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Temporal Urbanism in the Passive–Active Dynamics of Pedestrian Behavior along Piere Tendean Street, Manado City

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Abstract

The Piere Tendean Street corridor in Manado City lies within a high-intensity coastal commercial area, yet its pedestrian streetscape quality does not yet provide adequate comfort. The scarcity of vegetation and dominance of hardscape have led to a decline in pedestrian activity, while coastal climate also influences the comfort of public space use according to time of day. This study aims to identify the phenomenon of temporal urbanism through the distribution of vegetation and activity centers in shaping the passive-active dynamics of human behavior along the corridor. The method used is a qualitative-explorative approach through temporal-behavioral mapping and visual documentation of vegetation at two observation periods, 11:00–13:00 and 16:00–19:00 WITA, to analyze the relationship between the corridor's physical conditions, temporal rhythm of space use, and users' behavioral adaptation. Results show that existing vegetation has not formed continuous functional shade, causing users to move directly toward shopping centers at midday without using transitional space. In the late afternoon, as building shadows lengthen and comfort increases, the corridor transforms into an active social space marked by gathering points, sports activities, and informal interaction. The overlay map confirms that pedestrian behavior is shaped by the temporal relationship between shade, coastal visual access, and spatial configuration, not commercial function alone. The study concludes that coastal corridor design requires a time-inclusive streetscape approach, with local vegetation and community interaction spaces as the basis for design recommendations.

Keywords: Coastal street corridor, pedestrian behavior, streetscape, temporal urbanism, thermal comfort

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Introduction

The success of urban public spaces is evaluated not only in terms of visual aesthetics but also by their capacity to accommodate social interaction among community members throughout the day (Carmona 2021; Gehl 2011). Urban green spaces and green corridors are recognized as essential infrastructure for assessing quality of life, public health, social cohesion, and urban sustainability (Zhang and Kiyai 2024). In the context of street corridors, a successful streetscape must accommodate community activities and provide visual and spatial comfort through the integration of functional, ecological, social, and economic considerations (Fachrudin, Karolina, and Misnan 2025). The literature also emphasizes that vegetation along pedestrian routes, pedestrian connectivity, street furniture, and drainage constitute ecological and operational components that directly influence walkability. In coastal areas, these challenges become more complex because corridors must simultaneously function as mobility links, spaces for social interaction, representations of urban identity, and ecological thresholds that are sensitive to heat, surface runoff, and coastal hazards (Egam et al. 2026; Wuisang et al. 2023). Accordingly, coastal streetscapes must be designed not only in terms of their physical characteristics but also with regard to their social, economic, and cultural dimensions and the exposure of the landscape to the coastal environment (Egam et al. 2026; Chen and Wang 2020).

The Piere Tendean Street corridor represents the urban image of Manado City because it forms part of the B on B (Boulevard on Business) district, which has experienced rapid economic and architectural growth, although its coastal identity has not yet been fully optimized (Egam et al. 2024). The corridor provides direct access to Manado Bay and accommodates a wide range of activities, including business, sports, recreation, and waterfront activities. Nevertheless, the organization and comfort of pedestrian spaces have not kept pace with the intensity of their use (Egam et al. 2024). The principal gap lies in the absence of streetscape planning that explicitly addresses the temporal phenomena occurring along Piere Tendean Street. Existing studies of coastal areas and green spaces have primarily examined identity, ecological quality, or user preferences. However, the ways in which temporal rhythms, building shadows, and vegetation distribution influence the production of public space particularly pedestrian environments that may remain passive during the day but become active in the late afternoon have received comparatively little attention (Egam et al. 2026; Lourdes et al. 2021; Zhang and Kiyai 2024).

Street corridors, particularly those in coastal settings, are not merely spaces for movement; they are living landscapes that must preserve visual access to the sea, the identity of the coastal city, social functions, and thermal comfort within a unified design system (Egam et al. 2026; Chen and Wang 2020). Studies of coastal landscapes indicate that planting configurations in coastal cities must account for biodiversity, visual expression, and synchronization with the surrounding environment to improve ecological quality while enhancing the quality of spatial experience (Chen and Wang 2020).

