported in traditional semi-open alley structures in China, where permeable layouts facilitate stable airflow distribution under warm–humid conditions (Ma et al., 2025).

However, openness must be balanced with environmental control. A university building retrofit study found that reducing excessive openness during cooler periods contributed to improved indoor thermal stability (Ge et al., 2025). These findings indicate that effective semi-outdoor design requires adaptable permeability rather than maximum exposure.

Experimental investigations in semi-open environments also demonstrate that environmental modification strategies can influence thermal perception and spatial usability, highlighting the dynamic nature of semi-outdoor thermal conditions (Gao et al., 2023).

Building Geometry, Orientation, and Airflow Preservation

Building geometry plays a crucial role in determining airflow continuity and heat accumulation. Wind tunnel studies demonstrate that building orientation aligned with prevailing wind direction significantly improves airflow preservation compared to misaligned configurations (Azad & Karimimoshaver, 2025).

Vertical clearance and spatial proportions also affect heat dissipation. Geometry has been shown to significantly influence thermal comfort in semi-outdoor environments. A large-scale study of 20 courtyards in Southern Spain demonstrated that higher aspect ratios were associated with increased comfort hours, with AR values above 3 achieving up to 90–100% thermal comfort during summer periods (Diz-Mellado et al., 2023). Elevated open structures with insufficient ceiling height may experience thermal buildup despite having large openings (Ma et al., 2025). Additionally, research on window opening ratios confirms that ventilation performance is influenced not only by opening size but by airflow pathways and inlet–outlet balance (Özer, 2025).

Empirical studies in tropical residential contexts further support this conclusion, revealing that window quantity alone does not ensure effective ventilation without proper spatial configuration (Nur Azizah et al., 2025). Computational analyses of ecological building envelopes further indicate that façade configuration and surface treatment significantly affect outdoor and transitional thermal environments (Mosca et al., 2025).

A hybrid evaluation of building orientation in semi-arid climates demonstrated that integrating objective (PMV) and subjective (TSV) approaches provides a more accurate assessment of indoor thermal comfort, and identified east-facing orientation as a consistently favorable option across seasons (Muhy Al-Din et al., 2023).

Shading, Vegetation, and Radiation Control

Solar radiation significantly influences thermal conditions in semi-outdoor environments. Vegetation, roof overhangs, and shading devices have been shown to reduce local heat accumulation and moderate outdoor thermal stress (Mosca et al., 2025). Research on naturally ventilated office environments further emphasizes the importance of airflow and shading integration in maintaining acceptable indoor environmental conditions (Zaraa Allah et al., 2023).

Field-based research in humid tropical public spaces demonstrates that shaded areas with tree canopies exhibit improved environmental conditions compared to fully exposed areas (Priandani et al., 2024). These findings highlight that ventilation strategies must be integrated with radiation control to achieve optimal thermal moderation. Field-based investigations in tropical residential buildings further demonstrate that hybrid attic ventilation combining mechanical and natural airflow over a 24-hour cycle can reduce indoor temperature by approximately 1°C and decrease relative humidity while achieving measurable energy savings (Moharrami et al., 2025).

Furthermore, building envelope performance affects radiant heat exchange and perimeter thermal conditions (Kim et al., 2025). Recent computational studies in dual-seasonal climate zones further demonstrate that integrating phase change materials (PCM) into middle and inner wall layers can reduce total energy consumption by up to 47–56% when phase transition temperatures are optimized between 15–20°C (Tian et al., 2025). The study also confirms that inner-layer placement achieves the highest reduction in heating load, while mid-layer placement provides balanced seasonal performance. Semi-outdoor environments that lack adequate shading or surface protection may experience increased thermal exposure despite having high airflow potential.

Field-Based Evaluation of Transitional Spaces

Field measurement remains an essential method for evaluating environmental performance in transitional and semi-outdoor environments. Studies conducted in educational and campus settings demonstrate that airflow, shading, and spatial openness significantly influence observed thermal conditions (Eslamirad et al., 2022; Maharani & Prianto, 2022).

