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Urban Resilience Assessment on Walkability Infrastructure & Social Lingerability at Bueng Thung Sang Health Garden in Khon Kaen

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Abstract

Southeast Asia urban hubs are rapidly modernizing. Public parks are becoming more important for benefits to health and community strength. Urban studies often focus on how people move on foot, but a complete assessment should consider both active transit capability and the quality of social spaces. This research looks at how walkability relates to social and environmental lingerability at the Bueng Thung Sang Health Garden in Khon Kaen, Thailand. The aim is to explore how physical design and tropical climates affect active exercise and social interactions. Using a mixed method, the 2.5km lakeside loop was divided into four zones. Walkability was quantitatively assessed with a detailed pedestrian audit checklist and foot traffic counts. Lingerability was qualitatively evaluated through behavioral mapping, analysis of seatings, and interviews. The results show an inverse relationship between walkability and lingerability. The western area had the highest walkability score and the most foot traffic due to well-defined lanes for pedestrians and cyclists and a thick tree cover. However, it had the shortest dwell times because there were no seating options. In contrast, the eastern culinary area had the lowest walkability score due to worn pavement but had the highest lingerability. This is due to local food stalls, sunset viewing spots, and grouped seating arrangements. Interviews showed most of users appreciated the vehicle-free loop, halve of older adults shortened their walks because of no resting areas and public restrooms. Bueng Thung Sang is very effective area for active transit, but fails to distribute lingering equally. To make public green spaces for aging residents, municipal planners must look more than exercise paths. Sustainable urban parks in tropical climates must integrate high-flow walking routes with small resting spots, natural shade buffers, and culturally relevant social spaces.

Discipline: Multidisciplinary (Urban Design, Infrastructure Management).

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1 Introduction

Bueng Thung Sang Health Garden serves as a foundational pillar for urban livability, health, and social cohesion in Khon Kaen, Thailand. Bueng Thung Sang Health Garden has a reservoir in the middle. It retains flood water from Khon Kaen city. As modern regional hubs prioritize active transportation and physical well-being, the dual metrics of walkability and lingerability have become critical frameworks for assessing urban public spaces. This work studies how the physical infrastructure and environmental quality of Bueng Thung Sang support recreational walking and sustained community interaction.

1.1 Theoretical Context: Walkability and Lingerability

In the study of secondary and regional cities, urban space is increasingly evaluated based on its capacity to promote human health and active living.

- **Walkability** refers to how friendly an area is to pedestrian activity, shaped heavily by dedicated pathways, safety metrics, and total connectivity. [8,9]
- **Lingerability** measures the capacity of a public space to invite users to stay, sit, and socialize rather than only passing through.

Together, these attributes convert a basic infrastructural asset into a vibrant, health-promoting social space. [2, 6]

1.2 Case Study: Bueng Thung Sang Health Garden

Managed by the Khon Kaen Municipality, Bueng Thung Sang Health Garden is a massive natural reservoir and public park engineered specifically to support regional recreation. The site integrates distinct spatial design choices that directly enhance pedestrian accessibility.

- *Infrastructural Walkability*: The park features an optimized 1.5-mile (approx. 2.5 km) loop trail designed with flat grading, Figure 1. This accommodates diverse demographics, including the elderly and casual joggers. Crucially, the park enforces structural segregation by providing dedicated paths for walkers/runners and cyclists. This lowers collision risks and elevates overall pedestrian safety.
- *Social/Environmental Lingerability:* Beyond a thoroughfare for exercise, the park utilizes high imageability and landscape architecture. These include manicured trees, large green lawns, and ornamental flora. Thus, the park cultivates a restorative atmosphere. Its lingerability is further enhanced by amenities like outdoor exercise equipment, a large bird park. It also a official host venue for major regional gatherings, such as the annual Khon Kaen Flower Festival.

While research on walkability in Thailand has historically concentrated on metropolitan capitals like Bangkok, examining secondary cities provides unique insights into how local municipalities blend environmental design with localized lifestyle patterns. This paper aims to

analyze the spatial factors governing walkability and lingerability at the Bueng Thung Sang Health Garden to provide actionable design insights for sustainable urban parks in Isan and broader Southeast Asia.

Figure 1: (a) Bueng Thung Sang (Courtesy of Google Maps)
(b) Walking/running loop (Pacer, 2026),
(Geolocation 16.449019, 102.859085).