The selection of roadside vegetation should not be treated as a purely cosmetic decision. Species selection must be based on structural criteria, climatic requirements, and the use of local species that reflect the identity of the place (Guneroglu, Bekar, and Kaya Sahin 2019). In urban coastal landscapes, the most prominent criteria include urban tolerance, landscape effects, and ecological suitability. By contrast, the use of exotic species that are inappropriate for the local context can result in compositions that are functionally weak and inconsistent with local identity (Kahveci and Acar 2021).

From a social perspective, the management of inclusive green spaces and public corridors requires sustained user participation rather than merely temporary use (Fors et al. 2021). This principle is particularly relevant to Manado City, where coastal corridor design that emphasizes aesthetics without accommodating the rhythms of residents' activities risks reproducing patterns of tokenism: spaces may appear orderly but fail to function comfortably and inclusively throughout the day (Fors et al. 2021; Zhang and Kiyai 2024). Against this background, this study aims to: (1) identify the relationship between vegetation distribution and spatial comfort along the pedestrian route of Piere Tendean Street; and (2) map the passive–active dynamics of pedestrian behavior between daytime and the late afternoon–evening period, thereby establishing a foundation for developing coastal street corridor designs that are responsive to time, grounded in local identity, and suitable for further research in coastal landscape architecture (Egam et al. 2024; 2026; Wuisang et al. 2023).

Theoretical framework

Temporal urbanism conceptualizes urban space as a system that changes according to temporal rhythms. Consequently, the functions of public spaces are not fixed but are produced through the relationships among activities, light, temperature, and users' habits. A coastal commercial corridor can therefore be understood as a space whose intensity of use changes over time rather than as a static physical form. This approach is consistent with the argument that streets are public spaces in which diverse activities take place and that the visual experience of streets influences public health, economic activity, sustainability, and urban aesthetic quality (Egam et al. 2026).

Sustainable streetscape theory holds that corridor quality is determined by four interrelated aspects: functional, ecological, social, and economic considerations (Fachrudin, Karolina, and Misnan 2025). In urban applications, these aspects are expressed through pedestrian-path dimensions and materials, vegetation, drainage, connectivity between pedestrian routes, facilities for people with disabilities, and opportunities for formal and informal activities along streets (Fachrudin, Karolina, and Misnan 2025). In coastal landscape architecture, design theory emphasizes coastal exposure, the optimization of economic space, and the creation of a social street as three principal dimensions of corridor planning (Egam et al. 2026). Unobstructed access to sea views, open public spaces, and the distribution of activities that enable residents to enjoy the coastline are

essential conditions for ensuring that coastal identity is not obscured by commercial buildings. Vegetation-selection theory further strengthens the operational dimension of this framework. Roadside planting requires quantitative assessment to ensure that selected species are appropriate for available spatial dimensions, climatic requirements, local identity, and long-term ecological performance (Guneroglu, Bekar, and Kaya Sahin 2019). In coastal corridors, important criteria include urban tolerance, landscape effects, shading functions, and the capacity to enrich the character of a place (Kahveci and Acar 2021). Sociocultural considerations are also essential because effective green architecture must align with local identity, social needs, and participatory design processes (Iwuanyanwu 2024]. The revitalization of open spaces in Batam demonstrates that the synergy among local culture, vegetation, climate-responsive design, and inclusive access can produce public spaces that are ecologically sound while strengthening urban identity (Nursyamsu, Christine, and Suwarlan 2025).

Table 1
Relevant previous studies

Research focus	Key findings	Relevance to Piere Tendean
Green spaces and quality of life	Green spaces improve health, social cohesion, sustainability, and even urban economic value (Zhang and Kiyai 2024).	Emphasizes the importance of coastal green corridors as public infrastructure.
Coastal streetscape of Piere Tendean	The corridor constitutes Manado's waterfront central business district (CBD), but its coastal identity has not been fully optimized (Egam et al. 2024).	Provides the contextual foundation for the study.
Sustainable commercial streetscapes	Commercial corridor design must integrate functional, ecological, social, and economic considerations (Fachrudin, Karolina, and Misnan 2025).	Provides the basis for the corridor evaluation indicators.
Green spaces along commercial routes and waterfronts	Green spaces should respond to pathway widths, incorporate local plants and universal design, and include community landmarks (Pachankoo and Shen 2024).	Informs recommendations for subsequent design development.
Long-term participation	User participation should be cyclical, adaptive, and connected to long-term urban strategies (Fors et al. 2021).	Is important for implementing policies in Manado.