Research in naturally ventilated office environments further indicates that occupants demonstrate adaptive responses to fluctuating thermal conditions, reinforcing the importance of context-sensitive passive design strategies (Zaraa Allah et al., 2023).

Experimental studies on semi-open environments also show that environmental conditions are dynamic and influenced by airflow modulation and exposure duration (Gao et al., 2023). These findings support the use of field-based environmental measurement combined with spatial analysis when evaluating passive ventilation effectiveness.

Experimental evidence further confirms that indoor transition spaces significantly influence both physiological and psychological responses during summer exposure. (Zhong & Meng, 2025) demonstrated that transition space temperatures around 27°C reduced mean skin temperature decline and improved thermal comfort votes compared to lower or higher step changes. Their findings suggest that transitional zones should not be excessively cooled, as moderate buffering temperatures provide better adaptive comfort responses.

Although previous studies have examined semi-outdoor performance in residential, campus, and public environments, limited research specifically addresses the interaction between opening configuration and measured thermal conditions in operational hotel buildings. This gap highlights the need for empirical field-based evaluation in hospitality contexts, which forms the focus of this study.

RESEARCH METHODS

Research Design

This study adopts a field-based mixed-method research approach combining quantitative environmental measurements and qualitative architectural analysis. The quantitative component focuses on measuring environmental parameters in selected semi-outdoor spaces, while the qualitative component evaluates the configuration of building openings and spatial characteristics influencing airflow performance.

Field-based measurement was selected because semi-outdoor environments are directly influenced by dynamic microclimatic conditions, including temperature, humidity, solar exposure, and wind movement. Direct observation and on-site monitoring enable accurate evaluation of environmental performance in operational hospitality settings. Similar mixed-method approaches integrating field measurement, surveys, and environmental simulation have been successfully applied in outdoor thermal comfort assessment studies (Eslamirad et al., 2022).

The research process follows a sequential structure consisting of: (1) problem identification and literature synthesis, (2) case study selection, (3) environmental data collection, (4) building opening configuration analysis, and (5) interpretation of thermal conditions in relation to spatial characteristics. The methodological framework of the study is illustrated in Figure 1.

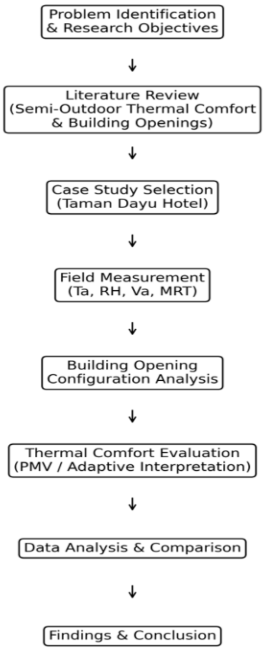

Figure 1. Research framework and methodological stages of the study.
Source: Authors (2026).

Figure 1 presents the systematic stages undertaken in this research. The study begins with identifying the research objectives and reviewing relevant literature on semi-outdoor thermal performance and building openings. Taman Dayu Hotel was then selected as the case study. Environmental measurements were conducted in various spatial typologies, followed by analysis of opening configurations including size, orientation, and cross ventilation potential. The final stage involves interpreting measured environmental conditions to evaluate the effectiveness of passive ventilation strategies in semi-outdoor hospitality spaces.

Study Area and Spatial Typology

The research was conducted at Taman Dayu Hotel, Indonesia, located in a tropical climate characterized by high temperatures and humidity levels throughout the year. The study focuses on different spatial typologies within the hotel, including indoor rooms, semi-outdoor corridors, balconies, lounge areas, restaurant areas, gym spaces, and fully outdoor zones.

These spaces were selected due to their varying degrees of openness, enclosure, and exposure to environmental factors. The variation in opening configuration allows comparative analysis of how spatial permeability influences airflow and thermal conditions.