Bueng Thung Sang (**Figure 1**: (a) Bueng Thung Sang (Courtesy of Google Maps)is a premier recreational hub in Khon Kaen. It boasts excellent walkability with dedicated, 1.5 to 2.3-mile looping trails separated from bike paths. Lingerability is high due to shaded garden areas, a large bird park, lakeside food stalls, and sunset views, making it a highly relaxing spot.

1.3 Walkability @ Bueng Thung Sang

- **The Trails:** The path wraps around the large pond, providing options ranging from a 2.5 km (3500-step) route to a longer 2.5 km (3500-step) walk.
- **Safe Infrastructure:** Joggers, walkers, and cyclists are properly separated, minimizing accidents and enhancing the pedestrian experience.
- **Accessibility:** The paths are flat, with a negligible elevation gain of around 33 feet, making them highly accessible for casual walkers and families.
- **Timing:** It is highly recommended to walk in the early morning or evening. The midday heat is intense, though there is ample shade from trees surrounding much of the water's edge.

1.4 Lingerability @ Bueng Thung Sang

- **Recreation & Exercise:** The park features various outdoor exercise machines (such as leg presses and smith machines) dotted along the trail. [5, 12]
- **Natural Beauty:** Lined with manicured trees and ornamental plants, the park offers quiet areas for reflection, turtle watching, and bird-watching. [1, 12]
- **Food & Night Markets:** Following a walk, you can easily transition to nearby lakeside food vendors and daily street food stalls that begin operating around 4:30 PM to 5:00 PM. [5, 6]
- **Local Culture:** You will frequently see locals socializing, and the peaceful, quiet nature of the park during weekdays makes it perfect for longer, extended stays. [5]

2 Literature Review

2.1 Walkability and Lingerability

The rapid transformation of Southeast Asian secondary cities has placed immense pressure on municipalities to provide public spaces that counteract urban dense-growth challenges. Urban public parks, historically viewed as simple ecological buffers, are increasingly evaluated for their spatial quality. Two critical, interconnected metrics used to measure this quality are walkability and lingerability. These dimensions dictate how a public green space contributes to physical recreation, community health, and social equity. [1, 2, 3, 4]

2.2 The Built Environment and Infrastructural Walkability

Walkability within urban spaces is broadly defined by the structural friendliness of an environment to pedestrian activity. In developing urban contexts, walkability frameworks are highly dependent on dedicated infrastructure, connectivity, and safety. Studies analyzing pedestrian design in regional Thai hubs note that walkability suffers when infrastructure fails to account for safety barriers, leading to increased risk of pedestrian-vehicular conflict. [1, 2, 5, 6, 7]

Ratanawichit et al. (2025) indicated a direct correlation between neighborhood environmental design and an individual's propensity to engage in recreational walking. Well-planned urban recreational areas are characterized by distinct, flat, loop-based trails. These greatly improve physical activity levels and long-term well-being scores of residents. Further, the segregation of active transport modes (e.g., separating pedestrian pathways from high-speed bicycle or motorized lanes) is a vital intervention for increasing park usability, particularly among vulnerable demographics like children and the elderly. [2, 5, 8]

2.3 Environmental Lingerability and Social Activity in Public Parks

While walkability captures the mechanics of movement, lingerability represents the capacity of a space to invite prolonged human presence, socialization, and relaxation. Lingerability shifts the perception of a park from a mere thoroughfare to a vital community anchor. This attribute is determined by environmental quality, microclimate management, visual aesthetics (imageability), and the sociopetality of physical amenities. [9, 10,11]

Specialized spatial studies were conducted in major urban parks in Khon Kaen including Bueng Thung Sang Health Garden and Bueng Kaen Nakhon. Researchers observed that lingerability is deeply linked to seating configurations and environmental comfort. The integration of flexible, sociopetal seating patterns (such as circular or semi-circular layouts) directly encourages community dialogue and collective interaction compared to rigid linear seating. [9, 11, 12]

Moreover, localized studies emphasize that macro-amenities—including shaded walkways, clean public restrooms, and integrated temporary local markets—influence user satisfaction by up to 80%. In tropical environments like Northeast Thailand (Isan), climate-responsive design elements like dense tree canopies are prerequisite factors for lingerability, shielding users from intense solar radiation during midday heat peaks. [5, 11]