Methods

This study employs a qualitative-exploratory approach using a case-study strategy focused on the Piere Tendean Street corridor in Manado City. This approach was selected because it enables the contextual investigation of public-space use patterns and the relationships between user behavior and the corridor's physical context through systematic observation and spatial interpretation. The Piere Tendean Street corridor was selected as the research site because it represents one of the most significant linear coastal public spaces reflecting the urban dynamics of Manado City.

Studies of linear spaces, such as waterfronts, emphasize that understanding pedestrian behavior is essential for explaining spatial dynamics, social interaction, and user experience within elongated urban environments. In this context, Piere Tendean can be understood as corridor that encapsulates the urban character of Manado City by integrating mobility, commerce, recreation, and social interaction within a single public-space network.

The primary method employed was behavioral mapping, a systematic observation technique used to document how people directly use their environments. This method enables researchers to record activity types, their locations, spatial distributions, movement patterns, and variations in space use in real time. These observations can subsequently explain whether a particular space supports or, conversely, constrains public activities. Data were collected through time-based, direct, non-participant observation. This approach is important in public-space research because the behaviors recorded are actual observed behaviors rather than merely behaviors reported by respondents. The observations were organized temporally by dividing the observation period into several time slots, allowing changes in the rhythms of corridor use to be identified. Studies employing behavioral mapping in public spaces generally compare morning, midday, afternoon, and evening conditions and distinguish between weekdays and weekends to capture variations in use patterns.

Results and discussion

Research site analysis

The site analysis of the sampled sections of the Piere Tendean Street corridor, including the section in front of the large shopping center, the shophouse-area section, and the open waterfront section, was conducted through a series of data-identification and analytical stages. These stages comprised identifying existing vegetation cover, documenting activities during the daytime, documenting activities during the late afternoon and evening, and conducting an integrated overlay analysis of the three datasets. The purpose was to examine the relationships between natural shading elements and the dynamics of space utilization.

Vegetation identification

At this stage, the types, quantities, and distributions of shading vegetation, including tree canopies, shrubs, and potted plants were documented along the three sampled sections. The identification process examined the position of vegetation relative to pedestrian pathways, distinguishing between vegetation that directly shaded sidewalks and vegetation located only along the road median. It also assessed canopy density and estimated the effective area covered by shade. The preliminary findings indicated that all three sections were dominated by hardscape surfaces, with very limited functional vegetation. Consequently, the shade available during the daytime was derived primarily from non-vegetative elements, particularly building facades, rather than tree canopies.

Identification of daytime activities

Daytime activities were documented at 1:00 p.m. Central Indonesia Time (WITA) by tallying pedestrian volumes and classifying the types of activities occurring in each section. These activities included walking or passing through, stopping temporarily, and remaining in place for extended periods. The data also recorded specific locations where pedestrians tended to avoid fully exposed areas. This served as an initial indication of the natural movement paths, or desire lines, formed as pedestrians sought whatever shade was available, whether from limited vegetation or partial building shadows.

Identification of late-afternoon and evening activities

Late-afternoon activities were documented at 4:30 p.m. WITA using the same technique, with particular emphasis on identifying gathering points that emerged as solar radiation decreased and architectural shadows from surrounding buildings appeared. The types of social activities occurring at these locations were also recorded, including social interaction, light exercise, and informal commercial activities. These activities served as indicators of the transformation of space from a passive condition into an active one.

Integrated overlay analysis

The three datasets described above, vegetation distribution, daytime activity patterns, and late-afternoon/evening activity patterns, were subsequently overlaid for each section to examine the correlation between the availability of shading elements, both natural and artificial, and spatial vitality during the two temporal phases. The integrated analysis of the section in front of the shopping center revealed a strong correlation between limited vegetation and the substantial decline in daytime activity. Meanwhile, the increase in afternoon activity was more strongly influenced by shadows cast by multistory building facades. In the shophouse section, the combination of small-scale building canopies and potted vegetation produced a more fragmented movement pattern, although pedestrians continued to demonstrate a preference for shaded routes during the daytime. The open waterfront section exhibited a different pattern. The absence of both vegetation and building shadows during the daytime resulted in almost no activity. However, activity increased sharply during the late afternoon and evening, even though shading elements remained limited. This finding suggests that declining ambient temperatures and the visual appeal of the waterfront also influence pedestrian activity beyond the effects of shade alone. Overall, the processes of vegetation identification, daytime activity documentation, late-afternoon/evening activity documentation, and integrated overlay analysis provide a comprehensive understanding of how the availability, or absence, of shading elements in each section contributes to temporal shifts in pedestrian-space utilization patterns. These findings also provide an empirical foundation for formulating recommendations concerning the types and placement of adaptive shading elements in the subsequent analytical stage.