Each space was categorized based on:

- Degree of enclosure (indoor, semi-outdoor, outdoor)
- Type of opening (single-sided, cross ventilation, fully open)
- Approximate opening area
- Orientation and shading condition

This classification supports structured evaluation of opening effectiveness across different spatial contexts.

Environmental Data Collection

Environmental measurements were conducted to record:

- Air temperature (°C)
- Relative humidity (%)

Measurements were taken during daytime operational hours to represent realistic thermal exposure conditions experienced by hotel users. Data were collected in each spatial zone and averaged to determine representative thermal conditions for comparison.

Observations were also conducted to document:

- Opening configuration
- Airflow direction (qualitative observation)
- Presence of shading elements
- Ceiling height and spatial proportions

This experimental structure is conceptually aligned with previous transition-space studies that simulated outdoor–transition–indoor thermal sequences to examine dynamic physiological and subjective responses (Zhong & Meng, 2025). Similar monitoring strategies have been applied in outdoor thermal comfort studies to capture environmental variations across different spatial configurations (Priandani et al., 2024).

Building Opening Configuration Analysis

- The analysis of building openings focused on:
- Opening size and estimated area
- Position and distribution of openings
- Presence or absence of cross ventilation
- Relationship between openings and adjacent outdoor spaces
- Shading and protective architectural elements

Cross ventilation potential was identified when openings were located on opposing sides of a space, allowing continuous airflow across the interior. Single-sided openings were classified as limited ventilation configurations.

This analytical framework enables evaluation of how spatial permeability and airflow pathways influence recorded thermal conditions.

Data Interpretation Approach

Measured temperature and humidity data were analyzed comparatively across spatial categories. Thermal conditions were interpreted based on typical comfort expectations for naturally ventilated tropical environments.

Rather than relying solely on opening size, the analysis emphasizes the relationship between airflow continuity, orientation, shading, and observed temperature differences. Comparative interpretation was conducted to determine which spatial configurations demonstrated more stable and moderate thermal conditions.

The results are presented in tabular and visual form in the following section, followed by discussion relating environmental performance to opening configuration and spatial design characteristics.

RESULTS AND DISCUSSION

Analysis of Building Openings and Thermal Conditions

This study examines the relationship between building opening configurations and thermal comfort across various spatial typologies at Taman Dayu Hotel. The measured temperature and humidity data indicate that spaces with large, opposing openings that enable cross ventilation exhibit more stable temperatures and relatively controlled humidity levels, particularly in semi-outdoor areas.

The effectiveness of natural ventilation has been widely associated with spatial permeability and airflow continuity in tropical environments (Gamero-Salinas et al., 2022). Similarly, studies on semi-open alley configurations demonstrate that air circulation potential increases significantly in spaces that allow uninterrupted cross ventilation (Ma et al., 2025). The findings of this study align with these observations.

Table 1 summarizes spatial categories, opening configurations, measured opening areas, and recorded average thermal conditions.

Table 1. Summary of Opening Analysis and Thermal Conditions

Space Name	Space Type	Type of Opening	Opening Area (m^2)	Average Temperature (°C)	Average Humidity (%)	Effectiveness Notes
Hotel Room	Indoor	Single-sided windows + glass door to balcony	±4.0	24.5	67.5	Openings are relatively large but limited to one side; restricted airflow
Room Balcony	Semi-Outdoor	Large glass door + open corridor side	±3.0	25.4	86.0	Good air circulation; high humidity
Hotel Corridor	Semi-Outdoor	Open on two sides	±10.0	28.8	75.5	Cross ventilation highly effective
Lounge	Semi-Outdoor	Open façade facing outdoors	±6.0	32.0	65.0	Direct exposure results in higher temperature

Restaurant Area	Semi-Outdoor	Fully open without walls	±8.0	29.0	72.2	Maximum openness; relatively comfortable temperature
Gym Area	Semi-Outdoor	No glazing, open with louvers	±6.0	31.0	65.0	Open airflow; temperature remains high due to low ceiling height
Playground & Outdoor Area	Outdoor	Without walls	–	30.0–30.5	72.0–72.5	Fully exposed to outdoor environment

Source: Temperature and humidity measurements and field observation documentation, May 2025.