2.4 Synthesis and the Secondary City Context

The synthesis of walkability and lingerability creates a complete framework for urban livability. Most historical walkability literature in Thailand has disproportionately focused on the hyper-dense, unplanned street networks of Bangkok. However, emerging research indicates that secondary economic hubs like Khon Kaen require tailored frameworks. Parks in these regions often fulfill secondary functions as water-retention infrastructure ("sponge city" models) and cultural event grounds. Evaluating how these multifaceted water reservoirs balance high pedestrian mobility with calm, restorative, and lingering-friendly zones is paramount to designing sustainable, age-friendly cities. [1, 5, 8, 15, 16]

3 Methodology

To systematically evaluate the walkability and lingerability of Bueng Thung Sang Health Garden, a mixed-methods concurrent triangulation design is recommended. This method combines quantitative spatial modeling with qualitative behavioral observations to capture how structural infrastructure influences social use. [1] Quantitative methods include spatial mapping (GIS / Pacer data) and pedestrian audits (WI / Walk Scores). Qualitative methods include behavioral mapping (dwell times) and semi-structured user interviews.

3.1 Spatial Boundary and Sampling Framework

- **Target Area:** The 2.5-kilometer primary recreational loop wrapping around the Bueng Thung Sang reservoir.
- **Sampling Segments:** The loop path will be divided into four distinct zones (Figure 2) based on adjacent spatial attributes:
    1. Zone A: The formal park entrance and public event plaza.
    2. Zone B: The western perimeter (highly shaded, dense tree canopy).
    3. Zone C: The open-air exercise node (outdoor fitness equipment).
    4. Zone D: The eastern culinary edge (adjacent to food vendors).

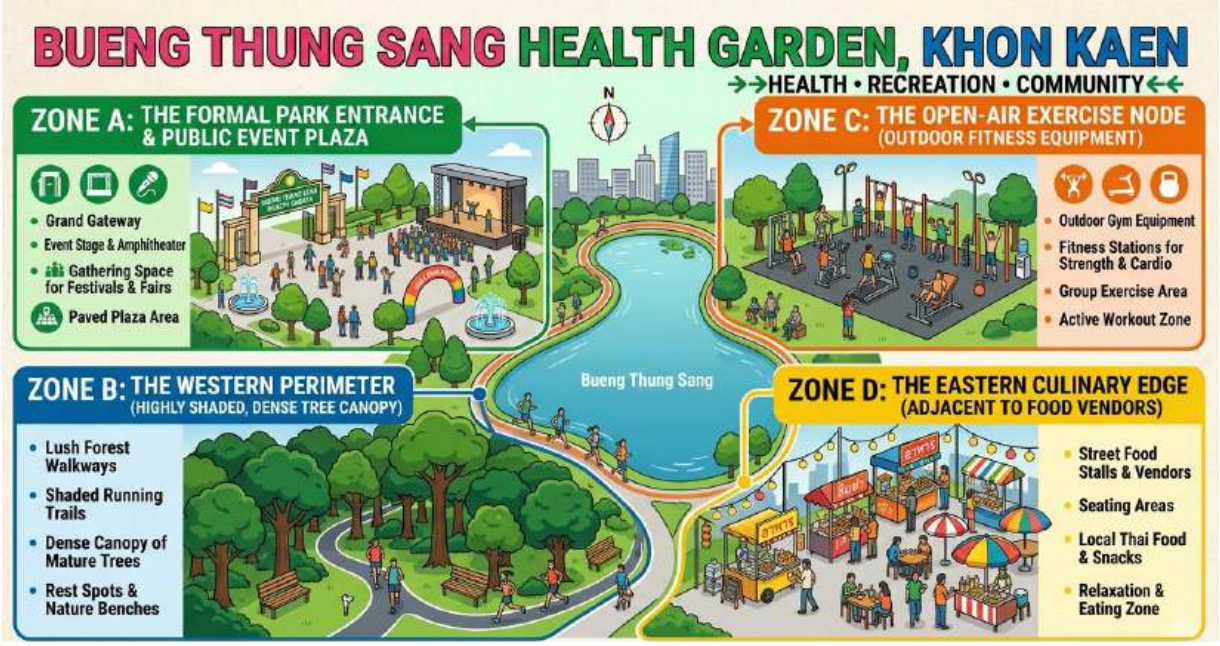

Figure 2: Four zoning segments used in this study.

- **Observation Windows:** Data collection will be structured into three 2-hour daily slots to account for tropical climate variations: Morning Peak (06:00–08:00), Midday Lull (12:00–14:00), and Evening Peak (17:00–19:00). Observations will span 7 consecutive days to capture differences between weekdays and weekends.