Identification of vegetation and pedestrian activity patterns

Vegetation Distribution along Piere Tendean Street

Vegetation distribution mapping indicates that the distribution of shade-tree canopies along the Piere Tendean Street corridor is uneven. Concentrations of vegetation with large canopies, approximately 2–3 m in radius, are clustered along the eastern side of the corridor. In contrast, the western side has very limited shading, while the western section has not yet undergone corridor improvements and is frequently used for unauthorized parking that obstructs pedestrian pathways. These conditions are particularly evident in the area bordering the Sario Utara and Sario urban villages. At the northern end of the corridor, near the intersection leading toward the coastal area, vegetation is extremely limited and consists of only a few isolated trees with small canopies, approximately 0.5–1 m in radius. In the southern section of the corridor, approaching Sario Tumpaan, vegetation density increases again. Nevertheless, the vegetation is dominated by a combination of medium-canopy trees, flowering plants, and shrubs that provide no substantial shading benefits for pedestrian pathways. This distribution pattern indicates that greening along the corridor has not been systematically planned to provide thermal amelioration. Instead, vegetation appears to have been introduced on an incidental basis, depending on the availability of roadside land in each section.



Figure 1
Vegetation distribution along the Piere Tendean Street Corridor, Manado



Figure 2
Vegetation distribution map

Daytime pedestrian activity patterns

The daytime activity map shows that pedestrian activity points, indicated in red, tend to be concentrated in three main clusters: the northern end of the corridor, the central section, and the southern section near Sario Tumpaan. The highest density occurs in the central section. Notably, the spatial distribution of activity points in the central section overlaps with the locations of large-canopy vegetation concentrations identified in figure 1. This spatial correspondence indicates a tendency for pedestrians to continue engaging in activities during the daytime at locations where natural shade is available. Conversely, in sections with limited vegetation, daytime activity points appear less frequent and more discontinuous. This pattern supports the initial assumption that pedestrian spaces without adequate shading tend to be abandoned or used only for transit during the daytime.



Figure 3
Existing conditions of daytime pedestrian activity along the Piere Tendean Street Corridor



Figure 4
Daytime pedestrian activity pattern map

Nighttime pedestrian activity patterns

In contrast to the daytime pattern, the nighttime activity map, indicated in blue, displays a substantially denser and more evenly distributed pattern of activity points along the corridor, including the northern section, which is relatively quiet during the daytime. The increase in both the volume and spatial distribution of activity points is consistent across all observed sections. This indicates that the absence of direct solar radiation at night is a major factor contributing to increased spatial vitality, regardless of the availability of daytime shade vegetation. The highest concentration of activity points remains in the central section of the corridor, reinforcing the indication that this section serves as the corridor's primary gathering point under both passive and active conditions. This pattern is likely attributable, at least in part, to its proximity to surrounding commercial activity centers.



Figure 5
Existing conditions of nighttime pedestrian activity along the Piere Tendean Street Corridor