Table 1 indicates that cross-ventilated semi-outdoor spaces such as the corridor and restaurant area demonstrate more optimal airflow performance. This confirms that opening configuration, rather than opening size alone, determines ventilation effectiveness. Previous research also suggests that window quantity does not necessarily correlate with improved thermal comfort unless supported by effective airflow pathways (Nur Azizah et al., 2025).

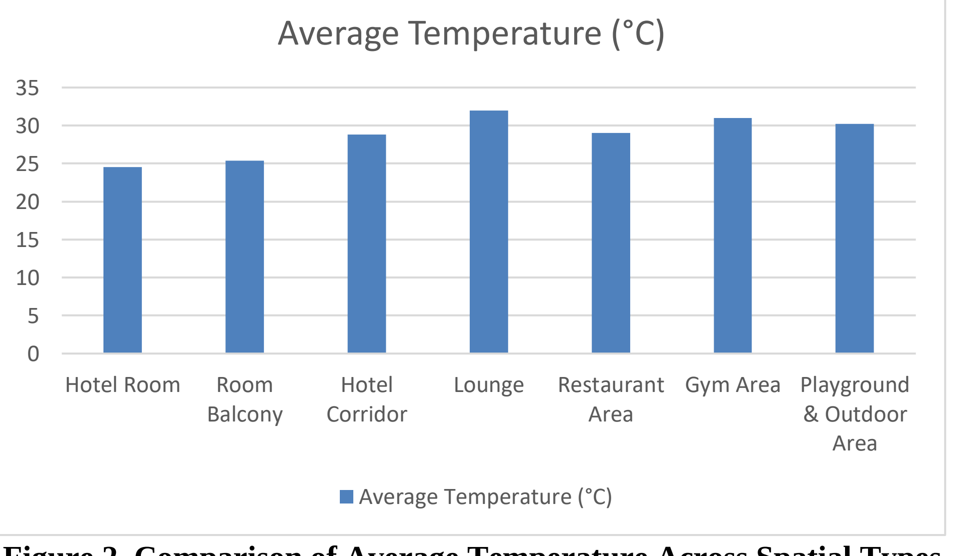

Figure 2. Comparison of Average Temperature Across Spatial Types (Source: Field measurement data, May 2025).

Figure 2 illustrates the variation in average temperature across different spatial types within the Taman Dayu Hotel complex. Indoor spaces, particularly the hotel room, recorded the lowest average temperature (24.5°C), primarily due to the operation of air-conditioning systems. In contrast, semi-outdoor and outdoor areas exhibited higher temperature ranges, with the lounge area reaching the highest average temperature (32.0°C). Transitional spaces such as the corridor and restaurant demonstrated relatively moderate thermal conditions (28.8°C and 29.0°C respectively), indicating that cross-ventilation and partial shading contribute to thermal stabilization. Although the gym and lounge areas feature wide openings, their higher temperatures suggest that openness alone does not guarantee thermal comfort without adequate shading and vertical clearance. Overall, the figure confirms that spatial configuration and ventilation strategy significantly influence temperature distribution across different building zones.