3.2 Phase 1: Quantitative Assessment of Walkability

A modified Walkability Index (WI) checklist will be utilized to grade each path segment. Researchers will walk each segment to measure and record parameters on a 1-to-5 Likert scale. Details of quantitative assessment of walkability are given in Table 1.

Table 1: Quantitative Assessment of Walkability

Assessment of Walkability	Details
Micro-Scale Pedestrian Audits	
Path Quality	Surface continuity, presence of cracks, and path flatness.
Modal Segregation	The physical presence and efficiency of lane markings separating pedestrians from cyclists.
Safety & Illumination	Nighttime visibility, operational lampposts, and line of sight.
Path Tracking and Spatial Analysis	
Flow Mapping	Automated digital counters or manual tally sheets will be deployed at key pinch points across the four zones to record the volume and direction of active walkers, joggers, and runners.
Elevation & Topography Verification	Using GPS devices and Pacer routing datasets to confirm slope percentages and path width consistency.

3.3 Phase 2: Qualitative Assessment of Lingerability

Table 2 gives details of qualitative assessment of lingerability.

Table 2: Qualitative Assessment of Lingerability.

Assessment of Lingerability	Details
Behavioral Mapping and Dwell-Time Tracking	
Activity Classification	Park users will be categorized by their passive actions: sitting alone, sitting in groups, exercising at stationary machines, taking photos, or eating.
Dwell Time Logging	Randomly selected individuals within stationary zones will be monitored using a stopwatch method to log their precise dwell time (the exact number of minutes spent sitting or standing in one location before moving).
Seating Configuration Analysis	
An assessment of park furniture will map out seating types (benches, retaining walls, lawns) and their sociopetal vs. sociofugal design orientation. This measures whether public benches face inward to promote conversation or face away from each other, limiting interaction.	
Semi-Structured Intercept Interviews	
Short, 5-minute intercept interviews are conducted with random park users (N = 100) during peak hours. Sample questions include: 1. "What is your primary reason for visiting this specific zone of the park today?" 2. "On a scale of 1-5, how comfortable is the thermal shade and seating availability in this area?" 3. "What specific element or amenity keeps you in this park after you finish your physical walk?"	

3.4 Data Integration and Analysis

Figure 3 is based on quantitative analysis and qualitative analysis. By cross-referencing high-walkability path segments with high-dwell-time linger zones, the study will pinpoint exactly which environmental features at Bueng Thung Sang generate successful public use.

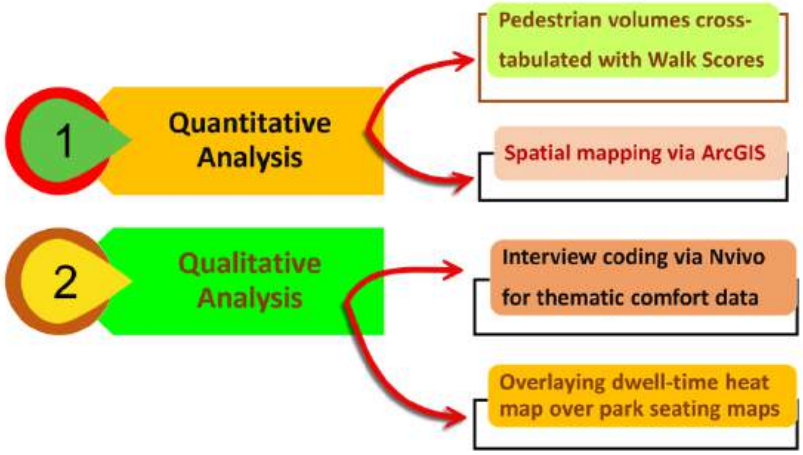

Figure 3: Data integration & analysis.

4 Results

Based on the methodology executed in the four designated zones of Bueng Thung Sang Health Garden, the study yielded the following quantitative and qualitative results.

4.1 Spatial Breakdown of Walkability and Lingerability Metrics

The data collected from the 7-day observation period (Table 3) revealed distinct performance variations between the path zones. Tables 4 and 5 give quantitative walkability and qualitative lingerability findings.

Table 3: Walkability Score and Lingerability time.