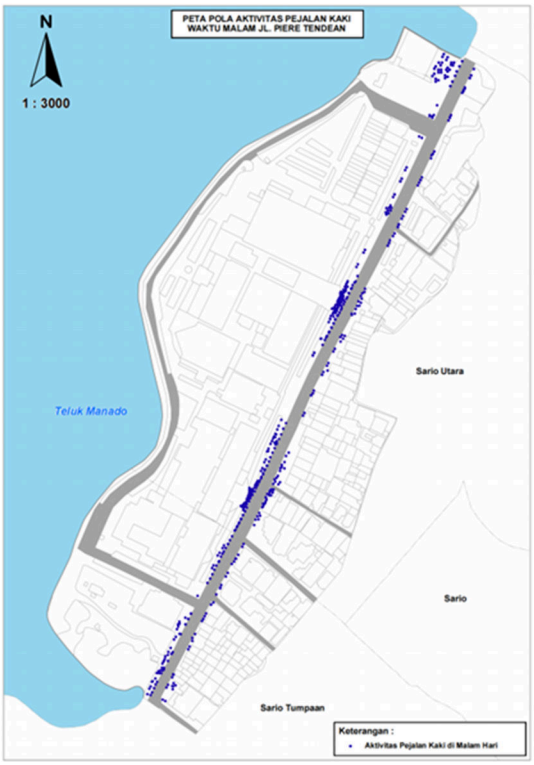


Figure 6
Nighttime pedestrian activity pattern map

Integrated analysis of spatiotemporal behavior

The overlay of vegetation distribution data and daytime and nighttime activity patterns presented in figure 4 provides a comprehensive understanding of the relationship between shading elements and the passive–active dynamics of pedestrians along the corridor. The overlay analysis identifies three principal patterns of association:

1. Sections with substantial vegetation and high activity levels during both daytime and nighttime. This pattern is evident in the central section of the corridor, where red points representing daytime activity and blue points representing nighttime activity closely overlap around clusters of large-canopy vegetation. This pattern indicates that the section maintains the most consistent spatial vitality throughout the day, with vegetation playing a significant role in sustaining thermal comfort during daytime hours.
2. Sections with limited vegetation but substantial increases in nighttime activity. This pattern is evident at the northern end of the corridor, where nighttime activity points form relatively dense clusters despite the sparse distribution of vegetation. This finding indicates that the transformation of space from passive to active in this section is driven more strongly by non-vegetative factors, such as building shadows, declining ambient temperatures, and the appeal of commercial and social activities at night.
3. Contrasting daytime and nighttime activity densities across all sections. Overall, the blue points representing nighttime activity are more numerous and more widely distributed across nearly all sections of the

corridor than the red points representing daytime activity. This visual evidence demonstrates the phenomenon of temporal urbanism that forms the focus of this study: pedestrian spaces that remain relatively passive during the daytime become substantially more active and more evenly utilized at night.

Taken together, the integrated analysis reinforces the finding that shade-providing vegetation plays an important role in pedestrian-space vitality along the Piere Tendean Street corridor, although it is not the sole determinant. The central section, characterized by a combination of relatively adequate vegetation and high activity levels throughout the day, can serve as a reference model or best practice for formulating recommendations concerning the addition and reorganization of shading elements in other sections where vegetation remains insufficient, particularly at the northern end of the corridor.



Figure 7
Spatiotemporal behavioral analysis map

Conclusion

Based on the identification of vegetation, mapping of daytime activity patterns, mapping of nighttime activity patterns, and the integrated overlay analysis, this study establishes three principal findings demonstrating the phenomenon of temporal urbanism along the Piere Tendean Street corridor. First, the findings reveal a time-dependent shift in spatial vitality. Pedestrian activity points are consistently denser and more evenly distributed along the corridor at night than during the daytime. This demonstrates that pedestrian spaces that remain relatively passive during the day transform into substantially more active spaces at night, with patterns of use that are more inclusive of different temporal conditions. Second, the findings indicate that the section with substantial large-canopy vegetation coverage, namely the central section of the corridor, maintains the highest level of spatial vitality consistently during both daytime and nighttime. Nevertheless, the northern section, despite its limited vegetation, also experiences a significant increase in nighttime activity. These findings confirm that vegetation plays an important role in maintaining thermal comfort during the daytime but is not the only factor governing the passive, active dynamics of pedestrian behavior. Other factors, including building shadows, declining temperatures, and the appeal of commercial and social activities, also contribute to these dynamics. Third, the application of Temporal-Behavioral Mapping demonstrates the feasibility of using this method to develop integrated spatiotemporal maps through field observations without relying on microclimate measurement instruments. The method therefore offers a potential evaluation tool for identifying shortcomings in public-space design and represents the methodological contribution of this study. These three conclusions constitute the principal outcomes of the field-identification and analytical stages. They can subsequently serve as baseline data for formulating recommendations for adaptive streetscape design along the street corridor.

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