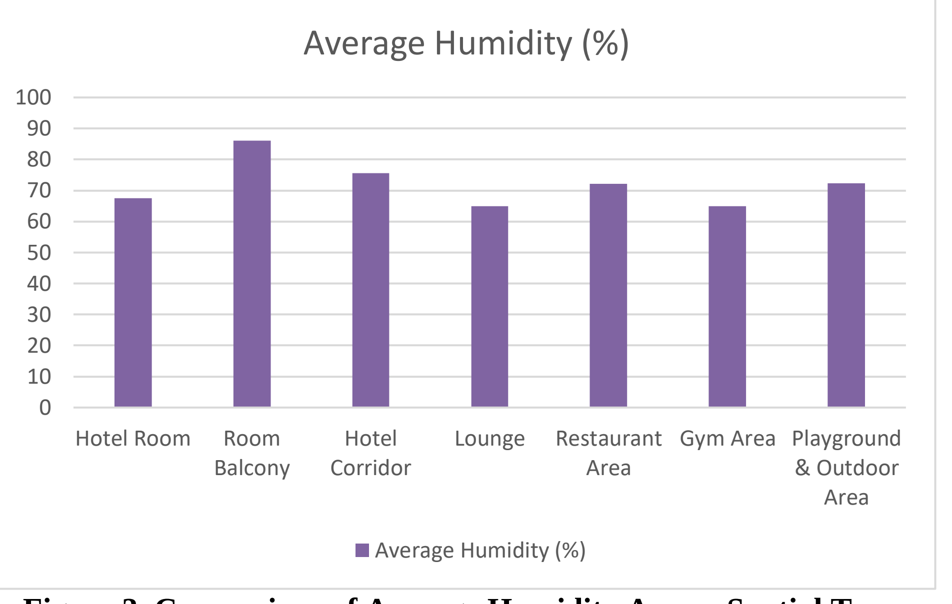

Figure 3. Comparison of Average Humidity Across Spatial Types
(Source: Field measurement data, May 2025)

Figure 3 presents the variation in average relative humidity across different spatial zones within the hotel complex. The semi-outdoor balcony recorded the highest humidity level (86.0%), reflecting its direct exposure to outdoor air and limited environmental control. The corridor and restaurant areas showed moderate humidity values (75.5% and 72.2%, respectively), indicating partial environmental buffering due to shading and airflow continuity. In contrast, the indoor hotel room maintained a lower humidity level (67.5%) as a result of mechanical air-conditioning systems. Interestingly, the lounge and gym areas, despite being semi-outdoor and highly open, recorded relatively lower humidity values (65.0%), suggesting that air movement contributes to moisture dispersion. Overall, the figure demonstrates that humidity levels are strongly influenced by spatial enclosure, exposure degree, and ventilation effectiveness.