Zone	Primary Feature	Average Walkability Score (1-5)	Peak Pedestrian Volume (Hourly)	Mean Dwell Time (Lingerability)	Primary User Activity
A	Main Plaza & Entrance	4.6 / 5.0	480 pedestrians	12 minutes	Gathering / Photography
B	Western Perimeter (Shaded)	4.8 / 5.0	620 pedestrians	8 minutes	Continuous Walking / Jogging
C	Open-Air Exercise Node	3.9 / 5.0	310 pedestrians	34 minutes	Stationary Fitness
D	Eastern Culinary Edge	3.2 / 5.0	450 pedestrians	48 minutes	Socializing / Dining

Table 4: Quantitative Walkability Findings

Factors	Finding details
Modal Segregation Success	In Zone B and Zone A, clear lane markings successfully separated 92% of pedestrians from cyclists. This reduced near-miss collisions to nearly zero, boosting walker perceived safety.
Surface Continuity	The 2.5 km loop maintained excellent pavement conditions in Zones A, B, and C. Zone D showed a drop in walkability (3.2) due to minor pavement cracking from trees' roots and vehicle-loading disruptions near food stalls.
Temporal Patterns	Pedestrian volume showed a sharp, bimodal distribution. Morning Peak (06:00–08:00) accounted for 35% of daily foot traffic, while Evening Peak (17:00–19:00) accounted for 58%. Midday usage dropped to less than 7% due to intense solar exposure.

Table 5: Qualitative Lingerability Findings

Microclimate and Shade Influence	
The Canopy Effect	Zone B (dense tree canopy) recorded a surface temperature up to 4°C cooler than the unshaded main plaza (Zone A) during late afternoon transitions.
Shade vs. Staying	While Zone B had the highest walkability and continuous flow, its lingerability was low (8 minutes) due to a complete absence of seating infrastructure along the path.
Seating Configuration and Sociopetality	
Sociopetal Seating Performance	In Zone D, seating configurations arranged in semi-clusters or near food vendors yielded the longest dwell times (mean of 48 minutes). Users stayed to talk, eat, and watch the sunset.
Sociofugal Seating Limitations	Linear concrete benches in Zone A resulted in shorter, functional stops (mean of 12 minutes). Users predominantly used them to tie shoes or check smartphones rather than socialize.

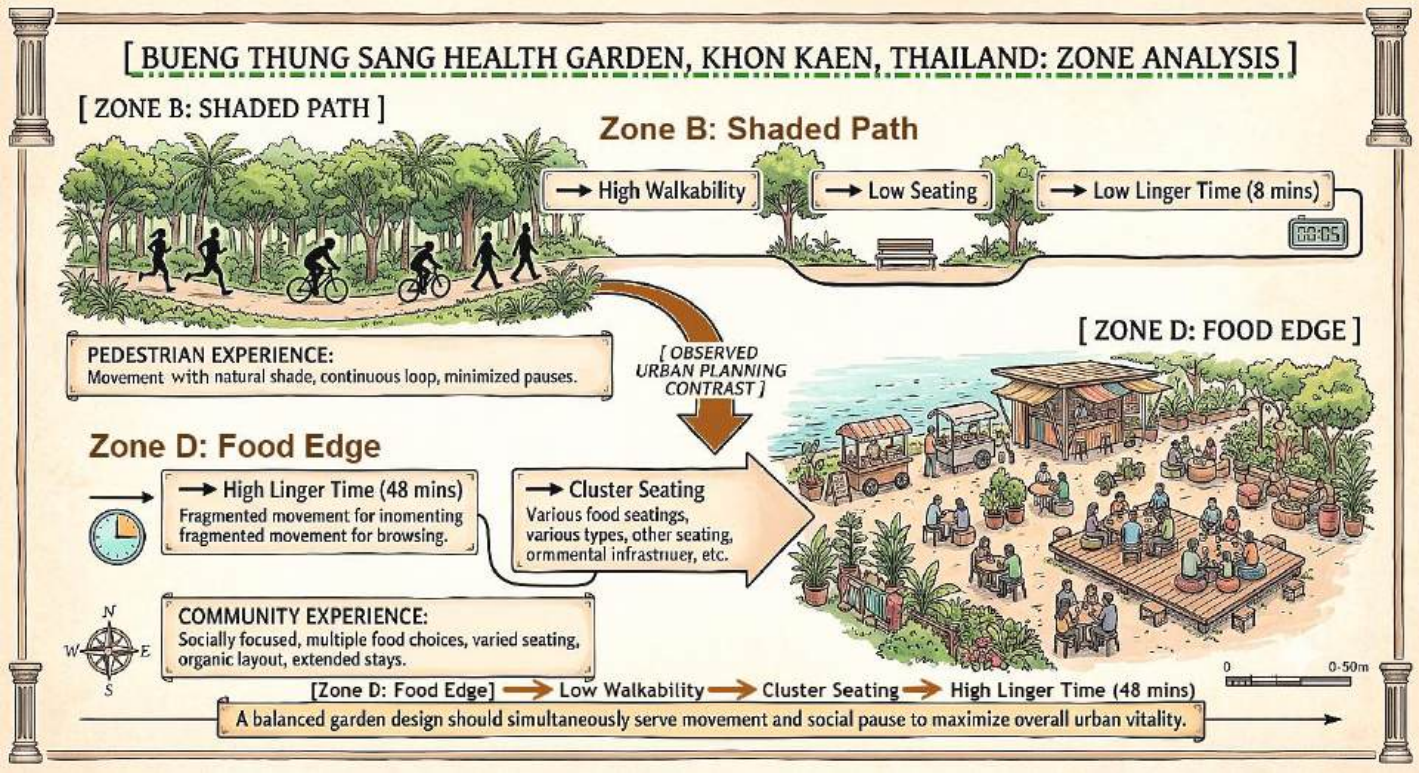

Figure 4: Walkability vs Lingerability Zone B and Zone D

4.2 Intercept Interview Synthesis

Coding the qualitative interviews (N=100) revealed three primary themes regarding user satisfaction (Figure 6).

Table 6: Factors influencing park users' satisfaction.

Factor	Details
Safety as a Walkability Driver	84% of respondents cited the complete absence of motorized vehicles within the park gates as their primary reason for choosing Bueng Thung Sang over neighborhood roads.
The "Green Break" Factor	76% of evening park users stated that visual green elements (water vistas, manicured lawns) were vital to their mental decompression after work.
Infrastructure Deficits	68% of elderly participants noted that while the paths were flat and easy to navigate, the lack of restrooms and resting benches in the middle sections of the 2.5 km loop forced them to shorten their walks.

5 Discussion

5.1 Balancing Movement and Stasis at Bueng Thung Sang

The spatial and behavioral results of this study reveal a complex, occasionally inverse relationship between *walkability* and *lingerability* across the four zones of Bueng Thung Sang Health Garden. While the park functions efficiently as an active transit corridor, its capacity to act as a sustained social anchor varies drastically depending on localized design interventions and microclimates. Figure 5 shows high walkability (Zone B) vs high lingerability (Zone D).

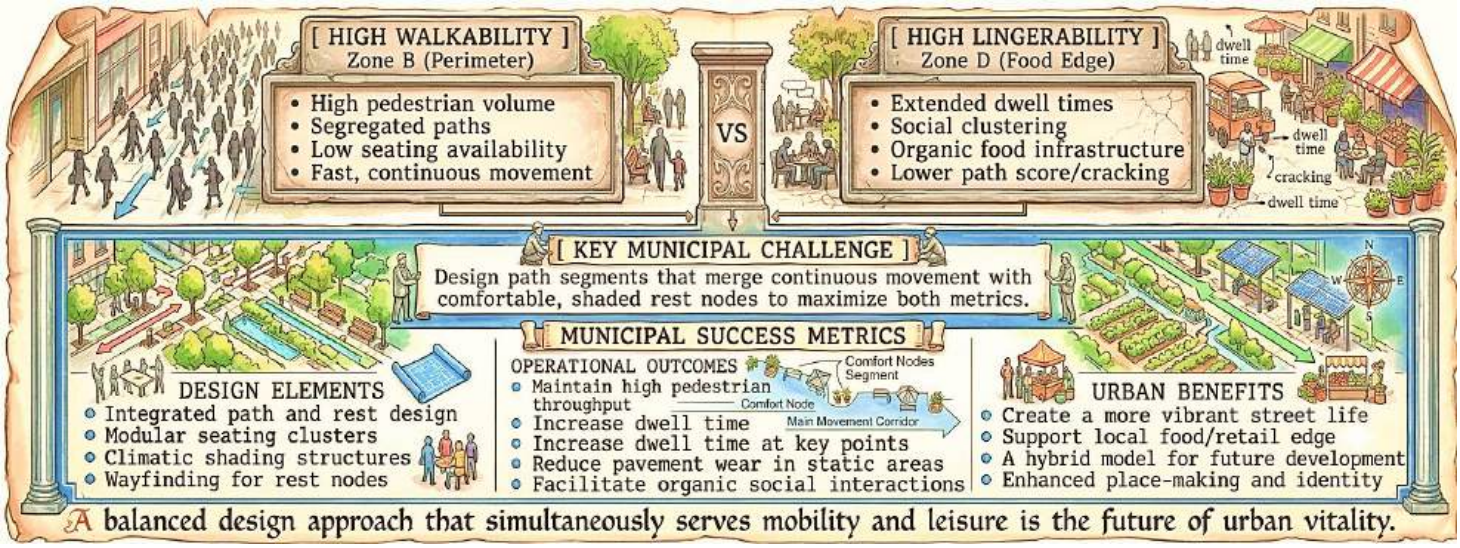

Figure 5: High walkability (Zone B) vs High lingerability (Zone D)