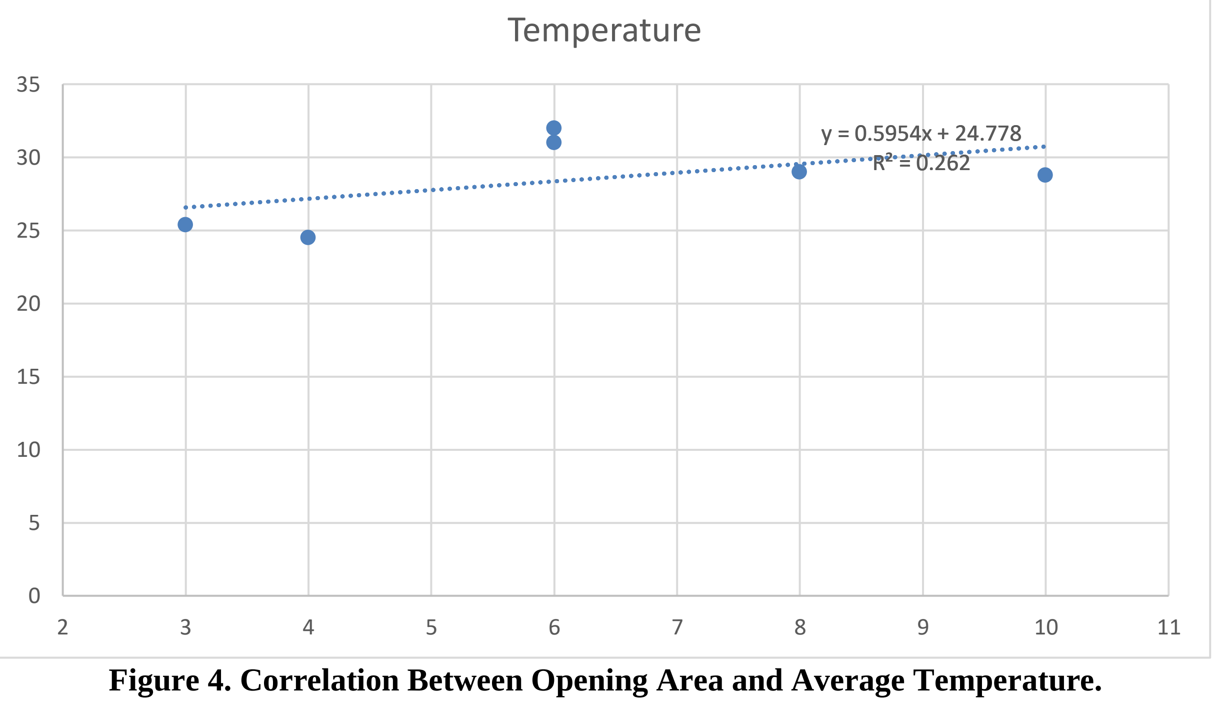

Figure 4. Correlation Between Opening Area and Average Temperature.
(Source: Field measurement data, May 2025).

Figure 4 presents the correlation between opening area and the recorded average temperature across selected spatial zones. The analysis indicates a weak to moderate positive correlation ($R^2 = 0.262$), suggesting that the size of openings alone does not significantly determine thermal conditions. Although larger openings theoretically promote increased airflow, the observed data demonstrate that temperature variation is influenced by multiple interacting factors, including shading elements, ceiling height, solar exposure, and cross-ventilation configuration. For example, the corridor, which has the largest opening area, exhibited relatively moderate temperatures, while the lounge and gym areas, despite having substantial openings, recorded higher thermal values. These findings reinforce that effective passive cooling strategies depend not only on opening magnitude but also on spatial orientation and environmental buffering strategies.

Indoor Space: Hotel Room Configuration

Figure 5. Windows and Glass Door in the Hotel Room
(Source: Field documentation, 2025)

Figure 5 illustrates the configuration of openings in one of the hotel rooms, consisting of two corner windows and a large glass door leading to the balcony. Although visually the room appears to have multiple openings, the lack of opposing inlets and outlets prevents effective cross ventilation. This configuration reflects findings from ventilation optimization studies, which indicate that airflow effectiveness depends on inlet–outlet balance rather than total opening area (Özer, 2025). Without mechanical cooling, such a configuration would likely struggle to maintain indoor comfort conditions.

Semi-Outdoor Corridor Performance

Figure 6. Corridor Openings Leading to the Communal Balcony
(Source: Field documentation, 2025)

The corridor area is open on multiple sides, enabling cross airflow between the communal balcony and adjacent circulation zones. Spaces designed with orientation aligned to prevailing wind directions have been shown to preserve airflow velocity more effectively (Azad & Karimimoshaver, 2025).

Although partially enclosed by solid walls, the corridor demonstrates improved passive cooling due to strategically positioned openings. This supports previous evidence that permeability and orientation significantly influence airflow performance in transitional environments (Gamero-Salinas et al., 2022).

Semi-Outdoor Restaurant Area

Figure 7. Semi-Outdoor Restaurant Area Without Enclosing Walls
(Source: Field documentation, 2025)

The restaurant area is fully open without enclosing walls and oriented toward an expansive outdoor landscape. This configuration allows continuous horizontal airflow, which contributes to relatively stable thermal conditions.

Outdoor comfort research demonstrates that shading elements and open configurations reduce thermal stress when properly oriented (Priandani et al., 2024). The wide roof in this case functions as a radiation control element while maintaining ventilation potential.