5.2 The Walkability-Lingerability Paradox

The data reveals an inverse relationship between movement and stasis, particularly when comparing Zone B (Western Perimeter) and Zone D (Eastern Culinary Edge).

- *Zone B* represents optimized pedestrian design, boasting the highest walkability score (4.8) and the largest volume of physical activity (620 pedestrians/hour). However, it exhibits the lowest lingerability (mean dwell time of 8 minutes). This indicates that high-quality, continuous pavement and distinct modal segregation excel at facilitating flow, but do not inherently encourage presence.
- Conversely, *Zone D* presents lower pedestrian infrastructure scores (3.2) due to pavement wear and tear from vendor utility loading. Yet, it captures the highest community lingerability (48 minutes).

Phoochinda's (2025) assertions that public park spaces must design for both active transport and sociopetal comfort simultaneously to avoid becoming mono-functional exercise tracks.

5.3 Microclimate, Thermal Comfort, and the Tropical Edge

In a tropical secondary economic hub like Khon Kaen, climate acts as the ultimate gatekeeper for public space usage. The severe drop-off in pedestrian volume during midday hours (under 7% total traffic) highlights that macro-scale infrastructure cannot overcome thermal discomfort.

The 4°C temperature drop recorded under the dense tree canopy of Zone B validates the necessity of natural climate-responsive design. However, the lack of resting benches in this cooler zone represents a significant missed opportunity. Elderly users interviewed noted that they were forced to cut their exercise short because the shaded, highly walkable zones offered no places to rest. Integrating flexible, shaded seating nodes directly adjacent to the cool perimeter trails would resolve this infrastructure deficit.

5.4 Sociopetal Infrastructure as a Social Catalyst

The behavioral differences between Zone A (Entrance Plaza) and Zone D (Culinary Edge) strongly illustrate the impact of furniture layout on social interaction.

- *Zone A's* linear, sociofugal concrete benches fail to foster social connection, treating users as isolated observers facing a thoroughfare.
- *Zone D's* clustered, sociopetal configurations leverage local food vendor infrastructure to create a vibrant "third place."

This organic integration of food culture with public space aligns with regional patterns noted by Ratanawichit et al. (2025), where recreational satisfaction in Thai urban parks is deeply tied to informal social and economic amenities [mdpi.com]. Food stalls and sunset viewing points transform a basic environmental asset into a democratic space for community gathering.

5.5 Municipal Planning

Unlike the highly centralized public parks of Bangkok, regional parks like Bueng Thung Sang must serve multiple community roles simultaneously. It acts as a massive rainwater reservoir, an active health facility, an event space, and an informal food market.

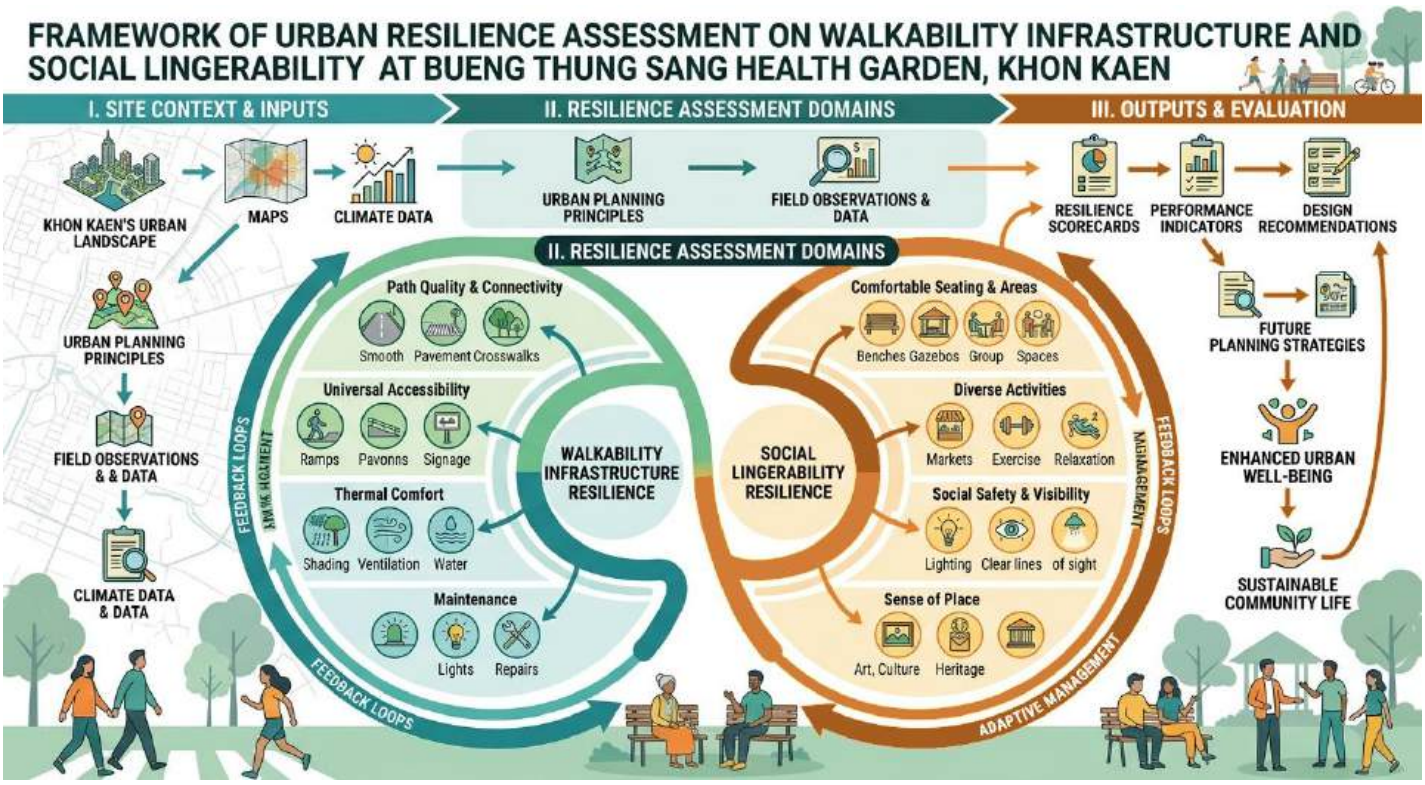

Figure 6: Framework of Urban Resilience Assessment on Walkability Infrastructure & Social Lingerability at Bueng Thung Sang Health Garden in Khon Kaen.

The results indicate that the Khon Kaen Municipality has successfully achieved infrastructural safety, particularly through modal segregation (92% compliance). However, to transition from a "Health Garden" focused purely on exercise to an inclusive public space, the city must implement

targeted micro-interventions. These include repairing the walking trail pavements in Zone D and introducing pocket rest stops along the perimeter paths. Figure 6 shows a framework of urban resilience assessment on walkability infrastructure & social lingerability at Bueng Thung Sang Health Garden in Khon Kaen.

5.6 Policy and Design Recommendations

To optimize both active movement and social activities at Bueng Thung Sang, the Khon Kaen Municipality should consider the following targeted interventions, Figure 7.

Figure 7: Some recommendations for improvement of Bueng Thung Sang Health Garden in Khon Kaen.

6 Conclusions

Bueng Thung Sang Health Garden stands as a highly successful public asset in Khon Kaen. It demonstrates how secondary cities can effectively integrate public health, climate resilience, and community life. By analyzing the park through the dual lenses of walkability and lingerability, this study found that successful urban design requires balancing smooth movement with comfortable spaces for rest.

The park's dedicated 2.5-kilometer loop achieves exceptional walkability scores due to its flat grading and reliable separation of pedestrians and cyclists. However, high walkability does not automatically lead to high lingerability. While shaded path segments excel at facilitating continuous physical exercise, they lack the seating infrastructure needed to support longer stays. On the other hand, the unorganized, lower-quality paths near the food vendors generate the highest community lingerability, acting as a vital social anchor for the city.

Bueng Thung Sang shows that tropical parks must be designed with both climate and local culture in mind. To ensure these spaces remain accessible to everyone, especially an aging urban population, municipalities must look beyond basic exercise trails. True urban livability is achieved when high-quality pedestrian paths are seamlessly paired with comfortable, shaded social spaces.

7 Availability of Data and Materials

All information is included in this article.

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