Gym Area: Louvers and Thermal Accumulation

Figure 8. Louvers in the Semi-Outdoor Gym Area
(Source: Field documentation, 2025)

Despite the presence of wide louvered openings, the gym area recorded temperatures reaching 31°C. This condition highlights that ventilation alone may not sufficiently reduce thermal accumulation. This finding indicates that spatial configuration must be supported by envelope performance and vertical air displacement strategies. Previous studies on elevated open structures and building thermal performance indicate that vertical clearance and envelope characteristics significantly influence heat accumulation in semi-open environments (Kim et al., 2025; Ma et al., 2025)

Microclimate simulation studies indicate that vegetation, shading devices, and envelope treatment significantly influence thermal moderation (Mosca et al., 2025). Similar findings who confirmed that optimized vegetation distribution based on generative algorithms produced measurable reductions in UTCI values across different urban morphologies (Maged et al., 2025). Additionally, elevated open structures with insufficient vertical clearance may experience heat retention (Ma et al., 2025)

Thus, the gym example reinforces that passive ventilation must be integrated with radiation control strategies.

Lounge Area: Openness Without Solar Protection

Figure 9. Semi-Outdoor Lounge Area Facing the Pool
(Source: Field documentation, 2025)

Although the lounge area is fully open and supported by structural columns only, recorded temperatures reached 32°C. This finding suggests that high openness without adequate solar protection may increase radiant heat exposure. Comparable trends have been observed in urban microclimate simulations, where fully exposed configurations recorded higher thermal stress compared to shaded environments (Mosca et al., 2025). Empirical measurements in humid tropical outdoor spaces confirm that shaded areas consistently recorded lower air temperatures and humidity levels compared to unshaded open spaces (Sitorus et al., 2023).

Adaptive comfort studies indicate that airflow improves tolerance ranges, but excessive radiant gain can offset ventilation benefits (Zaraa Allah et al., 2023). Therefore, balancing openness with shading is essential.

Building Mass and Passive Ventilation Strategy

Figure 10. Building Mass of the Superior Twin Hotel Room Type
(Source: Field documentation, 2025)

The building massing features a central open recess that enhances air movement between building segments. Transitional voids in building massing have been shown to facilitate airflow distribution and daylight penetration in semi-outdoor contexts (Eslamirad et al., 2022).

This architectural configuration supports passive ventilation strategies and reinforces the semi-outdoor character of circulation spaces.

CONCLUSIONS

This study investigated the relationship between building opening configurations and thermal comfort performance in semi-outdoor spaces at Taman Dayu Hotel, Indonesia. The findings demonstrate that the effectiveness of natural ventilation is strongly influenced not only by the size of openings but primarily by their spatial configuration, orientation, and ability to facilitate cross ventilation.

Semi-outdoor spaces designed with opposing openings and unobstructed airflow paths exhibited more stable thermal conditions compared to spaces with single-sided openings. Cross-ventilated areas such as corridors and the restaurant space showed improved air circulation and relatively controlled temperatures despite the absence of mechanical cooling systems. Conversely, spaces that relied solely on large openings without considering airflow continuity or solar protection recorded higher temperatures, indicating that openness alone does not guarantee thermal comfort.

The results further highlight that passive ventilation strategies must be integrated with additional architectural considerations, including shading devices, roof overhangs, vegetation, ceiling height, and building mass configuration. Semi-outdoor lounge and gym areas demonstrated that without adequate radiation control and vertical air displacement potential, thermal accumulation may still occur even in highly permeable spaces.

In indoor hotel rooms, thermal comfort was primarily maintained through mechanical cooling, as the opening configuration did not support effective cross ventilation. This condition underscores the importance of designing balanced inlet–outlet airflow systems when aiming to reduce dependency on air conditioning in tropical hospitality buildings.

Overall, this study confirms that strategic placement and orientation of openings significantly enhance passive thermal performance in tropical semi-outdoor environments. The findings contribute to the development of passive design guidelines for hospitality buildings in warm–humid climates, emphasizing that optimal thermal comfort is achieved through the integration of airflow management, spatial configuration, and solar protection rather than through opening size alone. These findings reinforce the importance of integrating airflow strategy with radiation control and spatial configuration in tropical semi-outdoor architecture.

This study provides empirical field evidence that spatial configuration of openings plays a more critical role than opening size alone in achieving passive thermal performance in tropical hotel buildings.

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